

Evaluation of Smart Transportation System on Efficiency and Sustainability of Urban Mobility in Lagos State

Babalola Obasanjo James (PhD)¹, Abdul-Rahaman Olalekan Badmus²

¹Department of Transport Management, Faculty of Management Sciences

²P. M. B 4000, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria.

ABSTRACT: Smart transport system is no longer a phenomenon in Nigeria, it is a transport system aided by advanced technology in communication and real-time location tracking. This system has helped in finding alternative route and decongestion. These are parts of smart cities features. The study was carried out in Lagos with the leading economy in Africa. It is also said to be housing the highest percentage of literacy. Lagos residents was estimated to be above 20 million. The study sampled respondents from six (6) bus terminals (TBS, Mafoluku, Oshodi, Oyingbo, Yaba and Ikeja). Data were sourced primarily by questionnaire administration from 120 respondents both technocrats and commuters. Descriptive and regression analysis was used to evaluate the effect of smart transportation system on efficiency and sustainability of urban mobility in Lagos. The study revealed that, four (4) STS tools (traffic management and control tools, navigational control system, speed breaker systems and signal control system) are significant at 34.2, 23.3, 21.7 and 20.8 percent respectively. Furthermore, the correlation coefficient R has the value of .889 (88.9%) while the R² has the value of .791 (79.1%) and adjusted R square of .785. This demonstrates the combined impact of independent variables on the dependent variable and the fitness of data into the model. Therefore, the study concluded that smart transport system influences the efficiency and sustainability of city mobility by minimizing greenhouse gases, travel time and increasing safety as vehicle can be easily tracked and also encourage the government to invest in STS.

KEYWORDS: Smart, Transport, Urban, Mobility, Performance

I. INTRODUCTION

"Smart Transportation Systems (STS) apply a variety of technologies to monitor, evaluate, and manage transportation systems to enhance efficiency and safety," Anwar and Oakil (2023). Efficiency, safety, and management are the three main components of smart transportation, leaving aside thoughts of transportation reminiscent of science fiction for the time being. Stated differently, smart transportation employs state-of-the-art technology to enhance accessibility, cost (for the city and the individual), and safety during urban transit, Ang., Ijamaru and Ngharamike (2022). Smart transportation can be broadly split into two areas, public infrastructure and the vehicle sector. Infrastructure and autos are considered "smart" when they include networked sensors for efficiency, safety, and remote administration and control. With all of these changes, an automobile can use LIDAR (Light Detection and Ranging) in conjunction with Bluetooth at a smart intersection to detect pedestrians and can then automatically apply the brakes to avoid an accident, according to Butt et al. (2022). Streetlights, which are able to detect distinct signals transmitted by each car, are far more accurate and efficient at determining how many cars are waiting in which direction than pressure plates and timers. Cars and streetlights can even communicate to the point where it is feasible for an autonomous start to occur when the light becomes green (or sends a "go" signal to the car's computer) and a stop and slow down to occur when the light turns red (or sends a "stop" signal to the car). The transportation industry uses IoT and 5G connectivity rates for real-time operations and remote sensing, which makes all of this possible. To improve the operational effectiveness of transportation networks, more information technology must be used, Kassler & Nasim (2012). Intelligent transportation systems, or smart transportation, are defined as "the application of advanced sensor, computer, electronics, and communication technologies, and management strategies in an integrated manner to improve the safety and efficiency of the surface transportation system" (McGregor et al., 2003). Intelligent transportation systems improve traffic flow and safety while reducing travel times and fuel consumption. Information and communication technology (ICT) must be seamlessly integrated and used more frequently as ICT infrastructures in order to create a sustainable and intelligent transportation system.

Rapid urbanization is causing people to migrate from rural to urban areas in quest of better living and employment prospects. The country's transportation infrastructure is under a great deal of strain as a result of urbanization in Nigerian cities in order to effectively support and handle the nation's expanding travel demand, Sam and Roy, (2023). As a result, in response to the state's increasing

