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UNLOCKING ARTIFICIAL INTELLIGENCE POTENTIAL: A REVIEW OF NIGERIA'S TRANSPORTATION SYSTEMS

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ABSTRACT
Artificial Intelligence (AI) is increasingly acknowledged as a transformative force in transportation systems worldwide. In Nigeria, where rapid urbanization intensifies mobility challenges, AI offers practical pathways to improve traffic management, logistics, public transport, and road safety. This study employed a systematic review to examine how AI is being applied within Nigeria's transportation sector, its benefits, and the barriers to adoption. A comprehensive search of academic databases, government reports, and scholarly literature published between 2015 and 2025 was conducted. Guided by PRISMA protocols, 1,245 records were identified, 1,000 screened after duplicates were removed, and 150 full-text articles assessed for eligibility. Seventy-seven studies met the inclusion criteria and were analysed thematically. The evidence highlights diverse applications of AI, including intelligent traffic systems, predictive logistics, smart scheduling for public transport, and safety monitoring. These innovations demonstrate clear benefits: greater efficiency, enhanced safety, improved commuter experiences, and contributions to environmental sustainability. Yet, significant challenges remain. Infrastructural limitations, policy and regulatory gaps, data quality concerns, financial constraints, and issues of public trust continue to hinder widespread adoption.
This review concludes that AI holds substantial promise for advancing Nigeria's transportation systems. Realising this potential will require deliberate investments in infrastructure, robust governance frameworks, and the cultivation of a skilled workforce. With these foundations in place, AI can become a catalyst for safer, more efficient, and more sustainable mobility across Nigeria's urban centres.

Keywords:
Public Transportation; Artificial Intelligence; Urban Centres; Smart Mobility; Traffic Management

INTRODUCTION

Nigeria's transport system functions as the pillar of its economy, yet it continues to struggle with congestion, inefficiency, and underdevelopment. These challenges slow industrial growth, limit access to goods and services, and weaken trade competitiveness. As cities expand and mobility demands intensify, the urgency for innovative solutions becomes clearer. Artificial Intelligence (AI) has emerged globally as a powerful tool to address such systemic issues. In many developed countries, AI is already reshaping transportation by easing congestion, improving safety, reducing costs, and enhancing service reliability. Intelligent traffic management, predictive logistics, smart public transport scheduling, and infrastructure maintenance are no longer futuristic concepts but practical realities. According to the American Society of Civil Engineers (ASCE), outdated infrastructure and congestion cost drivers over $1,000 annually in vehicle wear and fuel inefficiencies [77]. AI technologies such as machine learning and predictive analytics underpin intelligent transport systems that adapt to real-time conditions and support data-driven decision-making [35]. These innovations are central to the broader vision of smart cities, where AI, the Internet of Things (IoT), and big data analytics converge to manage resources efficiently, improve

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public safety, and enhance quality of life [21]. In Nigeria, however, AI adoption in transportation remains limited and fragmented. Persistent challenges—including inadequate infrastructure, ineffective logistics management, and chronic traffic congestion—continue to constrain efficiency [9, 51, 60]. While government and private sector initiatives have attempted to modernise transport systems, progress has been slowed by the absence of integrated, intelligent approaches. Lagos State, Nigeria's commercial hub, illustrates this tension: despite rapid urban growth and mounting transport challenges, AI applications remain underutilised, with limited empirical research guiding implementation [21]. Nonetheless, emerging initiatives such as AI-powered planning and scheduling for the Bus Rapid Transit (BRT) network signal a shift toward intelligent transport solutions. Studies also highlight the potential of Intelligent Transportation Systems (ITS) to reduce congestion and improve road network efficiency [10, 72].

This paper provides a Nigeria-specific systematic review of AI applications in transportation, examining current practices, benefits, limitations, and future possibilities. By synthesising evidence from academic research, government publications, and grey literature, it aims to give transport practitioners and policymakers a clearer picture of how AI can be harnessed to reform Nigeria's transportation systems. In doing so, it situates Nigeria's experience within global smart mobility trends while identifying context-specific opportunities and barriers to adoption.

