

An Evaluation of the Challenges and Limitations in the Adoption of Technological Innovations at Nnamdi Azikiwe International Airport

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Abstract

Nnamdi Azikiwe International Airport, Abuja, recently adopted advanced technological innovations, despite the recent adoption, operational inefficiencies and passenger dissatisfaction persist. This raises concern about the effectiveness of these innovations in improving operational efficiency and passenger satisfaction at this airport. This study examined the effects of technological innovation on airport operations and passengers experience at Nnamdi Azikiwe International airport Abuja, Nigeria. Data were collected through stratified random sampling from 380 passengers, population size of 5,484,839 and 376 airport operational staff with population size of 2758, through a structured questionnaire. The collected data was analysed using the descriptive and inferential statistics. The Unified Theory of Acceptance and Use of Technology (UTAUT) model was employed. Results on passengers show that technological innovation had a weak correlation with passenger perception and satisfaction, this was based on the holistic evaluation of the airport at ($r = .015, p = .776$) and with security and safety ($r = .002, p = .972$) while result on operational staff with ($r = .051, p = .322$) indicates a weak and statistically insignificant negative relationship between technological innovation and airport operations at Nnamdi Azikiwe International Airport (NIALA) this suggests that there is no strong relationship between airport operations and passenger perception on the effect of technological innovation at the airport. The study concludes that implementation of technological innovation depends on inclusion on operational staff in the adoption of technological equipment at the airport, regular staff training and continuous stakeholder engagement to overcome adoption barriers. The study recommended that, frontline staff should be involve in the selection and implementation of new technologies to aid seamless operational efficiency and passengers' satisfaction.

Keywords: Technology, innovation, airport, operations, challenges.

1.0 Introduction

Technological innovations have become a defining force in the global aviation industry, shaping how airports operate, manage passenger traffic, and ensure safety and efficiency [1]. Across advanced economies, the adoption of smart technologies such as biometric screening, automated baggage handling, digital air traffic management, and integrated security systems has enhanced operational efficiency and improved the passenger experience [2]. Typical examples of the technological advancement in the developed countries are the automated check-in kiosks and mobile check-in options which have reduced the time passengers spend in queues, improving the overall flow within airport terminals globally [3]. Similarly, the implementation of advanced baggage handling systems has minimized the incidence of lost luggage, ensuring that passengers' belongings are handled more efficiently [4]. However, in developing countries, such as Nigeria, the process of adopting and sustaining such innovations is often constrained by a variety of challenges [5].

Passenger experience is a critical aspect of airport operations, influencing customer satisfaction, airport reputation, and overall passenger throughput. The deployment of technology in airports has a profound impact on the passenger journey, from the moment they arrive at the airport to their departure. Technological innovations such as self-service kiosks, mobile applications, and digital way finding systems have empowered passengers to take control of their travel experience, providing them with greater flexibility and convenience [6].

[7] indicated that deploying technological systems such as automated check-in, RFID-assisted baggage handling, e-gates, and biometric border control significantly enhance airport operational efficiency, reduce costs, and improve passenger experience thus enabling airports to compete globally. For instance, applying Six Sigma methods to baggage handling in a Middle East international airport led to reductions of baggage handling time by about 10-19%, improving throughput and cutting delays [8]. Similarly, [7] shows that these systems alleviate congestion at immigration, speed up identity verification, and deliver more predictable processing times under rising passenger volumes. Studies from [9], in Egypt during the COVID-19 pandemic demonstrated that biometric technologies reduce traveler touchpoints, accelerate identity verification, and improve acceptance among passengers. In the context of Sub-Saharan Africa, a study at Jomo Kenyatta International Airport in Nairobi showed that adoption of biometric facial recognition, fingerprint recognition, and automated passport control correlates positively with improved security and operational control [10]. Technological innovations are not just convenience, but a strategic necessity for meeting rising passenger volumes and expectations.

In bid to improve passenger experience, Nigerian aviation scholars have, in the last few years, increasingly turned their attention to the question of what it really means to “adopt technology” in an airport environment. It is not enough, they argue, to simply purchase machines or install systems; adoption in practice is a multi-layered process that brings together equipment, people, rules, and space [5], [11].

