



The Effect of Technological Innovation on Airport Operations and Passengers' Experience at Nnamdi Azikwe International Airport Abuja, Nigeria

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Abstract

Nnamdi Azikiwe International Airport, Abuja, has recently implemented several advanced technological innovations. However, despite these advancements, operational inefficiencies and passenger dissatisfaction continue to persist. This raises concerns regarding the actual effectiveness of these innovations in improving operational efficiency and passenger satisfaction at the airport. The study examined the effect of technological innovation on airport operations and passenger experience at Nnamdi Azikiwe International Airport, Abuja, Nigeria. The sample size of the study is 2758 passengers. Stratified random sampling was used to select a sample of 380 passengers and structured questionnaire was to collect data from the respondents. The data were analyzed using both descriptive and inferential statistical techniques, guided by the Unified Theory of Acceptance and Use of Technology (UTAUT) model. The findings revealed that there is a weak correlation between technological innovation and passenger perception and satisfaction, based on an overall evaluation of the airport ($r = .015$, $p = .776$) and with respect to security and safety ($r = .002$, $p = .972$). Similarly, the results for operational staff ($r = .051$, $p = .322$) indicated a weak and statistically insignificant negative relationship between technological innovation and airport operations. These results suggest that there is no strong relationship between technological innovation, airport operations, and passenger perceptions at Nnamdi Azikiwe International Airport. The study concludes that the effective implementation of technological innovations depends largely on the inclusion of operational staff in the adoption process, regular staff training, and continuous stakeholder engagement to overcome barriers to technology adoption. It recommends that frontline staff should be actively involved in the selection and implementation of new technologies to promote seamless operational efficiency and enhance passenger satisfaction.

Keywords: Technology, Innovation, Airport, Operations, Passengers

1. Introduction

Technological innovations have significantly transformed airport operations worldwide, enhancing efficiency, security, and passenger experience (Budd & Ison, 2020). Aviation industry holistically as evolved and improved across the globe with significant technological transformations aimed at improving operational efficiency and service delivery. It is projected that the value of the overall travel industry will grow at an annual compound rate of 3.9% (Oluwole *et al.*, 2021), it is then expected for the airport to have adequate technological innovations to enhance performance. These advancements in the developed airports ranges from automated check-in systems, biometric verification, and baggage handling systems to air traffic management (ATM) systems, which Nnamdi Azikiwe International Airports in Nigeria is yet to tap fully into the technological advancement. 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 IATA (2019). Similarly, the implementation of advanced baggage handling systems has minimized the incidence of lost luggage, ensuring that passengers' belongings are handled more efficiently ACI (2020).

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 SITA (2018).

Del Rio *et al.*, (2016) studies 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 (Al-Qatawneh, *et al.*, 2025). Similarly, research on automated border control (ABC) e-gates and facial recognition in European/Schengen airports shows that these systems alleviate congestion at immigration, speed up identity verification, and deliver more predictable processing times under rising passenger volumes. Studies from (El Fkharany, 2022), 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 (Adago, 2021). Technological innovations are not just convenience, but a strategic necessity for meeting rising passenger volumes and expectations.

Nnamdi Azikiwe International Airport (NAIA), located in the capital city of Nigeria, is combined with both domestic and international terminals. As one of the busiest airports in the country, NAIA has undergone significant upgrades to accommodate the increasing demand for air travel and to improve service delivery. The Federal Airports Authority of Nigeria (FAAN) has been at the forefront of implementing technological solutions to enhance airport operations and the passenger experience at NAIA (FAAN, 2021). The international Civil Aviation organization (ICAO) audited the airport and certified it safe and secure for flight operations, with 96 percent score in 2018. Researchers have limited work done on how NAIA has integrated technological advancements into its operations. Understanding the impact of these innovations is crucial for improving service delivery and maintaining competitiveness in the aviation sector (Okeudo *et al.*, 2021).

