OPEN ACCESS
Global Journal of Research in Engineering & Computer Sciences
ISSN: 2583-2727 (Online)
Volume 06 | Issue 04 | July-August | 2026
Journal homepage: https://gjrpublication.com/gjrecs/
Research Article

The Impact of Artificial Intelligence on the Future of Transportation: A Focus on Autonomous Vehicles in Developing Economies

* [1]Shehu Hassan Ayagi, [2]Kabir Dalha Kabir, [3]Bello Abubakar Imam and [4]Sadiq Bello Abubakar

[1,2,3,4] Department of Computer Science Kano State Polytechnic, Kano State of Nigeria.
DOI: 10.5281/zenodo.21283654 **Submission Date: 25 May 2026 | Published Date: 09 July 2026**

***Corresponding author: Shehu Hassan Ayagi**
Department of Computer Science Kano State Polytechnic, Kano State of Nigeria.

Abstract
Artificial Intelligence (AI) is fundamentally reshaping global transportation systems, with autonomous vehicles (AVs) representing the most transformative innovation in this domain. While extensive research exists on AV deployment in developed nations, limited attention has been paid to the unique challenges and opportunities facing developing economies. This study examines the impact of AI on the future of transportation, with a specific focus on Nigeria's readiness for autonomous vehicle adoption. Using a mixed-methods research design, data were collected from 120 respondents, including commuters, transport professionals, AI experts, and policymakers. The findings reveal moderate public awareness of AV technology (45%), significant infrastructure deficits, high implementation costs, and the absence of legal frameworks as primary barriers to adoption. Despite these challenges, 89% of respondents strongly agreed or agreed that autonomous vehicles could reduce road accidents, which remain a major public health crisis in Nigeria. The study concludes that while AI-driven autonomous vehicles offer substantial benefits for safety, efficiency, and environmental sustainability, their successful integration into Nigeria's transportation system requires phased implementation beginning with intelligent transportation systems and partial automation, supported by infrastructure investment, regulatory development, and public education. This research contributes original empirical evidence on AV adoption barriers in a Sub-Saharan African context and provides actionable recommendations for policymakers and technology developers.

Keywords: *Artificial Intelligence, Autonomous Vehicles, Transportation Systems, Developing Economies, Nigeria, Smart Mobility.*

1. INTRODUCTION

Artificial Intelligence has rapidly transformed multiple sectors of human life, including healthcare, finance, education, and transportation. In recent years, the transportation sector has experienced significant technological changes driven by advancements in AI, machine learning, computer vision, and data analytics. These technologies are now being applied to develop intelligent transportation systems and autonomous vehicles capable of sensing their environment, making decisions, and navigating without human intervention (Badue et al., 2021).

The future of transportation is increasingly moving toward automation, efficiency, and safety. Autonomous vehicles, smart traffic systems, and AI-powered navigation platforms are expected to reduce road accidents, traffic congestion, and transportation costs. According to Litman (2022), the integration of AI into transportation systems has the potential to improve mobility, enhance road safety, reduce fuel consumption, and minimize environmental pollution. However, despite these benefits, the adoption of AI-driven transportation technologies also raises concerns related to safety, ethics, employment, and legal responsibility, particularly in developing economies where infrastructure and regulatory frameworks remain underdeveloped.

Nigeria presents a particularly compelling case for examining AI-driven transportation adoption. With over 80% of passenger and freight movement occurring by road (FRSC, 2022), the nation experiences disproportionately high rates of traffic accidents. According to the World Health Organization (2023), Nigeria has a road traffic fatality rate of 27.5 per 100,000 people, significantly higher than the global average. Human error—including speeding, drunk driving, distraction, and fatigue—accounts for approximately 80% of these accidents (Adebayo & Musa, 2023), suggesting that autonomous vehicle technologies could yield substantial safety benefits if successfully deployed.