Nnamdi Azikiwe International Airport, Abuja, is one of Nigeria’s busiest airports and a critical gateway for both domestic and international air transport. As the capital city airport, it plays a strategic role in connecting Nigeria to global aviation networks [12]. Despite ongoing modernization projects, the airport faces persistent difficulties in aligning with international standards for technological advancement. Issues such as financial constraints, infrastructural inadequacies, regulatory bottlenecks, and limited technical capacity continue to affect the pace and effectiveness of technological adoption [13].

Airports globally are embracing modern technologies to enhance operational efficiency, reduce delays, and improve passenger satisfaction [14]. However, in Nigeria, the adoption of such technologies has not been seamless. Nnamdi Azikiwe International Airport, despite being a priority hub, struggles with inadequate funding, outdated infrastructure, frequent operational disruptions, and regulatory inefficiencies [12].

Furthermore, human and social factors, including resistance to change, insufficient training, and limited awareness of emerging technologies, also pose significant obstacles. These challenges are compounded by infrastructural limitations such as space constraints and delayed policy implementation. If these issues remain unaddressed, the airport risks lagging behind global best practices, which may undermine Nigeria’s competitiveness in international aviation and compromise overall service quality [15].

Given the increasing demand for safe, secure, and efficient air transport services, there is a pressing need to evaluate the barriers that hinder technological innovations at Nnamdi Azikiwe International Airport. Understanding these challenges and limitations will provide useful insights for policymakers, aviation stakeholders, and regulatory authorities in formulating strategies that support sustainable innovation adoption within Nigeria’s aviation sector.

The aim of the study is to examine the effect of technological innovation on airport operations and passenger experience, with a view to enhancing airport operational efficiency and improving passenger experience. The above aim was achieved through the objective: Examined the types of technological innovations implemented at Nnamdi Azikiwe International Airport and analysed the effect of these technological innovations on the efficiency of airport operations and passenger experience. The remainder of the study is structured as follows: Section 2 reviews of relevant literature; Section 3 presents the methodology; Section 4 discusses the findings; Section 5 concludes with implications for policy, management, and future research.

1.1 Literature Review

1.1.1 Conceptual Review of Core Study Variables

Technology refers to the tools, systems, and methods, especially digital and informational, that facilitate airport processes and passenger services. In present-day airports, technologies such as self-service kiosks, biometric identification, automation, Internet of Things (IoT) devices and artificial intelligence (AI) are increasingly deployed. For example, [16] while examining AI-based services in airports found that passengers indicated relatively high attractiveness for self-driving terminal buses and lower attractiveness for AI-robots performing information-gathering roles. Moreover, the adoption of digital technologies is shown to contribute to enhanced passenger experience and operational integration: “through digital technologies and innovative services, the benefits for airports, airlines and passengers are increasing” [17].

The process by which technology (and other resources) is introduced in novel ways to create value, improve processes or differentiate services is termed “Innovation”. In the airport context, this refers to new service-delivery methods, operational processes, business models and passenger-experience enhancements [18]. When we say “airport”, we refer to the entire complex ecosystem in which operations, technology, staff, passengers, airlines, regulatory bodies and service providers interact. The airport serves both as infrastructure (physical and digital) and as a service provider within the air-transport system [19]. According to [18], airports operate in highly competitive and challenging environments and innovation is imperative for them to remain competitive.

“Operations” refers to the processes, workflows, resource allocations, efficiency metrics and performance outcomes associated with airport functioning. This includes check-in, security screening, baggage handling, boarding, passenger flow, and overall throughput [20]. While “challenges” encapsulate the barriers, limitations and contextual factors that hinder the effective adoption of technology and innovation in airports [21]. Such challenges may include: ad-hoc implementation lacking strategic coherence [18]; staff readiness and training; stakeholder alignment and organisational culture, technology adoption gaps, for instance, passengers may be cautious or less open to certain AI-based services despite availability [16]; cybersecurity and governance risks associated with “smart airports” as digitalisation introduces new threat surfaces [22]; and infrastructure and resource constraints, especially in developing countries such as Nigeria [23].

1.1.2 Review of Related Literature

In assessing airport security culture with 26 indicators, [5] used the Airports Council International (ACI 2021) survey instrument with 472 respondents. He found that while technology and other security parameters are increasing, expected security outcomes are not realised unless stakeholder behaviour, attitudes, norms are also aligned. His assessment further reminds us that technology can sit idle unless there is a culture of use, maintenance, and trust among those who interact with it daily.

