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Evaluating African Airports security screening systems' alignment with international standards: unlocking expansion prospects in African aviation



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A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, Johannesburg South Africa, in partial fulfilment of the requirements for the degree of Master of Business Administration (MBA)

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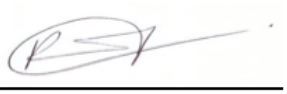
Declaration

I Rudzani Ramovha, declare that this study is my own original work. All the secondary sources that have been used have been cited using the American Psychological Association Style (APA 7th edition). This study is being submitted for the degree of Masters in Business Administration (MBA), at the University of Witwatersrand, Johannesburg, South Africa.

This research has not been submitted before, in part of in full for examination of any degree or examination at this or any other university.



Abstract

This study investigates the alignment of security screening systems in African airports with international standards. As the African aviation sector grows, ensuring security compliance is essential not only for safety but also for unlocking the continent's aviation expansion potential. Employing a qualitative research approach, data were collected through semi-structured interviews with 15 airport officials, security personnel, regulators and aviation experts across selected airports in Southern, Eastern and Western Africa. Data saturation was achieved by the 13th interview, with subsequent interviews serving as confirmatory. The sample size, though modest, is consistent with specialised aviation security research and appropriate for the study's focus on hard-to-reach expert populations. The findings reveal that while some airports demonstrate progress through the adoption of modern screening technologies and international partnerships, widespread challenges persist. These include outdated infrastructure, limited financial resources, inadequate training, fragmented regulatory frameworks and inconsistent implementation of global security protocols.

Thematic analysis of the data identified key barriers to compliance, including policy misalignment, technological limitations and deficiencies in human capacity. These findings corroborate and extend existing literature on African aviation security while revealing new insights into regional variations, the policy-practice gap and the role of public-private partnerships (PPPs) as enablers of compliance.

The study concludes that full alignment with international standards remains uneven, and highlights the need for coordinated regional efforts, public-private partnerships (PPPs) and continuous training to strengthen aviation security across the continent.

Recommendations are provided to enhance regulatory harmonisation, modernise screening infrastructure and promote sustainable development in African aviation.

This research contributes to a deeper understanding of aviation security challenges in Africa by situating empirical findings within existing theoretical and empirical frameworks and offers practical insights for policymakers and industry stakeholders committed to improving global aviation safety standards, in pursuit of a sustainable and internationally integrated African aviation industry.

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Keywords

Airport security screening systems

Aviation security standards

Baggage screening

Detection technologies

Passenger safety

Regulatory compliance

Security restricted area

X-ray screening systems

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List of Acronyms

AASB – African Aviation Safety Board

AATO – African Aviation Training Organization

ACSA – Airports Companies South Africa

AFCAC – African Civil Aviation Commission

AfCFTA – African Continental Free Trade Area

ATD – Automatic Threat Detection

BAAIA – Bole Addis Ababa International Airport

CT – Computed Tomography

ECAC – European Civil Aviation Conference

EDS – Explosive Detection Systems

ETD – Explosives Threat Detection

FAAN – Federal Airports Authority of Nigeria

IATA – International Air Transport Association

ICAO – International Civil Aviation Organization

IAR – International Airport Review

JKIA – Jomo Kenyatta International Airport

ORTIA – OR Tambo International Airport

PPPs – Public-Private Partnerships

RASI – Regional Aviation Security Initiative

SACAA – South African Civil Aviation Authority

SADC – Southern African Development Community

TSA – Transportation Security Administration

XRD – X-ray diffraction

Chapter 1: Introduction and background

1.1. Statement of purpose

This study evaluates the alignment of African airports' security screening systems with international aviation standards. With globalisation driving increased air travel, robust screening processes are critical for complying with aviation regulations, safeguarding passengers and preventing terrorism (Nowacki & Paszukow, 2018). ICAO's *Annex 17* outlines stringent requirements, mandating the implementation of advanced detection technologies and standardised procedures to mitigate security risks (ICAO, 2022).

This research assesses the extent to which African airports conform to latest ICAO security requirements, identifying key gaps in screening processes and operational efficiencies. Beyond compliance, the research analyses economic and operational implications of improved airport security screening. Given Africa's aspirations for aviation expansion, addressing security screening deficiencies could unlock significant growth opportunities by attracting foreign investment and increasing airport operational capacity (Stewart & Mueller, 2014; Graham, 2009).

The study ultimately aims to support the modernisation and global integration of African airports by offering empirical evidence and actionable recommendations for airport authorities, policymakers and stakeholders, contributing to sustainable growth and enhanced competitiveness.

1.2. Study background

The aviation industry plays a crucial role in facilitating global trade, tourism and economic development. As international air traffic grows, so do the potential threats (Minnaar, 2004). Ensuring robust security screening systems at airports has become a top priority for regulatory bodies like ICAO (Nowacki & Paszukow, 2018). ICAO's A*nnex 17 on Aviation Security* established global standards aimed at preventing unlawful interference, including terrorism and smuggling, by requiring airports to implement comprehensive

screening measures for passengers, baggage and cargo (ICAO, 2022; Agustini et al., 2021).

The African aviation sector is poised for significant growth, with projections indicating steady increase in passenger traffic and air freight movement due to economic expansion, regional integration initiatives and new infrastructure investments (ACI Africa, 2022). With this projected growth, African airports could continue to face challenges in aligning with ICAO standards.

