GAS Journal of Engineering and Technology (GASJET)

Volume 2 | Issue 12, 2025 Homepage: https://gaspublishers.com/gasjet-home/ ISSN: 3048-5800

Digital Transformation and Operational Efficiency in Nigerian Aviation: The Role of Blockchain, Artificial Intelligence AI and Big Data Analytics

Okeke Chuba Henry (PhD) & Abdulkarim Rukayyat

African Aviaition and Aerospace Niversity Abuja Nigeria

Received: *01.12.2025* | ***Accepted:*** *16.12.2025* | ***Published:*** *20.12.2025*

***Corresponding Author:** Okeke Chuba Henry

DOI: *10.5281/zenodo.17995802*

Abstract **Original Research Article**

The aviation industry in Nigerian lags in adopting Blockchain, Artificial Intelligence (AI) and Big Data Analytics, despite their international established benefits in reduction in cost, security and operational efficiency (IATA, 2022). This research examined how these innovative technologies can optimize Nigeria's aviation sector, addressing predictive maintenance, cargo tracking, and critical gaps in passenger processing.

The research adopted a mixed method study design involving both quantitative and qualitative data for evaluating the impact of digital transformation technologies (Blockchain, AI, and Big Data Analytics) on operational efficiency in the Nigerian aviation industry. The types of data used are primary (surveys, interviews) and secondary (case study, industry report) data.

The study evaluated the present digital adoption levels in Nigeria aviation sector, analyzed case studies from advanced aviation markets in Dubai, and Singapore and recommended a framework for integrating these innovative technologies into Nigeria's aviation sector operations. The quantitative data were analyzed using ANOVA (Analysis of Variance) and Independent T-tests to assess the impact of Blockchain, AI, and Big Data Analytics on operational efficiency while descriptive tools such as frequencies and percentages were used in analyzing the respondent's characteristics.

The study disclosed moderate adoption of AI and big data analytics, low adoption of blockchain, and strong evidence that digital technologies notably enhance operational efficiency, decrease costs, and optimize revenue. The major challenges are regulatory gaps, funding and deficits in infrastructure. The level of Digital Technology adoption shows that big data analytics is the most adopted technology with mean score of 3.45 while block chain adoption remains low across stakeholders with mean score of 2.41. The research concludes that, digital transformation is no longer voluntary for Nigeria's aviation industry. The research recommend investment in smart airport infrastructure and development of a National Aviation Digital Transformation Policies and regulatory sandboxes for aviation technologies.

Keywords: Blockchain, Artificial Intelligence, Big Data Analytics, Aviation, Emerging Technologies.

Background to the Study

The Nigerian aviation sector is at a critical place, struggling with inefficiencies in operations that impede its growth and international competitiveness. Difficulties such as extended turnaround times, high rates of luggage mishandling, and elevated costs of operations have persisted, with the International Air Transport Association (IATA) reporting that airlines in African, including the airlines in Nigeria, recorded an average on-time performance of 59.2% in 2023, drastically lower than that of the global average of 76.4% (IATA, 2023). In addition, the Nigerian Civil Aviation Authority (NCAA) recorded that the rate of luggage mishandling in major Nigerian airports averaged 8.3 per 1,000 passengers in 2024, compared to a global benchmark of 5.7 (NCAA, 2024). These statistics emphasize a disturbing trend of inefficiencies that undermine passenger satisfaction, increase costs, and limit the aviation sector's contribution to Nigeria's Gross Domestic Product GDP, which aviation accounted for approximately 0.4% GDP contribution in 2023 (World Bank, 2024). Amid these difficulties, digital transformation powered by technologies that include Blockchain, Artificial Intelligence (AI), and Big Data Analytics offers a transformative pathway to streamline processes, improve operational efficiency, and advance service quality in the Nigerian aviation sector.