Research indicates that the adoption of advanced technologies in airport operations can lead to improved efficiency, reduced wait times, and enhanced passenger experiences (Okechukwu, 2021). However, there is limited empirical evidence on how these technologies have impacted operations at NAIA specifically. Although Nnamdi Azikiwe International Airport (NAIA) has adopted several technologies such as self-check-in kiosks, CCTV, baggage-handling systems, and digital displays operational inefficiencies persist, including long queues, delay and mishandling of baggage's at the arrivals, and disruptions in power supply. This reflects a critical gap between technology adoption and effective utilization. While developed airports like Changi, Schiphol, and Heathrow have achieved measurable efficiency gains through integrated systems and process redesign (Tan & Masood, 2021; Miskolczi, 2021). Similarly, Ugo & Chigozie, (2022) found that despite visible infrastructure, passenger satisfaction remains low, while (Nwaogbe *et al.*, 2021) observed performance gaps in the areas of baggage and check-in efficiency how it makes operations seamless. Similarly, Adenigbo,

(2024) noted that security technologies depend on staff culture and compliance, highlighting human and institutional barriers in achieving operational efficiency.

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.

2. Literature Review

Conceptual Review

The conceptual review for this study was anchored on three key concepts; technological innovations, airport operations, and passenger experience.

Technological Innovations

Technological innovation refers to the process of introducing new or significantly improved products, processes, or services to enhance efficiency, productivity, and competitiveness, (Canton, 2021). Contemporary context, technological innovation extends to the integration automation, and data-driven systems that improve organizational efficiency (Schymanietz et al., 2022). The recently adopted technological innovation in the aviation sector promote efficiency, safety, and security in the operating process, and raise passenger satisfaction by better understanding their needs, preferences, and habits (Molchanova, 2022). Similarly, deployment of biometric systems, automated check-in counters, and self-service baggage systems exemplifies process and service innovations that directly influence operational performance and passenger satisfaction (Dsouza, 2024). Technological innovations facilitate deployment of advanced technological innovations provides seamless operational efficiency and enhances passengers travel experience at the Nnamdi Azikiwe International Airport (NAIA).

Airport Operations

Airport operations refer to the coordinated and systematic activities that ensure the safe, secure, and efficient movement of passengers, baggage, and aircraft within airport premises (Zografos et al., 2013). Airport technologies are expected to significantly impact future airport operations, requiring strategic challenges to ensure aviation security, passenger convenience, operational efficacy, and resource efficiency (Rajapaksha & Jayasuriya, 2020). Research shows IoT enhances airport operational efficiency, enhances traveller experience, and generates new revenue through digital technologies like blockchain, biometrics, and cloud computing (Yaqoobi, 2019). However, an evaluation on the terminal airspace system using safety, delay, and predictability metrics, it reveals high air incidences due to faulty equipment and lack of modern technological innovations at the airport for operational efficiency, (Ejem et al., 2020). In line with that, another research focuses on smart airport technologies including RFID tags, self-tagging, smart check-in, and automated baggage systems to demonstrate the potential for automation-driven operational efficiency, passenger delight, and security (Dias, 2024). Automated service data capture, innovative digital passenger services, big data, indoor navigation, and wearable technology in airport ground operations enables seamless operational activities (Kovynyov & Mikut, 2019). Contrary to that study, (Nwagwu & Adeleke, 2022) reveals that Nigeria's international airports primarily use conventional technologies like flight information display systems being the most familiar, while biometric

identification systems are less familiar. In a different opinion, a study indicated that autonomous mobile robots (AMR) were top-ranked technology, in efficiently integrating logistics operations, enhancing productivity, and ensuring high levels of data security and scalability. In addition to AMR, technologies such as the Internet of Things (IoT) and blockchain were identified as pivotal in improving operational processes in air cargo operations (Tadić *et al.*, 2024). Similarly observed by (Olajide & Musa, 2020) that the digital transformation of Nigerian airports as led to enhanced time management and customer satisfaction. Furthermore, the International Air Transport Association (IATA, 2021) highlighted that airports with high digital integration experienced fewer operational disruptions and increased passenger loyalty.

Airport operations conceptualized this study as the mediating factor through which technological innovations impact passenger experience. The assumption is that innovations enhance operational efficiency, and in turn, improve the quality of passenger experience.