RESEARCH OBJECTIVES

The main aim of this study is to provide a comprehensive, Nigeria-specific synthesis of how Artificial Intelligence (AI) is being applied in the transportation sector, and to evaluate its potential for addressing systemic challenges. Building on global insights and local realities, the review seeks to bridge the gap between theoretical potential and practical application. Therefore, the specific objectives are to:

- Identify currently deployed AI applications in Nigeria's transportation systems.
- Assess the benefits of AI adoption, such as cost reduction and improved safety.
- Examine the challenges of AI integration, including infrastructural limitations and financial constraints.
- Highlight opportunities for future development in smart and sustainable urban mobility.
- Provide evidence-based recommendations for policymakers, practitioners, and researchers.

LITERATURE REVIEW

Artificial Intelligence (AI) is increasingly transforming transportation systems worldwide, offering innovative solutions for traffic congestion, logistics inefficiencies, and public transport optimisation. Nigeria, despite infrastructural limitations, has begun adopting AI-driven technologies to address pressing mobility challenges. This review synthesises existing research on AI applications in Nigeria's transport and distribution sectors, highlighting benefits, challenges, and lessons from global best practices.

AI in Traffic Management

Traffic congestion is a persistent problem in Nigeria's major cities, including Lagos, Abuja, and Port Harcourt, with significant impacts on productivity and quality of life [64]. AI-powered traffic management systems, leveraging machine learning and predictive analytics, provide real-time data analysis to optimise traffic signals, reduce bottlenecks, and enhance safety [63, 72]. Lagos has piloted AI-driven traffic control centres in partnership with technology firms [21, 53]. Global examples underscore the potential of such systems: Singapore achieved a 15% reduction in congestion and a 30% decrease in travel times through AI traffic optimisation [31], while Columbus, Ohio, recorded a 25% reduction in crashes and a 12% improvement in travel times [15].

AI in Public Transport

AI applications in public transport have improved efficiency and passenger experience. In Lagos, the Bus Rapid Transit (BRT) system employs AI for route planning, scheduling, and fleet management, resulting in reduced wait times and enhanced service reliability [21]. Machine learning enables dynamic scheduling, adjusting bus frequencies and headways in real time to match passenger demand [4, 2]. Centralised planning with optimisation software has demonstrated measurable gains when agencies integrate data pipelines and commit to unified scheduling and rostering.

AI in Logistics and Distribution

Nigeria's distribution sector faces inefficiencies in supply chain management and logistics [36, 58]. AI technologies strengthen inventory management, streamline delivery routes, and improve demand forecasting [29]. E-commerce platforms such as Jumia and Konga employ AI-driven logistics solutions to analyse consumer data, forecast purchasing trends, and optimise delivery schedules [37, 46]. AI-powered inventory systems reduce stockouts and surplus inventory, while logistics platforms provide real-time shipment tracking, enhancing transparency and customer satisfaction [17, 48]. By automating processes such as order processing and restocking,

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AI improves warehouse productivity and reduces holding costs [67]. Route optimisation algorithms further cut fuel usage and delivery times, benefiting freight companies operating in Nigeria's challenging road conditions [54].

AI in Predictive Maintenance

Predictive maintenance is a critical application of AI in Nigeria's transport sector. AI-enabled systems use sensors and machine learning to monitor vehicle conditions in real time, forecasting mechanical issues before they occur [28]. Data on tyre pressure, brake wear, and engine temperature can be analysed to predict maintenance needs, reducing downtime and costs while improving reliability [69, 71]. Ride-hailing services such as Uber and Bolt also integrate AI to match drivers with passengers, optimise routes, and provide real-time traffic information [12, 63]. These applications enhance customer experience, while predictive analytics extend vehicle longevity and minimise breakdowns [62].

Global Perspective and Indigenous Challenges

International experiences demonstrate AI's capacity to revolutionise transportation, from self-driving cars in San Francisco to AI-optimised traffic systems in Singapore [31, 15]. Nigeria's adoption, however, is constrained by limited infrastructure, inadequate data availability, and a shortage of skilled professionals [5, 8]. These challenges present opportunities for innovation through investment in AI talent, improved data infrastructure, and public-private partnerships. Early initiatives in Lagos demonstrate feasibility, and lessons from global successes suggest that Nigeria can achieve significant improvements in efficiency, safety, and reliability by scaling pilot projects, fostering collaboration, and investing in technological capacity.