Evaluation of Smart Transportation System on Efficiency and Sustainability of Urban Mobility in Lagos State

urbanization, the Lagos State administration has declared intentions to build a smart transport system that will match the local government area's travel demand, Mishra, (2023). The main objectives of today's modern public transit systems are to reduce commuter reliance on private vehicles and slow down the rate of urbanization in order to make the transportation system more sustainable. According to Sam and Roy (2023), the number of cities expanded from 35 in 2001 to 55 in the 2011 Census, and 107.9 million people, or 39% of the population, lived in urban areas. There is a vast disparity between the availability and demand for public transportation in the majority of Nigeria's large cities. These communities also face problems with traffic, inadequate infrastructure for public transportation, false information, a lack of parking, and environmental damage. Sustainable transportation in smart cities ensures greater quality of life, cheaper costs, and higher efficiency by utilizing intelligent transportation systems (Dungan & Pop, 2022). Intelligent transportation systems are essential in today's transportation system and a necessary expansion for the development of a sustainable transportation due to concerns about the economy, ecology, safety, and social equality (Yannis & Chaziris, 2022). Thus, it is essential that Intelligent Transport Systems be created with consideration for social, economic, and environmental needs in order to ensure future mobility, accurate information access, and safety (Javed et al., 2022). Momo et al. (2022) define urban mobility as the study of how goods and people can move efficiently and sustainably through densely populated areas of the built environment. Due to population increase, modern and emerging cities and communities must manage the increasing demands for efficient mobility within limited physical infrastructure capacities. Urban population growth will continue to be a burden on urban transportation, but new mobility services enabled by digital technology innovations are proliferating across many of the world's largest cities. Such creative solutions are not only needed to lessen traffic, but also to maintain air quality and regulate environmental toxins. Modern computational, electronic, and communications capabilities are implemented and deployed to enable the management of transportation networks, traffic flow control, and information transfer.

REVIEW OF LITERATURE

Modern technology like cameras, sensors, artificial intelligence, and data analytics are used in autonomous driving in smart transportation systems to enable automobiles to operate with little to no human intervention (Faisal et al., 2019). This means that a car is considered autonomous only if its automated system can complete all alternating tasks, such as navigating through traffic in different driving situations. These systems typically consist of both hardware and software components to enable autonomous driving. These driverless vehicles are equipped with lidar, radar, and cameras, among other hardware and sensors, to help them perceive their environment (Schwartz et al., 2018). To assess the information and make decisions, they also employ advanced processing systems. Among the software elements of autonomous driving systems in smart transportation systems are algorithms and machine learning models that can understand sensor data (Wiseman, 2019). Most developing countries—including Nigeria—deal with problems such environmental pollution, traffic accidents, congestion, lack of information, and parking places as a result of inadequate intelligent transportation systems (Oladimeji et al., 2023). Nigeria is one of the countries in the world that has the highest rate of road fatalities and one of the highest accident rates. Therefore, in order to control traffic and address the increased risk of traffic fatalities and accidents, the development of intelligent transport systems is desperately needed in Nigerian cities. The effectiveness of passenger information systems (such as real-time traffic updates and navigation systems), parking space availability, and traffic management and control are all significantly influenced by the Intelligent Transport System. ITS must consider the essential requirements of Nigeria's Sustainable Transport System in order to develop smart cities. Intelligent transportation solutions can help Nigerian cities with issues related to parking, public transportation, environmental degradation, traffic congestion, and safety.

Development of Passenger Information System

Nigeria's transportation system lacks the passenger information system, which could provide real-time traffic conditions, bus routes and locations, weather reports, detected incidents, and busiest routes, among other information. The passenger information system provides all the information needed for passengers to react appropriately. Passengers can respond correctly if all the necessary information is produced and made available to them via an intelligent transportation system.

A. Intelligent Traffic Control and Management

An intelligence transport system uses a variety of cutting-edge traffic safety technology, such as CCTV cameras connected to a central monitoring system to monitor different areas of the road network, public transportation vehicles, and terminal stations. Traffic demand management is another aspect of traffic control and management. It is simply controlled by using artificial intelligence systems to properly observe the traffic condition in real time. Using artificial intelligence, traffic signals may be appropriately timed to minimize waits at intersections. ITS can be used for electronic ticketing system management and revenue collection, and digital systems can handle data for improved transparency.

B. MADT:

A Multiple-Application Driver Terminal is a board computer that is connected to ITCS (MADT). The current line, daily line planning, and driver management for the whole bus are among the productive data that are offered. In a nutshell, this unit ensures that the right information is displayed at the right time and place.

Evaluation of Smart Transportation System on Efficiency and Sustainability of Urban Mobility in Lagos State

C. Intelligent Parking System

The Intelligent Parking System is an intriguing functional system that ensures quick, damage-free parking at any suitable site in the least amount of time. The system will alert the driver if harm occurs to the vehicle while they are not in it (Morais, 2023).