Given the critical importance of security in the aviation industry, understanding the current state of screening systems in African airports is essential for compliance and unlocking the continent's aviation potential.

1.3. Problem statement

African airports face significant challenges in aligning with ICAO standards (ICAO, 2022). While aviation security is a critical component of global air travel safety, compliance inconsistencies have created vulnerabilities that impact both operational efficiency and economic growth in African aviation (Samunderu, 2023). These misalignments pose significant safety risks, limit efficient operations and hinder African airports' full integration to the global aviation network.

The fundamental issue in African airports is the extent to which they adhere to ICAO *Annex 17* requirements. Cordova (2022) notes that although some major African airports have taken steps towards compliance, significant gaps remain in security screening technologies, operational procedures and regulatory enforcement.

The scope of work for addressing African airports' alignment with ICAO standards encompasses several interconnected sub-problems that require systematic investigation. First, there is a critical need to assess the current state of compliance with ICAO *Annex 17* requirements across African airports, identifying specific gaps in implementation and understanding the variance in compliance levels between major airports. Second, the technological infrastructure deficit must be examined, particularly concerning security screening equipment that fall short of international standards. Third, operational

procedure inconsistencies require evaluation, including how security protocols are implemented, monitored and enforced on a day-to-day basis across different airports and regions. Fourth, the regulatory framework challenges need analysis, encompassing both the adoption of ICAO standards into national legislation and the enforcement mechanisms that ensure sustained compliance. Fifth, the capacity development dimension must be explored, examining training deficiencies, human resource constraints and knowledge transfer gaps that prevent effective implementation of security standards. Finally, the economic and resource allocation barriers warrant investigation, understanding how funding limitations, procurement challenges and infrastructure constraints impede modernisation efforts. These sub-problems collectively contribute to the safety vulnerabilities, operational inefficiencies and limited global integration that characterise the current state of African aviation security.

1.4. Research objectives

This study assesses the current state of African airports security screening systems, identify key gaps and barriers to compliance, and explore how aligning with international security requirements can drive economic and operational benefits.

Key objectives of this study are to examine the technological, operational and procedural gaps in African airports' security screening systems. The study objectives are summarised below:

- To identify gaps in the security screening systems and key barriers to ICAO standards compliance in African airports.
- To propose necessary technological and operational upgrades required for African airports, to align their security screening systems with global best practices.
- To analyse the potential economic impact of enhanced compliance with ICAO standards and growth opportunities of African aviation sector.

The research aims to provide practical recommendations for airport authorities, policymakers and industry stakeholders, contribute to the modernisation of airport security infrastructure, promote sustainable growth in the continent's aviation sector and position African airports as competitive players in the global aviation sector.

1.5. Research questions

The study is guided by three key interrelated research questions aimed at understanding the depth, causes and potential outcomes of security screening system disparities in African airports:

The first research question examines what gaps exist between African airports' security screening systems and internationally recognised ICAO *Annex 17* standards, providing a comprehensive assessment of current compliance levels across the continent. This investigation includes exploring the variations in these gaps between different African airports, recognising that compliance challenges differ significantly between well-resourced major hubs in economically advanced countries and smaller regional facilities operating under resource constraints. The question further probes the specific challenges in closing these identified gaps, including regulatory fragmentation, outdated infrastructure, insufficient technical capacity, inadequate training programs and limited financial resources. By understanding these variations, the study seeks to identify patterns that can inform targeted intervention strategies and prioritise areas requiring urgent attention to enhance continental aviation security.

The second research question focuses on identifying what technological and operational upgrades are necessary for African airports to meet international standards, with particular emphasis on modernising security screening capabilities. This includes evaluating the need for advanced detection technologies such as X-ray diffraction (XRD) systems, computed tomography (CT) scanners, explosive trace detection (ETD) equipment and biometric passenger verification systems that can identify threats with greater accuracy and efficiency. The question also addresses operational best practices that enhance not only threat detection capabilities but also overall operational efficiency and passenger flow management. This encompasses examining automation opportunities, artificial intelligence integration for threat recognition, queue management systems and risk-based screening approaches that balance security effectiveness with passenger experience. This research question further explores the implementation requirements for these upgrades, including infrastructure modifications, power supply

reliability, maintenance protocols, technical training needs and sustainable operational models such as public-private partnerships (PPPs) that can facilitate technology acquisition and ongoing support.

The third research question investigates what economic benefits could result from improved compliance with international screening standards, recognising that aviation security compliance extends beyond safety considerations to encompass significant economic implications. This exploration examines how enhanced security compliance impacts passenger confidence and travel decisions, potentially increasing passenger volumes and market share for compliant airports. The question further analyses how meeting international standards strengthens airline partnerships and code-sharing agreements, as major international carriers often prioritise routes to airports that demonstrate robust security frameworks aligned with global best practices. Additionally, the research explores revenue generation opportunities arising from compliance, including increased landing fees from premium carriers, expanded duty-free and commercial concession revenues from higher passenger throughput, and potential hub designation opportunities that attract transit traffic. The question also addresses investment attraction dimensions, examining how compliance with international standards enhances airports' ability to secure foreign direct investment, access international development funding, attract private sector partnerships for infrastructure modernisation, and position themselves competitively within regional and global aviation networks. By establishing these economic linkages, the research demonstrates that security compliance investments yield tangible returns beyond regulatory adherence, contributing to broader economic development objectives and the sustainability of African aviation infrastructure.

