

Policy Options for Improved Use of Emerging Technologies for Aviation Security in Nigeria

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Abstract

Original Research Article

Emerging technologies are increasingly shaping aviation security through biometric identification, Artificial Intelligence (AI), advanced screening systems, automated surveillance, digital identity and passenger-information platforms. Their effective utilisation, however, depends on appropriate policies governing procurement, deployment, infrastructure, interoperability, cybersecurity, data protection, maintenance and institutional coordination. This paper examined policy options for improving the use of emerging technologies for aviation security in Nigeria. The study adopted a qualitative research approach based entirely on documentary analysis. Relevant peer-reviewed journal articles, government publications, aviation security policies, legislation, regulatory frameworks, institutional reports and international aviation standards were purposively selected and subjected to systematic review, coding and thematic interpretation. The analysis focused on technology deployment, regulatory frameworks, financing and infrastructure, human capacity, cybersecurity and data governance, interoperability, maintenance, institutional coordination and performance monitoring. The study identified seven policy options: encouraging Public-Private Partnerships (PPPs); developing a comprehensive regulatory framework; improving investment in airport infrastructure; enhancing awareness and communication; establishing robust cybersecurity and data governance; promoting interoperability and integrated aviation security systems; and establishing a national technology maintenance and lifecycle management programme. The analysis indicates that technology acquisition alone is insufficient for sustained improvements in aviation security without supportive regulatory, institutional, infrastructural and operational arrangements. Effective policy implementation could strengthen technology utilisation, improve information exchange, protect sensitive aviation data, support system reliability and enhance coordination among aviation security stakeholders. The paper recommends coordinated government and aviation-agency action to establish an enabling policy environment for secure, sustainable and integrated use of emerging technologies across Nigerian airports.

Keywords: Emerging technologies; aviation security; policy options; cybersecurity; data governance; interoperability.

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Introduction

Aviation security in Nigeria increasingly depends on the ability of airports and aviation

agencies to adopt technologies that improve threat detection, passenger identification, surveillance, screening and information management. Emerging technologies such as Artificial Intelligence (AI),



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biometrics, advanced Computed Tomography (CT), automated surveillance, digital identity systems and integrated passenger-information platforms provide additional capabilities for addressing security risks within complex airport environments. Their security value, however, extends beyond the acquisition of equipment because effective use requires appropriate policies covering procurement, deployment, interoperability, data protection, cybersecurity, maintenance, personnel competence and institutional coordination (Alketbi & Sipos, 2024). The development of airport technology therefore creates a policy requirement for aligning technological investment with operational security needs, regulatory standards and institutional capacity (Mishra et al., 2024). AI-enabled systems further introduce policy considerations relating to data governance, accountability, human oversight and responsible use within security operations (Zaoui et al., 2024).

Germany has incorporated biometric identification and automated passenger-processing systems into airport operations as part of broader efforts to strengthen identity verification and facilitate secure passenger movement. At Frankfurt Airport, biometric technologies have been integrated into different stages of passenger processing, including check-in, security and boarding, creating a more connected identity-verification process (Fraport, 2024). Germany's automated border-control arrangements also employ biometric information to support passenger identity verification and border-security procedures (Federal Police, 2024). These developments highlight the importance of regulatory and institutional arrangements that define how biometric information is collected, processed and used within airport security operations (European Commission, 2024).

Singapore has pursued an integrated approach to airport technology through biometric identification, automated immigration clearance and digital passenger-processing systems at Changi Airport. The use of facial and biometric verification has reduced reliance on repeated presentation of physical travel documents

during selected stages of passenger processing (Immigration and Checkpoints Authority of Singapore [ICA], 2024). Changi Airport has also expanded automated processing across check-in, baggage drops, immigration and boarding, linking passenger identity with different stages of the airport journey (Changi Airport Group, 2024). Singapore's experience places considerable emphasis on institutional coordination, digital identity management and appropriate governance arrangements for the secure use of biometric technologies (Ministry of Home Affairs Singapore, 2024).

Egypt has similarly pursued technology-based improvements in airport security through electronic gates, surveillance systems, passenger-processing technologies and modern airport infrastructure. Cairo International Airport has introduced electronic processing systems that support passenger identification and controlled movement through airport facilities (Egyptian Holding Company for Airports and Air Navigation [EHCAAN], 2024). Egypt's aviation sector has also pursued digital transformation alongside investments in airport infrastructure and security systems (Ministry of Civil Aviation Egypt, 2024). These developments underline the importance of policies that connect technological acquisition with operational requirements, institutional responsibilities and continuous system management within airport security (International Air Transport Association [IATA], 2024).

