Open Access

Contemporary Research Analysis Journal

e-ISSN: 3050-5909
p-ISSN: 3050-5895

Volume 02 Issue 01 January 2025

CrossRef DOI: 10.55677/CRAJ/06-2025-Vol02I01

Page no: 40-51

# Intelligent Traffic Control, Gathering and Monitoring Traffic Data Using CCTV Images

**Luther Kington Nwobodo**
Independent Researcher Scotland United Kingdom

**Corresponding Author: Luther Kington Nwobodo**

**ABSTRACT:** Although the number of automobiles on the road currently is more than it was a few years ago, the infrastructure of roads and traffic systems has not kept up with this expansion, which makes handling traffic challenging. This mismatch causes hence a lot of traffic congestion, crowding, and pollution. All throughout the globe, handling increasing traffic is a major challenge. Operations depend on traffic management in great part. It has to do with planning, running, and purchasing the necessary transportation services—cars, trucks, railroads, boats—that carry commodities and vehicles. Intelligent Traffic Systems (ITS) might be a fantastic approach to address these types of issues by means of modern technology. Given this, traffic control philosophy has to change to accommodate smart cities—which use computer vision techniques to run an adaptive traffic management system depending on CCTV image stream analytics. The adaptive traffic management system detects and counts vehicles accurately. In smart cities, where traffic lights must be automated based on vehicle density, this technique is particularly helpful. This study investigated intelligent traffic control, gathering and monitoring traffic data through using CCTV images. It embodies possible risks in the implementation state, benefits, challenges, as well as the future prospect of ITS.

**KEY WORDS:** Intelligent traffic control, Gathering and monitoring traffic, data, CCTV images.

## INTRODUCTION

One of the main issues in most metro areas, particularly in developing nations, is traffic congestion. Queues, slower speeds, and longer travel times are all examples of traffic congestion, which wears commuters out and causes stress, which lowers productivity and generates intangible costs for society (Dighe, Nikam, and Markad, 2024). Additionally, a variety of aspects are impacted either directly or indirectly, including the environment, commuter safety, and the usage of natural resources. As a result, traffic congestion is a problem for every expanding metropolis. Due to a number of factors, building additional roads is seldom successful as traffic congestion increases. On the other hand, building new roads may increase traffic by increasing the demand for motor vehicle travel, which quickly exhausts the additional capacity (Aouedi, Piamrat, and Parrein, 2022). This is becoming more and more obvious as large cities experience traffic jams and delays. As a result, throughout time, a number of mitigating strategies are being put into place. Real-time, high-quality traffic data is necessary for the development of Intelligent Traffic Systems (ITS).

Access to real-time traffic information is becoming commonplace globally, and techniques for gathering traffic data have been changing significantly over the last several years due to mounting need to improve traffic management. Due to their limited coverage and high installation and maintenance costs, conventional on-road sensors—like inductive loops—are required but insufficient for data collection (Vidya, & Amruth, 2020). Alternative data sources have emerged in recent years, which would help meet the increasing demand from drivers who are willing to pay service providers as long as they have access to pertinent real-time information. For example, will my usual route be congested today? How can it be avoided? How long will it last if not? etc. For such enquiries, traffic data must be as precise, dependable, timely, and comprehensive as feasible. As a result, MMTS has grown in significance, especially in metropolitan areas, to lessen traffic congestion, increase traffic efficiency, support the creation of smart roads, and facilitate driving. Drivers may remain safe, comfortable, and cut down on travel time by being given information about road traffic conditions, such as density, speed, and accident sites.

By 2050, it is predicted that over six billion people, or 70% of the world's population, would reside in cities and surrounding areas (Jin et al. 2014). Due to the enormous population and the expanding demands of the city's residents, traffic in the city is remarkably rising daily, making it very difficult for the authorities to control it. There is a wealth of human resources available to the authorities who can keep an eye on and manage traffic in any area of the city. By making intelligent decisions in real time without human intervention, authorities want to make their cities smarter. One of the biggest issues facing the government is keeping an eye on and managing city traffic (Butilă & Boboc, 2022). These days, a few locations along roads have static network cameras installed to monitor city traffic. In order to save the movies as a black box, the majority of cars are also fitted with cameras. However, utilising

these thousands of cameras to monitor and regulate city traffic generates an excessive volume of high-speed films that are difficult to interpret in real time. Additionally, there is a possibility that officials and police personnel would mistreat citizens while managing traffic. These kinds of things are causing a lot of social issues in the community. As a result, many nations are using intelligent computer-based systems these days to make wise judgements and manage many systems (Mazhar, Hojae, Awais & Anand, 2018). Several ITS systems, including as remote sensing satellites, inductive loop detectors, and fixed surveillance cameras, are available to monitor traffic. Although this method is expensive and hard to use, inductive loop detectors determine the traffic density by taking into account the proportion of time a measurement site is occupied by vehicles. Furthermore, it is not feasible to put loop detectors throughout a network of roads. Another way to keep an eye on traffic is to utilise security cameras, which may capture still photos or video clips. A single camera, however, is unable to take pictures from every angle because of its set arrangement, and it is also costly to maintain and run. Although they are costly and have technological limits (time-space resolution), remote sensing satellites provide an option that can give traffic data on a big scale (Butilă & Boboc, 2022). Furthermore, a lot of traffic monitoring and management facilities use human operators to monitor traffic patterns and oversee traffic issues, which may be difficult to identify and time-consuming. Thus, using modern MMTS technology to solve the aforementioned problem is an alternate approach that is seen to be a first step in creating an intelligent traffic management system.

The problem of traffic congestion has been the subject of several studies. Jain et al. (2019) detailed earlier works on traffic monitoring using invasive and non-intrusive in situ video and image processing approaches, as well as future views. Won (2020) gave an overview of traffic monitoring systems, emphasising the most crucial function of vehicle classification. They also looked at technical difficulties and research issues, and they talked about the design of hardware and software, deployment experiences, and overall performance of vehicle classification systems. An extensive review of the IoT's uses in smart traffic management systems was provided by Rabby, Islam, and Imon (2019). These systems function as IoT-based middleware and enhance the idea of a smart city by controlling traffic lights, parking, and anti-theft security systems, among other things.
In their 2020 study, Outay, Mengash, and Adnan examined recent advancements in the use of UAVs in three important transportation domains: highway infrastructure, traffic monitoring, and road safety. In addition to this, they described the ways in which computer vision algorithms gathered vital information from photographs and videos obtained by unmanned aerial vehicles (UAVs) in order to enhance risk assessments, traffic flow analysis, and assistance for bridge and pavement accidents.
Hamdi and Al-shared (2020) conducted a study of the traffic monitoring centre and vehicle ad hoc networks (VANET), which would safeguard drivers and passengers by identifying problems at an earlier stage. Following the collection of data and the classification of traffic incidents, the Intelligent Transport System at the Traffic Monitoring Centre addresses early incident detection as well as the beneficial and detrimental aspects of this method. Butilă and Boboc (2022) examined the uses of unmanned aerial vehicles (UAVs) in civil engineering, particularly traffic monitoring.