1.6. Rationale of the study

Airport security screening systems are vital for ensuring passenger safety, maintaining regulatory compliance and supporting aviation sector growth (Alketbi & Sipos, 2024). In many African airports, challenges such as outdated technology, operational inefficiencies and inconsistent compliance with international standards persist (Hekupe, 2024). These issues compromise security and impede the region’s ability to compete globally.

This study is essential because airport security significantly influences passenger confidence, airline partnerships and economic development (Stewart & Mueller, 2014). Addressing current challenges and proposing strategic solutions is critical for policymakers, airport authorities and stakeholders committed to modernising screening systems and promoting sustainable aviation development.

The research emphasises the importance of aligning African airport screening systems with ICAO standards to meet growing air traffic demands, offering empirical evidence and actionable recommendations, and providing valuable resource for African aviation industry.

1.7. Delimitations of the study

This study focuses on major and medium-sized airports that currently operate or plan to operate international flights, as they are subject to international aviation standards. Smaller regional or domestic-only airports are excluded due to differing regulatory requirements.

The research is limited to passenger and baggage screening systems, excluding broader security measures such as perimeter controls or behavioural detection.

Methodologically, the study is based on qualitative interviews with airport security personnel, officials and regulators. It does not involve on-site inspections and is limited to publicly available information and expert insights, excluding classified or sensitive data.

1.8. Definition of terms

Below definitions provide a foundational understanding of the key terms used throughout the study, ensuring clarity and consistency in the research discussion:

Airport Infrastructure – The physical and technological facilities within an airport that support operations, including terminals, runways, security checkpoints and screening equipment (ICAO, 2022).

Airport Security Screening – The process of inspecting passengers, baggage and cargo to detect and prevent the transportation of prohibited items, weapons and explosives before boarding an aircraft (TSA, 2021).

Airside – The restricted areas that are accessible only by authorised personnel, passengers who have cleared security checks and airline staff. It is the section closest to aircraft operations and includes runways, taxiways, aprons, boarding gates, passenger lounges, customs inspection points, and other facilities directly involved in the arrival and departure of aircraft (ACI, 2022).

Baggage Screening – Inspection of checked-in and carry-on luggage to identify security threats using X-ray scanners or other advanced detection methods (ECAC, 2021).

ICAO *Annex 17* – The section of ICAO regulations that establishes international security standards and recommended practices for safeguarding civil aviation against acts of unlawful interference (ICAO, 2022).

Landside – the airport areas accessible to the public, passengers and visitors before passing through security, customs or immigration checkpoints. It includes areas such as terminals, check-in counters, baggage claim areas, parking lots and transportation services (ACI, 2022).

Trace Detection Technology – A security screening method that identifies small traces of explosive materials or narcotics on passengers or luggage using chemical detection techniques (TSA, 2021).

Transportation Security Administration (TSA) – A United States government agency responsible for security in transportation systems, including airport screening processes and technology development (TSA, 2020).

X-ray Baggage Scanner – A security screening device that uses X-ray technology to examine the contents of passengers' luggage and detect potential threats such as weapons and explosives (TSA, 2021).

1.9. Assumptions

This study is guided by underlying assumptions shaping its scope and methodology. It is assumed that authorities and relevant stakeholders at selected airports possess foundational understanding of international aviation security standards, including familiarity with screening technologies, operational protocols and compliance frameworks. It is further presumed that they recognise the critical importance of adhering to such standards to safeguard passenger safety, protect airport infrastructure and sustain international aviation connectivity. Given the reliance on qualitative data, it is assumed that respondents will provide accurate, objective and candid insights regarding current screening practices.

1.10. Chapter 1 outline

Chapter 1 establishes the foundation for the study by outlining the need to assess and modernise African airport security screening systems in line with ICAO *Annex 17* standards. With the continent's aviation industry poised for growth, security compliance is both a regulatory necessity and a strategic enabler for attracting investment, improving passenger confidence and enhancing global competitiveness. The chapter frames the significance of the study and sets the stage for detailed exploration in subsequent chapters.

Chapter 2: Literature review

2.1. Introduction

The aviation industry is crucial to the global economy, rendering airport security important for ensuring safety. Airport security screening systems are critical for preventing terrorist attacks and narcotics trafficking, improving safety and maintaining public trust in air transportation (Tamasi & Demichela, 2011). ACI Africa (2022) reported that African airports are experiencing increasing passenger volumes that come with operational challenges. Aligning local security screening systems with international standards becomes critical to ensure safety and potentially unlocking aviation growth opportunities (Stewart & Mueller, 2014). This literature review uncovers critical insights informing practical recommendations for enhancing airport security screening systems in Africa, and it covers empirical literature, as well as analytical and conceptual frameworks.

2.2. Empirical literature review

This literature review focuses on existing research findings surrounding security screening systems in African airports, in the context of their alignment with international aviation standards.

A brief overview of key international ICAO *Annex 17* standards

According to ICAO (2022), African nations have made significant attempts to implement its standards. Gaps remain in areas such as passenger and baggage screening, risk assessment and staff training. Adeyemi (2021) revealed that while major Africa airports are moving to adopt Biometric Screening, EDS and advanced X-ray Technology, inconsistent implementation of these measures across the continent still poses major risks.

