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Effectiveness of Intelligent Transport System in the Management of Traffic Congestion in Abuja Metropolis, Nigeria

Abstract

This study examined the effectiveness of the Intelligent Transport System (ITS) in reducing traffic congestion in Abuja metropolis, Nigeria. The study assessed the causes of traffic congestion, the level of deployment of ITS and the effectiveness of ITS in traffic management. The study adopted a mixed research design, with a population of 42973 road users and a sample size of 396 respondents shared between different categories of road users such as private and commercial vehicle drivers. A structured questionnaire administered to road users and interview with transport officials served as data collection instruments. Collected data was analysed using descriptive and inferential statistics such as mean, percentages and frequencies. The hypothesis was tested using Pearson correlation analysis, while interview responses were analysed thematically. Findings revealed that high level of vehicle ownership, poor public transport and traffic management systems were the major causes of traffic congestion in Abuja. ITS was still at a nascent stage, characterised by a coverage rate of less than 30% of total road intersections in Abuja, with a moderately effective impact on traffic management (mean = 3.37). Pearson correlation analysis further revealed that improvement in ITS effectiveness will result in reduced congestion ($r = 0.584$, $p < 0.05$). Government was encouraged to invest more in the expansion of ITS infrastructure across major road corridors and intersections within Abuja metropolis.

Keywords : Deployment, Effectiveness, Intelligent Transport System, Management, Traffic Congestions

Introduction

The rate of congestions across major cities around the world has intensified as a result of rapid urbanisation, population growth and rising motorisation. This is particularly critical in developing countries where transport infrastructure and traffic management systems are underdeveloped. Traffic congestion is caused by an imbalance between the demand for transport and the capacity of the road network in terms of travel time, travel speeds, vehicle queuing, and efficiency of the travel flow (Falcocchio et al., 2015). Congestion is a chronic issue across many urban centres that has a significant impact on economic productivity, environmental sustainability, road safety and urban way of life. In Nigeria, major cities such as Lagos, Abuja, Kano and Port Harcourt continue to suffer from high level traffic congestion, largely as a result of the high rate of vehicle ownership, poor public transport infrastructure, poor traffic management and urbanization. Research has revealed that the rapid expansion of motorisation in Nigerian cities has placed an increasing strain on the road network, making urban travel increasingly time-consuming and inefficient (Noma-Osaghae et al., 2022).

The traditional solutions to traffic congestion such as road expansion, traffic control, parking measures, and road pricing have only yielded short-term results. Research has shown that the extension of road capacity is sometimes ineffective because new road capacity brings more traffic on to the network,



known as induced traffic (Duranton and Turner, 2011). Hence, there has been a growing focus on Intelligent Transport Systems (ITS) for urban traffic management which are more sustainable and technology-oriented. Adeniran *et al.* (2026) defined ITS as the application of Information and Communication Technologies (ICT) to the transport infrastructure and vehicles to enhance sustainability, safety, and mobility of urban transport system. Traffic control applications like adaptive traffic signals, CCTV surveillance systems, automated number plate recognition systems, real-time traffic information systems and Variable Message Signs (VMS) have been deployed in many cities to optimize traffic and alleviate congestion. Cheng *et al.* (2020) claimed that ITS can help solve congestion problems by helping road users make informed travel decisions and by helping transport agencies to proactively control traffic conditions based on real-time information and smart traffic control systems.

Despite enjoying increased recognition around the world, many developing cities have zero to low levels of ITS adoption due to infrastructure, financial, technical and institutional limitations. Garg and Kaur (2023) found that lack of internet connectivity, high installation and maintenance cost, lack of technological infrastructure and low awareness among the public were the significant challenges for implementing ITS. Likewise, Damana *et al.* (2025) reported that lack of knowledge of ITS and inadequate government funding were major factors which hinder the adoption of ITS in Niger State, Nigeria. Despite the introduction of some ITS related projects like Adaptive traffic lights, Speed cameras and CCTV Traffic monitoring system, in Abuja metropolis, there is scarce empirical evidence on the level of deployment of ITS and the impact of these ITS applications to traffic congestion management in Abuja. Against this background, this study seeks to examine the cause of traffic congestion, the level of ITS deployment and the effectiveness of adopted ITS application in Abuja metropolis.