In Nigeria, the government has deployed emerging technologies within airport security through biometric verification, electronic passenger processing, advanced screening and surveillance systems. E-verification gates at Nnamdi Azikiwe International Airport use biometric scanning to support passenger identification and security checks (Federal Ministry of Information and National Orientation [FMINO], 2024a). The operationalisation of the advance Passenger Information System has strengthened the collection and sharing of passenger information for traveller screening and border-security purposes (FMINO, 2024b). Advanced Rapiscan screening machines

and surveillance systems at Murtala Muhammed International Airport have further expanded technological support for passenger and baggage security (FMNO, 2025).

Despite these developments, the effective use of emerging technologies for aviation security in Nigeria remains affected by institutional, financial, infrastructural and human-capacity constraints. Nigerian airport security requires appropriate security culture and personnel practices to translate technological capabilities into effective security outcomes (Adenigbo, 2024). Technology adoption within the Nigerian Civil Aviation Authority is also associated with organisational readiness, infrastructure, compatibility and human-resource capacity (Opuala-Charles, 2025). Financial constraints, inadequate infrastructure, regulatory bottlenecks and limited technical capacity have further affected the adoption and operation of technological innovations at Nnamdi Azikiwe International Airport (Kolawole & Abdulrafiu, 2025).

The policy challenge therefore extends beyond increasing the quantity of emerging technologies available at Nigerian airports. Effective utilisation requires policies that establish clear standards for technology selection, procurement, deployment, interoperability, cybersecurity, data protection, maintenance and performance assessment. Such policies also need to clarify the responsibilities of FAAN, NCAA, security agencies and other relevant institutions in technology-enabled aviation security. This creates a need for policy options that address the conditions limiting effective technology utilisation while aligning technological investment with Nigeria's aviation security requirements. This paper therefore focuses on policy options for improved use of emerging technologies for aviation security in Nigeria.

Aim

The aim of this paper is to propose policy options for improving the use of emerging technologies for aviation security in

Nigeria.

Methodology

The study adopted a qualitative research approach based entirely on documentary analysis to examine policy options for improving the use of emerging technologies for aviation security in Nigeria. The approach was considered appropriate because the study focused on understanding existing policies, regulatory provisions, institutional arrangements, technological requirements and implementation challenges associated with emerging technologies in aviation security. The documentary materials comprised peer-reviewed journal articles, books, government publications, aviation security policies, legislation, regulatory frameworks, institutional reports, international aviation standards and other credible documents relating to emerging technologies and aviation security. Documents were purposively selected based on their relevance to the study objectives, authority, and direct connection with aviation security and technology utilisation. Particular attention was given to documents addressing emerging technology. Nigerian policy and regulatory documents were examined alongside relevant international aviation security frameworks and documented experiences from selected countries to identify policy approaches applicable to Nigeria.

The collected documents were subjected to qualitative documentary analysis through systematic review, coding and thematic interpretation. The analysis involved identifying recurring issues, policy gaps, institutional responsibilities, implementation challenges and technology-governance requirements across the selected documents. The themes were subsequently organised around technology deployment, regulatory and policy frameworks, financing and infrastructure, human capacity, cybersecurity and data governance, interoperability, maintenance, institutional coordination and performance monitoring. The analysis provided the basis for developing policy options aimed at improving the effective, sustainable and secure use of emerging

technologies for aviation security in Nigeria.

Findings: Policy Options

Enhancing the deployment and utilisation of emerging technologies for improved aviation security in Nigeria, requires a comprehensive and forward-thinking approach. Some policy options the Federal Government of Nigeria and its aviation agencies could adopt include the followings:

A. Encourage More Public-Private Partnerships

Foster partnerships between the government and private sector companies involved with the provision of emerging technologies. Public-Private Partnerships (PPPs) can facilitate the deployment of cutting-edge security systems, as well as encourage private companies to invest in research and development in the aviation industry to enhance the safety and security of airports. Private companies are generally more agile and innovative in adopting new technologies due to market pressures and competition. Collaborating with the private sector will assist the Federal Government of Nigeria to accelerate the adoption and implementation of advanced technology security systems and reduce the time required to implement upgrades. This partnership would foster synergy between the government and the private sector, potentially leading to cross-sector knowledge exchange, skill development, and increased collaboration on other aviation projects. This will reduce part of the financial burden on the government while enhancing private sector contribution to the development of aviation industry in the country.