D. Development of Environmental Friendly Transport System

The modern transportation system faces serious challenges as a result of the steadily rising demand for transportation. An inefficient transportation system's main issue is controlling environmental contamination. Therefore, this study encourages the development of energy-efficient technology to create an environmentally friendly transportation system. Clean technology vehicles, such as those powered by electric motors, compressed natural gas, or biodiesel, can be promoted by using modern technology (Sandaka & Kumar, 2023). Cars that emit noise and pollute the air can be identified using sensors, and for better enforcement, an automated challan system can be used to collect taxes from these vehicles.

E. Role of Internet-of-Things (IoT) in Smart Transportation Systems

Recent advances in cloud computing, big data, wireless sensor networking, and the Internet of Things are giving rise to a new wave of smart transportation applications. The Internet of Things, also known as the Internet of Physical Things, is a network of physical objects that are web-accessible and equipped with sensors, processors, and communication devices to collect environmental data (Rizvi et al., 2018). These devices establish pervasive monitoring platforms that enable massive real-time data collection and sharing, paving the way for the creation of intelligent transportation systems. According to El Khateeb (2018), complex services can be provided through both physical and virtual connections thanks to current and future improvements in information and communication technology (ICT).

II. METHODOLOGY

One of the cities in the world with the quickest rate of growth is Lagos State. With a gross domestic product of \$84 billion, comparable to Ghana's \$75 billion, Angola's \$70 billion, and Ethiopia's \$93 billion, it has one of the largest economies in Africa. It also houses the most populous city and one of the most significant states in Nigeria, as well as a significant financial hub. Lagos State serves as a major center for transportation, education, and culture in both Nigeria and Sub-Saharan Africa. The state also boasts Nigeria's highest percentage of literacy. It is well-known for its thriving marketplaces, lively culture, and substantial commercial activity. Lagos State boasts many development initiatives and the highest Human Development Index in Nigeria, despite chronic crippling traffic and congestion. With an estimated 20 million residents, the Lagos state government is dedicated to improving the order and organization of the metropolitan capital city's transportation system. Several bus terminals, including those at Ikeja, Mafoluku, Oshodi, Oyingbo, Yaba, and TBS Bus Terminals, were sampled. Selected ICT-based transport providers in Lagos, including BRT, Uber, and Lag-ride, are included in the study's population. The heterogeneous population was divided into homogeneous groups using the stratify technique. Based on the anticipated number of ICT base transport providers in the State, the sample size was calculated. The ICT base transport operators that were selected were drawn from several terminal layers, including the TBS Bus Terminal, Mafoluku, Oshodi, Oyingbo, Yaba, and Ikeja Bus Terminal. The study adopted primary data collection due to the bureaucracy in access to secondary data. Questionnaire was administered by 120 respondents in the designated terminals. Multiple regression analysis was used to evaluate the effects of the smart transportation system on the effectiveness and sustainability of urban mobility in Lagos State, descriptive analysis was used to determine the extent of smart transport facilities that were available and to assess the indicators of smart transport facilities.

III. RESULTS AND EXPLANATIONS

A. Level of Smart Transport Facilities Available in the Lagos state.

Smart transport facilities help in the reduction of stress encountered by the road transportation users. There are various degrees of smart transport facilities ranging from signal control system to traffic management and control. Results from the survey distribution revealed that, most of the samples representing 34.2% (41 units) of the respondents recognized traffic management control tools as one of the available facility of smart transport system, followed by navigational control system that had 28 units representing 23.3% of the sample size. Also, speed breaker had a total number of 26 responses while the remaining 25 units recognized signal control system. This implies that to have an efficient and responsive transportation system, several smart transport facilities must be available.

Table 1.1: Level of Smart transport facilities available in the study area.

Variables	Frequency	Percent
Signal control	25	20.8
Navigational control	28	23.3
Speed breaker	26	21.7
Traffic Management Control	41	34.2

Source: Author's Field Work, (2026).

Evaluation of Smart Transportation System on Efficiency and Sustainability of Urban Mobility in Lagos State