Butilă and Boboc (2022) carried out a comparative study of the approaches put forward by different scholars. They highlighted the unresolved issues with intelligent traffic management, including the need to reroute or divert incoming cars in order to reduce traffic congestion. These strategies include traffic camera tactics, the use of sensor-based technologies to direct cars down the shortest or alternative routes, and the transfer of signals from smart devices in cars via Bluetooth, Zigbee, and Wireless Fidelity (Wi-Fi). They also spoke about using car counts to analyse traffic patterns. Using CCTV pictures to collect and monitor traffic data, intelligent traffic management will be the main topic of this presentation.

**STATEMENT OF PROBLEM**

Singh, Sahatiya, and Ganatra (2023), Afrin and Yodo (2020), and Aleko and Djahel (2020) found that traditional traffic management systems that use predetermined traffic light timings fail to reduce traffic congestion, which endangers commuters' health, increases fuel consumption, and lengthens travel times in cities worldwide. Traffic costs the economy billions of dollars every day, according to many studies (Singh et al., 2023; Afrin and Yodo, 2020;, and Aleko and Djahel, 2020) Most individuals waste time at traffic lights on their way to work, school, shopping, and socialising. Bad traffic prevents fire, ambulance, police, and others from responding to emergencies. Congestion is more probable before, during, and after construction on major roads. Air travel (which can be expensive for the average person), water travel (which can be dangerous in developing countries due to ferries and canoes), and railways (which, even in our developing country, have outdated and boring designs) are also limited. Vehicle travel will always be required at some point, even if these other options are accessible and practical.

The majority of traffic light systems use a timing mechanism that switches the lights after a predetermined amount of time. This may not be effective in certain situations. Given that the timer control system is a kind of open loop control system in which the controller (traffic control system utilising lights) does not get input from the controlled variable (traffic volume). For example, regardless or not the road is crowded, the green light's duration will always be the same.

The emissions from vehicles are one of the primary sources of harmful pollutants such as nitrogen oxides (NOx) and particulate matter (PM), and the existence of traffic congestion is another factor that contributes to the pollution of the air. The findings of Klein et al. (2017) and Ameer et al. (2019) indicate that these pollutants have a detrimental effect on public health since they are responsible for respiratory diseases and other associated health problems. In addition, the number of accidents that occur on the road is another factor that puts pedestrian safety in jeopardy (Srivastava et al., 2021). According to Srivastava et al. (2021) and Bahiru et al. (2018), the primary factors contributing to these issues include inadequate road infrastructure, adverse weather conditions, and, most importantly, inefficient traffic management. In light of this, it is abundantly clear that solutions for traffic management that effectively reduce the amount of air pollution and ease traffic congestion are desperately needed. In addition, it is of the utmost importance to have sustainable transportation networks that have the potential to lessen the amount of traffic and encourage more active and shared modes of transportation. In order to handle these congestion difficulties, it is advisable to design a new control system (one that is sophisticated and intelligent), since this is the most effective solution. It is the responsibility of an intelligent traffic signal system to determine whether or not there are automobiles present and then to react properly.

Intelligent traffic systems are designed to reduce the amount of time that cars must wait for traffic signals to change. There are several methods by which an intelligent traffic system may identify traffic. The lengthy, common lines and traffic jams that we encounter every day on our way to (and from) work show that, despite all the technological advancements, traffic congestion has not been completely eradicated. Despite the fact that several traffic control systems have been developed throughout time, it is essential that these controls be intelligent. Hence, this study investigates intelligent traffic control, gathering and monitoring traffic data through using CCTV images

## STUDY OBJECTIVE

The overall aim of this study is to investigate intelligent traffic control, gathering and monitoring traffic data through using CCTV images. Essentially, the study seeks:

i. To examine the advantages of adopting intelligent traffic control system
ii. To identify the issues and challenges in the adoption of intelligent traffic control system
iii. To identify opportunities in the adoption of intelligent traffic control system
iv. To discuss and propose future direction for the adoption of intelligent traffic control system

## RESEARCH METHODOLOGY

Desk research, secondary research, or supplemental research are all terms that refer to the process of gathering information and data from pre-existing sources. These sources might include books, journals, articles, websites, reports, and other published materials. Users are responsible for doing analyses and synthesis on the information that is currently available to them.

The examination and analysis of relevant literature on the topic is the only focus of this research. It examines results from a range of literary works, such as government agencies, academic papers, novels, articles, studies, traffic journals, and internet publications. The steps are as follows:

1. Choosing the purpose and subject of the study.
2. Pick pertinent secondary sources of information.
3. Examine the available data.
4. Arrange and contrast the information gathered.
5. Examine and discuss the data.

### Review of the literature on traffic management systems

Traffic management systems, often known as TMSs, are primarily concerned with the organisation, arrangement, direction, and administration of both stationary and moving traffic, in addition to various types of vehicles, bicycles, and pedestrians. (Roopa & Shanta, 2021) The Transportation Management System (TMS) is an initiative that aims to enhance the quality of the environment around traffic areas and ensure maximum efficiency, safety, and orderliness throughout the movement of both people and goods. The present section addresses the many choices for intelligent transportation systems (ITS) that are available for effective traffic management, as well as the drawbacks associated with its use. The use of wireless sensor networks (WSNs) for discovering traffic and avoiding congestion is increasing. The rapid transmission of data, the simplicity of installation, the minimal maintenance needs, the small size, and the affordability of wireless sensor networks (WSNs) make them an efficient network choice when compared to other network alternatives. There have been a great number of research conducted on TMS that makes use of WSNs in order to reduce the amount of time that vehicles have to wait at signals, minimise traffic bottlenecks, and give priority to emergency vans.

The Neural Network technique was used by Huang et al. in 2021 in order to develop an artificial intelligence-based traffic control system that was given the name YOLO. By categorising each kind of vehicle, such as a car, a bike, a bus, and so on, this system collects data from closed-circuit television cameras that are strategically positioned along highways and then puts that data through

an algorithm to assess the density of traffic. Following that, this system will calculate which traffic light needs to be turned green and for how long, taking into account the volume of traffic that is travelling along the route. According to Uddin et al. (2021), this is one of the most important studies that has been conducted on traffic management systems. The research conducted by Uddin et al. (2021) was based on an artificial intelligence (AI)-based traffic management system that also included Internet of Things (IoT) capabilities. In addition to that, this system makes use of a camera in order to determine the current traffic situation on the road in time. The data is then processed by the NVIDIA ML algorithm, which is used to assess the traffic density and then turns the traffic light on and off in accordance with the results of the analysis. Additionally, it is able to identify cars that are in violation of traffic regulations, relay information about the offender to the authorities responsible for traffic regulation, and send a text message to the offender using the MQTT protocol.