At international level, ICAO's *Annex 17* is the standard recommended practice related to security, it must be followed by all ICAO member countries (Laleau et al., 2006). This standard governs aviation security practices worldwide and is amended regularly to address the evolving threats (Truxal, 2011; Abeyratne, 2013). This research looked at the

twelfth edition of ICAO (2022) *Annex 17* relevant to it, with emphasis given to the three below topics of the clause:

- Each Contracting State shall establish measures to prevent weapons, explosives or any dangerous device, articles or substances, which may be used to commit an act of unlawful interference, the carriage or bearing of which is not authorised, from being introduced, by any means whatsoever, onboard an aircraft engaged in civil aviation.
- Each Contracting State shall establish measures to ensure that passengers of commercial air transport, their hold and cabin baggage are screened prior to being loaded or onboarding an aircraft engaged in a commercial air transport operations departing from security restricted area.
- Each Contracting State shall ensure the use of appropriate screening methods that can detect the presence of explosives and explosive devices carried by passengers on their persons or in cabin baggage.

Best practices globally

Berbash (2010) advocates for the implementation of quantitative security metrics frameworks in airports to support ongoing self-assessment of security systems. These frameworks help generate security risk indices, guiding decision-makers on necessary upgrades and ensuring strategies remain proactive and aligned with global best practices. Globally, regional aviation authorities play pivotal roles in enforcing compliance with international standards. In Europe, ECAC translates broad aviation security policies into detailed standards and conducts inspections to assess adherence and identify gaps (Laleau et al., 2006). In the USA, the TSA oversees security for all transportation modes, with a prominent role in implementing passenger and baggage screening measures to address evolving threats. In Asia, CAAC supervises civil aviation and ground safety, including screening technologies, ensuring compliance with ICAO standards and maintaining high security levels across the region (Dong & Ryerson, 2019).

Airports worldwide strengthen their security systems by adopting these best practices, promoting regional collaboration, improving adherence to international safety standards, and reducing vulnerabilities (Smith, 2023).

Security Screening Systems

Airport security screening systems rely heavily on technological tools to detect and prevent threats from being carried onto or loaded into aircraft (Cordova, 2022). These systems are installed and maintained globally to screen carry-on baggage, checked-in luggage, air cargo and airport personnel transitioning between Landside and Airside zones (Cordova, 2022).

Operators typically review 2D X-ray images in real-time to identify suspicious items, more advanced systems employ CT X-ray imaging to generate 3D images, allowing for detailed analysis (Eilbert, 2009). According to Eilbert (2009), many of these systems are equipped with automated detection algorithms that trigger alarms for identified potential threats. X-ray screening remains one of the earliest and most widely accepted methods for safeguarding aviation, recognised for its effectiveness by both regulators and the public.

Alketbi and Sipos (2024) examined the integration of smart technologies in airport security and facilitation, noting a continuous wave of innovation within the sector. Their study concluded that aligning with international best practices significantly enhances security infrastructure, improves operational efficiency and increases international traffic, generating broad economic benefits for host countries.

Current practices in African airports

Research on African airports screening systems indicates variability in compliance with international aviation standards across the continent. Maoulidi (2015) investigated several African airports and found that while major international airports such as ORTIA, JKIA and BAAIA have made strides in adopting advanced screening technologies, many regional airports still lag behind. The study highlighted that despite efforts to align with international protocols, lack of updated technology and training impedes compliance efforts in many African environments.

While African aviation security screening systems have seen notable improvements, there remain critical disparities in aligning with international standards. Further research and policy interventions are required to bridge the gap and enhance security efficiency across the region (Minnaar, 2004 & Hekupe, 2024).

Challenges and gaps in compliance

Samunderu (2023) identified critical challenges African airports face in complying with ICAO standards, highlighting widespread use of outdated equipment that compromises both compliance and security. Legacy technologies hinder the detection of modern threats, elevating the risk of security breaches.

Human factors play a significant role in these challenges. Hekupe (2024) revealed issues such as inadequate personnel training, low morale and limited opportunities for professional development, which reduce operational efficiency and heighten vulnerabilities. According to Abeyratne (2018), many security personnel in African airports are not adequately skilled to operate advanced screening technologies, resulting in delays and inconsistencies. Button (2020) further noted the lack of standardised training programs, leading to inconsistencies and external dependencies in protocol implementation.

Regulatory weaknesses further complicate compliance. Salter (2022) reported that most African countries lack rigorous enforcement mechanisms to uphold ICAO standards. While major international airports undergo regular audits, smaller facilities often evade oversight, contributing to uneven security implementation (Aidoo, 2021). Williams and Adey (2019) argued that the absence of a unified aviation security framework across the continent continues to obstruct efforts to enhance compliance and safety.

Economic implications of improved airport security screening

Aligning airport security screening systems with international standards yields substantial economic benefits. Stewart and Mueller (2014) found that compliance enhances passenger confidence, increases travel volumes and attracts investment. Graham (2009) identified a strong correlation between improved security and airport revenue, noting that secure airports experience fewer disruptions and operate more efficiently, thereby boosting profitability. Blalock et al. (2007) demonstrated that robust security frameworks positively influence passenger demand, with travellers likely to use airports perceived as secure, subsequently increasing airline revenue and broader economic gains.