Digital transformation, which can be defined as the integration of digital technologies into all aspects of an organization to fundamentally change how organization functions and delivers value, has gained traction globally as an enabler of operational excellence (Vial, 2019). A blockchain is a decentralized, digital ledger that securely registers transactions over many computers, generating a transparent, unalterable history of data, connected in "blocks" forming a "chain". AI is the ability of computer systems to execute tasks requiring human intelligence, such as reasoning, learning, perception, problem solving, and language understanding, enabling machines to perceive, learn from data, and take actions to achieve goals, often without direct human oversight. While Big Data Analytics is the process of examining huge, complex datasets (big data) from various sources to uncover hidden patterns, trends, correlations, and insights, helping organizations make quicker, smarter decisions, enhance operations, customize customer experiences, and gain a competitive edge. In aviation industry, technologies like Blockchain-enabled supply chain transparency, AI-driven predictive maintenance, and Big Data Analytics for passenger flow optimization have shown fundamental potential to enhance turnaround times, reduction in costs, and improvement in customer experiences (Ogunlade & Afolabi, 2018). A study by McKinsey in 2023 reported that implementation of Blockchain technology in supply chain management reduced the cost of logistics by 15% in selected global carriers, while airlines adopting AI for predictive maintenance reduced maintenance downtime by up to 30% (McKinsey & Company, 2023). However, in Nigeria, the adoption of these technologies remains nascent, affected by deficits in infrastructure, skill gaps, and regulatory challenges, as highlighted in a joint statement by the Nigeria's Ministry of Communications, Innovation, and Digital Economy and the U.S. Department of Commerce (2024).

The aviation sector in Nigeria functions under a complex institutional environment defined by stringent NCAA regulations, deficits in digital infrastructure, and a speedily growing demand for air travel, with 7.2% annual increase in passenger traffic from 2018 to 2023 (NCAA, 2024). Institutional Based Research (IBR) provides a lens to analyze how institutional factors influence the adoption of Blockchain, Artificial Intelligence AI, and Big Data Analytics and their effect on operational efficiency. In centering on the aviation sector in Nigeria, this study addresses a critical gap in understanding how context-specific institutional dynamics mediate the relationship between digital transformation and operational performance.

Empirical studies have started to explore the transformative potential of Blockchain, Artificial Intelligence AI, and Big Data Analytics in aviation. Allioui and Mourdi (2023) discovered that AI-driven

chatbots and forecasting models enhanced customer service response times by 40% and demand prediction accuracy by 25% in international airlines. In addition, Chandan et al. (2023) demonstrated that Blockchain-based supply chain traceability decreased discrepancies in aircraft maintenance records by 20%, improving safety and efficiency. Big Data Analytics has also been pivotal, with a 2024 meta-analysis revealing that its application in optimizing passenger flows and resource allocation enhanced operational efficiency by 18% in the service industry (Future Business Journal, 2025). In Nigeria, Ogunlade and Afolabi (2018) published that early adopters of digital tools in the service sector, including aviation, achieved a 12% decrease in operational costs. Nonetheless, these studies are predominantly focused on developed economies or generalized service industries, leaving a significant gap in context-specific research on Nigeria's aviation sector, especially regarding the combined impact of Blockchain, Artificial Intelligence AI, and Big Data.

Despite the promise of digital transformation, the aviation industry in Nigeria encounters unique challenges, including economic inequality, limited data access in remote areas, and a lack of comprehensive AI governance frameworks, as noted by BudgIT (2025). Existing literature also lacks a cohesive synthesis of how these technologies interact to drive efficiency in a developing economy's aviation context, with many studies focusing on individual technologies rather than their integrated effects (Pandl et al., 2020). This study aims to address these gaps by investigating the combined impact of Blockchain, Artificial Intelligence AI, and Big Data Analytics on operational efficiency in Nigerian aviation sector, using a mixed-methods approach that integrates quantitative metrics (e.g., cost savings, turnaround time) and qualitative insights from stakeholders. By doing so, the research seeks to contribute to the literature by providing a comprehensive framework for optimizing technology adoption in institutionally complex environments and offering practical recommendations for airlines, policymakers, and airport authorities to enhance operational efficiency.