A smart traffic management system based on digital image processing was presented by Soman et al. (2018). It employs CCTV cameras to gather data and then uses the "openCV" platform to evaluate traffic density at crossings. This aids in determining when various traffic lights should be used.

Gandhi et al. (2020) suggested an AI and image processing-based approach to traffic management. To collect data, a single camera on a pole spins and periodically captures a picture of the road. These photos are then transformed to greyscale, and the timer values of the traffic signals with the higher traffic density are calculated by comparing the captured image with the reference image of the empty road using methods of clever edge recognition and image enhancement. Additionally, this system uses a sound sensor to identify the lane occupied by fire trucks or ambulances and releases that lane first.

A complete, integrated Smart Road Traffic Management System (SRTMS) was presented by Sharma et al. (2020). In order to identify driving patterns and tendencies, this article proposes combining many factory-installed sensors in the car. The way a car communicates with various road items, such as poles, traffic signals, other cars, etc., determines the traffic condition. To reduce the risk of a data breach, all conversations will take place over blockchain technology. The system as a whole will be able to effectively control traffic, identify collisions on the road, and notify the traffic authorities of an occurrence involving an offender.

In order to enhance the functionality of current signal design selection systems, Degas et al. (2022) proposed using artificial intelligence techniques to urban traffic management issues. Specifically, the several layers of information collection, data interpretation and analysis, decision-making, and control are used to characterise the architecture of a smart traffic management system. Both the artificial intelligence technology used and the characteristics of the hybrid modules that are being presented are described. Lastly, a description of recent study on the subject is given.

In order to create a sustainable society, Iyer et al. (2021) investigate the applications of AI in the field of public transportation.This study takes into consideration the four subsystems that make up the Intelligent Transportation System. These subsystems include traffic management, public transportation, safety management, manufacturing, and logistics. In addition, the research assembled a number of artificial intelligence applications from a variety of towns and organisations, providing them with a standard to measure themselves against in the future. By doing this study, they would be able to aid the transportation and industrial sectors in discovering new uses of artificial intelligence as a solution in their respective fields. Businesses may carefully consider the advantages and disadvantages of the recommendations before putting them into practice and moving closer to building a sustainable society.

According to Sukhadia et al. (2020), a smart congestion governance system employs automated administration and execution, along with artificial intelligence to monitor and control the transportation route, to improve travel situations in major cities with significant traffic issues.

Another artificial intelligence method for forecasting traffic flow is described by Okwu et al. (2019). Jordan's neural network was used by the authors in order to construct a simple recurrent neural network that has the potential to be utilised for short-term forecasting. For one thing, it contains a context layer, which is something that is not included in traditional feed forward networks. As a memory box, the context layer is responsible for storing information that was previously stored. After then, the data that was saved at (t-1) is transferred back into the hidden layer together with the input that was received at (t). According to the fact that it assists the network in predicting the subsequence, it is often referred to as "Jordan's Sequential Network." The data that was used as input was the amount of traffic that was collected by Ireland's road traffic management. In this particular instance, the network in question is trained as a network of feed-forward neural networks with a back propagation, which ultimately results in the predicted traffic flow in order to reduce error.

Friesen et al. (2004) suggested a thorough method for gathering data. This system collects data at major traffic lights in cities using various WSN devices and technologies. A Bluetooth method is used to collect vehicle count and trajectory data, which are then sent to a master node via the IEEE 802.15.4 protocol, which manages all incoming data. The node uses a GSM-enabled mobile phone to send the real-time data to a server every five minutes. Users may get the necessary real-time data by retrieving this data from the database. Bluetooth tracking has been shown to be a dependable method of real-time vehicle and traffic monitoring. However, this approach has serious security flaws, poor data rates, and short-range limitations.

When Saqib and Lee (2010) demonstrated their application, they employed wireless sensor networks (WSNs) to make predictions

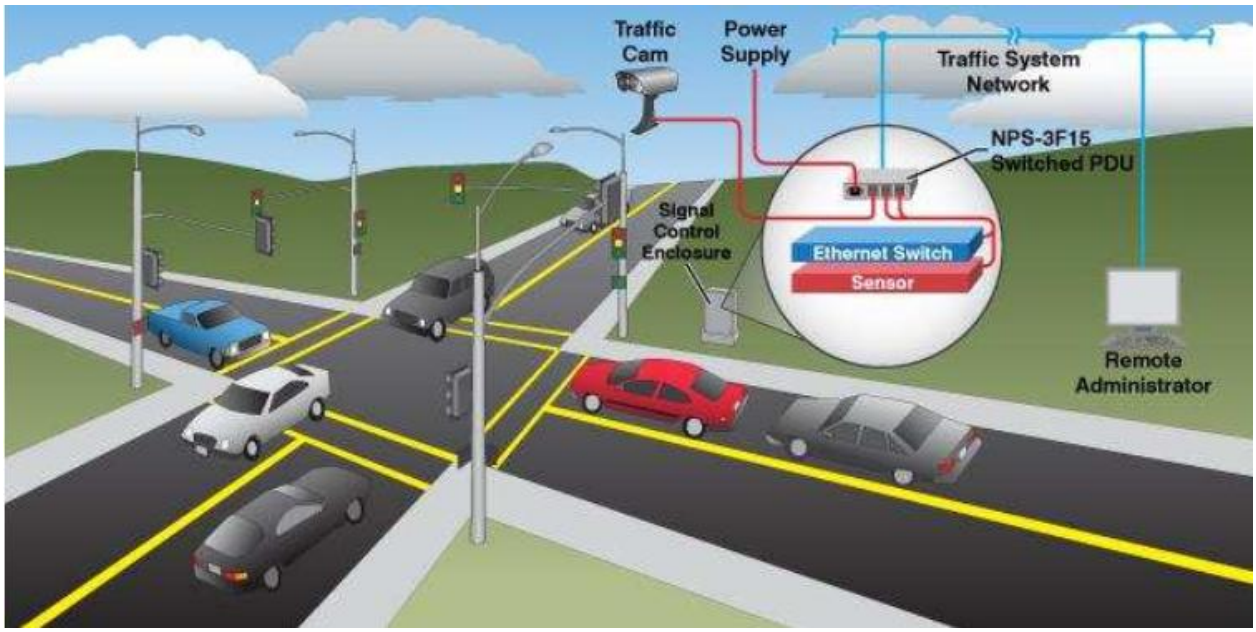
about the location and speed of a vehicle. The pavement readers served as anchor sensing nodes in the network. When a moving vehicle reached the operational range of the nodes, a symmetrical two-sided range algorithm was used to transmit the position signal to the computer. We are able to determine the speed of the cars by monitoring their whereabouts at certain intervals. When compared to alternative methods for calculating the location and velocity of autos, it was found that the model that was offered would be more cost-effective. When there was an excessive amount of network traffic, however, its usage was restricted since there was a higher rate of errors.