Investigating how perceived usefulness, compatibility, and organisational readiness influence digital transformation outcomes such as operational efficiency and workforce enablement, [15] provided empirical support for structural equation modelling of adoption variables in aviation regulatory bodies. [24] explored how the COVID-19 shock affected operations in departments such as aviation security, finance, cargo development at NAIA. Among findings: interruptions in operations, reduced capacity, delay in adopting or maintaining technologies. Though not solely about “technology adoption,” it provides context about operational/technical challenges and financial constraints during crises.

[25] examined several emerging technologies (AI, IoT, ML, robotics, etc.), assessed obstacles such as electrical power supply, network connectivity, availability of devices, and skills/misconception. Though wider than aviation, many challenges are directly applicable (e.g. infrastructure, human/technical skills). [11] took NAIA and Lagos MMIA as case studies, surveyed airlines staff and passengers, applied SERVQUAL model; found that “tangibles” (physical facilities, equipment), “reliability,” “responsiveness” are key determinants of perceived service quality. Implicitly, equipment availability and functionality (tangibles) influence satisfaction and by extension willingness to adopt advanced technological innovations for better service.

[26] though focused on mobile technologies, this work used UTAUT/technology acceptance theories, and identifies perceived usefulness, ease of use, infrastructure, network connectivity, regulatory concerns, and skills as determinants for adoption; highlighting that these same factors (infrastructure, human/social, regulatory) can be adopted for airport technological innovations.

The first technical notion is “availability”. When airport staff or passengers are asked about technology, they often think in terms of what they can see: biometric gates at the immigration desk, flight information displays, baggage scanners, or kiosks for self-check-in. [11] captured this visible side of technology under the dimension of “tangibles” in their SERVQUAL analysis of Nigerian airports. They showed that the sheer presence of equipment shapes passengers’ perceptions of service quality. Yet, as staff members habitually note, “having” equipment does not always mean it is usable [11].

That leads us to “functionality”. Equipment can be installed but may not function because of erratic power supply, inadequate maintenance, or missing spare parts. In Abuja, as a case study, airport workers surveyed by [13] explained that certain technologies were present but “not working as intended,” leaving staff to revert to manual processes. Functionality, therefore, means operational readiness (systems that are not only installed but actively used, updated, and delivering the intended purpose) [13].

Another crucial term is “organisational readiness”, sometimes expanded to include “compatibility” and “perceived usefulness”. In a study of the Nigerian Civil Aviation Authority, [15] demonstrated that digital transformation only succeeds when staff believe that new systems will help their work, when those systems are compatible with existing workflows, and when the organisation has invested in training and support. This means that adoption is as much a matter of human conviction as of technical installation.

The human and social dimension is seemingly the most unpredictable. [5] found that leadership attitudes and stakeholder behaviour, rather than hardware, determined whether security technologies were trusted and properly used. Similarly, [13] reported that staff often resist innovations out of fear of redundancy or because training was inadequate. These insights show why “resistance to change” is not an abstract phrase; it is an actual situation in Nigerian airports where the promise of automation collides with anxieties about jobs, culture, and trust.

Then there are the “regulatory and institutional limitations.” Airports are governed by multiple agencies, such as FAAN, NCAA, and security services, whose overlapping mandates often slow down decision-making [15]. Finally, there is the “infrastructural and spatial limitation” such as how [25] in their exploration of emerging technologies in Nigeria, highlighted how power supply, network connectivity, and physical space determine whether technologies can thrive. Airports, being complex infrastructures, face unique versions of these problems: limited terminal space may prevent installation of new baggage handling systems, while unreliable electricity can reduce the functionality of advanced security scanners. [11] similarly noted that the state of physical facilities influences passenger satisfaction, which in turn affects how innovations are perceived.

Taken together, these clarifications show that “technological innovation” in Nigerian airports is not just a machine or a software package. It is the outcome of a chain: first, the equipment must be available; then it must be functional; next, the organisation must be ready and willing; staff must be trained and socially prepared; regulations must be clear and supportive; and finally, infrastructure and space must permit its use. If any of these links are weak, adoption struggles. This chain-like view provides the conceptual backbone for the empirical analysis

in Chapter 3, where the availability and functionality of equipment will be measured alongside staff and passenger perceptions of the challenges that shape adoption.