METHODOLOGY

This study employed a systematic review to synthesise existing research on the applications and implications of Artificial Intelligence (AI) in Nigeria's transportation sector. Searches were conducted across academic databases including Scopus, Web of Science, Google Scholar, and JSTOR, as well as government publications and grey literature. The review covered the period 2015–2025 to capture recent developments in AI adoption. Keywords such as "Artificial Intelligence," "Transportation," "Nigeria," "Traffic Management," "Logistics," and "Public Transport" were combined with Boolean operators and truncations to refine results. Reference lists of included studies were also screened to identify additional publications.

Inclusion and Exclusion Criteria

Studies were included if they:

- Focused on AI applications within Nigeria's transportation sector.
- Reported empirical findings or expert insights.
- Were published in English between 2015 and 2025.

Exclusion criteria applied to studies that:

- Did not focus on Nigeria.
- Addressed transportation without AI relevance.
- Were conceptual or opinion pieces lacking empirical evidence.
- Were published in languages other than English.

Study Selection and PRISMA Flow

The selection process followed PRISMA 2020 guidelines to ensure transparency. A total of 1,245 records were identified. After removing 245 duplicates, 1,000 records were screened by title and abstract. Of these, 850 were excluded as irrelevant. The remaining 150 full-text articles were assessed for eligibility, with 73 excluded for reasons such as insufficient AI focus, lack of empirical evidence, or being outside the Nigerian context. Ultimately, 77 studies met all criteria and were incorporated into the qualitative synthesis.

Data Extraction and Thematic Analysis

Data from the included studies were extracted using a structured template capturing study objectives, AI applications, transportation domain (e.g., traffic management, logistics, public transport), reported benefits, and challenges. A thematic analysis was then conducted to identify recurring patterns and insights. Codes were developed inductively and refined iteratively. Themes were organised into three overarching categories:

- Applications of AI (e.g., intelligent traffic management, predictive logistics, smart public transport systems).
- Benefits of AI adoption (e.g., efficiency gains, reduced congestion, improved safety).
- Challenges and barriers (e.g., infrastructural limitations, policy gaps, data quality issues).

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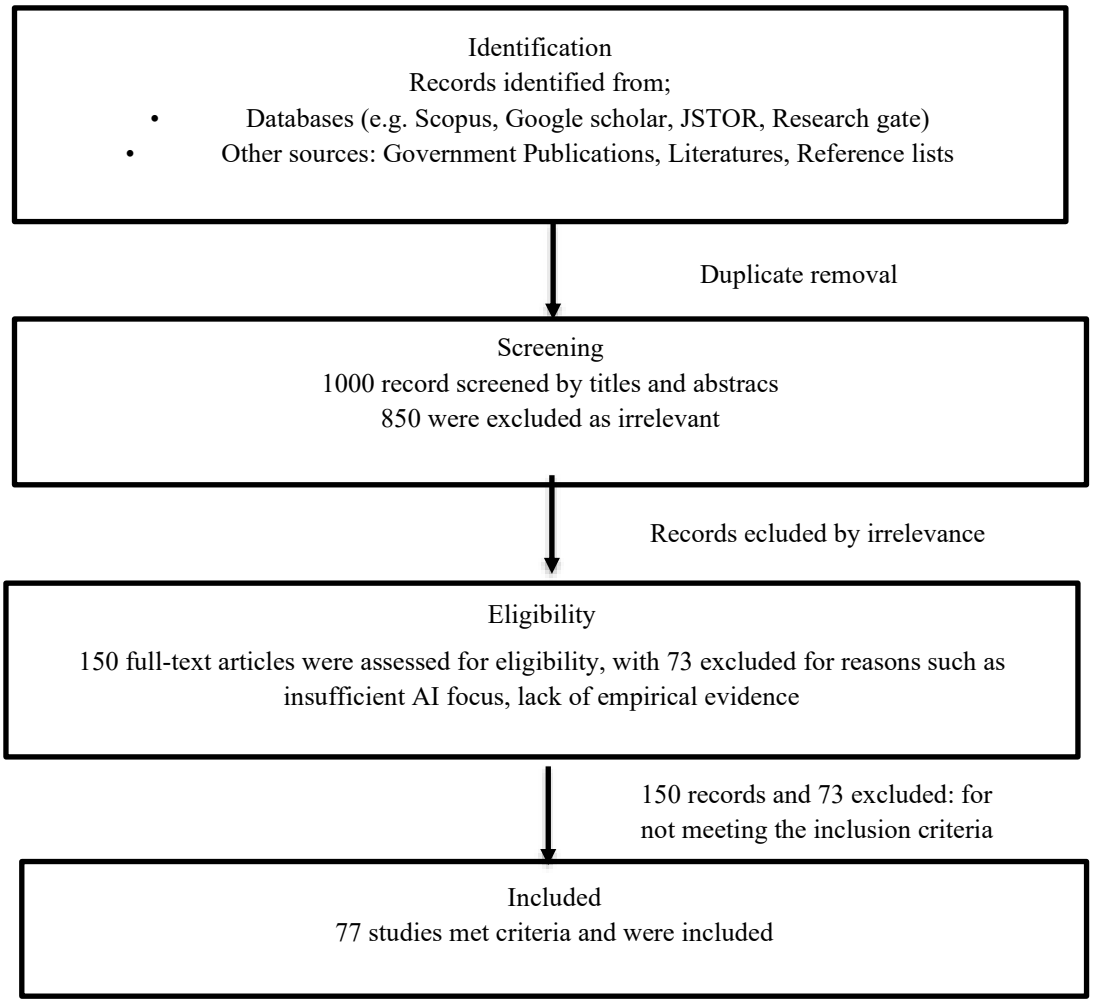