B. Develop a Comprehensive Regulatory Framework for Emerging Technologies

Establish a flexible and adaptive regulatory framework that ensures the safe integration and deployment of emerging technologies in aviation security. A clearly articulated regime of regulations would facilitate innovation while maintaining safety and security standards. Aligning the

regulatory framework with international standards and best practices will ensure that Nigeria remains at par with global aviation security norms. This alignment will facilitate international cooperation and allow for seamless integration with global aviation systems.

C. Improve Investment in Infrastructure

There is a need to improve airport infrastructure to support seamless integration of emerging technologies. This includes upgrading communication networks, enhancing power supply, and establishing appropriate data centres. Robust and high-speed communication networks are fundamental for the successful deployment of emerging technologies. Airports need reliable data connectivity to facilitate real-time information exchange between various systems, such as surveillance cameras, access control systems, and biometric scanners. Upgrading to modern communication protocols and implementing sufficient bandwidth capacity are necessary steps to ensure data transmission is efficient and secure. A stable and resilient power supply is critical to maintain continuous operation of essential airport systems. Emerging technologies often require additional power resources, and investing in backup power solutions (e.g., uninterruptible power supplies using renewables) is essential to prevent disruptions during power outages or other electrical issues.

D. Enhance Awareness and Communication

Raising awareness among stakeholders and the public about the benefits and importance of adopting emerging technologies for aviation security is necessary to address cultural barriers. Transparent communication will assist in building trust and support for these initiatives. Developing educational and training programmes is vital to ensure that stakeholders fully understand the implications and capabilities of emerging technologies. This includes providing detailed information about how these technologies work, their safety features, and how

they contribute to aviation security. Organising live demonstrations and pilot projects showcasing the practical applications of emerging technologies can be highly impactful. Such initiatives provide tangible evidence of the technologies' effectiveness and build confidence among stakeholders, particularly the passengers.

E. Establish a Robust Cybersecurity and Data Governance Framework

The Federal Government of Nigeria could establish comprehensive cybersecurity and data governance requirements for technology-enabled aviation security systems. The framework could address the collection, storage, processing, sharing and protection of passenger and security information generated through biometric systems, surveillance technologies and passenger-information platforms. Clear responsibilities could be assigned to FAAN, NCAA, airlines, security agencies, technology providers and other relevant stakeholders for protecting sensitive information. Regular cybersecurity assessments, access controls, encryption, incident-reporting procedures and contingency arrangements could form part of technology deployment requirements. Strong data governance could protect aviation security systems from cyber threats while strengthening public confidence in technology-enabled security operations.

F. Promote Interoperability and Integrated Aviation Security Systems

The Federal Government of Nigeria needs to develop national interoperability standards for emerging technologies used across Nigerian airports. Different systems, including biometric identification, CCTV, access control, passenger information, baggage screening and other security technologies, could operate within an integrated architecture that supports secure information exchange. FAAN and relevant aviation security agencies could establish common technical standards for equipment acquisition to prevent isolated systems that cannot communicate

effectively. Interoperability requirements could also be incorporated into procurement processes and technology specifications. An integrated approach could improve information sharing, facilitate coordinated threat detection and reduce duplication of technological systems across aviation security operations.

G. Establish a National Technology Maintenance and Lifecycle Management Programme

The Nigerian Government needs to establish a structured maintenance and lifecycle management programme for emerging aviation security technologies. Technology acquisition could include provisions for preventive maintenance, software updates, replacement of obsolete components, technical support and eventual system renewal. FAAN and other relevant agencies could maintain technology inventories indicating equipment condition, operational status, maintenance schedules and expected replacement periods. Technology suppliers could also be required to provide technical support, spare parts and personnel training throughout agreed service periods. Regular performance assessments could assist aviation authorities in identifying malfunctioning or obsolete systems before they affect security operations and could improve the sustainability of investments in emerging technologies.