2.0 Methodology

Nnamdi Azikiwe International Airport is an international airport Abuja is located in Abuja the Federal Capital Territory of Nigeria, west Africa. study was conducted in the Federal Capital Territory (FCT) of Nigeria that covers a landmass of 7315km^2 latitude $8^{\circ}25'$ and $9^{\circ}20'$ N of the Equator and longitude $6^{\circ}45'$ and $7^{\circ}39'$ E of Greenwich Meridian with a total population of 3,840,000 [27], it lies in the Guinean forest-savannah mosaic zone of the West African sub-region. In Abuja, the wet season is warm, oppressive, and overcast, and the dry season is hot and partly cloudy. Over the course of the year, the temperature typically varies from 60°F to 93°F and is rarely below 54°F or above 100°F . It has four terminals, international wing, domestic wing, cargo wing, and General Aviation Terminal (GAT). A single runway of 3.6km serves all four terminals, respectively.

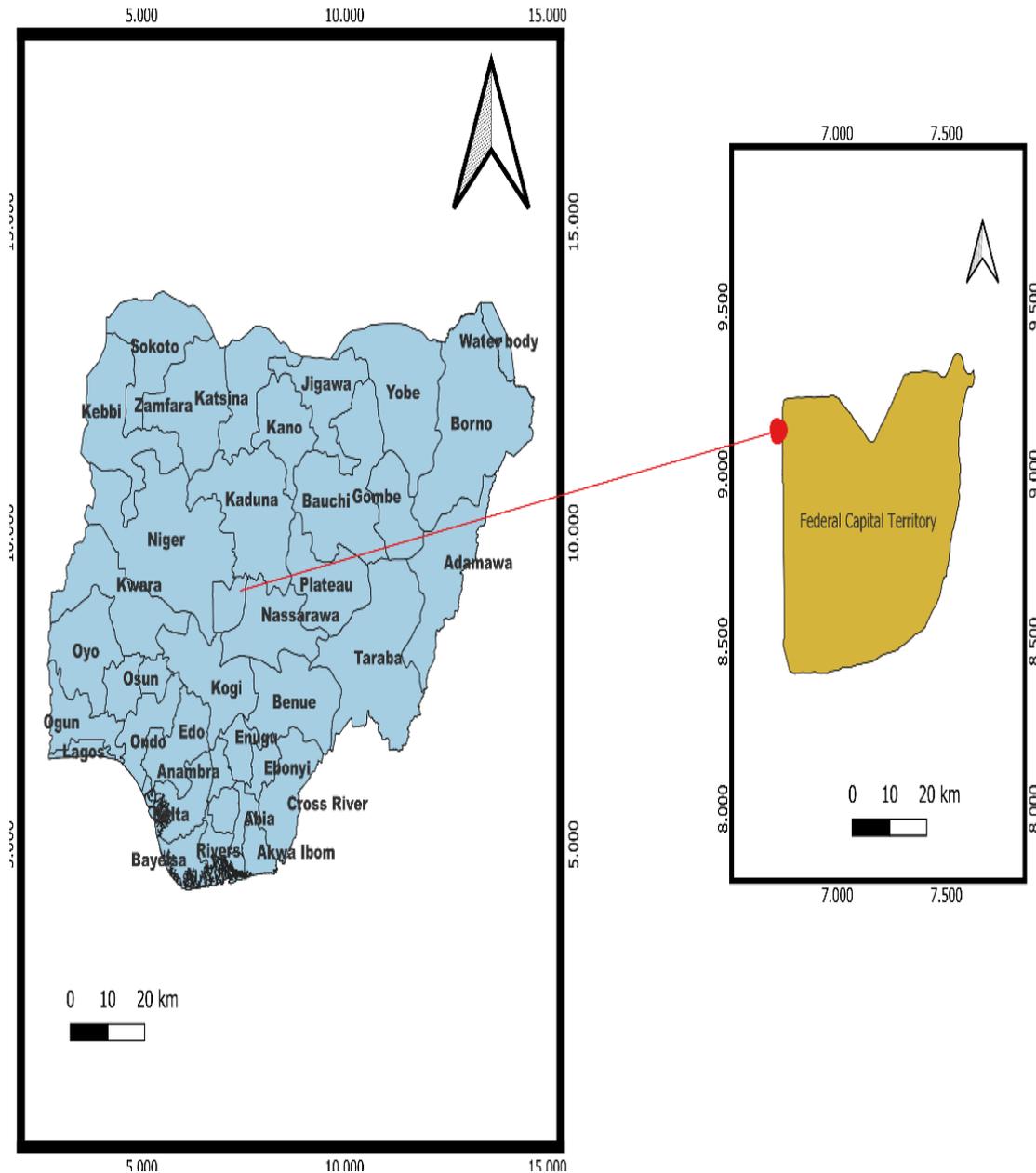


Figure 1: The study area [Source: System Quantum Geographic Information Software]