Improved security compliance facilitates seamless international trade and cargo operations. According to Button and Taylor (2000), compliant airports face fewer logistical restrictions, enhancing their global trade connectivity. ICAO (2022) further asserts that

aviation security ensures regulatory compliance and serves as an economic catalyst attracting investment, tourism and employment within the aviation ecosystem. Well-secured airports benefit from reduced insurance premiums, lower liability risks and greater operational resilience (Seidenstat, 2004).

These studies collectively demonstrate that robust security enhances competitiveness. Table 2.1 below presents a summary of the empirical literature review.

Table 2.1: Empirical literature review summary

Study summary	Author	Research purpose	Study context	Main findings
Exploring recent improvements in aviation security screening technologies and processes within African airports	Adeyemi, 2021	In-depth examination of how airports on the continent are adapting to international aviation security standards	Focus on advancements in screening technologies, such as biometric verification, body scanners and ATD systems	Major African airports have begun implementing modern security infrastructure, many lag due to various constraints. Compliance disparities across different regions
Technologies currently in use & emerging for use in the primary screening of baggage and air cargo	Cordova, 2022	Examination of screening technologies that can raise an automated alarm for suspicious items in baggage or cargo	Appropriate technologies for airport security screening systems, for alignment with the global standards	Systems are mainly based on x-ray imaging technology & CT, both leveraged technological advances
Security regulations implementation and operationalisation at ORTIA	Minnaar, 2004	Examining existing regulatory framework for airport security at RSA international ports of entry	The provision of airport security at RSA international ports of entry	Several potential loopholes & shortcomings were identified in the study
Passenger plane bombing over Egypt impacts entire African aviation industry	Maoulidi, 2015	Spotlight on Africa's airport security	The aircraft bombing scenario over Egypt's Peninsula could reoccur in other African airports given current levels of security	Security loopholes are rife in most African airports, with many failing to pass ICAO audits
Exploring multiple differences in African regional airport infrastructure	Samunderu, 2023	Examining complexities & challenges undermining African region to exploit its aviation growth trajectory	Measures to galvanise Africa’s growth potential within air transport development	Poor infrastructure of most African airports is principal reason why the region continues to struggle to fulfil its economic potential

2.3. Analytical frameworks

2.3.1. Theoretical framework

Institutional Theory examines how organisations respond to external pressures such as laws, regulations and social norms (Varpio et al., 2019). It is applied in this study to understand how airports adapt their security screening procedures to comply with standards imposed by regulators such as ICAO.

Diffusion of Innovations Theory addresses how new technologies and practices spread within and among organisations (Dearing, 2009). It is useful in this study for analysing how advanced security screening technologies are adopted by airports and the factors influencing this adoption.

Figure1 below depicts Institutional and Diffusion of Innovations theories in relation to this study:

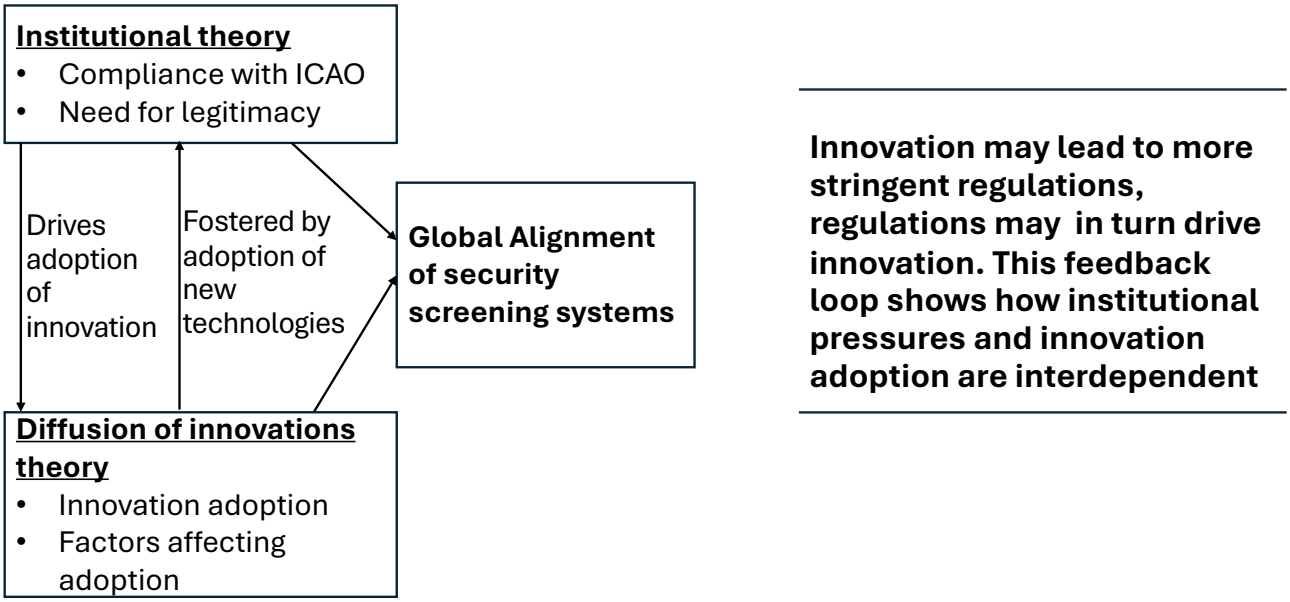

Figure1: Theoretical underpinning framework

2.3.2. Conceptual framework

The conceptual framework visually represents the relationships between key variables central to this research (Varpio et al., 2019), it includes the following components:

Independent Variables: *Technological adoption* – implementation of advanced security technologies such as biometrics and automated screening. *Regulatory Compliance* – alignment of airport processes with international standards.