Literature review

Overview of Road Congestion

Traffic congestion is one of the most common urban transportation problems. It refers to a condition where the demand for road space is higher than the capacity of the transport system, causing reduced speeds of vehicles, increased travel times, delays, and vehicle queuing (Falcocchio *et al.*, 2015). It has been described as a physical

and relative phenomenon because it is related to the overuse of road networks beyond their capacity, as well as to the gap between the performance of the roads, and the expectations of the road users for speed, comfort and reliability of the trip (Elmansouri, Almhroog, & Badi, 2020). Traffic congestion has been noted to be as a result of inadequate transport facilities, including poor road infrastructure, inadequate parking space, ineffective traffic control as well as poor signal coordination (Newman *et al.*, 2020). With the advancement of urbanisation and motorisation, the pressure on the transport system in economically active cities keeps rising, with traffic congestion becoming an almost inevitable phenomenon in fast developing urban centres (Noma-Osaghae *et al.*, 2022).

Causes of Road Congestion

There are numerous causes of traffic congestion and some studies have been carried out to identify the causes of traffic congestion such as Abuh and John (2023), Raheem *et al.* (2015) and Popoola (2013). Abuh and John (2023) carried out a geographic analysis of traffic congestion in the Federal Capital Territory (FCT) Abuja, Nigeria. The study aimed in particular to map traffic congestion zones through Geographical Information System (GIS) techniques, identify the main causes of traffic congestion and analyse potential solutions to the issue. The researchers used random sampling method to distribute a total of 384 structured questionnaires to the road users, and descriptive analysis such as means, percentage, standard deviation and Likert scale analysis were used to analyse the collected data. It was found that traffic congestion is most observed along the Abuja-Keffi expressway, Kubwa-Zuba expressway and Gwagwalada-Lokoja expressway in the FCT. The top causes of traffic congestion in the study were: too many taxis (mean score 4.14), poor traffic control management (4.06), malfunctioning vehicles (4.02), lack of parking space (3.92), and poor parking habits (3.91). Poor road network (2.76) was dismissed as significant because the road infrastructure in the FCT is relatively good. Regarding solutions, road maintenance (mean score 4.19) was the top ranking solution, followed by education and enlightenment (4.14), traffic management and planning (3.95) and provision of pedestrian facilities (3.77). The study concluded that the problem of congestion in Abuja is mainly attributed to high level of vehicular movement especially taxis and recommended railway service, improvement of mass transit and road maintenance as

sustainable measures to reduce the congestion problem in the metropolis.

Raheem *et al.* (2015) studied the causes and effects of traffic congestion on Basorun – Akobo road, Ibadan, Oyo state, Nigeria and possible solutions to the problem. Both experimental and theoretical approaches were used in this study, with the use of traffic counting and delay survey as instruments for data collection. To determine the severity of congestion, the researchers looked at traffic along the selected route and recorded how often congestion caused delays for commuters. It was found that the traffic congestion on the study road was mostly attributed to the rapid population growth, high human activities on the urban area, high vehicle ownership and the inadequate provision of transport facilities to cater for this. The consequences that were found were the loss of productive time, slow moves, higher risk of accidents, lack of prediction of travel time, unnecessary fuel usage, road rage and environmental pollution. The study recommended the dualisation of the road to improve capacity, provision of adequate parking space to minimise indiscriminate parking, building proper drainage systems to avoid obstructions on the road and installing traffic control devices to improve flow efficiency and reduce delays.