In a research, Zhou et al. (2013) proposed a user-dependent traffic data-gathering technique based on WSNs to exploit all routing features for decision-making in order to achieve a compromise between the sensor power required and the data delivery latency. However, its spread was restricted by its main shortcomings, which were poor data rate and security difficulties. In order to lower communication costs and power consumption, Ahmad et al. (2013) proposed a channel switching strategy for traffic management. OPNET was used for simulation of this proposed model. The feasibility of implementing the model at traffic lights was observed. However, vehicle-to-vehicle channel interference caused the suggested method to fail. Two practical data collection methods, GREEDY and Probabilistic Data Collection (PDC) for car multimedia SNs, were developed by Bruno and Nurchis (2013). The NS-2 simulator and VANET MobiSim were used by the researchers to simulate this technique. The results showed that the GREEDY algorithm could use less network capacity and cover more evenly. Nevertheless, cooperative storage between vehicles and picture replications were not taken into account by these methods. This might thus have a major impact on the precision of data collecting, which is why this plan was not well received. An RFID-based intelligent system is another piece of technology used to control traffic.

Chao and Chen (2014) presented an intelligent traffic management system (TMS) that was based on radio frequency identification (RFID). The radio frequency identification (RFID) technology that is used by the intelligent traffic light control system (ITLCS) that is being suggested is in accordance with the protocol that is used to ascertain the number of automobiles and the duration of time that vehicles spend on main roads and local roads as they go through the intersection when the light is green. They sent real-time data to the regional control centre, including vehicle registration details and weather conditions, using Zig Bee modules. Remote gearbox and a decrease in traffic accidents are two potential benefits of the suggested technology. But even with a good effort, Zig Bee's utility for data transmission was limited since it consistently showed a very low data transfer rate that might compromise accuracy. In an effort to create a traffic management system, Choi et al. (2015) developed an additional method known as the optimum VSN routing strategy. The variables affecting VSNs' delay performance were examined by the researchers. They created an algorithm called Optimal VSN Data Forwarding (OVDF) and structured the packet routing issue as a Markov Decision Process (MDP). They used a GloMoSim simulator to do simulations. They evaluated OVDF's performance against the Trajectory Based Data (TBD) forwarding system and the Vehicle Assisted Data Delivery (VADD) algorithm. In comparison to VADD and TBD, the simulation results showed that the OVDF provided the best sensing coverage, a greater packet delivery ratio, and a delay reduction of around 25% and 20%, respectively.

**Intelligent traffic system Management (ITS)**

Information and communication technology that enhances transportation outcomes, including safety, productivity, social fairness, environmental performance, educated travel choices, and network operating resilience, is referred to as an intelligent traffic system.



**Intelligent traffic management's objective**

Katerna (2019) asserts that leading nations have a propensity to coordinate the management of infrastructure and transportation flows. The country's transit potential can be increased, intermodal and international transport corridors can be developed, a favourable investment climate can be created, traffic safety and decision-making efficiency can be improved, the quality and competitiveness of transport services can be raised, operators of logistics services for passenger transportation can receive high-quality information support, and so on, thanks to creative advancements in the modelling and management of transport flows and It should be mentioned that predictions based on data already saved in the system may be used by ITS. The primary objectives of ITS development, which are shown in Fig. 1, are formed by the indicated variables.

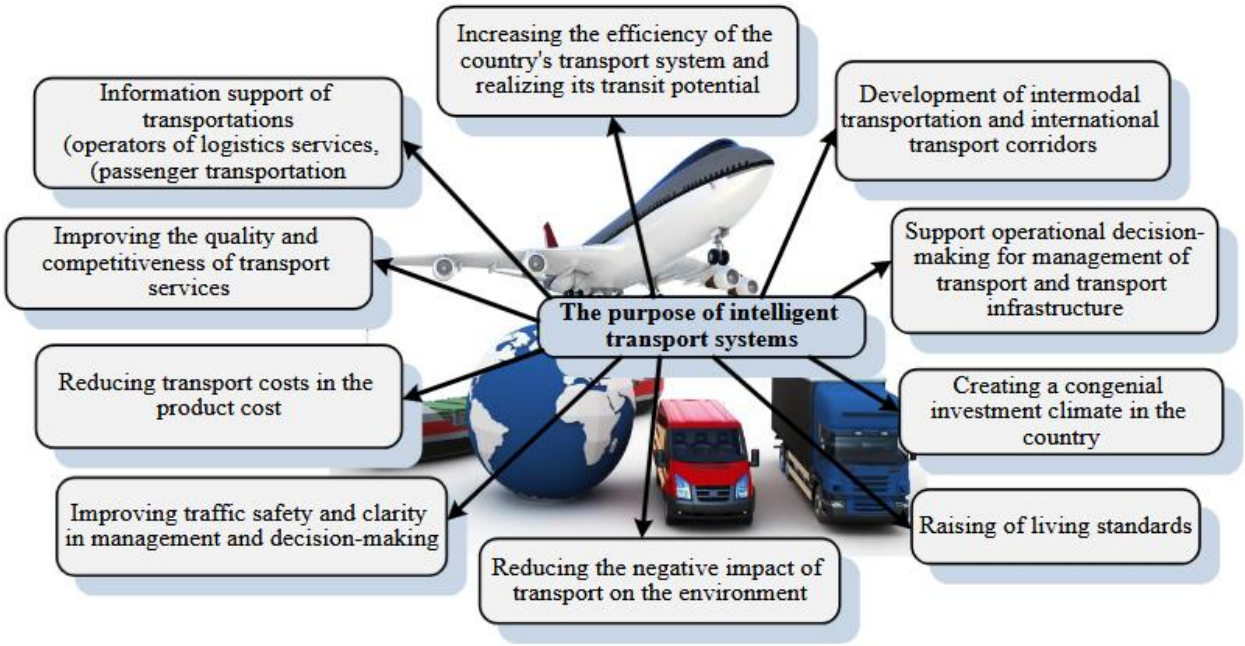



**Figure 1: Summary of the purpose of ITS**
**Source: Katerna, (2019).**

The Intelligent Transportation System (ITS) is a prime example of a complex system, exhibiting characteristics such as multicriteria, which arises from the immanence (divergence) of the goals of individual system elements; complex (probabilistic and dynamic) behaviour in the interconnection of subsystems and the requirement for management feedback; purposefulness, integrity, hierarchy, multidimensionality, emergence, and multifunctionality of system elements (Katerna, 2019).