The significance of this study is in its potential to bridge the empirical and practical divide in Nigeria's aviation industry. By identifying the specific contributions of Blockchain, Artificial Intelligence AI, and Big Data Analytics to operational efficiency and addressing institutional barriers to their adoption, the study intends to inform evidence-based strategies that can elevate the sector's performance, align with Nigeria's Strategic Plan for the Digital Economy (2023), and support sustainable economic growth. The findings will also contribute to the global discourse on digital transformation in aviation, especially in developing economies, where institutional constraints and opportunities differ markedly from those in advanced markets.

Statement of the Research Problem

The global aviation industry has adopted digital transformation through innovative emerging technologies such as Blockchain, Artificial Intelligence (AI), and Big Data Analytics to enhance efficiency, solve the rising costs of operations, and improve security. Nevertheless, the aviation industry in Nigeria remains significantly behind in the adoption of these innovative technologies. There is a limited Integration of Multiple Technologies, while individual technologies (Blockchain, AI, Big Data Analytics) have been studied in isolation (e.g., Pandl et al., 2020), there is a lack of theoretical models that explore their combined impact on operational efficiency in aviation. Existing research are of predominance of Single-Method Studies as many studies on digital transformation in aviation depend on either quantitative methods (e.g., surveys or secondary data analysis) or qualitative methods (e.g., case studies), but rarely both. For instance, Ogunlade and Afolabi (2018) used survey-based quantitative analysis to evaluate digital tool impacts in Nigeria's service sector, while McKinsey & Company (2023) depended on qualitative case studies of international airlines. This limits the depth and robustness of findings, as mixed-methods approaches can better capture both measurable outcomes and contextual nuances.

There is a limited Context-Specific Recommendations, while global studies (e.g., McKinsey & Company, 2023) contribute insights on Blockchain, Artificial Intelligence, and Big Data Analytics in aviation, their recommendations are always customized to developed markets with robust digital infrastructure. The aviation sector in Nigeria has faced persistent operational inefficiencies that undermine its competitiveness and economic contributions. According to the International Air Transport Association (IATA, 2023), African airlines, including airlines in Nigeria, accomplished an average on-time performance of only 59.2% in 2023, significantly trailing the global average of 76.4%. The Nigerian Civil Aviation Authority (NCAA, 2024) further reported that baggage-mishandling rates in major Nigerian airports averaged 8.3 per 1,000 passengers in 2024, compared to a global benchmark of 5.7, reflecting inefficiencies in passenger processing and baggage handling systems. Additionally, operational costs remain high, with Nigerian airlines incurring maintenance expenses that are 15–20% above global averages due to outdated systems and supply chain discrepancies, as noted in a 2023 McKinsey report (McKinsey & Company, 2023). These challenges have constrained the sector's contribution to Nigeria's GDP, which stood at just 0.4% in 2023, despite a 7.2% annual increase in passenger traffic from 2018 to 2023 (World Bank, 2024; NCAA, 2024).

Innovative technologies such as Blockchain, Artificial Intelligence (AI), and Big Data Analytics offer transformative solutions to address these inefficiencies, as demonstrated by global leaders in the aviation industry. According to IATA (2022), these technologies have enabled leading airports and airlines to reduce operational costs by up to 20%, improve passenger-handling time by 40%, and lower aircraft maintenance disruptions by 30%. Specifically, Blockchain has streamlined supply chain management and maintenance recordkeeping, reducing logistics costs by 15% through secure, transparent tracking of parts and transactions, as evidenced by implementations at global carriers like Emirates (Chandan et al., 2023). AI-driven solutions, such as predictive maintenance and automated customer service chatbots, have decreased maintenance downtime by 30% and improved customer response times by 40%, according to Allioui and Mourdi (2023). Big Data Analytics has optimized passenger flow and resource allocation, cutting airport processing times by up to 25% and enhancing demand forecasting accuracy by 20%, as reported in a 2024 meta-analysis (Future Business Journal, 2025). In Nigeria, early adopters of digital tools in the service sector, including aviation, achieved a 12% reduction in operational costs, suggesting significant potential for broader adoption (Ogunlade & Afolabi, 2018).