Popoola *et al.* (2013) examined the causes, effects and remedies of traffic congestion on the Lagos – Ibadan expressway, Mowe/Ibafo section of Lagos State, Nigeria. A survey research design was used and purposive sampling was used to select relevant stakeholders. Structured questionnaires were circulated to 300 road users (commercial vehicle and private vehicle drivers, churchgoers, pedestrians, traffic officers, community leaders and residents of the study area). Of these, 276 questionnaires were completed and returned, which were analysed for the study. The study used the Relative Importance Index (RII) technique to identify what the public considers as the most important causes and effects of congestion. It was found that the most important reasons for traffic jams were the lack of road capacity, worn down road surface, poor drainage, ineffective traffic management, poor parking practices, poor junction/roundabout design, indiscriminate heavy truck parking and lack of pedestrian facilities, and the lack of adequate road furniture. The study also showed congestion-related issues were: wasted time, slowed traffic, stress, increased risk of accidents, unreliable travel times, increased fuel use, road rage, moving residents, increased night driving and environmental pollution. From

the study, it is recommended that some of the following measures be implemented to solve the problems: Road widening, road renovation of poor roads, construction of proper drainage, providing alternative routes for heavy duty vehicles, pedestrian facilities, traffic education, prohibition of road trade and hawking, elimination of unnecessary bus stops and better training of transport and traffic workers. The study found that these would help to significantly decongest Nigeria's main highways.

Traditional Method of Managing Traffic Congestion

Traffic congestion remains a major urban transport problem that has been a topic of discussion in transportation economics and planning literature. Traditionally, congestion management has been about managing travel demand and increasing transport capacity. To curb the menace of traffic congestion, road expansion and infrastructure development became heavily adopted methods of congestion management. This “build our way out” approach involved expansion of road capacity by building new roads, flyovers, and bypasses in order to meet the needs of growing traffic volumes. However, several studies have demonstrated that the effects of roadway expansion were generally short-lived due to induced traffic demand; a phenomenon by which increased roadway capacity leads to an increased vehicle ownership and travel activities (Wang *et al.*, 2023). Ossokina *et al.* (2023) contended that road capacity expansions tend to be accompanied by commensurate increases in traffic levels. Other initiatives that have been implemented in many cities include congestion pricing, traffic signal coordination, parking restrictions, toll roads, public transport subsidies, park-and-ride schemes, and car-pooling programmes.

Despite the implementation of these measures, the problem of traffic congestion remains prevalent in many urban areas, especially in fast-growing cities with high transportation demand. The growing challenge of congestion and limitations of conventional approaches have therefore shifted attention towards Intelligent Transport Systems (ITS) as a more integrated and technology-driven solution. Unlike traditional methods that focus mainly on infrastructure expansion, ITS improves traffic management through real-time information provision, traffic monitoring, and smart coordination of transport systems. Studies such as Damana *et al.* (2025) suggest that traffic information systems help road users make better travel decisions and improve

traffic distribution, although Cabannes (2022) and Zhou *et al.* (2024) cautioned that significant system challenges such as triggering of synchronous driver over-reaction, transfer of congestion to alternative local corridor may arise due to identical travel decisions. Despite this, ITS is becoming accepted as a more viable, efficient supplement to conventional traffic control measures.

The Role of ITS in Traffic Congestion Management.

Intelligent Transport Systems (ITS) have increasingly been recognized as a way of dealing with traffic congestion by incorporating information and communication technologies in transport systems. According to Cheng *et al.* (2020) ITS can help reduce congestion by providing real time traffic information that helps commuters plan their trips, including route selection, departure time, mode selection. In the absence of ITS, road users may resort to their own experience or assumption, which may not adequately represent the traffic situation at hand. ITS uses technologies like Variable Message Signs (VMS), interactive traffic maps, mobile navigation apps, and real-time traffic alerts to help drivers react more efficiently to traffic situations. Real-time traffic monitoring enhances traffic flow, minimizes congestion, and improves travel times (Nguyen *et al.*, 2020).

Besides its benefit to road users, ITS also contributes to the traffic management capacity of government agencies and transport operators. According to Cheng *et al.* (2020), ITS can offer real-time data regarding traffic to transport managers to help them proactively manage traffic by means of adaptive traffic signals, dynamic lane management, electronic toll systems, and automated traffic monitoring systems. They enhance coordination between the various traffic control devices currently in use, and respond faster to traffic incident and unexpected congestion. It also underscores the role of ITS in bolstering both demand management and supply management aspects of traffic management, which in turn enhances the effectiveness of commuter decision making and serves to improve the efficiency of urban transport systems. ITS is therefore emerging as an effective, affordable and viable means of enhancing urban mobility and alleviate urban congestion in fast-growing cities.