PRISMA flowchart methodology
Source: PRISMA 2020 guidelines.

RESULTS AND DISCUSSIONS

The review highlights the transformative potential of Artificial Intelligence (AI) in Nigeria's road transportation systems, with applications spanning traffic management, logistics optimisation, predictive maintenance, and safety enhancement. Evidence from both domestic and international studies demonstrates AI's capacity to streamline procedures, improve decision-making, and enhance operational efficiency [66]. And the result of the discoveries from the review can be explicitly presented as follows;

Efficiency Gains in Transportation and Logistics

AI-powered ride-hailing services such as Uber and Bolt have reduced passenger wait times and improved route optimisation, thereby increasing service efficiency [20]. Similarly, AI-driven logistics solutions have enhanced delivery networks by minimising delays and maximising resource utilisation [67]. These innovations have contributed to lower operating costs in both distribution and transportation sectors through automation and resource optimisation [29]. Importantly, the integration of AI into logistics platforms has improved customer satisfaction by ensuring timely deliveries and providing real-time tracking updates, as demonstrated by e-commerce platforms such as Jumia and Konga [59, 70].

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Predictive Maintenance and Safety

Predictive maintenance systems represent a critical advancement in Nigeria's transport sector. By anticipating mechanical issues before they escalate, these systems reduce downtime and repair costs, while improving vehicle reliability [22]. Beyond maintenance, AI contributes to road safety by detecting hazardous driving behaviours and risky road conditions, enabling proactive accident prevention [75, 76]. This is particularly relevant in Nigeria, where road accidents remain a pressing public safety concern. The development of autonomous vehicle technologies and AI-enabled traffic management systems further underscores AI's role in reducing human error and enhancing safety [61].

Demand Forecasting and Inventory Management

AI-driven demand forecasting and inventory management systems have reduced inefficiencies in Nigeria's distribution industry by lowering costs associated with excess inventory and stockouts [20]. These systems analyse consumer behaviour and market trends to optimise stock levels, thereby improving supply chain resilience. The ability to forecast demand accurately not only reduces waste but also strengthens the reliability of Nigeria's distribution networks.

Synthesis and Analytical Insights

The findings collectively reveal that AI's integration into Nigeria's transport and distribution systems is not merely a technological upgrade but a structural transformation. Efficiency gains in ride-hailing and logistics demonstrate AI's capacity to address urban mobility challenges, while predictive maintenance and safety applications highlight its potential to mitigate systemic risks. However, the benefits are contingent upon overcoming persistent barriers related to infrastructure, policy frameworks, and equity. Limited data availability and a shortage of skilled professionals constrain the scalability of AI solutions, while policy gaps hinder coordinated adoption.