Passenger Experience

Passenger experience is defined as the perception, and satisfaction that passengers experience from their interactions with airport staff, and technological innovations throughout their journey (Untaru *et al.*, 2024). A study on service quality (Humza & Hacıoglu, 2023), who suggested that technological preferences of travellers are significantly influenced by biometric technology, personal device usage, customization, and streaming and on-demand entertainment, (Adeniran & Fadeyi, 2019) concluded that there is a very strong relationship between passengers' satisfaction and the service quality. Similarly, a study explored machine learning techniques for improving passenger experience in the aviation industry, including self-service check-in, baggage claims processes, predictive analysis, and mixed reality, paving the way for touchless, seamless operations, (Jiang *et al.* 2023).

Effective communication is critical in the airport environment, where coordination among departments such as security, operations and customer service is essential for seamless operational activities. This corroborate the findings of (Ogunyemi & Alabi, 2020), who investigated the impact of automation and self-service options such as e-check-in kiosks and mobile boarding passes are significantly cutting down on the time passengers spend in queues. This enhances the passenger experience also improves staff productivity by reducing the burden of repetitive tasks. This findings is in line with the work of (Adepoju & Akinwale, 2019), who examined self-service technologies at Murtala Muhammed International Airport, Lagos. They found that digital check-in options led to a 50% reduction in average check-in time and increased passenger satisfaction due to shorter queues and less reliance on manual processes.

Passenger experience conceptualizes this study as the ultimate outcome of technological and operational efficiency within the airport environment. It reflects how passengers perceive and evaluate the quality of services mediated through technological and operational activities.

Conceptual Framework

Conceptual framework showing the relationship between dependent variable, mediating variable and independent variables.