However, Nigeria's transportation ecosystem differs fundamentally from the environments in which AV technologies have been developed and tested. Challenges including poor road quality, inconsistent lane markings, limited 5G coverage, weak enforcement of traffic laws, and the absence of legal frameworks for autonomous vehicle operation create unique barriers to adoption (Okoro & Ahmed, 2022). Understanding these barriers is essential for developing realistic deployment strategies and avoiding the pitfalls of technology transfer from developed to developing contexts.

This study addresses the following research questions: (1) What is the level of awareness of autonomous vehicles in Nigeria? (2) What challenges affect the adoption of autonomous vehicles in Nigeria? (3) What are the perceived benefits of autonomous vehicles among Nigerian transportation stakeholders? By answering these questions, the research contributes empirical evidence on AV adoption readiness in a Sub-Saharan African context and provides theoretically grounded recommendations for policy and practice.

2. LITERATURE REVIEW

2.1 Autonomous Vehicle Technology and Levels of Automation

Autonomous vehicles, commonly called self-driving cars, are vehicles capable of sensing their environment and navigating without human input. They use AI, LiDAR, cameras, radar, GPS, and machine learning algorithms to interpret data and make decisions on steering, braking, and acceleration. The Society of Automotive Engineers (SAE, 2021) defines six levels of driving automation, ranging from Level 0 (no automation) to Level 5 (full automation in all conditions). Countries such as the United States, Germany, China, and Japan have begun deploying Level 3 and Level 4 autonomous vehicles (Li et al., 2021).

2.2 AI in Traffic Management and Intelligent Transportation Systems

Beyond vehicle-level automation, AI is transforming broader transportation infrastructure. Chen et al. (2020) demonstrated that AI-powered traffic control systems can adapt to real-time traffic conditions by adjusting signal timings and optimizing traffic flow, reducing congestion by 15-25% in urban areas. Intelligent Transportation Systems (ITS) integrate AI with CCTV monitoring, real-time vehicle diagnostics, electronic ticketing, and connected vehicle communication. AVs are considered a key component of ITS because they require digital infrastructure, real-time communication, and automated decision-making processes.

2.3 Safety Implications of Autonomous Vehicles

Safety is a dominant theme in the AV literature. Badue et al. (2021) and Kalra and Paddock (2016) emphasized that AI-based driving systems have the potential to enhance road safety by eliminating human errors such as distraction, fatigue, and impaired driving. Li et al. (2021) found that Level 3 and Level 4 autonomous vehicles reduce crash rates by up to 90% in controlled environments. However, Kalra and Paddock (2016) also cautioned that ensuring AV safety requires extensive validation across millions of driving scenarios to account for rare and unpredictable events—a challenge magnified in developing countries with chaotic traffic patterns.

2.4 Human-AI Interaction and Trust

Kuutti et al. (2020) examined how users interact with autonomous systems and highlighted challenges related to trust, transparency, and control handover between humans and AI. The study found that poor interface design and unclear system behavior can lead to misuse or misunderstanding of autonomous features, which may compromise safety. This suggests that technological advancement alone is insufficient; human factors must be carefully considered in AV design and deployment.

2.5 Developing Country Perspectives

Limited research exists on AV adoption in developing economies. Okoro and Ahmed (2022) conducted a feasibility study of autonomous vehicles in Lagos and Abuja, finding that while Nigerians are increasingly aware of AV technology, the country lacks advanced road markings, traffic sensors, legal frameworks, and roadside digital infrastructure. They concluded that Nigeria can only realistically adopt partial automation in the short term. Adebayo and Musa (2023) analyzed FRSC accident data and found that over 80% of accidents in Nigeria are caused by human factors, highlighting AVs' potential benefits while warning that cyber-attacks, data manipulation, and software errors pose significant risks.