Discussion of Findings

The identified policy options on PPPs, regulatory development and infrastructure investment reflect the need to address the institutional and resource conditions surrounding emerging technology adoption in Nigerian aviation security. The emphasis on PPPs is consistent with Opuala-Charles (2025), who identified PPPs and policy revisions as measures for creating a supportive environment for technology adoption and digital transformation in Nigeria's aviation sector. The need for improved infrastructure and technical capacity also aligns with Kolawole and Abdulrafiu (2025), who identified

financial constraints, infrastructural inadequacies, regulatory bottlenecks and limited technical capacity as continuing challenges at Nnamdi Azikiwe International Airport. Similarly, Kombo and Abdullahi (2026) identified regulatory gaps, funding limitations and infrastructure deficits as major barriers to digital technology adoption in Nigerian aviation, while advocating investment in smart airport infrastructure and national digital transformation policies. These positions support policy measures that connect private-sector participation, regulatory clarity and infrastructure development with the deployment of emerging aviation security technologies.

The policy option on awareness and communication further reflects the importance of human and organisational factors in technology utilisation. Public awareness, stakeholder engagement and personnel understanding are relevant because the introduction of biometrics systems, automated screening and other emerging technologies affects established airport procedures and interactions with passengers. Adenigbo (2024) found that technology alone does not guarantee secure airports and identified stakeholder behaviour, attitudes and security culture as important dimensions of aviation security in Nigeria. Adedokun (2025) similarly identified insufficient training, weak access-control practices and gaps in security awareness as vulnerabilities within Nigeria's aviation security framework, recommending regular training and awareness programmes. Paul and Ofuebe (2019) further identified fragmented and largely manual information systems as constraints on effective information management within Nigeria's aviation environment, highlighting the importance of institutional capacity and coordinated information systems. The findings therefore support communication, stakeholder education and training as complementary measures for achieving sustained acceptance and effective utilisation of emerging technologies.

The options concerning cybersecurity and data governance, interoperability, and technology

maintenance address the requirements for secure and sustainable technology deployment. Emerging aviation security systems increasingly depend on interconnected digital platforms that process passenger information, surveillance data and operational security information, creating requirements for data protection, secure information exchange and continuous system management. Okeke and Okoro (2026) identified inadequate cybersecurity financing, shortages of experienced cybersecurity personnel, weak regulatory enforcement, legacy information systems and poor institutional collaboration as major challenges affecting cybersecurity and data governance in Nigerian aviation. The NCAA's 2025 aviation cybersecurity guidelines similarly require aviation entities to identify critical ICT systems and data and implement risk-based measures against unlawful interference. The need for integrated systems is also supported by Osumaje et al. (2026), whose assessment of Nigerian aviation information management identified fragmented systems and limited information sharing as constraints on operational efficiency and data reliability. These positions support the establishment of interoperability standards, cybersecurity controls, data governance arrangements and lifecycle management mechanisms as integral components of emerging technology policy for aviation security in Nigeria.

Conclusion and Recommendations

Improved utilisation of emerging technologies for aviation security in Nigeria requires coordinated policy measures covering private-sector participation, regulatory development, infrastructure investment and stakeholder engagement. Public-Private Partnerships could support technology acquisition and technical expertise, while a comprehensive regulatory framework could provide clear requirements for procurement, deployment and operational use. Improved communication infrastructure, reliable power supply and appropriated data facilities could support continuous operation of technology-enabled security systems.

Awareness and communication could also strengthen stakeholder understanding and acceptance of emerging technologies within Nigerian airports.

Effective technology utilisation also requires attention to cybersecurity, data governance, interoperability and technology lifecycle management. Emerging aviation security systems increasingly depend on interconnected platforms that process sensitive passenger and operational information. Appropriate cybersecurity controls and data governance arrangements could protect these systems, while interoperability standards could facilitate secure information exchange among aviation security stakeholders. Structured maintenance and lifecycle management could support equipment reliability, timely upgrades and sustained value from investments in emerging technologies.

Given the findings of this paper, it is suggested that the Federal Government of Nigeria needs to strengthen PPPs for aviation security technology deployment while establishing clear regulatory requirements for private-sector participation. The Government could also improve investment in airport communication networks, reliable power supply and data infrastructure to support technology-enabled security operations. To ensure the actualisation of these, FAAN and NCAA could strengthen stakeholder awareness programmes, personnel training and technology sensitisation initiatives to improve understanding and acceptance among aviation security personnel and airport users.

In addition, the Federal Government of Nigeria could establish national requirements for cybersecurity, data governance and interoperability across emerging aviation security systems. Consequently, FAAN, NCAA and other relevant security agencies could adopt common technical standards for biometric systems, CCTV, passenger-information systems, access control and screening technologies to facilitate secure information exchange. Aviation agencies could also establish technology inventories, preventive maintenance schedules, equipment performance assessments and

lifecycle replacement plans to support continuous operation and sustainable utilisation of emerging technologies.

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