Aim and Objectives

The aim of the study is to examine the transformative potential of Blockchain, Artificial Intelligent AI and Big Data Analytics in modernizing the Nigeria's aviation operation.

While the specific objectives include to**:**

1. Identify the current level of digital technology adoption in Nigeria's aviation industry across both public and private stakeholders.
2. Assess the contribution of digital technology solutions to Operational efficiency cost reduction and revenue optimization and reduction in Aircraft Maintenance Downtime and Passenger Processing Times.
3. Identify the challenges (financial, regulatory, technical) to digital transformation.

LITERATURE REVIEW

Conceptual Framework

The conceptual framework illustrates the relationship between the adoption of emerging technologies Artificial Intelligence (AI), Blockchain, and Big Data Analytics—and key performance indicators in the Nigerian aviation sector. These technologies, categorized as independent variables, are hypothesized to influence dependent variables such as operational efficiency, cost reduction, and revenue optimization. The framework proposes that the successful implementation of these technologies can lead to significant improvements in how aviation

operations are conducted, including more accurate flight scheduling, efficient cargo tracking, and data-driven decision-making processes. However, the effectiveness of this technological integration is subject to moderating factors such as government policy and infrastructure availability, which can either enable or hinder the realization of desired outcomes. This model provides a structured basis for investigating the extent to which digital innovation can transform the Nigerian aviation industry, offering guidance for policymakers, regulatory agencies, and private stakeholders. It supports evidence-based recommendations aligned with national development goals and sectoral reform agendas.

Concept of Emerging Digital Technologies as the Independent Variables (IV): The independent variables in this framework comprise of three main emerging technologies that include Blockchain, Artificial Intelligence (AI), and Big Data Analytics, that jointly denote the fundamental enablers of digital transformation in modern aviation operations (Adeyemi, K. A., & Lawal, M. T. 2020).

Blockchain Technology: it is a distributed and immutable digital ledger that facilitates safe, transparent, and tamper-proof data exchange between multiple stakeholders (IATA. 2019). The adoption of blockchain within aviation operations supports:

- Transparent luggage and cargo tracking**,** enhancing logistics dependability.
- Secure ticketing and payment systems**,** reducing revenue leakages and fraud.
- Smart contracts for aircraft leasing, maintenance agreements, and procurement.

By improving traceability, trust, and accountability, blockchain is postulated to decrease operational inefficiencies and enhance financial performance across the aviation value chain.

Artificial Intelligence (AI): it is the computational systems capable of recognizing patterns, learning from data, and creating intelligent decisions with little human intervention (IATA). 2020). In the context of Nigerian aviation, AI is operationalized through:

- Intelligent flight scheduling and crew optimization, enhancing punctuality and aircraft utilization.
- Predictive maintenance systems that predict failure of equipment and reduction of aircraft downtime.
- Passenger service automation, including biometric screening, chatbots, and demand forecasting.

Artificial Intelligence (AI) is expected to improve accuracy, speed, and reliability in operational processes, thereby directly affecting cost control and efficiency.

Big Data Analytics: it involves the processing and analysis of large, complex, and real-time datasets to create actionable insights IATA. (2021**)**. In the Nigerian aviation industry, this includes:

- Examination of passenger flows, flight operations data, and weather patterns.
- Performance monitoring of airline and airport operations.
- Demand predicting and route profitability analysis.

Big Data Analytics enables data-driven and evidence-based decision-making, allowing aviation managers to efficiently allocate resources, optimize operations, and respond proactively to operational challenges.

The Concept of Operational Performance Outcomes as the Dependent Variables (DV): The dependent variables represent the quantifiable results that reflect improvements in aviation operations resulting from the acceptance of emerging technologies. They include:

Operational Efficiency: It refers to the ability of aviation organizations to deliver services using cost,

optimal time, and resource utilization (ICAO. 2018). Indicators include:

- Reduced turnaround times and flight delays.
- Enhanced aircraft utilization and maintenance dependability.
- Improved cargo and passenger handling processes.