From a broader perspective, AI's role in Nigeria's transport sector should be understood as both incremental and disruptive. Incremental improvements, such as route optimisation and predictive maintenance, which deliver immediate operational benefits. Disruptive innovations—such as autonomous vehicles and integrated traffic management centres—hold the potential to redefine mobility paradigms but require long-term investment and regulatory adaptation.

Implications for Nigeria

The synthesis of domestic and global evidence suggests that Nigeria's path to unlocking AI potential lies in strategic scaling of pilot projects, fostering public-private partnerships, and investing in AI talent development. By addressing infrastructural and policy barriers, Nigeria can leverage AI to enhance urban living, reduce congestion, and improve safety. The challenge is not whether AI can transform Nigeria's transport systems, but how quickly and effectively these innovations can be institutionalised within the country's unique socio-economic context.

CHALLENGES OF AI ADOPTION IN NIGERIA

Nigeria's distribution and transportation networks benefit significantly from artificial Intelligence (AI), but several obstacles prevent widespread deployment [21]. These include a shortage of skilled workers, expensive overhead, insufficient infrastructure, and worries about the security and privacy of data.

One major obstacle to the successful application of AI technology in Nigeria is the country's inadequate infrastructure, especially roads and energy [57]. Furthermore, for AI systems to operate at their best, dependable power supplies and well-maintained road networks are necessities, and both are deficient in many Nigerian regions, especially the rural areas [7]. Additionally, the full potential of AI in distribution and transportation can only be achieved with the required infrastructure. Thus, this restricts the application of AI technology in general, especially in rural areas.

The financial burden of implementing AI technology is another significant obstacle, according to [3], particularly for small and medium-sized firms (SMEs), which account for a sizable share of Nigeria's economy. Substantial financial investments are needed for AI systems, which include trained workers, software, and hardware [26, 42]. Furthermore, these expenses are unaffordable for many Nigerian companies, especially those in the logistics and transportation industries, which restricts the potential applications of AI. Thus, the potential for AI adoption in Nigeria's distribution and transportation industries is constrained by this financial hurdle.

[74] state that artificial Intelligence (AI) is a highly specialised discipline requiring software development, machine learning, and data science knowledge. Regretfully, there is a severe lack of professionals in Nigeria who possess the necessary abilities to design, create, and manage AI systems [52]. In addition to impeding the

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development of AI solutions, this labour scarcity limits the nation's capacity to realise AI's advantages in its distribution and transportation networks.
According to [41], there are worries regarding data security and privacy as the extensive use of AI mainly depends on the availability and usage of massive datasets. Concerns regarding how businesses gather, retain, and utilise personal data are becoming more widespread in Nigeria. Businesses might be cautious about deploying AI technologies requiring sensitive data access if unclear regulatory frameworks address these concerns [1, 33]. Fostering trust in AI systems requires solid legal frameworks to address these issues.

CONCLUSION

Artificial Intelligence (AI) can significantly transform Nigeria's transportation and distribution systems, driving productivity, lowering costs, and improving customer satisfaction. However, successful adoption requires addressing challenges such as weak infrastructure, high costs, limited expertise, and data protection concerns [6]. Strategic investments in policy development, infrastructure, and education are essential, alongside government funding for modernising transport networks and ensuring reliable electricity [19]. Building capacity through training programs and collaborations between academia and industry will equip Nigerian professionals with the skills to design and manage AI systems [18, 25, 21]. Private sector participation should be encouraged through incentives such as tax breaks and grants to reduce adoption costs [13, 44, 40]. Clear regulatory frameworks must also be established to safeguard data security and privacy, creating an enabling environment for innovation [30, 43]. While this study provides valuable insights into AI's applications in Nigeria's transport and distribution sectors, several research gaps remain. These include the need for localised data on AI adoption, exploration of rural applications, deeper investigation into policy frameworks, and assessment of socioeconomic impacts such as employment shifts. Environmental implications, SME participation, and cultural and ethical considerations also require further study to ensure equitable and sustainable AI integration.

RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER STUDIES

In order to improve AI adoption in Nigeria's transport and distribution sectors, this review report concluded with recommendations for government policies to be implemented, infrastructure investments to be adopted, and skill development to be initiated. It is suggested that future researchers should include looking into;
The economic effects of AI
The role SMEs play in adopting AI
Moreover, there is a necessity for localised AI solutions that consider Nigeria's infrastructure limitations.

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