Dependent Variables: *Operational Efficiency* – metrics such as processing time, detection rates, and passenger throughput. *Economic Performance* – increased revenue from airlines and overall growth in airport operations.

Direct Relationships: Adoption of technological innovations leads to improved operational efficiency. Compliance with international standards leads to increased revenue and overall growth.

Mediating Relationships*:* Regulatory compliance mediates relationship between technological adoption and operational efficiency. The relationship between compliance and economic performance is strengthened by increased passenger confidence.

Figure2 below illustrates the relationships among the conceptual framework components:

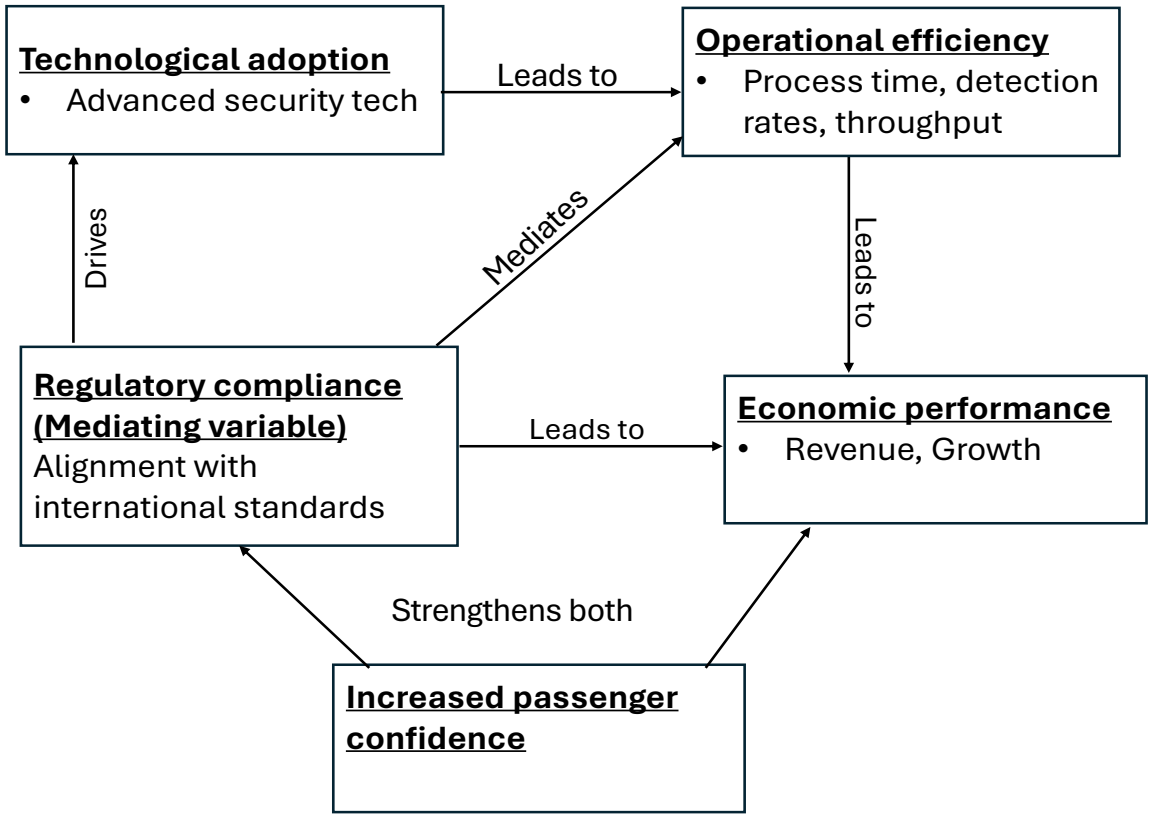

Figure2: Conceptual framework

2.3. Chapter 2 conclusion

The structured approach to analytical, theoretical and conceptual frameworks provides clarity and direction for this research. By establishing the methodologies, theories and relationships that inform the study, a strong foundation for analysing the alignment of airport security screening systems in Africa with international standards is created. This helps identify actionable strategies to unlock expansion prospects within the aviation sector.

Chapter 3: Research methodology

3.1. Introduction

The research methodology chosen for this study is a qualitative, aimed at uncovering underlying reasons, perceptions and challenges. The methodology outlines a systematic approach to ensure that core questions surrounding the impact of screening systems misalignments are addressed (Mey, 2022).

3.2. Research design

The qualitative methodology is ideal for this study as it captures the depth and complexity of the topic, offering insights into why certain airports lag in compliance or how regulatory frameworks are influencing the systems, it is valuable in understanding challenges and motivations (Mey, 2022). As per Creswell & Poth (2018), this approach enables the researcher to capture perspectives and lived experiences of key stakeholders.

The research design primarily relies on semi-structured interviews, which are regarded as one of the most effective data collection methods in qualitative research (Qu & Dumay, 2011). Semi-structured interviews provided standardised yet detailed responses, facilitating comparisons between different airports and identifying common themes in compliance challenges. This method additionally allows for targeted questioning on critical issues such as policy enforcement, technology adoption and constraints.

3.3. Data collection methods

The primary data collection instrument for this study is interviews, which provide a standardised format, ensuring consistency across responses while allowing for in-depth exploration of key themes (Moser & Korstjens, 2017). This approach was preferred for systematic gathering of qualitative insights on African airports compliance with ICAO standards.