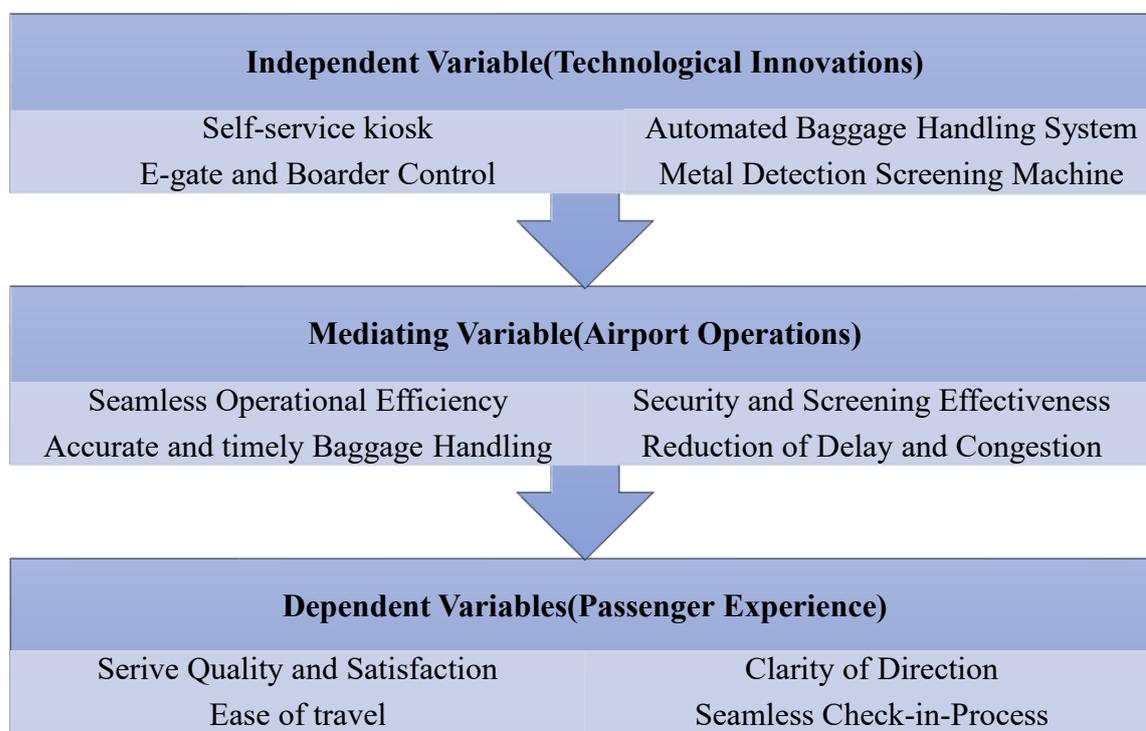


Figure 2.1: Conceptual Framework

Theoretical Review

The unified theory of acceptance and use of technology (UTAUT) is a technology acceptance model formulated by Venkatesh and others in user acceptance of information technology: Toward a unified view. The UTAUT aims to explain user intentions to use an information system and subsequent usage behaviour. The theory holds that there are four key constructs: 1) performance expectancy, 2) effort expectancy, 3) social influence, 4) facilitating conditions.

UTAUT helps explain how and why different stakeholders adopt technology at the airport. By understanding these factors, airport management can improve the introduction of new systems, ensure smooth implementation, and enhance user satisfaction for both staff and passengers. The Unified Theory of Acceptance and Use of Technology (UTAUT) is highly relevant to analyzing the effect of technological innovation on airport operations and passenger experience at Nnamdi Azikiwe International Airport, Abuja.

Empirical Review

This review of the literature concentrates on empirical results from research that utilize different studies to analyse the effect of technologies on airport operation and passengers experience, included are reviews of literature and empirical research from peer-reviewed journal papers on the dependent, mediating and independent variables.

Humza & Hacıoglu, (2023), analyzed optimizing passenger experience: A technological preference analysis in Turkish Airports. The study employed purposive sampling with a sample size of 455. Various statistical techniques, such as regression, correlation, and descriptive statistics, was used to analyze data, results show that passenger satisfaction are significantly influenced by biometric technology, personal device use, and streaming and on-demand entertainment. Empirical gap, NAIA, Abuja, in a developing country, where technology is still struggling to be fully adopted passengers are yet to gain optimum satisfaction from the implemented technology.

Ali & Hasan, (2023) conducted a study on IoT-Based Smart Airport Check-In System Via Three-Factor Authentication (3FA), at Kurdistan Region. Iraq. Raspberry Pi 4B hardware was employed to analyze a smart airport check-in system using the Internet of Things, two cameras for scanning processing BCBP data, and a fingerprint reader for biometric authentication. The system is monitored using the KAA platform and ensures smooth, secure, and reliable check-ins. Tested on 100 travelers, the system significantly reduces check-in time compared to traditional methods, resulting in faster and more efficient check-ins. Empirical gap, NAIA lagging behind in adopting a similar technological advancement which can aid operational efficiency and enhance passenger's experience.

Ogbonna *et al.*, (2023) examined the sociological perspective on the impact of technology on airport management in Nigeria, the paper used a qualitative descriptive technique, tabulation, and graphic illustrations in its analysis. Findings indicated that technology has both positive and negative impacts on Nigeria's airport management, it helps airport personnel workflow convenience while also portending future job loss. Empirical gap, NAIA staff may feel threatened portending future job loss regardless of how technology enhances their jobs.

Bassey *et al.* (2024), examined Factors influencing adoption of service robots in Nigerian Airports. The study adopted cross-sectional survey design, and data were obtained from 241 airport staff using structured questionnaires. Hypothesized relationships were tested using multiple regression analysis. study suggested that, the majority of airport operators are rapidly using robotics into their service delivery infrastructure due to the requirement to increase prompt customer service delivery. In summary, empirical review of existing studies reveals that researchers have linked technological innovation with airport operations and passenger experience, few have examined the mediating role of airport operations within this context. Moreover, most previous studies were conducted in developed countries with limited empirical evidence from the developing countries. This creates a contextual gap that the present study addresses by examining how technological innovation affects both operational efficiency and passenger experience within the airport at Nnamdi Azikiwe International Airport, Abuja.

3. 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 (NPC, 2023), 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.