There are several studies in developed countries that show that ITS has proven to be effective in improving traffic flow, reducing congestion and improving safety. In one such example, a research conducted by Smith *et al.* (2020)

showed that using real-time traffic monitoring and automated toll collection on highways increased travel speeds by 15% and lowered accident rates by 10%. The results demonstrate that the applications of ITS, if they are implemented well, have a significant positive effect on urban traffic management.

Toulouki *et al.* (2017) carried out research on benefits of ITS in Greece. The authors adopt the survey method and find that the use of ITS cannot only bring more personal income to the population, but also make the population choose a more environmentally friendly way of transportation. The authors also postulate that ITS can help enhance the quality of public transport service. In terms of economic benefits, Vencataya *et al.* (2018) and Neverauskienė *et al.* (2021) (Lithuania) in their study discovered that ITS can reduce the cost of producing and trading goods and services respectively, ITS can also have a positive impact on annual income and job creation. The authors believe that it is necessary to identify the costs of transport system in order to establish the economic impact of ITS. In their study it was also discovered that the main causes of financial damages in transport sector are traffic congestions and traffic accidents.

Puzio *et al.* (2025) explored the use of intelligent transport systems (ITS) and smart technology to solve urban traffic management problems in smart cities in Poland. The study has used a mixed-method approach, using analysis of crowd sourced mobility data provided by GPS, Smartphones and municipal reports and GIS mapping, big data analysis, and machine learning algorithms. It was conducted in the 7 major cities in Poland: Warsaw, Krakow, Wroclaw, Gdansk, Poznan, Katowice, and Lodz, where several intelligent transport solutions were deployed, including dynamic traffic lights, intelligent pedestrian crossings, accident prediction systems, and smart parking management. The effectiveness of the solutions was evaluated in terms of six performance indicators: waiting time at intersections, travel time, congestion, CO₂ emissions, energy consumption and traffic incidents. Results showed that the use of AI- and IoT-based ITS had a positive impact on traffic flow, lowered emissions, increased road safety, and was part of sustainable urban mobility. The study also suggested new innovations, such as integratability of behavioural data in traffic models, dynamic public transport and emergency vehicle priority systems, and improved interoperability for future digitization. The authors have concluded that ITS not only solves the problems of urban mobility but also

contributes to the environmental sustainability and quality of life in smart cities.

John *et al* (2019) discussed the contribution of Intelligent Transport Systems (ITS), which is part of Internet of Things (IoT) to the improvement of traffic management, safety, and efficiency in India. A case study approach was followed, based on a few selected implementations of ITS applications in the major cities of India. Secondary data collection was done by accessing technical reports, government reports and case evaluations of published reports of ITS trials. In particular, the study analysed projects like the Advanced Traffic Management System (ATMS) trial in Chennai, Advanced Traveller Information System (ATIS) in Bangalore and Hyderabad, Advanced Public Transport Systems (APTS) in Bangalore, Chennai and Indore, and the Bus Rapid Transit (BRT) schemes in Pune, Ahmedabad and Chennai. Other examples of such projects by the MWWDC were the rollout of Electronic Toll Collection (ETC) and Advanced Parking Management (APM). The results of the study showed that although ITS projects could contribute to alleviating congestion, enhancing mobility and optimizing urban travel, their widespread use was hindered by infrastructure shortcomings, financial limitations, and the necessity of substantial technological improvements. The study concluded that there are significant opportunities for scaling up ITS solutions in India with the emergence of new technologies like Bluetooth 5, 5G networks and Cellular IoT, if systemic issues are tackled.