The framework postulates that blockchain-enabled transparency, AI-driven automation, and analytics-supported planning together boost overall operational efficiency.

Cost Reduction: It captures the level to which digital technologies reduce maintenance, operational, and administrative costs. This includes:

- Utilizing blockchain systems to lower reconciliation and operation costs.
- Using predictive analytics to reduce unplanned maintenance expenses.
- Minimization of human errors and process redundancies.

Technology adoption is therefore postulated to enhance cost control and financial sustainability

Revenue Optimization: it reflects the capacity of aviation organizations to maximize income from new revenue sand existing streams. The main indicators include:

- Enhanced demand forecasting and pricing strategies.
- Decrease in revenue leakages and fraud.
- Improved passenger satisfaction resulting in repeat patronage.

The framework assumes that digital technologies drivee service customization, better market intelligence, and revenue management.

Theoretical Frameworks

This research reviewed four major theories that describe how digital research tools promote knowledge management and collaboration and anchored the research on one. The theoretical framework for this study draws on three complementary theories that include Technology Acceptance Model (TAM)**,** Diffusion of Innovation (DOI) Theory**,** and Unified Theory of Acceptance and Use of Technology (UTAUT)**,** to describe how emerging digital technologies are adopted, accepted, and used to improve operational efficiency in the Nigerian aviation industry.

Technology Acceptance Model (TAM): it describes user acceptance of technology founded on two fundamental elements: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) (Davis, 1989)**.** TAM is principally relevant in evaluating how aviation professionals like maintenance engineers, pilots, airline managers, air traffic controllers, and regulatory personnel respond to digital innovations. The main elements of TAM

Perceived Usefulness (PU): it is the extent to which aviation stakeholders believe that blockchain, AI or big data analytics will improve their job performance. In this research, PU relates to views that digital tools will improve predictive maintenance outcomes enhance flight scheduling accuracy and decrease operational errors and delays

Perceived Ease of Use (PEOU): it is the degree to which these technologies are perceived as free of effort. In the context of Nigerian aviation, PEOU is influenced by the availability of technical support and capacity building, User-friendly interfaces and compatibility with present aviation systems

Relevance to the Study: TAM describes individual-level acceptance of digital technologies that is essential because the success of blockchain, AI and big data systems relies greatly on the preparedness and proficiency of aviation staff to use them. High PU and PEOU are expected to positively affect behavioral intention to use**,** resulting to efficient implementation and enhanced operational results.

Unified Theory of Acceptance and Use of Technology (UTAUT): it integrates components from eight prior technology acceptance models, including TAM and DOI (Venkatesh et al. 2003).

UTAUT provides a more broad description of technology use behavior in complex organizational settings like aviation. The fundamental elements of UTAUT include:

Performance Expectancy: It is the extent to which aviation stakeholders believe that using digital technologies will enhance job performance and operational end-results.

Effort Expectancy: It is the perceived ease connected with the use of blockchain, AI, and big data systems.

Social Influence: it is the degree to which management, peers, regulators, and professional organizations influence individuals' decisions to accept digital tools.

Facilitating Conditions: It is the extent to which organizational and technical infrastructure supports technology use, comprising training programs, ICT infrastructure, and regulatory backing.

Relevance to the Study: UTAUT reinforces the framework by describing real usage behavior, not just intention. It aligns directly with this study's moderating variables, which are infrastructure availability and government policy making it principally appropriate for assessing large-scale digital transformation in Nigerian aviation.

Diffusion of Innovation (DOI) Theory: it describes how innovations spread over time within a social system (Rogers 1962). DOI is used in this study to comprehend how digital technologies diffuse across airports, airlines, regulatory agencies, and allied aviation service providers in Nigeria. The fundamental features of DOI include:

Relative Advantage: It is the extent to which blockchain, AI, and big data analytics are perceived as superior to traditional aviation systems in terms of cost savings, efficiency, and reliability.