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, six groups of respondents distributed using Slovin strata method among the six categories of respondents, which includes the domestic and international passengers in the category of passengers with four organizations in the categories of airport staff, namely; FAAN, SACHOL, NACHO and PATHFINDER respectively. The sample size of the passengers and the airport staff was calculated separately for clearer understanding and to get detailed insights. Therefore, both categories have 400

sample size. A total of 376 questionnaires from respondent was correctly answered from staff while a total number of 380 questionnaires was correctly filled by passengers from both wings. Stratified random sampling technique was employed which include four strata groups from airport operational staff and two strata groups international and domestic wings passengers.

Data was collected through a structured questionnaire from 756 respondents which includes the airport staff and passenger, descriptive, correlation and regression analysis was used to analyzed data collected with the aid of SPSS statistical software.

4. Results and Discussion

This section analyses the types, availability, and functionality of technological innovations implemented at Nnamdi Azikwe International airport, Abuja and to analyse these technological innovations on the efficiency of airport operations and passenger satisfaction.

Table 4.1. Instrument Validation and Reliability Analysis

S/N	Variable Name	Cronbach Alpha	No of Items
1.	Availability and functionality of TI	.906	24
2.	Effect of TI on Airport Operations	.783	10
3.	Passenger experience and satisfaction	.757	10
4.	Security and Safety	.962	10

Source: Author's Computation, 2025.

Table 4.1 shows the availability and functionality of Technological Innovation with a Cronbach's Alpha of 0.906, which is excellent. This suggests that the 24 items under this construct are highly consistent and reliable for measuring the concept, Effect of technological innovation on Airport Operations as well as Cronbach's Alpha of 0.783, which is as well excellent. Passenger experience and satisfaction with a Cronbach's Alpha of 0.757, Cronbach's Alpha with above 0.9 indicates excellent internal consistency (George & Mallery, 2024). the internal consistency is acceptable for reliability analysis. The table above shows there is a stable internal consistency among the variables to test for further analysis.

Table 4.2. 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%)	2.2	1.379
E-Gates / Automated Border Control	116 (29.0%)	50 (12.5%)	234 (58.5%)	2.9	1.332
Mobile Check-In	102 (25.5%)	75 (18.8%)	223 (55.8%)	2.9	1.332
Biometric Verification Systems	90 (22.5%)	81 (20.3%)	229 (59.3%)	2.9	1.332
Baggage Drop Stations	81 (20.3%)	92 (23.0%)	227 (56.8%)	3.1	1.178

Flight Information Display Systems (FIDS)	87 (21.8%)	82 (20.5%)	231 (57.8%)	3.1 5	1.194
Wayfinding Technologies / Interactive Maps	82 (20.5%)	95 (23.8%)	223 (55.8%)	3.1 3	1.177
Free High-Speed Wi-Fi	85 (21.3%)	83 (20.8%)	231 (57.8%)	3.1 5	1.197
CCTV Surveillance Systems	90 (22.5%)	87 (21.8%)	223 (55.8%)	3.0 9	1.217
Automated Security Screening Equipment	92 (23.0%)	79 (19.8%)	229 (57.3%)	3.1 1	1.215
Explosive and Metal Detection Systems	83 (20.8%)	95 (23.8%)	222 (55.5%)	3.1 2	1.178
Access Control Systems	90 (22.5%)	81 (20.3%)	229 (57.3%)	3.1 2	1.205
Emergency Alert Systems	81 (20.3%)	93 (23.3%)	226 (56.5%)	3.1 4	1.171
Automated Fire Detection and Suppression Systems	89 (22.3%)	80 (20.0%)	231 (57.8%)	3.1 3	1.202
RFID Baggage Tracking	84 (21.0%)	93 (23.3%)	223 (55.8%)	3.1 2	1.184
Automated Conveyor and Sorting Systems	90 (22.5%)	81 (20.3%)	229 (57.3%)	3.1 2	1.205
Baggage Reconciliation Systems	102 (25.5%)	75 (18.8%)	223 (55.8%)	3.0 5	1.252
Chatbots and Virtual Assistants	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.0 3	.304
Digital Feedback and Complaint Portals	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.0 3	.304
Multilingual Digital Displays and Audio Systems	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.0 3	.304
Smart Retail and Digital Payment Systems	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.0 3	.304
Automated Parking Systems	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.0 3	.304
Real-Time Public Transport Integration	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.0 3	.304
Ride-Hailing Integration Points	395 (98.8%)	2 (0.5%)	3 (0.8%)	1.0 3	.304

Source: Author's Computation, 2025.