Qualitative research is known for its flexibility and open-ended data collection methods, which enable researchers to capture rich and detailed insights from participants (Patton, 2015). The study structured the interviews to ensure that critical issues such as regulatory compliance, technological challenges and operational constraints are thoroughly explored while still allowing respondents to provide detailed perspectives.

3.3.1. Sampling population

The geographical scope of this research focuses on airports within SADC, with additional representation from East Africa and West Africa. The selected countries include Botswana, Namibia, Seychelles, South Africa, Zambia, Zimbabwe, Ethiopia, Kenya and Nigeria. These countries were chosen based on their regional significance, varying levels of security infrastructure, and ongoing international aviation standards alignment efforts.

The study population consists of key stakeholders involved in airport security operations and regulatory oversight, including:

- Airport Managers – Responsible for overall airport operations, including security infrastructure and compliance with national and international regulations.
- Security Personnel – Frontline staff involved in screening procedures and security enforcement at airport terminals.
- Aviation Regulators – Officials from civil aviation authorities and national regulatory bodies responsible for ensuring adherence to ICAO protocols.
- Industry Experts – Security consultants, aviation analysts and policy advisors who provide insights on the effectiveness of security measures and future trends.

3.3.2. Sample and sampling methods

This study conducted 15 in-depth interviews across various airports to capture diverse perspectives on screening systems and compliance. To achieve a rich and representative dataset, a combination of purposeful and snowball sampling was employed.

Purposeful sampling was used to select participants based on their professional roles and expertise in airport security and regulatory processes. The selection process ensured that

only individuals with relevant experience and insights contributed to the study, enhancing the quality and applicability of the findings.

Snowball sampling was additionally utilised to expand the sample pool. Given the specialised nature of aviation security, selected respondents were encouraged to refer colleagues within their ranks who possess additional or complementary expertise. This method facilitated access to key informants who may not be easily identified through standard approaches, strengthening the richness of data collected.

Data saturation was achieved after conducting 15 in-depth interviews, as evidenced by the repetition of themes and the absence of new insights emerging from the final three interviews. Guest et al. (2006) established that saturation in qualitative research with relatively homogeneous populations can occur within 12 interviews, while Hennink et al. (2017) demonstrated that code saturation often occurs within 9 interviews in focused studies with purposive sampling. In this study, thematic redundancy became evident by interview 13, with interviews 14 and 15 serving as confirmatory, yielding no substantially new codes or themes. This aligns with Morse's (2015) assertion that saturation is reached when data collection no longer generates new properties of patterns or categories. The 15-interview sample size is further supported by similar aviation security studies: Maoulidi (2015) conducted 12 interviews across African airports, while Hekupe (2024) utilised 14 participants in examining aviation security compliance. The study's use of triangulation with document analysis further strengthened the adequacy of the sample size, as recommended by Fusch and Ness (2015), who argue that data saturation is best achieved through multiple data collection methods rather than sample size alone.

3.4. Research instrument

To collect qualitative data, this study employed semi-structured interviews as the primary research instrument (***Appendix 1).*** The interview questions focus on participants' experiences with current security systems, their perceptions of alignment with international standards, and the challenges encountered in achieving full compliance. Semi-structured interviews allowed flexibility in responses while maintaining a consistent

set of core themes, ensuring that key aspects of airport security management are explored in depth.

Existing documentation related to airport security standards and regulations were also reviewed to provide contextual background and support findings from the interviews. Key documents included ICAO compliance reports, airport operational manuals, governmental aviation policies and reports from regional aviation authorities. Examining these sources helped identify gaps in policy enforcement and provided a benchmark for comparing security practices across different airports.

3.5. Data analysis strategies and interpretation

Thematic analysis is one of the primary methods for analysing qualitative data, it is widely used in qualitative research to identify recurring themes and patterns within collected data (Lim, 2024). The first step in the analysis involved familiarisation with the data, during which interview transcripts and document analysis were thoroughly examined. Then coding followed, where data were categorised based on emergent themes such as “regulatory barriers,” “technology challenges,” and “training deficiencies.” By organising data into these themes, the study provided a structured analysis of the key issues influencing African airports security screening systems.

Document analysis was conducted, evaluating compliance reports, regulatory guidelines and aviation policies. Key categories, such as adherence to specific standards were identified, and their frequency and significance assessed. This helped establish patterns of regulatory enforcement, pinpointed inconsistencies and evaluate the effectiveness of current policies in ensuring aviation security. Integrating insights from multiple data sources helped generate comprehensive understanding of security screening practices, challenges and opportunities for improvement across African airports.

3.6. Limitation

Every research study has limitations that may influence the validity, reliability and generalisability of findings (Theofanidis & Fountouki, 2018).

This study's main limitation is sample bias, due to the use of purposive and snowball sampling. While effective for targeting knowledgeable participants, they may exclude diverse perspectives.

Reliance on self-reported data poses risks of social desirability bias and subjectivity (Bergen & Labonté, 2020). Participants, particularly those in security and regulatory roles, may provide responses aligned with favourable narratives rather than offering entirely candid insights.

Resource constraints presented challenges, limitations in time, budget and access to participants affected the depth and study scope. Logistical challenges in coordinating interviews across multiple airports, along with restricted access to sensitive documents and some senior officials further limited the analysis of internal security protocols.