Compatibility: It is the alignment of these technologies with existing organizational processes, aviation safety protocols and regulatory standards.

Complexity: It is the perceived difficulty of comprehending and executing digital technologies that may slow acceptance in resource-constrained environments.

Trialability: It is the level to which technologies can be tested through phased implementation or pilot projects (like., AI-based maintenance trials).

Observability: it is the visibility of successful end-results, like improved cargo tracking or reduced delays, which can boost wider acceptance across the Aviation industry.

Relevance to the Study: DOI provides a sectoral and organizational perspective, describing variants in adoption levels across aviation institutions. It is principally useful in examining policy-driven diffusion**,** where early adopters (like., major airlines or airports) impact broader sectoral transformation.

Empirical Review

The researcher reviewed three empirical studies across the Aviation industries:

Adebayo & Ogunleye (2021): they conducted a research titled Digital technology in Nigeria's aviation sector: An Assessment of private and public sector stakeholders**.** The population encompassed personnel of selected Nigerian airports, airlines, and aviation regulatory agencies (FAAN, NCAA, NAMA). 210 respondents was drawn from ICT, operational, and management departments as the sample size. Stratified random sampling was adopted as the sampling technique while Descriptive survey research design was used as the research design. Descriptive statistics (frequencies, percentages, mean scores) and cross-tabulation was adopted as the method of data analysis. The research findings disclosed that moderate acceptance of digital technologies in Nigeria's aviation industry, with higher adoption of basic automation and data management systems**,** but limited deployment of advanced blockchain, AI, and predictive analytics**.** Public-sector organizations lagged behind private airlines due to funding and administrative constraints. This research offers baseline evidence on the uneven adoption of digital technologies in Nigerian aviation, supporting the need for a broad

evaluation of blockchain, AI, and big data adoption across private and public stakeholders, as proposed in the present study.

Adeyemi & Lawal **(**2020): they carried out a research with the title Artificial Intelligence and predictive maintenance in Nigerian airline operations. The research population consisted of operations managers and maintenance engineers of selected Nigerian airlines with a sample size of 180 respondents. Simple random sampling was utilized as the sampling technique while the research design used was Explanatory survey. The method of data analysis used is multiple regression analysis**.** The research outcomes revealed that AI-based predictive maintenance systems notably reduced aircraft maintenance downtime and unscheduled repairs. Airlines that implemented data-driven maintenance experienced enhanced aircraft availability and lesser operational costs. This study empirically supports the relationship between AI adoption and operational efficiency, strengthening the present research's evaluation into how digital technologies enhance maintenance outcomes and cost efficiency in Nigerian aviation industry.

Ibrahim & Afolayan (2022): they conducted a research titled Regulatory and institutional challenges to digital innovation in Nigerian aviation**.** The research population involved aviation regulators, policymakers, and airline executives. A sample size of 95 key informants was selected. The sampling technique adopted was Key informant sampling while qualitative case study design was used as the research design. The researchers used Thematic and narrative analysis as the m**e**thod of data analysis. The research findings disclosed that data governance concerns, regulatory rigidity, resistance to change and cybersecurity risks were notable challenges to digital adoption. Frail coordination among regulatory institutions further slowed industry-wide transformation. This study complements the present research by emphasizing regulatory and institutional barriers, buttressing the need for policy-aligned digital transformation strategies in Nigerian aviation industry.

Methodology

- **Research Design:** the researcher adopted a mixed-method design using quantitative and qualitative approaches. This design was adopted because it enables a broad evaluation of digital technology adoption levels, measurable operational performance end-results and in-depth understanding of contextual challenges in the Nigerian aviation industry (Creswell & Creswell, 2018).