Passenger and freight flows are the primary focusses of ITS management, which include both interior and outside traffic flows in infrastructure components. The information that pertains to the control item comes from a variety of sources, including a large number of sensors and detectors, several identification technologies, and linked information systems. Regarding the information analysis of the control object, a model—a concept about this item—must be programmed into the system. The activities that must be completed by the ITS alone dictate the model's level of depth and accuracy.

Intelligent transport systems offer assistance in decision-making in the following areas: enhancing road safety, which leads to an increase in capacity; minimising adverse effects on the environment; disseminating information about traffic conditions to all relevant parties; optimising the distribution of traffic within the network in terms of both time and space; enhancing the capacity of the existing transportation network; establishing transport priorities for a specific mode of transport. It is specifically acknowledged that the political and economic climate of the nation has an impact on the advancement of technology as a result of the use of ITS. Consequently, ITS technology may be developed by the commercial sector relatively quickly (Katerna, 2019).

**Intelligent Transportation Systems' technology**

1. AI and ML: Algorithms predict traffic, identify bottlenecks, and improve signal timing. AI finds traffic data patterns and trends. More precise traffic control allows proactive decision-making. Machine learning can change traffic signals based on demand.
2. Sensor networks and IoT devices capture real-time traffic data using lidar, radar, cameras, and loop detectors. These sensors monitor traffic, occupancy, vehicle velocity, and environmental changes. The IoT simplifies data integration from several sources, improving traffic management and monitoring.
3. Improved traffic flow: AI, IoT, and data analytics may improve real-time traffic flow. Dynamic traffic signal management reduces commuter travel time.

4. Updated information: Travellers will get real-time traffic warnings, alternate routes, and tailored trip options via linked digital platforms and mobile apps. It simplifies emergency response planning, route design, and location analysis, improving traffic management.
5. Cloud computing: Scalable cloud platforms process, store, and analyse massive volumes of traffic data. Cloud-based technologies let traffic managers collaborate and exchange real-time data. Cloud computing makes ITS services and applications more accessible, making smart city systems simpler to communicate.
6. Technologies for communication (5G and V2X): Next-generation communication technologies, such as 5G, allow for fast connections with low delay. These technologies are essential for managing traffic in real time. Vehicle-to-everything (V2X) communication lets cars talk to people on the street, infrastructure, and other cars, making cooperative and linked movement possible. These communication technologies enable more advanced ways to handle traffic, such as adaptable signal control, junction coordination, and dynamic routes (Dighe, Nikam, and Markad, 2024).

## RESULTS AND DISCUSSION

How well the suggested study goals have been met in this investigation is shown by the talk in this section, which is in line with the research goals. This study used case studies and book reviews to draw conclusions. Thus, it satisfies all study objectives.

**To examine the advantages of adopting intelligent traffic control system**

The following are the advantages of adopting intelligent traffic control system as elicited from the literature and empirical studies reviewed in the course of this study.

- Intelligent Traffic Systems improve traffic management, which is one of its finest features. These devices provide authorities a real-time view of traffic so they can relieve it. ITS might save journey time and improve road utilisation by adjusting traffic signal timing depending on traffic. This management oversees traffic daily and plans construction and road maintenance projects to minimise public disruption.
- Improved Safety: It makes pedestrians and automobiles safer. ITS devices may notify automobiles of potential threats and occurrences. Systems might alert automobiles of traffic congestion or construction projects so they can slow down or change routes. Smart pedestrian crossing systems integrate with traffic lights to improve roadway safety.
- Fuel economy: Intelligent traffic systems may boost fuel economy. By optimising traffic flow, ITS may save drive time and parking searches. Cutting unnecessary car movement may save drivers and transport companies a lot of gas.
- Environmental benefits: Finally, ITS may preserve an ecosystem. Greenhouse gas emissions are reduced through reduced travel and improved fuel efficiency. ITS technology that minimizes the necessity for infrastructure includes digital toll collection and smart parking. This results in a reduction in environmental degradation and land use. Consequently, the implementation of intelligent traffic systems may serve to foster the long-term expansion of urban areas.
- Improved traffic flow: AI, IoT, and data analytics may improve real-time traffic flow. Dynamic traffic signal management reduces commuter travel time.
- Updated information: Travellers will get real-time traffic warnings, alternate routes, and tailored trip options via linked digital platforms and mobile apps. It is possible that drivers could improve their preparation and make better judgements with reliable information.
- How cost-effective: The innovative traffic management system will cost money to install, but it will save money on gasoline, make roads safer, and boost production. Resource economy and traffic flow will save travellers and transportation authorities money over time.
- Future-ready: The system is scalable and responsive to traffic patterns and new technologies. The Intelligent Traffic System will assist everyone arrive to their destination on time, regardless of age, handicap, or location. The system will meet changing transportation demands efficiently since it is monitored, improved, and expanded upon.

**To identify the issues and challenges in the adoption of intelligent traffic control system**

**a. Problem of in the implementation of Intelligent traffic system**

An example of a complex system is the Intelligent Transportation System (ITS), which is characterised by its purposefulness, hierarchy, multidimensionality, emergence, and multi-functionality of its components. The immanence (divergence) of the objectives of individual system parts, the complicated behaviour in the interconnection of subsystems (both probabilistic and dynamic), and the demand for input from management are all factors that contribute to the existence of multi-criteria.

Passenger and freight movements, as well as internal traffic flows in infrastructure components, are the focus of ITS management. Identification technologies, many sensors and detectors, and interconnected information systems are the sources of data on the control object. For the purpose of analysing data about the control object, a model—a concept about the object—must be programmed into the system. The tasks that the ITS must do influence the model's level of depth and precision.

Intelligent transport systems support decision-making in the following areas: maximising the network's time and space distribution of traffic; expanding the network's capacity; establishing transport priorities for a particular mode of transport; managing transport

in the event of accidents, natural disasters, or other events that impact traffic; enhancing road safety, which results in increased capacity; minimising adverse environmental effects; and informing all stakeholders.

As a result of ITS use, it is explicitly acknowledged that the political and economic climate of the nation is one of the variables influencing technological development. ITS technology may thus be developed by the commercial sector relatively quickly. In her study, Mikheeva (2007) describes how ITS jobs are categorised based on distribution on characteristics monitoring, transportation flow management, transportation process management, and information assistance for movement participants.

This categorisation, however, focuses more on road transportation and the external management of the transportation flow, omitting management activities in infrastructure items. In addition to providing the necessary circumstances for the information environment's important activities, the informatisation infrastructure also handles its technical tracking and physical support. Through the use of information technology and infrastructure, ITS unifies a number of modern, high-tech, and scientific approaches to managing different forms of transportation. Therefore, Katerna (2019) classified ITS difficulties as follows (Fig. 2).