Materials and Methods

The study adopted a mixed research design, combining quantitative and qualitative approaches. The study population is comprised of vehicle operators within Abuja metropolis. A total population of 42,973 registered road users with Vehicle Inspection Office (VIO) served as the population of the study, out of which a sample size of 396 was calculated using Taro Yamene formula as presented in Equation 1. The sample size was calculated as follows:

$$n = \frac{N}{1} + n(e)^2 \tag{Eq. 1}$$

$$n = \frac{42973}{1+42973(0.05)^2}$$

$$= \frac{42973}{1+42973(0.0025)}$$

$$= \frac{42973}{108.433}$$

$$= 396.3$$

Questionnaire was adopted as instrument of data collection, the validity of the instrument was assessed by an expert from Centre for Logistics and Transport Studies (CELTRAS), University of Port Harcourt, Rivers State, Nigeria. The expert critically examined the contents of the instrument and useful suggestions was made to improve the quality of the instrument. The expert’s suggestion and corrections was taken into consideration in the final draft of the questionnaire. Also, stratified random sampling technique was used to select respondents among private and commercial road users. Interview was further conducted with officials at the Abuja Traffic Management Agency (ATMA) and responses were analysed thematically. Collected questionnaires were analysed using descriptive statistics such as frequencies, percentages and mean while hypothesis was tested using Pearson correlation. Data were presented in tables and charts to enhance clarity and understanding.

Results and Discussion

Causes of Road Congestion in Abuja

Table 1 presents results on the causes of road congestion in Abuja. Finding revealed that the most important factors that contribute to congestion are high vehicle ownership (Mean = 4.32; SD = 0.84), poor public transport system (Mean = 4.23; SD = 0.88), and inadequate traffic management (Mean = 4.12; SD = 0.91). These mean values indicate that high level of agreement between the respondents on the critical role of these factors. This observation concurs with the available literature that cites rapid motorisation, poor public transport networks, and poor traffic management as leading causes of congestion in developing cities (Abuh & John, 2023). It further supports the claim that the major causes of congestion in Abuja are caused by transport demand exceeding the capacity of the system, heightened by institutional inefficiencies.

Table 1: Causes of Road Congestion

S/No	Causes of Road Congestion	N	Mean	Standard Deviation
i.	Poor road infrastructure	386	3.11	1.12
ii.	High vehicle ownership	386	4.32	0.84
iii.	Inadequate traffic management	386	4.12	0.91
iv.	Road accidents and breakdowns	386	2.13	1.05
v.	Poor public transport system	386	4.23	0.88
vi.	Natural disaster (weather and flooding challenges)	386	1.25	0.72
vii.	Street trading/road encroachment	386	3.23	1.10
viii.	Poorly managed pedestrian crossings	386	3.21	1.08
ix.	Informal stops	386	2.83	1.14
x.	Checkpoints	386	2.98	1.16
xi.	Illegal parking	386	2.34	1.07

Source: Author's field Survey (2026).

Conversely, the lowest mean score was recorded by natural effects like weather and flooding (Mean = 1.25; SD = 0.72) indicating that these factors play a minor role in traffic congestion in Abuja. This indicates that congestion in Abuja is not caused by natural or environmental factors but is more anthropogenic. These findings are consistent with Raheem *et al.* (2015) who argued that, in planned cities with relatively stable climatic conditions, congestion is more closely linked to human activities and infrastructure limitations than to natural events.

Also, road accidents and breakdowns had a rather low mean (Mean = 2.13; SD = 1.05) which means that the respondents do not have a strong perception of them as a major source of congestion. The larger standard deviation, however, implies that there is variation in opinions, so, although some respondents might feel congestion is as a result of such incidences, others do not regard them as a major issue. This variation can be explained by the difference in space in terms of exposure to traffic disturbances within the city. Such factors as street trading/road encroachment (Mean = 3.23; SD = 1.10), poorly managed pedestrian crossings (Mean = 3.21; SD = 1.08), poor road infrastructure (Mean = 3.11; SD = 1.12), are in the medium range, which expresses a general consensus that these factors contribute to congestion. The standard deviations are however relatively higher indicating less agreement among respondents. These results emphasize the importance of city management and the quality of infrastructure in determining traffic conditions. Past research like Raheem *et al.* (2015) and Popoola *et al.* (2013) has underlined that informal

activities and lack of pedestrian facilities can greatly interfere with traffic especially in fast developing cities.