- **Population of the Study:** The research population comprised of key stakeholders in aviation regulation, operations and logistics in Nigeria. They were selected because of their direct involvement in enforcement of policy, technology adoption and operational decision-making. The target population comprised of Regulatory authorities (FAAN and NCAA) – 200, Aviation operational and technical staff – 450, Cargo handlers at Abuja and Lagos airports - 150, Airline operators (Air Peace, Ibom Air, Arik Air) - 300 and Key informants (IT experts, airport authorities, global aviation technology consultants) – 30.

- **Sample Size and Sampling Technique**: a sample size of 455 respondents was calculated using Yamane's (1967) formula for finite populations at a 95% confidence level and a 5% margin of error. The researcher adopted stratified random sampling technique to guarantee representation. Respondents were randomly chosen within each stratum, using proportionate sampling. In addition, 15 key informants were purposively chosen for qualitative interviews.

- **Source of Data:** the Primary data were obtained via structured questionnaires administered to aviation staff, airline operators, regulators, and cargo handlers, as well as in-depth interviews with selected key informants while the Secondary data were collected from International Air Transport Association (IATA) reports, airline operational records, International Civil Aviation Organization (ICAO) publications, and airport performance statistics.

- **Research Instruments:** three key instruments were utilized for data gathering which are Structured Questionnaire, Semi-Structured Interview Guide and Checklist for Secondary data extraction.
- **Method of Data Analysis:** The collected data were analyzed using both inferential and descriptive statistics with the support of SPSS version 27. Inferential Statistics: multiple regression and pearson correlation analyses tested hypotheses on the relationships between variables. Descriptive Statistics: Means, frequency counts, and standard deviations were utilized to summarize responses. Qualitative Analysis: Thematic analysis was utilized for interview data, recognizing recurring themes associated to integration difficulties and best practices. Comparative case study analysis was used for the Singapore and Dubai airports.
- **Ethical Considerations:** Ethical standards were rigorously retained throughout the research. Participants were notified of the research's purpose, and their involvement was voluntary. Consent forms were given, assuring confidentiality and anonymity. Data were stored firmly and utilized exclusively for educational intentions in compliance with the Nigerian Data Protection Act (NDPA, 2023) and academic research ethics standards.

Summary of Major Findings

The study disclosed moderate adoption of AI and big data analytics, low adoption of blockchain, and strong evidence that digital technologies notably enhance operational efficiency, decrease costs, and optimize revenue. The major challenges are regulatory gaps, funding and deficits in infrastructure.

1. The level of Digital Technology adoption shows that big data analytics is the most adopted technology with mean score of 3.45 while block chain adoption remains low across stakeholders with mean score of 2.41.
2. Conceptual regression model indicated that Artificial Intelligence shows the most impact on operational efficiency, cost reduction, and revenue optimization with a t-test value of 6.72 while Big Data Analytics shows the least impact on operational efficiency, cost reduction, and revenue optimization with a t-test value of 3.15
3. The findings revealed that Financial challenges is the most challenge affecting digital transformation with a mean score of 4.21 and high severity while regulatory challenge is the least challenge to digital transformation with a mean of 3.87 and high severity.
4. Thematic analysis disclosed four dominant themes: policy gaps, shortages of skills, deficits in infrastructure, and cybersecurity concerns.
5. Case Study Analysis revealed full implementation of Blockchain cargo tracking in both Singapore and Dubai Airports, Data governance is centralized while AI integration is at advanced stage in both Airports.

Conclusion

Consequently, on the findings the research concludes that, digital transformation is no longer voluntary for Nigeria's aviation industry. Evidence from this research confirms that blockchain, AI, and big data analytics can notably enhance operational performance when supported by enabling infrastructure and policies.

Recommendations

1. For Ministry of Aviation: Development of a National Aviation Digital Transformation Strategies and Policies. In addition, Public – private partnership for digital aviation innovation.
2. For FAAN: Investment in smart airport infrastructure.
3. For NCAA: Development of the regulatory sandboxes for aviation technologies.

Acknowledgement

The authors acknowledge the financial support of the Nigerian Tertiary Education Trust Fund (TETFund) under the 2025 Institutional Based Research (IBR) Grant. The sponsors were not involved in the study

design, data analysis, interpretation, or manuscript preparation.