B. Influence of Smart transportation system on efficiency and sustainability of urban mobility in Lagos state.

In a bid to analysis the significant influence of smart transportation on efficiency and sustainability of urban mobility in Lagos State, multiple regression analysis was adopted in table 1.2, 1.3 and 1.4. From the findings, 88.9% of the variation influence of smart transportation on efficiency and sustainability of urban mobility in Lagos State that could be explained by the multiple regression model. Therefore, the model is unable to account for only 11.1%. It was statistically significant by an F-value of 145.928, $P < 0.05$ as depicted in table 1.3. Again, only two out of three examined variables are statistically significant. The correlation coefficient R has the value of .889 (88.9%) while the R^2 has the value of .791 (79.1%) and adjusted R square of .785. This demonstrates the combined impact of independent variables on the dependent variable and the fitness of data into the model. Influence of smart transportation on efficiency and sustainability of urban mobility is depicted in Table 1.4. Smart transportation efficiency and sustainability of urban mobility was measured using the independent variables such as Travel time, reduction of green gas emission and socio-economic activities. Among the identified variables, Travel time had the highest significant contribution to the dependent variable, at 0.559 (55.9%) followed by reduction of green gas emission, which made a considerable contribution of 0.362 (36.2%) while socio-economic activities made a lowest contribution of 0.027 less than other variables. This implied that smart transportation had statistically significant influence on efficiency and sustainability of urban mobility. Also the critical p-value between smart transportation and sustainability of urban mobility was 0.000 which was lower than 0.05 level of significance. Dependent Variable: Smart transportation, Predictors (Constant), Influence on socio – economic activities, effect on green gas emission, smart transportation reduces travel time.

Table 1.2: revealed that, Smart transportation system has significant influence on efficiency and sustainability of urban mobility in Lagos State.

Table 1.2: Model Summary

Model	R	R Square	Adjusted Square	R	Std. Error of the Estimate
	.889 ^a	.791	.785		.62731

Source: Author's Field Work, (2026).

Table 1.3 shows the ANOVA results, Smart transportation system has significant influence on efficiency and sustainability of urban mobility in Lagos State.

Table 1.3: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	172.277	3	57.426	145.928	.000 ^b
	Residual	45.648	116	.394		
	Total	217.925	119			

Source: Author's Field Work, (2026).

Table 1.4: revealed that, Smart transportation system has significant influence on efficiency and sustainability of urban mobility in Lagos State.

Table 1.4: Coefficients of Regression

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
	(Constant)	-.097	.138		-.703	.484
	Smart transportation reduces travel time	.636	.105	.559	6.045	.000
	Effect on green gas emission	.354	.067	.362	5.288	.000
	Influence on socio-economic activities	.025	.094	.025	.270	.787

Source: Author's Field Work, (2026).

IV. CONCLUSION

The study concluded the laxity in the traditional and informal transport system operated before the evolution of smart transport system. Therefore, the study concluded that smart transport system influences the efficiency and sustainability of city mobility by minimizing greenhouse gases, travel time and increasing safety as vehicle can be easily tracked. Recommendations were made

Evaluation of Smart Transportation System on Efficiency and Sustainability of Urban Mobility in Lagos State

based on the findings, government should be responsible for the largest percentage of public transit operations, and government should invest in ICT and other navigational tools and lessen tax on application-driven mobility to moderate the cost.

Disclosure of interest

I hereby state that, no competing interest on this research work. I am a university lecturer researching in the area of transportation for the betterment of mankind. This research work is not affiliated to any organization or Institution for gain or whatever reward. This research work is done to contribute to knowledge in the area of modern transport in urban settlements Lagos as case study. I make this disclosure in utmost faith.

Declaration of Funding

From beginning to the end of this research work no fund was received from any organization or institution. This work was solely funded by the author as research funding is at the premature stage in developing Africa.