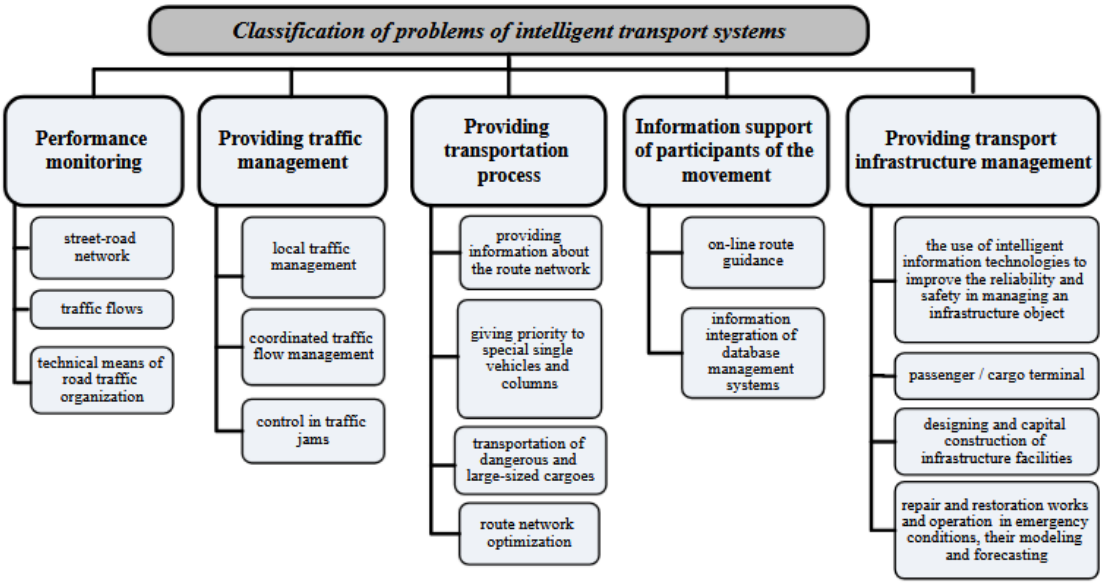



**Figure 2: Classification of ITS's problems**
**Source: Katerna, (2019).**

The categorisation of ITS issues by Katerna (2019) includes performance monitoring, traffic management, transportation process, information assistance for movement participants, and transport infrastructure management. Street-road networks, traffic patterns, and technological methods of road traffic organisation are among the issues with performance monitoring (figure 2). Local traffic management, coordinated traffic flow management, and traffic congestion control are all factors that influence traffic management service delivery. The figure also shown that the transportation process has issues supplying information about the route network, prioritising specific single vehicles and columns, conveying huge and dangerous goods, and optimising the route network. Issues with online route leading and database management system information integration impede the movement's ability to deliver information to participants.

**b. Disadvantages of Intelligent Traffic Systems**

Using intelligent traffic systems has several drawbacks even if there are many positives. Here are several ITS-related challenges:

Extensive Implementation and Maintenance: Its implementation may have a high initial outlay. This provides funding for the configuration of sensors, cameras, data processing tools, and other essential pieces of equipment. For the same reason that these systems need continuous updates, replacements, and repairs, the cost of maintaining them may also be rather high. These fees might be rather costly, particularly for municipalities that are not adequately supported. In the same way as other digital systems are susceptible to technical issues and failures, ITS are one of them. The situation in which these systems are operating well is directly related to the dependability of each individual component. A single malfunctioning sensor or a mistake in the data processing software might result in erroneous choices on traffic management, which could then lead to anarchy on the roads.

Privacy concerns have been raised by the data collecting in ITS using cameras and sensors. These gadgets follow and record people's and automobile movements constantly, which may lead to the misuse of personal data. Maintaining people's privacy while utilising ITS technology is one of the main challenges to its acceptance and use.

**c. The risk/issues and challenges in the adoption of intelligent traffic control system**

**Risk factors**

Almost every part of engineering projects has some degree of inherent risk. Consequently, depending on the tasks performed and the areas visited, the people engaged in this project will face hazards that are either moderate or severe in severity.

For example, working at a height is required while installing auxiliary control systems and cameras. Some possible dangers include acrophobia, a severe fear of heights, and using climbing aids that are not up to par. This operation calls for qualified workers, sufficient labour, and the proper lifting gear.

Some of the risks that could arise from the project include working long hours, getting tired from getting local traffic information from sources like the internet and the Federal Road Safety Corp (FRSC), having to travel to specific areas to watch traffic, the possibility of electrocution, and using the wrong values for electronic components. Danger may also come from environmental elements like weather. Therefore, activities will be planned and carried out in a way that eliminates or minimises the consequences of hazards.

In order to find promising avenues for implementing an intelligent traffic management system.

**The possible benefits of an automated traffic management system**

IT is drastically altering the transportation industry, just as it does in so many other industries. Despite what many people think, modernizing a country's transport system entails more than merely building new roads and repairing existing ones. In the years to come, information technology will become more and more significant in this industry. An intelligent transport system is emerging as a result of the integration of microchips and sensors as well as their wireless communication capabilities. Roads, cars, traffic signals, message signs, etc. are all included in this. By creating and implementing an intelligent system to monitor and control traffic lights, this project aims to reduce urban traffic congestion.

It would be beneficial to first comprehend Nigeria's current traffic management system in order to develop an intelligent traffic control system that could eventually replace manual and conventional methods. It is anticipated that this project would greatly reduce the issue of traffic stalemate that has lately surfaced on our roads since shorter wait times translate into lower fuel consumption, lower air and noise pollution, easier emergency response, increased productivity, and fewer accidents.

However, it would be easier to use this technology if the government considers placing cameras and sensors at major crossings and roads. Private investors may be required by law to purchase and install security cameras in strategic locations. Data input into the traffic management system is one potential use for these sensors and cameras.

**Prospects for the use of intelligent traffic management systems in the future**

*Enhancement of data gathering:* Because cars are always moving, the data that is gathered may not always be reliable, accurate, or comprehensive. It would be important to do research on methods that provide data of higher quality. Numerous emerging sensing techniques might aid in enhancing data collection and quality in the Internet of Things era. Data quality enhancement may also be aided by studies on the use of automated data-capturing methods that minimise human data entering.

*Combining data from non-uniform sources*: The number of gadgets has increased recently, and each one has its own criteria. All of these gadgets must be compatible with traffic management systems. As a result, creating uniform standards is difficult and requires a lot of cooperative research.

*Handling massive volumes of data*: With the expansion of the Internet of Things, data is growing to enormous sizes. Another significant problem is the smooth integration and processing of data, and data management requires extensive study.