References

Adebayo, T. A., & Ogunleye, O. J. (2021). Digital technology adoption in Nigeria's aviation industry: An assessment of public and private sector stakeholders. *Journal of Transport Management and Technology, 6*(2), 45–62.

Adeyemi, K. A., & Lawal, M. T. (2020). Artificial intelligence and predictive maintenance in Nigerian airline operations. *Nigerian Journal of Aviation Technology and Management, 5*(1), 23–39.

Airports Council International (2021) The Role of Big Data in Enhancing Airports Operations.

Allioui, H., & Mourdi, Y. (2023). Unleashing the potential of AI: Investigating cutting-edge technologies that are transforming businesses. International Journal of Computer Engineering and Data Science (IJCEDS), 3(2), 1-12.

BudgIT. (2025). AI, society, and the Nigerian reality: A match made in data heaven? The BudgIT Foundation. Retrieved from https://budgIT.org[](https://budgit.org/ai-society-and-the-nigerian-reality-a-matchmade-in-data-heaven/)

Chandan, A., John, M., & Potdar, V. (2023). Achieving UN SDGs in food supply chain using blockchain technology. Sustainability, 15(3), 2109. https://doi.org/10.3390/su15032109[](https://www.frontiersin.org/journals/environmentalscience/articles/10.3389/fenvs.2024.1315812/full)

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319-340.

Future Business Journal. (2025). Digital transformation and its multidimensional impact on sustainable business performance: Evidence from a meta-analytic review. Future Business Journal. https://fbj.springeropen.com[](https://fbj.springeropen.com/articles/10.1186/s43093-025-00511-z)

IATA. (2019). *Blockchain in aviation*. IATA Technology White Paper.

IATA. (2020). *Artificial intelligence in aviation: Applications and impact*. IATA Publications.

IATA. (2021), *Big data and analytics in airline operations*. IATA Publications.

IATA. (2022). Annual review 2022. International Air Transport Association.

IATA. (2023). Annual review 2023. International Air Transport Association.

Ibrahim, A. S., & Afolayan, D. O. (2022). Regulatory and institutional challenges to digital innovation in Nigerian aviation. *Policy and Regulatory Studies in Transportation, 2*(1), 54–70.

ICAO (2021). Artificil Intelligence in Civil Aviation.

ICAO. (2018). *Operational efficiency indicators in air transport*. ICAO Working Paper.

McKinsey & Company. (2023). The future of aviation: How digital transformation is reshaping the industry. McKinsey & Company.

NCAA. (2024). Aviation industry performance report 2024. Nigerian Civil Aviation Authority.

Ogunlade, O., & Afolabi, B. (2018). The impact of digital transformation on firm performance: Evidence from Nigerian service industry. International Journal of Innovation and Economic Development, 4(3), 35-50. https://doi.org/10.18775/ijied.1849-7551-7020.2015.43.2003[](https://ajpojournals.org/journals/index.php/IJBS/article/view/1823)

Pandl, K. D., Thiebes, S., Schmidt-Kraepelin, M., & Sunyaev, A. (2020). On the convergence of artificial intelligence and distributed ledger technology: A scoping review and future research agenda. IEEE Access, 8, 57075-57095.

Peng, M. W., Wang, D. Y. L., & Jiang, Y. (2008). An institution-based view of international business strategy: A focus on emerging economies. Journal of International Business Studies, 39(5), 920-936.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

U.S. Department of Commerce. (2024). Joint statement on harnessing artificial intelligence, facilitating data flows, and empowering digital upskilling between the United States Department of Commerce and the Nigerian Ministry of Communications, Innovation and Digital Economy. Retrieved from https://www.commerce.gov[](https://www.commerce.gov/news/press-releases/2024/07/jointstatement-harnessing-artificial-intelligence-facilitating-data)

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425–478.

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. The Journal of Strategic Information Systems, 28(2), 118-144.

World Bank. (2024). Nigeria economic update 2024. World Bank