In addition, checkpoints (Mean = 2.98; SD = 1.16) and informal stops (Mean = 2.83; SD = 1.14) registered near-neutral mean value, which means that respondents have a certain ambivalent attitude. The standard deviations are also relatively large, which also indicates varying experiences, which may represent variations in the enforcement practices and transport operations in different routes. Similarly, illegal parking (Mean = 2.34; SD = 1.07) is viewed as a less important factor in general, however, the range of responses used shows that there could be localised problems in some regions.

Level of ITS Deployment in Abuja

Figure 1 presents respondents' perception of the level of Intelligent Transport Systems (ITS) deployment in Abuja metropolis. The results indicate that the largest proportion of respondents (35.40%) perceive the level of ITS deployment as very low, followed by 29.00% who rated it as low. This shows that a combined majority of 64.40% of respondents hold the view that ITS deployment in Abuja is inadequate. Furthermore, 26.90% of respondents rated the level of deployment as moderate, suggesting that a notable proportion acknowledges some presence of ITS infrastructure, although not at an optimal level. In contrast, only a small percentage of respondents perceive ITS deployment as high (5.20%) or very high (3.20%), indicating that very few respondents believe that ITS is extensively implemented within the metropolis.

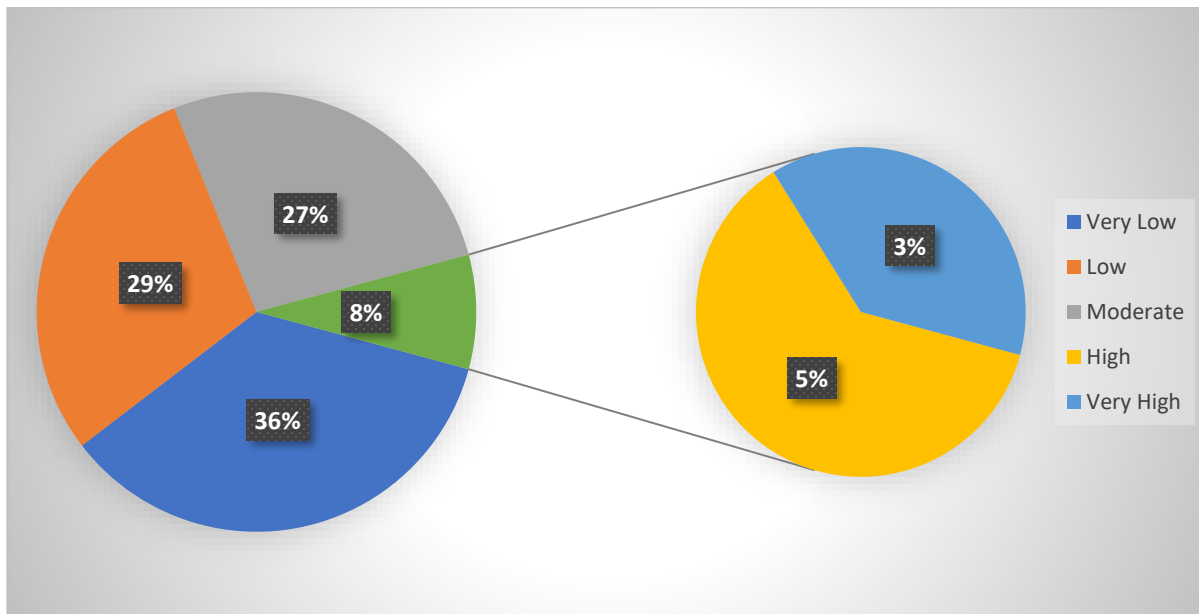


Figure 1 Perception on Level of ITS deployment in Abuja
Source: Author’s field survey (2026).