Table 4.2 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 virtually unavailable at the airport. This aligns with findings on airports adoption of digital

systems but struggle with post-adoption usability, maintenance, and integration (Wongyai *et al.*, 2024). Moreover, research on airport digital transformation emphasizes that organizational readiness and infrastructure significantly influence whether technology delivers anticipated benefits (Halpern *et al.*, 2021). Consequently, the results imply that NAIA's technological assets are unevenly functional, and many newer systems remain underutilized.

Automated Security Screening Equipment, Self-Service Check-In Kiosks, Mobile Check-In, Biometric Verification Systems, Explosive and Metal Detection Systems, Emergency Alert Systems, and Access Control Systems, Flight Information Display Systems (FIDS) and Wayfinding Technologies, each fall in the categories of AFF and ranges between (55-57%). This suggests strong implementation and user confidence in self-service and customer interface technologies at NAIA which aids seamless airport efficiency and passenger processing speed. Similarly, Baggage Drop Stations Automated Conveyor Systems also reflected that while automation is in place, maintenance and functionality still pose challenges. Efficient baggage handling is vital for operational efficiency and customer satisfaction (Ojo & Edeh 2023). Functionality of FIDS aligns with the findings of (Adeyemi & Gbadamosi, 2020) who observed that real-time information systems significantly improve passenger satisfaction and reduce anxiety caused by flight uncertainties in Nigerian airports. CCTV Surveillance Systems was the highest of all technologies surveyed. This suggests that the airport prioritises comprehensive surveillance coverage, which is essential for maintaining safety, monitoring passenger movement and responding swiftly to incidents. The high performance of these systems aligns with global standards in aviation security and enhances both passenger trust and institutional credibility. This aligns with the study of Okeke & Okechukwu, (2018), which stressed that security infrastructure is a key determinant of airport efficiency and traveller confidence in Nigeria. Their research found that well-implemented surveillance systems enhance safety, deter crime, and facilitate quicker incident response.

On the other hand, Chatbots and Virtual Assistants, Digital Feedback Systems, and Smart Retail and Digital Payment Systems, Multilingual Digital Displays, Automated Parking Systems, and Real-Time Transport Integration systems are (98%) unavailable at NAIA. Overall, the data reveals a moderate adoption of modern technologies at NAIA, with strong availability of smart technologies, further enhancement in critical operational systems and security infrastructure is still needed. However, the airport needs to prioritize maintenance and upgrades of foundational systems such as baggage handling, emergency alerts, and security detection to ensure seamless functionality and enhance overall service delivery.

Table 4.3 Correlation between Airport operations, Passenger perception and satisfaction on effect of Technological Innovation.

Variables	Technological innovations	Passenger, Perception and Satisfaction	Security and Safety
Technological innovation	1		
	376		
Passenger, Perception and Satisfaction	.015	1	
	.776		
	376	380	
Security and Safety	.002	.893**	1
	.972	.000	
	380	380	380

Source: Author's Computation, 2025.

Results show that technological innovation had a very weak and negative correlation with passenger perception and satisfaction ($r = .015, p = .776$) and with security and safety ($r = .002, p = .972$). These correlations are not statistically significant ($p > .05$), suggesting that the availability and functionality of technological innovations have not directly translated into improved passenger satisfaction and perceived security at the airport.

On the other hand, there was a strong positive and statistically significant correlation between passenger perception and satisfaction and security and safety ($r = .893, p < .001$). This indicates that higher levels of perceived security and safety are strongly associated with greater passenger satisfaction.