2.6 Theoretical Framework

This study is guided by three theoretical frameworks. The Technology Acceptance Model (TAM) (Davis, 1989) explains that technology adoption depends on perceived usefulness (PU) and perceived ease of use (PEOU). Innovation Diffusion Theory (Rogers, 2003) identifies relative advantage, compatibility, complexity, trialability, and observability as key determinants of adoption speed. Socio-Technical Systems Theory emphasizes that successful technology adoption requires balance between technical systems (machines, infrastructure, digital networks) and social systems (laws, cultural attitudes, institutions, behaviors).

2.7 Research Gap

Despite growing global literature on autonomous vehicles, significant gaps remain. First, most AV studies use data from Europe, North America, and Asia, with limited attention to Nigeria's unique transportation patterns, road culture, and infrastructure. Second, few studies explore how road conditions, digital mapping, internet coverage, and power supply affect AV deployment in developing economies. Third, insufficient literature exists on liability in AV accidents, cybersecurity rules, and insurance for autonomous cars in African contexts. Fourth, little research examines how Nigerian drivers, passengers, and transport stakeholders perceive autonomous vehicles. This study addresses these gaps by providing contextualized empirical evidence on AV adoption readiness in Nigeria.

3. METHODOLOGY

3.1 Research Design

The study adopted a descriptive and exploratory research design within a mixed-methods framework. This approach was selected because transportation systems are complex, involving technology, human behavior, regulations, and ethics. A purely quantitative design might miss deeper insights into ethical challenges or user trust, while a purely qualitative design might lack the statistical evidence needed to convince policymakers.

3.2 Population and Sampling

The population included four stakeholder groups: technology companies developing AI transportation solutions, policymakers and government regulatory agencies, transportation and logistics companies, end users (commuters and general public), and academics and researchers. A purposive sampling technique was employed to select participants with relevant knowledge or experience in transportation and AI systems. The final sample comprised 120 respondents: 60 commuters, 30 transport professionals, 20 AI experts, and 10 policymakers.

3.3 Data Collection

Primary data were collected through structured questionnaires containing both closed-ended (Likert-scale) and open-ended questions, administered to commuters and professionals. Semi-structured interviews were conducted with AI experts and policymakers to gain in-depth insights. Secondary data were obtained from published journals, conference proceedings, government reports, and industry publications.

3.4 Data Analysis

Quantitative data were analyzed using descriptive statistics (percentages, frequencies, means) with SPSS version 26. Qualitative data from interviews and open-ended responses were analyzed using thematic analysis, where responses were grouped into themes including safety, efficiency, ethical issues, and regulatory challenges.

3.5 Validity, Reliability, and Ethics

The questionnaire and interview guide were reviewed by experts in AI and transportation to establish content validity. A pilot study conducted with 10 respondents yielded a Cronbach's alpha of 0.87, indicating good internal consistency. Ethical guidelines were strictly followed: participants gave informed consent, identities remained confidential and anonymous, data were used solely for academic purposes, and sensitive information was handled in compliance with established ethical standards.

4. RESULTS

4.1 Demographic Characteristics

Of the 120 respondents, 60% were male and 40% female. The majority (38.3%) were aged 26-35 years, representing the most active road user demographic. Transport professionals constituted 25% of the sample, followed by commuters (50%), AI experts (16.7%), and policymakers (8.3%).

4.2 Awareness of Autonomous Vehicles

Regarding the first research question on awareness levels, 29.2% of respondents reported high awareness of autonomous vehicles, 45.0% reported moderate awareness, and 25.8% reported low awareness. These results indicate that while awareness is not yet widespread, exposure to AV technology through media and global developments is steadily increasing.

4.3 Challenges Affecting AV Adoption

Table 1 presents respondents' perceptions of challenges affecting autonomous vehicle adoption in Nigeria.

Table 1: Perceived Challenges to AV Adoption

Challenge	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
Poor road infrastructure	56.7	31.7	8.3	3.3
High cost of technology	60.0	29.2	7.5	3.3
Lack of legal framework	49.2	36.7	10.0	4.1
Cybersecurity risks	44.2	33.3	15.0	7.5

The results demonstrate that high technology cost (89.2% agreement) and poor road infrastructure (88.4% agreement) are perceived as the most significant barriers to AV adoption in Nigeria. Lack of legal framework (85.9% agreement) and cybersecurity risks (77.5% agreement) were also identified as major concerns.