Also, interview responses revealed that ITS in Abuja is in its nascent phase, focusing mainly on simple traffic monitoring and enforcement solutions instead of integrated, user-friendly, and data-driven systems. It was pointed out that the implementation of ITS in Abuja is sparse and uneven, covering less than 30% of roads in Abuja. Responses also revealed that only three (3) ITS tools have been adopted and are operational at public level in Abuja. In particular, the adaptive smart traffic lights, CCTV/Automatic Number Plate Recognition (ANPR) systems and speed cameras were implemented. This supports the road users’ perception of low level of ITS deployment in Abuja as presented in Table 1.

Interview response also revealed that there was a low operational uptime of less than 70 percent indicating possible inconsistency of the system reliability, which could be attributed to infrastructural issues like power supply and communication systems. In general, the functional efficiency of ITS in Abuja seems to be limited by a small scale and infrastructural inefficiency.

Effectiveness of ITS in Traffic Management in Abuja

Table 2 shows the evaluation of the effectiveness of ITS by respondents in key traffic management indicators with 3.29 to 3.47 mean values and 1.05 to 1.13 standard deviations. The values represent rather moderate perceptions of effectiveness, though there is some variation in the answers. Among the indicators, the

greatest mean score was found in the case of getting safety at (Mean = 3.47; SD = 1.05) indicating that respondents feel that ITS is the most effective when it comes to improving road safety. The standard deviation is relatively low, which implies that there was a fair degree of consensus among respondents on the same. This is then followed by cutting down on the travel time (Mean = 3.37; SD = 1.10), and cutting down on the waiting time (Mean = 3.34; SD = 1.12), both of which show moderate consent that ITS helps in the improvement of travel efficiency, but with the slightly higher standard deviations denoting variation in user experiences. Conversely, the least mean score was on reducing traffic congestion (Mean = 3.29; SD = 1.13), though it is still above the neutral mark.

Upon further analysis of the indicators of effectiveness, it was evident that ITS is seen to be most effective in enhancing road safety, then the reduction of travel time and waiting time. The comparatively high rate of agreement on safety is reflected in the study by Puzio *et al.* (2025), which found that the deployment of ITS leads to a significant improvement in road safety due to intelligent monitoring systems, traffic signal control, and automated enforcement measures. Similarly, Cheng *et al.* (2020) found that ITS helps to decrease the time spent in traffic jams and enhance efficiency in traffic flow in cities. Nonetheless, the comparatively lower average score in making congestion reduction indicates a serious deficiency in the existing ITS system. This is in line with John *et al.*

(2019) and Ibrahim and Musa (2023) who concluded that the effects of ITS on congestion in developing settings are also minimal because of partial implementation and shortages of infrastructures. Cheng *et al.* (2020) also highlighted that ITS is more effective at reducing congestion when used at scale and is coupled with larger-scale transport systems.

This implies that although the respondents admit that ITS influences reduction of congestion to some extent, it is not much felt. The standard deviation is also comparatively large, which also suggests a broader range of opinions and implies that the effect of ITS on the reduction of congestion might not be as prevalent at different sites or among different users. These results suggest that ITS has

significantly influenced traffic control in Abuja with its most significant effects being on enhancing road safety. The medium performance in terms of travel and waiting time indicates that ITS is working but its full capabilities are yet to be achieved. This could also be due to slow implementation and adoption of ITS throughout the metropolis as indicated in the interview that, ITS adoption and its implementation have received intense resistance and poor policies. The somewhat reduced perception of its effectiveness in congestion reduction is a pointer that the current ITS deployment might not be of adequate scale or well-integrated to have a significant impact on the congestion issue. This reflects the need for expansion and optimisation of ITS infrastructure as well as coordination with other traffic management actions.

Table 2 Effectiveness of ITS

Statement	Mean	Std. Deviation
Reduce waiting time	3.34	1.12
Reduce travel time	3.37	1.10
Improve safety	3.47	1.05
Reduce congestion	3.29	1.13
Grand mean	3.37	

Source: Author’s field survey (2026).