The sample size of the study was calculated with the Slovin’s E 1960 formula of 95% confidence level, $100\% - 95\% = 5\%$ margin of error. The sample size for the study has been calculated as in total from both the passengers and the airport staff, four groups of respondents distributed using simple random sampling technique strata method among the four groups of respondents, which includes the airport operational staff, namely; FAAN, SACHOL, NACHO and PATHFINDER respectively. Therefore, with a sample size of 400. A total of 376 questionnaires from respondent was correctly answered. Data was collected through a structured questionnaire

from 376 respondents which includes the four airport operational staff, descriptive, and regression analysis was used to analyzed data collected with the aid of SPSS statistical software. Qualitative and quantitative method was employed. This analysis was conducted to examine the relationship between the adoption of technological innovations dependent variable and the identified independent variables, which include inadequate staff training, poor infrastructure, inconsistent management policies, limited funding, resistance to change, and system maintenance challenges. Furthermore, the study seeks to assess the impact of each of these factors on the effective adoption and utilization of technological innovations at Nnamdi Azikiwe International Airport, Abuja.

2.1 Regression Model for the Study

The multiple regression model for this study is designed to examine the challenges and limitations affecting the adoption of technological innovations at Nnamdi Azikiwe International Airport (NAIA). The regression model is as shown in Equation (1):

$$Y = a^0 + b^1X^1 + b^2X^2 + b^3X^3 + b^4X^4 + b^5X^5 + b^6X^6 + e \quad (1)$$

where:

Y = Level of adoption of technological innovations (dependent variable)

a_0 = Constant

$b_1 - b_6$ = Regression coefficients of the independent variables

X_1 = Inadequate staff training

X_2 = Inadequate infrastructure and maintenance culture

X_3 = Limited funding for technological upgrades

X_4 = Operational challenges

X_5 = Inconsistent policy framework

X_6 = Technical system reliability challenges

e = Error representing other factors not captured in the model

3.0 Results and Discussion

This section analyses the types, availability, and functionality of technological innovations implemented and regression analysis was carried out on the challenges and limitations in the adoption of technological innovations at the Nnamdi Azikiwe International Airport, Abuja.

Table 1: Types, availability and functionality of technological equipment at NAIA

Types, Availability and Functionality of Technological Equipment	U	APF	AFF	M	STD D
Self-Service Check-In Kiosks	81 (20.3%)	92 (23.0%)	229 (59.3%)	2.26	1.379
E-Gates / Automated Border Control	116 (29.0%)	50 (12.5%)	234 (58.5%)	2.98	1.332
Mobile Check-In	102 (25.5%)	75 (18.8%)	223 (55.8%)	2.98	1.332
Biometric Verification Systems	90 (22.5%)	81 (20.3%)	229 (59.3%)	2.98	1.332
Baggage Drop Stations	81 (20.3%)	92 (23.0%)	227 (56.8%)	3.15	1.178
Flight Information Display Systems (FIDS)	87 (21.8%)	82 (20.5%)	231 (57.8%)	3.15	1.194
Wayfinding Technologies / Interactive Maps	82 (20.5%)	95 (23.8%)	223 (55.8%)	3.13	1.177
Free High-Speed Wi-Fi	85 (21.3%)	83 (20.8%)	231 (57.8%)	3.15	1.197
CCTV Surveillance Systems	90 (22.5%)	87 (21.8%)	223 (55.8%)	3.09	1.217
Automated Security Screening Equipment	92 (23.0%)	79 (19.8%)	229 (57.3%)	3.11	1.215
Explosive and Metal Detection Systems	83 (20.8%)	95 (23.8%)	222 (55.5%)	3.12	1.178
Access Control Systems	90 (22.5%)	81 (20.3%)	229 (57.3%)	3.12	1.205
Emergency Alert Systems	81 (20.3%)	93 (23.3%)	226 (56.5%)	3.14	1.171
Automated Fire Detection and Suppression Systems	89 (22.3%)	80 (20.0%)	231 (57.8%)	3.13	1.202
RFID Baggage Tracking	84 (21.0%)	93 (23.3%)	223 (55.8%)	3.12	1.184
Automated Conveyor and Sorting Systems	90 (22.5%)	81 (20.3%)	229 (57.3%)	3.12	1.205
Baggage Reconciliation Systems	102 (25.5%)	75 (18.8%)	223 (55.8%)	3.05	1.252
Chatbots and Virtual Assistants	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.03	.304
Digital Feedback and Complaint Portals	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.03	.304
Multilingual Digital Displays and Audio Systems	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.03	.304