4.4 Perceived Benefits of Autonomous Vehicles

Table 2 summarizes respondents' perceptions of the potential benefits of autonomous vehicles.

Table 2: Perceived Benefits of AV Adoption

Benefit	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
Reduction in road accidents	62.5	26.7	6.7	4.1
Improved traffic flow	58.3	28.3	8.3	5.1
Reduced fuel consumption	52.5	33.3	9.2	5.0
Environmental improvement	48.3	35.0	10.0	6.7

Despite identifying significant adoption barriers, respondents expressed strong optimism regarding AV benefits. Reduction in road accidents received 89.2% agreement (strongly agree/agree), representing the most highly valued potential benefit. Improved traffic flow (86.6% agreement), reduced fuel consumption (85.8% agreement), and environmental improvement (83.3% agreement) were also widely endorsed.

4.5 Qualitative Findings

Thematic analysis of interview data and open-ended survey responses revealed four additional themes. First, regarding infrastructure readiness, participants consistently emphasized that Nigeria's current road conditions—including potholes, absence of standardized lane markings, and lack of dedicated autonomous vehicle lanes—are incompatible with current AV technologies. Second, on trust and cultural factors, several transport professionals noted that Nigerian driving culture, characterized by aggressive maneuvers, frequent lane changes without signaling, and disregard for traffic rules, would pose significant challenges for AV perception and prediction algorithms. Third, regarding economic concerns, commercial drivers expressed anxiety about potential job displacement, suggesting that AV adoption could eliminate approximately 5-10 million driving-related jobs in Nigeria's informal transport sector. Fourth, concerning regulatory gaps, policymakers acknowledged that Nigeria currently has no legal provisions for AV testing, licensing, liability determination, or data privacy, creating an environment of regulatory uncertainty that discourages both local innovation and foreign investment.

5. DISCUSSION

5.1 Interpretation of Findings

The findings reveal a paradoxical situation: Nigerian transportation stakeholders recognize autonomous vehicles' substantial potential benefits—particularly for road safety—while simultaneously identifying major infrastructural, economic, legal, and cybersecurity barriers to adoption. This paradox reflects the complex reality facing developing economies as they contemplate advanced technology adoption.

The moderate awareness levels (45%) align with Okoro and Ahmed's (2022) findings in Lagos and Abuja, suggesting that while AV technology has not penetrated deeply into public consciousness, awareness is growing through media coverage of global AV developments. This level of awareness is arguably sufficient to begin public education campaigns that could shape realistic expectations and build trust before deployment.

The overwhelming identification of poor road infrastructure as the primary barrier (88.4% agreement) validates the infrastructure-first perspective. This finding suggests that pursuing AV deployment without simultaneously addressing fundamental road quality and standardization would be premature. Similarly, the high cost barrier (89.2% agreement) indicates that even if technical challenges were resolved, economic feasibility remains questionable for a nation where per capita income is approximately $2,100 (World Bank, 2023).

The strong endorsement of safety benefits (89.2% agreement) is particularly significant given Nigeria's road traffic fatality crisis. This finding suggests that safety messaging could serve as an effective public engagement strategy, potentially building the political will needed for infrastructure investment and regulatory development.

5.2 Theoretical Implications

The findings extend the Technology Acceptance Model (TAM) in important ways. In developed country applications of TAM, perceived usefulness typically drives adoption intentions most strongly. However, in the Nigerian context, perceived ease of use—operationalized as infrastructure readiness, affordability, and regulatory clarity—emerged as equally or more important. This suggests that TAM applications in developing economies may need to place greater emphasis on contextual ease-of-use factors that extend beyond the technology itself to encompass the broader socio-technical system.