Barriers to ITS Adoption and Effectiveness

Response from interview further revealed major constraints to the adoption and successful implementation of ITS. These obstacles were noted to be infrastructural, financial, technical and institutional. Infrastructure-related challenges include; lack of power as well as poor internet connection which was noted to have significant negative impact on both the functionality and reliability of ITS. This closely correlates with Dukiya (2013) who cited power failure, and inadequate functioning infrastructure as the primary constraints to ITS in Nigeria. This could be the reason for a limited ITS uptime as noted above. This is because the effectiveness of ITS is dependent on the quality and reliability of power and communication infrastructure.

Financial limitations were also identified as major challenges facing ITS adoption and effectiveness. This includes the lack of sufficient funds for procurement and maintenance of ITS system which usually costs much to acquire and maintain. Waqar *et al.* (2023) and Ahmed *et al.* (2022) observed that expensive maintenance and installation costs are one of the major obstacles to the adoption of ITS in developing economies. This has resulted

in reluctance to adopt and implement. This could also be the reason for the limited level of deployment within Abuja.

Further institutional and technical obstacles include lack of interoperability, lack of standardisation, lack of skilled staff, and the issue of data governance and privacy, system integration challenges and regulatory loopholes. Elassy *et al.* (2024) also emphasize the issue of data security as a severe challenge in smart cities that are ITS-enabled. Other challenges include vandalism and insecurity, the low rates of social acceptance and compliance.

Relationship between ITS Effectiveness and Reduction of Traffic Congestion

H₀₁: There is no significant relationship between the effectiveness of ITS and the level of congestion reduction in Abuja.

A Pearson correlation was conducted to examine the relationship between the perceived effectiveness of ITS and the level of congestion reduction in Abuja. From the result presented in Table 3, a correlation coefficient (r) of 0.584, indicates a moderate to strong relationship between the variables, implying that improvement in effectiveness

of ITS, results in improvement or reduction in the level of congestion in Abuja. The associated p-value (0.000) is less than the 0.05 level of significance, indicating that there was a statistically significant relationship between the two variables. Hence, the null hypothesis is rejected while the alternative is accepted. This results therefore suggested

that the level of congestion is significantly influenced by the effectiveness of ITS. Therefore, improving the operational effectiveness and efficiency of ITS system, for example in areas of improved signal coordination, real time traffic management and overall reliability will result in reduction in congestion levels.

Table 3: Pearson Correlation between ITS Effectiveness and Congestion Reduction

		Effectiveness of ITS	Congestion Reduction
Effectiveness of ITS	Pearson Correlation	1	0.584**
	Sig. (2-tailed)		0.000
	N	386	386
Congestion Reduction	Pearson Correlation	0.584**	1
	Sig. (2-tailed)	0.000	
	N	386	386

Note: Correlation is significant at the 0.01 level (2-tailed)
 Source: Author’s field survey (2026).

Conclusion

The study examines the effectiveness of Intelligent Transport Systems (ITS) in managing traffic congestion in Abuja metropolis. Findings revealed that high vehicle ownership, poor public transport systems, and inadequate traffic management are the major causes of congestion in the city. The research also confirmed low and disparate implementation of ITS in Abuja with the current ITS applications limiting to traffic monitoring and enforcement systems like smart traffic lights, CCTV/ANPR and speed cameras. While respondents agreed that ITS has moderately helped to enhance road safety, to shorten travel time, and to improve traffic management, they felt that its effect on reducing congestion was moderate due to infrastructural, financial, technical, and institutional challenges. The Pearson correlation analysis also showed a significant positive correlation between ITS effectiveness and congestion reduction (correlation coefficient $r = 0.584$, $p < 0.05$), suggesting that the effectiveness of the operational efficiency of ITS can exert significant influence in reducing traffic congestion in Abuja.

Based on these findings, the study recommends that the government and relevant transport agencies should endeavour to expand the infrastructure of ITS in the Abuja metropolis by increasing investment in smart traffic management technologies, integrated traffic monitoring systems and real-time traffic information platforms. Supporting infrastructure, including stable power supply and Internet connections, also needs to be improved to

ensure reliability and operational uptime of ITS systems. In addition, attention should be paid to the root causes of congestion by prioritising policies that would enhance public transport conditions and regulate the excessive use of private vehicles.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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