*Utilising technologies like edge and cloud computing could be taken into consideration*: Traffic congestion analysis, traffic flow prediction, and prudent transportation infrastructure planning issues may be resolved by using Big Data technology to collect traffic data for an entire city. This data can then be used to guide traffic and urban planning (Wang et al., 2018).

*Privacy issues:* Large volumes of data saved using modern technology may include the owners' private information. Such sensitive information might be intercepted by hackers during transmission. As a result, maintaining safe traffic management systems is a problem that needs further investigation.

*Identifying traffic dangers:* The methods for identifying traffic risks have been examined, but they are insufficiently effective. For drivers to respond appropriately, potential threats must be accurately detected and communicated to them. Research is still needed in the field of identifying traffic risks.

*Formulations of policies*: In order for policymakers to utilise such data for draughting traffic laws, parameters such as accidents and traffic offences must be connected with traffic controlling systems in the future (Ravish & Swamy, 2021). Research on the integration of such data would help to avert preventable accidents.

**CONCLUSIONS**

In order to determine the effectiveness of the main Intelligent Transportation Systems (ITS) now in use for traffic management, the

current study carried out a literature review. The study examined research on intelligent traffic management and the collection and tracking of traffic data using CCTV footage. According to the assessment, ITS performed noticeably better than other data collecting methods when using wireless network technologies to collect vehicle data. However, its use is limited by the expensive cost of antennas. Additionally, several research using various technologies for traffic management have shown that the use of a certain approach depends on the kind of area where traffic management is required. According to a study of research on the use of various technologies in traffic management, using deep learning technologies and specific optimisation algorithms, such as the Ant and Bee algorithms, produced improved traffic management outcomes. The analysis of several technologies for accurately predicting travel time by detecting traffic congestion revealed that technologies based on two models offer superior accuracy in detecting vehicle congestion, which leads to highly accurate travel time predictions.

In summary, this study on the use of ITS to reduce traffic congestion shows that there are many different ITS alternatives available, using a variety of technologies, and that they may potentially alleviate the majority of traffic issues. Nonetheless, the application need to be dependent on the location's characteristics, where traffic control is required. Better safety and productivity might be achieved by reducing travel time and lines if the right ITS is deployed for the site. The analysis also identified certain uncharted areas, which provide the way for further investigation.

The Intelligent Traffic System will provide travellers more accurate information about the services that are available. The Intelligent Traffic System may potentially contribute to lower fares. Because of the effective traffic coordination, drivers will charge less and use less gasoline. In order to guarantee that the transportation system is responsive to the requirements and interests of its users, intelligent traffic systems may assist in communicating such needs and interests to those in charge of system management.

The Intelligent Traffic System may assist transport system management in improving the safety of their services.

The Intelligent Traffic System will assist in concentrating the transport system on satisfying the requirements of each and every one of its clients. A greater emphasis on customer service and efficient operations will be necessary to better meet the expectations of consumers.

Our transport networks might be completely transformed by Intelligent Traffic networks (ITS). Among their many advantages are better traffic control, more safety, higher fuel economy, and environmental preservation. By efficiently controlling traffic and lowering greenhouse gas emissions, these technologies may be essential to the development of sustainable, smart cities. However, a number of obstacles must be overcome for ITS to be implemented successfully, such as exorbitant prices, dependability problems, and privacy difficulties. Given the long-term advantages, the deployment and maintenance expenses might be prohibitive, but they are well worth the effort. To guarantee that the systems are dependable and considerate of people's privacy, technical problems and privacy issues need constant attention and creative solutions. It is reasonable to assume that these difficulties will be lessened as technology develops further, opening the door for ITS to be widely adopted and implemented globally.

**REFERENCES**


1. Afrin, T, & Yodo, N. (2020). A Survey of Road Traffic Congestion Measures towards a Sustainable and Resilient Transportation System. Sustainability; 12(11): 4660. doi: 10.3390/su12114660
2. Ahmad, F., Basit, A., Ahmad, H., Mahmud, S. A., Khan, G. M., & Yousaf, F. Z. (2013) Feasibility of deploying wireless sensor based road side solutions for intelligent transportation systems. In: 2013 International Conference on Connected Vehicles and Expo (ICCVE), 320-326
3. Aleko, D. R, & Djahel, S. (2020). An Efficient Adaptive Traffic Light Control System for Urban Road Traffic *Congestion Reduction in Smart Cities. Information*.; 11(2): 119. doi: 10.3390/info11020119
4. Ameer S, Shah MA, Khan A, et al. (2019). Comparative Analysis of Machine Learning Techniques for Predicting Air Quality in Smart Cities. *IEEE Access*. 2019; 7: 128325-128338. doi: 10.1109/access..2925082
5. Aouedi, O., Piamrat, K. and Parrein, B., (2022). Intelligent traffic management in next-generation networks. *Future internet*, 14(2), p.44.
6. Bahiru TK, Kumar Singh D, Tessfaw EA. (2018). Comparative Study on Data Mining Classification Algorithms for Predicting Road Traffic Accident Severity. In: Proceedings of the 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT); 20-21 April 2018; Coimbatore, India. pp. 1655-1660. doi: 10.1109/icicct.2018.8473265
7. Bruno, R., & Nurchis, M. (2013) Robust and efficient data collection schemes for vehicular multimedia sensor networks. In: 2013 IEEE 14th International Symposium on" A World of Wireless, Mobile and Multimedia Networks" (WoWMoM), 1-10. IEEE
8. Butilă E.V., Boboc R.G. (2022). Urban traffic monitoring and analysis using unmanned aerial vehicles (UAVs): A systematic literature review Remote Sens., 14 (3) (2022)
9. Chakraborty, P, Adu-Gyamfi, YO, Poddar S, et al. (2018). Traffic Congestion Detection from Camera Images using Deep Convolution Neural Networks. Transportation Research Record: *Journal of the Transportation Research Board.;* 2672(45): 222-231. doi: 10.1177/0361198118777631