In summary, these findings suggest a technology performance paradox: despite the presence of technological innovations, their effectiveness in enhancing operational efficiency and passenger satisfaction remains limited. This aligns with recent research emphasizing that mere adoption of airport technology does not guarantee improved service outcomes unless supported by consistent functionality, staff training, and user awareness.

Variables	Technological Innovation	Airport Operations
Technological Innovation	1	
	376	
Airport Operations	-.051	1
	.322	
	376	376

Source: Author's Computation, 2025.

The result shows a weak negative correlation between technological innovation and airport operations ($r = -.051, p = .322$). This correlation is not statistically significant ($p > .05$), indicating that improvements in technological innovation have not translated into measurable gains in airport operational efficiency.

This implies that, although NAIA has implemented various technological innovations such as biometric verification systems, e-gates, and automated check-in kiosks, these technologies are not yet being fully utilized to enhance daily operational activities. The weak negative association suggests that operational performance may depend more on the effective use and maintenance of technology rather than its mere availability. This finding supports previous research by Nwasonuba & Okeudo, (2022), who emphasized that Nigerian airports face persistent operational inefficiencies due to inconsistent technological deployment, poor maintenance culture, and inadequate training of airport personnel. And lastly, a study which aligns with the operational factors that are often not strong predictors of satisfaction unless they enhance perceived service quality and user experience such as staff responsiveness, information clarity, facility comfort, and self-service technologies (Bogicevic et al., 2017).

5. Conclusion

The objective of this study is to: (1) Examine the types of technological innovations implemented at Nnamdi Azikiwe International Airport. (2) Analyse the effect of these technological innovations on the efficiency of airport operations and passenger experience. The method of data analysis was through descriptive, correlation and regression analysis. Results on passengers show that technological innovation had a weak correlation with passenger perception and satisfaction was based on the holistic evaluation of the airport ($r =$

.015, $p = .776$) and with security and safety ($r = .002$, $p = .972$). These correlations are not statistically significant ($p > .05$), suggesting that the availability and functionality of technological innovations have not directly translated into improved passenger satisfaction and perceived security at the airport. On the other hand, there was a strong positive and statistically significant correlation between passenger perception and satisfaction and security and safety ($r = .893$, $p < .001$). This indicates that higher levels of perceived security and safety are strongly associated with greater passenger satisfaction. 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 (NAIA) was based also on the overall evaluation of the both wings, there are more unevenly implemented technological innovations at the terminals. This means, introduction technological innovations have not improved the overall operational performance at the NAIA. Linking the correlation result to the theoretical model for this study Unified Theory of Acceptance and Use of Technology (UTAUT) proposed by (Venkatesh *et al*, 2000), result implies that the adoption and effective utilization of technological innovations among airport staff may be influenced by the core determinants of the model performance expectancy, effort expectancy, social influence, and facilitating conditions.

Summarily, the insignificant correlation aligns with the UTAUT's emphasis that technology acceptance does not automatically translate into effective use unless end-users find the system useful, easy to use, and adequately supported by organizational conditions. This finding also aligns with the argument by Kim & Lee, (2020) that in developing economies, technological investments in airports often yield limited operational outcomes when human and institutional factors are neglected.

Recommendations and Future Research

The findings indicate that technological innovation has a weak and statistically insignificant relationship with airport operations. This suggests that while new technologies are being introduced, they are not yet be fully integrated into the operational processes and effectively utilized by staff. It is therefore recommended that the airport authority focus on improving user engagement and practical application of technology within daily operations. Emphasis should be placed on staff training, adequate system maintenance, and creating an enabling environment that supports technology. Management should also strengthen internal communication and support mechanisms to ensure that technological systems are not only available but actively contribute to operational efficiency.

For future research, attention should be directed toward exploring factors that influence the acceptance and use of technology among airport staff and passengers. Studies could also investigate how organizational culture, user perception, and infrastructural readiness affect the success of technological innovations in improving efficiency and service delivery. Expanding the study across multiple airports would provide a broader understanding of the variations in technological innovations and airport operations.

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