REFERENCES

- 1) Ang, K. L. M., Seng, J. K. P., Ngharamike, E., & Ijamaru, G. K. (2022). Emerging technologies for smart cities' transportation: geo-information, data analytics and machine learning approaches. *ISPRS International Journal of Geo-Information*, 11(2), 85.
- 2) Anwar, A. M., & Oakil, A. T. (2023). Smart Transportation Systems in Smart Cities: Practices, Challenges, and Opportunities for Saudi Cities. *Smart Cities: Social and Environmental Challenges and Opportunities for Local Authorities*, 315-337.
- 3) Bendell, J. (2022). Replacing sustainable development: Potential frameworks for international cooperation in an era of increasing crises and disasters. *Sustainability*, 14(13), 8185.
- 4) Butt, F. A., Chattha, J. N., Ahmad, J., Zia, M. U., Rizwan, M., & Naqvi, I. H. (2022). On the integration of enabling wireless technologies and sensor fusion for next-generation connected and autonomous vehicles. *IEEE Access*, 10, 14643-14668.
- 5) Chatti, W., & Majeed, M. T. (2022). Information communication technology (ICT), smart urbanization, and environmental quality: Evidence from a panel of developing and developed economies. *Journal of Cleaner Production*, 366, 132925.
- 6) Dungan, L., & Pop, M. D. (2022). Block chain-based solutions for smart mobility sustainability assurance. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1220, No. 1, p. 012057). IOP Publishing.
- 7) El Khateeb, S. (2018). IoT architecture a gateway for smart cities in Arab world. In *Proceedings of the 2018 15th Learning and Technology Conference (L&T)*, Jeddah, Saudi Arabia, 25–26 February 2018; pp. 153–160.
- 8) Faisal, A. Kamruzzaman, M., Yigitcanlar, T., Currie, G., (2019). Understanding autonomous vehicles. *J. Transp. Land Use* 2019, 12, 45–72. [CrossRef]
- 9) Guerrero-Ibanez, J.A. Zeadally, S. Contreras-Castillo, J. (2015). Integration challenges of intelligent transportation systems with connected vehicle, cloud computing, and internet of things technologies. *IEEE Wirel. Commun.* 2015, 22, 122–128. [CrossRef]
- 10) Javed, A. R., Shahzad, F., Rehman, S., Zikria, Y. B., Razzak, I., Jalil, Z., & Xu, G. (2022). Future smart cities: Requirements, emerging technologies, applications, challenges, and future aspects. *Cities*, 129, 103794.
- 11) McGregor, R.V. Eng, P. MacIver, A. (2003). Regional its architectures—From policy to project implementation. In *Proceedings of the The Transportation Factor 2003, Annual Conference and Exhibition of the Transportation Association of Canada*, (Congres et Exposition Annuels de l'Association des transport du Canada) Transportation Association of Canada (TAC), St. John's, NL, Canada, 21–24 September 2003.
- 12) Mishra, A. K. (2023). Smart Cities and the Poor: Towards an Agenda for Inclusive Urbanization in India. Taylor & Francis.
- 13) Momoh, J., Medjdoub, B., Ebohon, O. J., Ige, O., Young, B. E., & Ruoyu, J. (2022). The implications of adopting sustainable urbanism in developing resilient places in Abuja, Nigeria. *International Journal of Building Pathology and Adaptation*.
- 14) Morais, H. (2023). New approach for electric vehicles charging management in parking lots considering fairness rules. *Electric Power Systems Research*, 217, 109107.
- 15) Nasim, R.; Kassler, A. (2012). Distributed architectures for intelligent transport systems: A survey. In *Proceedings of the 2012 Second Symposium on Network Cloud Computing and Applications*, London, UK, 3–4 December 2012; pp. 130–136.
- 16) Oladimeji, D., Gupta, K., Kose, N. A., Gundogan, K., Ge, L., & Liang, F. (2023). Smart transportation: an overview of technologies and applications. *Sensors*, 23(8), 3880.
- 17) Rizvi, S.R. Zehra, S. Olariu, S. Aspire (2018). An agent-oriented smart parking recommendation system for smart cities. *IEEE Intell. Transp. Syst. Mag.* 2018, 11, 48–61. [CrossRef]
- 18) Saarika, P. Sandhya, K. Sudha, T., (2017). Smart transportation system using IoT. In *Proceedings of the 2017 International Conference On Smart Technologies For Smart Nation (SmartTechCon)*, Bengaluru, India, 17–19 August 2017; pp. 1104–1107.

Evaluation of Smart Transportation System on Efficiency and Sustainability of Urban Mobility in Lagos State

- 19) Sam, R., & Roy, S. K. (2023). Assessment and Characterisation of the Service Quality of Existing E-bus System Based on the Road Users' Perception Encouraging the Sustainable Transport in Kolkata City. In *Emerging Technology and Management Trends in Environment and Sustainability: Proceedings of the International Conference, EMTES-2022* (p. 221). Taylor & Francis.
- 20) Sandaka, B. P., & Kumar, J. (2023). Alternative vehicular fuels for environmental decarbonization: A critical review of challenges in using electricity, hydrogen, and bio-fuels as a sustainable vehicular fuel. *Chemical Engineering Journal Advances*, 100442.
- 21) Schwarting, W.; Alonso-Mora, J.; Rus, D., (2018). Planning and decision-making for autonomous vehicles. *Annu. Rev. Control. Robot. Auton. Syst.* 2018, 1, 187–210. [CrossRef]
- 22) Wiseman, Y., (2019). Autonomous vehicles. In *Research Anthology on Cross-Disciplinary Designs and Applications of Automation*; IGI Global: Hershey, PA, USA, 2022; pp. 878–889
- 23) Yannis, G., & Chaziris, A. (2022). Transport system and infrastructure. *Transportation research procedia*, 60, 6-11.



There is an Open Access article, distributed under the term of the Creative Commons Attribution – Non Commercial 4.0 International (CC BY-NC 4.0) (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits remixing, adapting and building upon the work for non-commercial use, provided the original work is properly cited.