The findings also support Innovation Diffusion Theory (IDT) predictions. The compatibility factor (whether AVs fit with existing road culture and driving habits) was consistently identified as problematic. Nigerian driving culture's aggressive and unpredictable characteristics represent a fundamental compatibility challenge that cannot be resolved through technology alone, requiring simultaneous behavioral and cultural change.

Socio-Technical Systems Theory is strongly validated by these findings. Successful AV adoption clearly requires simultaneous development of technical systems (roads, sensors, communication networks) and social systems (laws, regulations, insurance frameworks, public trust, driving culture). Nigeria's current imbalance—with social systems lagging even further behind technical systems than in developed countries—suggests that technology-only solutions will fail.

5.3 Comparison with Previous Research

The finding that human error accounts for approximately 80% of Nigerian road accidents (Adebayo & Musa, 2023) is consistent with global patterns, though the specific manifestations (e.g., poorly maintained vehicles, inadequate driver training, weak enforcement) differ. The 90% crash reduction potential reported by Li et al. (2021) in controlled environments likely represents an upper bound; actual safety benefits in chaotic Nigerian traffic conditions would probably be lower, at least initially.

The infrastructure challenges identified mirror those reported in other developing economy studies (Okoro & Ahmed, 2022; Yusuf & Otene, 2023), suggesting that Nigeria's situation is not unique but rather representative of a broader pattern affecting many Sub-Saharan African and South Asian nations. This implies that solutions may be transferable across similar contexts.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study examined the impact of artificial intelligence on the future of transportation with a specific focus on autonomous vehicle adoption readiness in Nigeria. The findings reveal that while Nigerian transportation stakeholders recognize autonomous vehicles' substantial potential benefits—particularly for road safety—significant infrastructural, economic, legal, and cybersecurity barriers currently preclude full AV deployment. Moderate public awareness, poor road infrastructure, high technology costs, and the absence of legal frameworks represent the most critical challenges.

The study concludes that autonomous vehicles represent a major technological milestone that could transform transportation systems by increasing safety, reducing congestion, and improving efficiency. However, Nigeria currently lacks the infrastructural, technological, and regulatory capacity required for full adoption. Without proper planning, investment, and policy development, the benefits of autonomous vehicles may remain unattainable in the near term. Gradual integration through intelligent transportation systems and partial automation is the most realistic path forward.

6.2 Recommendations

Based on the findings, the following recommendations are offered to policymakers, technology developers, and researchers:

For Government and Policymakers:

1. Prioritize investment in road infrastructure upgrades, including standardized lane markings, improved signage, and dedicated smart mobility corridors, to create a foundation compatible with autonomous vehicle technologies.
2. Develop comprehensive legal frameworks addressing AV testing, licensing, liability determination, data privacy, and cybersecurity requirements before significant deployment occurs.

3. Collaborate with telecommunications companies to expand 5G and high-speed internet coverage in major urban centers to support connected vehicle systems and vehicle-to-infrastructure communication.

For Technology Developers:

4. Design autonomous vehicle systems that are robust to infrastructure variability, including the ability to operate safely on roads without standardized markings using alternative perception and localization strategies.
5. Develop tiered automation solutions appropriate for different market segments, including lower-cost Level 2 and Level 3 systems that could be more feasible for the Nigerian market in the near term.

For Educational and Research Institutions:

6. Establish research and training programs on autonomous vehicle technologies, intelligent transportation systems, and AI applications in transportation to build local technical capacity.
7. Conduct experimental testing of semi-autonomous vehicles within controlled Nigerian environments (e.g., university campuses, special economic zones) to generate context-specific performance data.

For Public Engagement:

8. Launch public education and awareness campaigns focusing on safety benefits and realistic expectations to build trust and acceptance before deployment.
9. Engage commercial driver associations and transport unions in dialogue about transition pathways that address employment concerns and identify new roles in the autonomous vehicle ecosystem.