Types, Availability and Functionality of Technological Equipment	U	APF	AFF	M	STD D
Smart Retail and Digital Payment Systems	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.03	.304
Automated Parking Systems	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.03	.304
Real-Time Public Transport Integration	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.03	.304
Ride-Hailing Integration Points	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.03	.304

Source: Author's Computation, 2025.

Table 1 presents the availability and functionality of 24 technological equipment examined at Nnamdi Azikiwe International Airport (NAIA). The results were examined by the operational staff only, and findings were categorized into three sections: Unavailable (U), Available but Partially Functional (APF), and Available and Fully Functional (AFF). Out of the 24 technological equipment examined 16 was available while 8 of the equipment is unavailable, data then revealed several core technologies such as baggage drop stations, flight information display systems (FIDS), high-speed Wi-Fi, Metal detection screening machines and emergency alert systems with a mean score above of 3.10, indicated evenly deployed and perceived to function well. Then, technologies like self-service check-in kiosks ($M = 2.26$, $SD = 1.379$) are rated as only partially functional, suggesting a gap between availability and effective operational use of the equipment. Notably, more advanced digital systems chatbots, digital feedback portals, automated parking all has a mean score with 1.03, indicated they are unavailable at the airport. This aligns with findings on airports adoption of digital systems but struggle with post-adoption usability, maintenance, and integration [28]. Moreover, research on airport digital transformation emphasizes that organizational readiness and infrastructure significantly influence whether technology delivers anticipated benefits [29]. Consequently, the results imply that NAIA's technological innovations are unevenly functional, and some newly implemented technological equipment are underutilized.

Table 2: Regression analysis

Analysis of variance						
		Sum of Squares	Df	Mean Square	F	Sig.
Regression	10.068	9	1.119	.927	.502	
Residual	441.709	366	1.207			.000
Analysis of Identified Variables						
	Unstandardized Coefficients		Standardized Coefficients		t	Sig.
	B	Std. Error	Beta			
(Constant)	0.312	0.541			6.268	.000
X1	-0.265	0.072	0.301		4.331	0.001
X2	-0.245	0.081	-0.49		-3.284	0.001
X3	-0.218	0.076	-0.212		-2.868	0.004
X4	0.104	0.068	0.099		1.529	0.127
X5	-0.198	0.073	-0.186		-2.712	0.007
X6	-0.243	0.069	-0.232		-3.522	0.001

Source: Author's computation, 2025.

Table 2 shows the regression model, which is statistically significant $F(6, 369) = 27.824$, $p < 0.001$, indicating that the six variables jointly explain about 63.3% ($R^2 = 0.633$) of the variation in the level of technological innovation adoption at NAIA. This means the model has strong explanatory power, suggesting these variables substantially affect how technologies are adopted and used at the airport.

3.1 Variable Interpretation

Inadequate Staff Training ($\beta = 0.301$, $p < 0.001$), has a significant positive influence on adoption. This implies that as staff training becomes more adequate, technology adoption improves, Inadequate Infrastructure and Maintenance ($\beta = -0.245$, $p = 0.001$), has a significant negative effect on Poor maintenance and infrastructure reduce the efficiency and reliability of technological systems, discouraging adoption., Limited Funding ($\beta = -0.212$, $p = 0.004$) has a significant negative relationship. Budgetary limitations hinder acquisition and upgrading of technology. Operational Challenges ($\beta = 0.099$, $p = 0.127$) has a positive but not statistically significant. Daily operational constraints may contribute to inefficiencies but do not independently affect adoption. Inconsistent Policy Framework ($\beta = -0.186$, $p = 0.007$) has a significant negative effect. Unclear or frequently changing policies reduce the continuity and sustainability of technology initiatives. Technical System Reliability ($\beta = -0.232$, $p =$

0.001) has a significant negative effect. Frequent breakdowns and unreliability discourage continuous use and trust in technological systems.