10. Chao, K. H., & Chen, P. Y. (2014) An intelligent traffic flow control system based on radio frequency identification and wireless sensor networks. International journal of distributed sensor networks, 10(5), 694545
11. Chen Y., Qin R., Zhang G., Albanwan H. (2021). Spatial temporal analysis of traffic patterns during the COVID-19 epidemic by vehicle detection using planet remote-sensing satellite images Remote Sens., 13 (2)
12. Chin J, Callaghan V, Lam I. (2017). Understanding and personalising smart city services using machine learning, The Internet-of-Things and Big Data. In: Proceedings of the 2017 IEEE 26th *International Symposium on Industrial Electronics (ISIE);* 19-21 June; Edinburgh, UK. pp. 2050-2055. doi: 10.1109/isie.2017.8001570
13. Choi, O., Kim, S., Jeong, J., Lee, H. W., & Chong, S. (2015) Delay-optimal data forwarding in vehicular sensor networks. IEEE transactions on vehicular technology, 65(8), 6389-6402.
14. de Souza A.M., et al. (2017), Traffic management systems: A classification, review, challenges, and future perspectives. Int. J. Distrib. Sens. Netw., 13 (4)
15. Degas, et al. (2022)."A survey on artificial intelligence (ai) and explainable ai in air traffic management: Current trends and development with future research trajectory." Applied Sciences 12, no. 3 (2022): 1295
16. Dighe, B., Nikam, A., and Markad, K. (2024). Intelligent Traffic Management Systems: A Comprehensive Review. *International Journal of Creative Research Thoughts (IJCRT).*12, (4)pp*912- 917*
17. Fattah, M., Morshed S.R, & Kafy, A.A. (2022). Insights into the socio-economic impacts of traffic congestion in the port and industrial areas of Chittagong city, Bangladesh. *Transportation Engineering*; 9: 100122. doi: 10.1016/j.treng.2022.100122
18. Gandhi, Mihir M., Devansh S. Solanki, Rutwij S. Daptardar, and Nirmala Shinde Baloorkar (2020). "Smart control of traffic light using artificial intelligence." In 2020 5th IEEE international conference on recent advances and innovations in engineering (ICRAIE), pp. 1-6. IEEE, 2020.
19. Hamdi M.M., Rashid L.A.S.A., Al-shareed a M.A. (2020). Techniques of early incident detection and traffic monitoring centre in VANETs: A review. J. Commun., 15 (12), pp. 896-904
20. Jain N.K., Saini R.K., Mittal P. (2019). A review on traffic monitoring system techniques. Ray K., Sharma T.K., Rawat S., Saini R.K., Bandyopadhyay A. (Eds.), Soft Computing: Theories and Applications, Springer Singapore, Singapore (2019), pp. 569-577
21. Jain N.K., Saini R.K., Mittal P. (2019). A review on traffic monitoring system techniques. Ray K., Sharma T.K., Rawat S., Saini R.K., Bandyopadhyay A. (Eds.), Soft Computing: Theories and Applications, Springer Singapore, Singapore, pp. 569-577
22. Katerna, O. (2019). Intelligent transport system: the problem of definition and formation of classification system. Economic analysis, 29 (2), 33-43. DOI: https://doi.org/10.35774/econa2019.02.033
23. Kleine, D. J, Zalakeviciute R, Gonzalez M, et al. (2017). Modeling PM2.5 Urban Pollution Using Machine Learning and Selected Meteorological Parameters. *Journal of Electrical and Computer Engineering,* 1-14. doi: 10.1155/2017/5106045
24. Mazhar, R. Hojae, S. Awais, A. & Anand, P. (2018). Real-time video processing for traffic control in smart city using Hadoop ecosystem with GPUs. Soft Computing, 22:1533–1544
25. Mehmood Y., Ahmad F., Yaqoob I., Adnane A., Imran M., Guizani S. (2017). Internet-of-things-based smart cities: Recent advances and challenges. IEEE Commun. Mag., 55 (9), pp. 16-24
26. Okwu, Modestus O., Vitalian U. Chukwu, and Onyewuchi Oguoma. (2019). "Application of artificial neural network model for cost optimization in a single-source, multi-destination system with non-deterministic inputs." In Advances in Computational Intelligence: 15th International Work-Conference on Artificial Neural Networks, IWANN 2019, Gran Canaria, Spain, June 12-14, 2019, Proceedings, Part II 15, pp. 539-554. Springer International Publishing, 2019
27. Outay F., Mengash H.A., Adnan M. (2020). Applications of unmanned aerial vehicle (UAV) in road safety, traffic and highway infrastructure management: Recent advances and challenges Transp. Res. A: Policy Pract., 141, pp. 116-129
28. Rabby M., Islam M.M. & Imon S.M. (2019). A review of IoT application in a smart traffic management system. 5th International Conference on Advances in Electrical Engineering, ICAEE, pp. 280-285.
29. Ravish, R. & Swamy, S. R. (2021). Intelligent traffic management: a review of challenges, solutions, and future perspectives. *Transport and Telecommunication*, 22 (2), 163–182; DOI 10.2478/ttj-2021-0013
30. Roopa, R. & Shanta, R. (2021). Intelligent traffic management: A review of challenges, solutions, and future perspectives. Transport and Telecommunication, 2021, volume 22, no. 2, 163–182 Transport and Telecommunication Institute, Lomonosova 1, Riga, LV-1019, Latvia DOI 10.2478/ttj-2021-0013
31. Saqib, M., Lee, C. (2010) Traffic control system using wireless sensor network. In: 2010 The 12th International Conference on Advanced Communication Technology (ICACT), 1, 352-357. IEEE
32. Shankar, I. L.. (2021): "AI enabled applications towards intelligent transportation." Transportation Engineering 5 100083.
33. Sharma, A., Yogesh, A., and Sunil, K. (2020). "The role of blockchain, AI and IoT for smart road traffic management system." In 2020 IEEE India Council International Subsections Conference (INDISCON), pp. 289-296. IEEE, 2020

34. Singh, D.K., Sahatiya, P. & Ganatra, A. (2023). Enhancing traffic control systems with live video analytics: Issues, challenges, opportunities, and recent problems. *Information System and Smart City* 3(1), Pp 1-12
35. Soman, Renjith, and K. Radhakrishnan (2018). "Traffic Light Control and Violation Detection Using Image Processing." Traffic 8, no. 4.
36. Srivastava S, Divekar AV, Anilkumar C, et al. (2021). Comparative analysis of deep learning image detection algorithms. Journal of Big Data.; 8(1). doi: 10.1186/s40537-021-00434-w
37. Sukhadia, A., Khush, U., Meghashree, G., Smit, S. & Manan, S. (2020). Optimization of smart traffic governance system using artificial intelligence. *Augmented Human Research* 5, 1-14
38. Uddin, M. et al. (2021). "Ai traffic control system based on deepstream and iot using nvidia jetson nano." In 2021 2nd International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST), pp. 115-119. IEEE, 2021
39. Vidya, R., & Amruth, L. (2020). Intelligent Traffic Control System. International Journal of Recent Technology and Engineering. DOI:10.35940/ijrte.f9526.038620
40. Won M. (2020). Intelligent traffic monitoring systems for vehicle classification: A survey IEEE Access, 8, pp. 73340-73358
41. Zhou, J., Chen, C.P., Chen, L., & Zhao, W. (2013) A user-customizable urban traffic information collection method based on wireless sensor networks. IEEE Transactions on Intelligent Transportation Systems, 14(3), 1119-1128.