6.3 Limitations and Future Research

This study has several limitations. First, the sample, while adequate for exploratory analysis, is not fully representative of Nigeria's diverse population; future research should employ probability sampling across multiple states. Second, the study relied on stated preferences and perceptions rather than observed behavior; future research should conduct field experiments with semi-autonomous vehicles where feasible. Third, the cross-sectional design captures attitudes at a single point in time; longitudinal research tracking how perceptions evolve as exposure increases would be valuable.

Future research should address: (1) experimental testing of semi-autonomous vehicles within Nigerian cities to generate performance data under local conditions; (2) detailed analysis of cybersecurity threats specific to autonomous driving systems in developing economy contexts; (3) economic modeling of job displacement and creation resulting from AV adoption in Nigeria's informal transport sector; (4) comparative studies across multiple Sub-Saharan African nations to identify context-specific versus generalizable barriers and solutions; and (5) public trust and ethical concerns associated with autonomous vehicle decision-making in culturally specific traffic scenarios.

REFERENCES

1. Adebayo, T., & Musa, S. (2023). Road accidents and autonomous vehicle potential in Nigeria. *Journal of Transportation Safety*, 15(2), 112-128.
2. Badue, C., Guidolini, R., Carneiro, R. V., Azevedo, P., Cardoso, V. B., Forechi, A., ... & De Souza, A. F. (2021). Self-driving cars: A survey. *Expert Systems with Applications*, 165, 113816.
3. Chen, M., Wang, X., & Zhang, Y. (2020). AI-powered traffic management systems in smart cities. *IEEE Transactions on Intelligent Transportation Systems*, 21(8), 3345-3357.
4. Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
5. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319-340.
6. FRSC. (2022). *Annual road traffic crash report*. Federal Road Safety Corps, Nigeria.
7. Kalra, N., & Paddock, S. M. (2016). Driving to safety: How many miles of driving would it take to demonstrate autonomous vehicle reliability? *Transportation Research Part A*, 94, 182-193.
8. Kuutti, S., Bowden, R., Jin, Y., Barber, P., & Fallah, S. (2020). A survey of deep learning applications to autonomous vehicle control. *IEEE Transactions on Intelligent Transportation Systems*, 22(2), 712-733.
9. Li, W., Wu, C., & Zhang, J. (2021). Safety and performance evaluation of Level 3 and Level 4 autonomous vehicles. *Transportation Research Part C*, 125, 103045.
10. Litman, T. (2022). *Autonomous vehicle implementation predictions: Implications for transport planning*. Victoria Transport Policy Institute.
11. Okoro, C., & Ahmed, M. (2022). Feasibility of autonomous vehicles in Lagos and Abuja: Infrastructure and regulatory assessment. *African Journal of Transport Studies*, 8(1), 45-62.
12. PwC. (2023). *Global consumer survey on autonomous vehicle acceptance*. PricewaterhouseCoopers.
13. Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.
14. Russell, S., & Norvig, P. (2021). *Artificial intelligence: A modern approach* (4th ed.). Pearson.

15. SAE International. (2021). *Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles* (J3016 Standard). SAE International.
16. World Bank. (2023). *Nigeria economic update*. World Bank Group.
17. World Health Organization. (2023). *Global status report on road safety*. WHO.
18. Yusuf, A., & Otene, I. (2023). Digital transformation and intelligent mobility in Nigerian cities. *Journal of Urban Technology*, 30(2), 88-105.
19. Zhang, Y., & Kim, S. (2020). Automation and road safety: A meta-analysis. *Accident Analysis & Prevention*, 145, 105695.

CITATION

Ayagi, S. H., Kabir, K. D., Imam, B. A.& Abubakar, S. B. (2026). The Impact of Artificial Intelligence on the Future of Transportation: A Focus on Autonomous Vehicles in Developing Economies. Global Journal of Research in Engineering & Computer Sciences, 6(4), 42–48. https://doi.org/10.5281/zenodo.21283654