Overall, the results suggest that staff training, infrastructure, funding, policy consistency, and system reliability are the key determinants of successful technological innovation adoption at NAIA and addressing these areas holistically can substantially enhance operational efficiency.

Table 3: Content analysis

Question	Raw Response	Initial Code	Categories	Interpretation
What are the main challenges you face in adopting new technologies at the airport?	“Frequent system breakdowns delay our work.”	System failures	Technical challenges	Staff experience frustration due to unreliable systems.
What limitations affect the effectiveness of technological innovation at your department?	“We don’t get enough training before using new systems.”	Lack of training	Human capacity limitation	Staff are not adequately prepared for new technology.
How do management policies influence the use of technology?	“Sometimes, policies are unclear or change often.”	Policy inconsistency	Organizational limitation	Unclear policies reduce consistent technology adoption.
What improvements would help in adopting technology better?	“More stable network and maintenance support.”	Infrastructure improvement	Technical support need	Better infrastructure and IT support would ease adoption.

Source: Author’s computation, 2025.

The content analysis of staff responses revealed several persistent barriers to adopting technological innovations at NAIA. First, many staff felt excluded from decision-making regarding technology adoption, which is consistent with studies showing that organizational readiness and stakeholder involvement are critical for successful digital transformation in airports [29]. Second, ethical and cultural objections such as reluctance toward full-body scanning systems due to religious or moral beliefs echo themes in the literature about how cultural norms and security culture influence the acceptance of security technology in Nigeria.

Third, respondents noted that when systems function properly, they do enhance operational effectiveness aligning with the global challenges and success factors identified for airport digital technologies, which emphasize that well-implemented technology can improve reliability and process flow. However, a recurring limitation is the high cost of upgrades and maintenance; such financial constraints are among the most cited barriers in technology adoption research, especially in contexts with limited resources [30].

From the passenger perspective, themes of uneven system implementation across terminals and power outages disrupting service reflect infrastructure readiness issues noted in airport digitalization studies, where reliable supporting systems power, connectivity are essential for sustained technology performance. Despite these constraints, many passengers expressed considerable satisfaction with e-gates and automated border control systems reinforcing the idea that visible, reliable innovations can drive positive perception and user acceptance even in imperfect environments.

Overall, the staff and passenger views converge to show that while the airport has introduced several technological systems, their effectiveness is circumscribed by organizational, cultural, infrastructural, and financial factors highlighting that adoption is not enough without supportive ecosystems, inclusive governance, and sustainable maintenance.

4.0 Conclusion

The study concludes that the adoption of technological innovations at Nnamdi Azikiwe International Airport is influenced primarily by factors such as inadequate staff training, poor infrastructure and maintenance culture, limited funding, inconsistent policy frameworks, and technical system reliability challenges. These variables collectively explain a substantial portion of the variations in adoption levels, highlighting the importance of both human and structural capacities in driving technological integration, the overall model indicates that strategic investment in human resources, stable infrastructure, and coherent policy implementation is essential to enhance efficiency and at the airport.

This study provides one of the first empirical assessments of technological innovation adoption at Nnamdi Azikiwe International Airport (NAIA), integrating both staff and passenger perspectives through the UTAUT framework. Methodologically, this combines quantitative regression with qualitative content analysis to reveal

multi-dimensional barriers to adoption. This study establishes that the presence of technology does not automatically improve efficiency or satisfaction, showing weak but meaningful correlations between innovation and performance outcomes. Theoretically, it extends UTAUT by identifying context-specific constraints (policy inconsistency, poor infrastructure, limited funding, and system unreliability) as moderating factors in developing-country airports. Conceptually, it proposes a “chain-link model” suggesting that adoption success depends on sequential enablers: availability, functionality, organizational readiness, staff competence, regulatory clarity, and infrastructural reliability. These findings contribute to research on airport digital transformation and provide actionable guidance for policymakers and aviation managers seeking sustainable technological integration.

Future research should expand the current model by including mediating variables such as organizational culture, leadership commitment, and change management practices to better understand their role in shaping technology adoption outcomes. Additionally, comparative studies across other major Nigerian or African airports would provide broader insights into regional patterns of technological innovation and operational performance. Mixed-method approaches combining quantitative regression with qualitative interviews are also encouraged to capture deeper contextual factors influencing adoption effectiveness.

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