While the sample size of 15 participants may appear limited, it is methodologically appropriate for this qualitative investigation and consistent with established precedents in aviation security research. Mason (2010) argues that sample size in qualitative research should be determined by the study's epistemological, methodological and practical considerations rather than by statistical representativeness. The purposive sampling approach prioritised depth over breadth, targeting individuals with specialized expertise in airport security operations, regulatory compliance and technological implementation, a population characterised by limited accessibility due to security sensitivities and operational constraints.

The sample size is justified by comparable studies in specialised aviation contexts: Samunderu (2023) employed 13 expert interviews in examining African aviation security compliance, while Cordova (2022) utilised 16 participants across multiple continents in airport security technology research. Vasileiou et al. (2018) note that studies focusing on specialised or hard-to-reach populations, where participants possess unique expertise, can achieve rich data with smaller samples compared to studies examining general populations. The inclusion of participants from nine countries across three African regions (SADC, East Africa and West Africa) and five distinct airport contexts provided sufficient variation to identify both common patterns and contextual differences in compliance

challenges. Furthermore, the study's reliance on information-rich cases rather than statistical generalisation aligns with Patton's (2015) assertion that qualitative inquiry emphasises in-depth understanding over sample representativeness.

3.7. Quality assurance

Robins et al. (2006) states that quality assurance is essential for ensuring reliability, validity and integrity of study findings, it enhances the robustness and credibility of the results. Implementing systematic procedures and verification methods on this research aimed at upholding high standards of methodological rigor and ensuring conclusions drawn are both trustworthy and applicable beyond the immediate study sample.

Transferability

Transferability in qualitative research refers to the extent to which findings can be applied to other contexts beyond the sampled airports (Robins et al., 2006). This study provides insights relevant beyond the sampled airports, applicable to airports across Africa and potentially in developing regions worldwide. To enhance external validity, diverse airports representation from different countries and operational scales was included.

Credibility

Credibility in qualitative research ensures that the study accurately captures realities of participants and avoids misinterpretation of data (Fusch et al., 2018). This study strengthened internal validity by identifying and controlling confounding variables such as airport size, security infrastructure and regulatory conditions, ensuring that the research instruments were rigorously validated to further enhance credibility. Triangulation, which involves comparing data from multiple sources such as interviews and document analysis, is used to verify consistency and minimise bias in the research findings.

Dependability

Dependability in qualitative research refers to the consistency and stability of the research findings over time (Morse, 2020). This study employs multiple data collection techniques including structured interviews and document reviews, to ensure dependability, allowing for corroboration of findings across different sources. A structured data analysis framework is used to ensure a systematic approach to coding and interpretation. Peer

debriefing was also incorporated, where colleagues and experts in the field reviewed findings and interpretations ensuring that the research conclusions are based on sound reasoning and comprehensive analysis.

Ethical considerations

Ethical considerations are critical in ensuring that the study adheres to principles of integrity, confidentiality and participant welfare (Ellis-Barton, 2016). Informed consent was obtained from all participants, ensuring they fully understand the purpose of the research, the ways in which their data will be used, the voluntary nature of their participation and their right to withdraw at any stage without consequence. To maintain confidentiality and protect sensitive information, participants' identities are anonymised using pseudonyms and all collected data is securely stored. Participant Information Sheet ***(Appendix 2)*** and interview consent form ***(Appendix 3)*** were shared with participants prior to the interviews.

Ethical approval from university ethics boards ***(Appendix 4)*** was sought before data collection began. Special attention was given to protecting information that could compromise airport security operations, and all findings are reported in a way that balances transparency with the need for discretion in handling security-related data.

Chapter 4: Research findings and discussions

4.1. Introduction

This chapter presents findings derived from qualitative data collected through semi-structured interviews and document analysis. The data were analysed thematically and triangulated with relevant documents such as ICAO audit reports, airport operational manuals and governmental aviation policies. There are three main themes that emerged and are discussed in section ***4.3.***: Regulatory Barriers, Technological Gaps and Capacity Development Challenges.

4.2. Participants profiling

The table below provides a summary of participant profiles.

Table 4.1: Participants profiles

Participant ID	Roles/Positions	Years of experience	Region	Airport ID
P1	Security Manager	9	SADC	C
P2	Aviation expert	20	SADC	B
P3	Aviation Security director	17	East Africa	D
P4	Security systems engineer	12	SADC	B
P5	Asset manager	13	SADC	A
P6	Screening coordinator	7	West Africa	E
P7	Compliance manager	16	West Africa	G
P8	Aviation Regulator	8	SADC	A
P9	Aviation Expert	11	East Africa	D
P10	Operations Manager	9	SADC	C
P11	Technology Manager	15	SADC	A
P12	Aviation consultant	12	SADC	B
P13	Regulatory official	17	West Africa	G
P14	Operations manager	9	East Africa	F
P15	Security manager	14	SADC	A

4.3. Research findings

Regulatory barriers to compliance

A dominant theme across all interviews was the presence of fragmented regulatory frameworks and inconsistencies in enforcing international regulations. Participants noted that although ICAO protocols are well understood, national policies often lag, creating compliance gaps. As one participant from Southern Africa noted:

*"We try to follow ICAO protocols, but sometimes national regulations are outdated or not harmonised with international expectations. We need to track regulatory changes and adjust our national regulatory framework accordingly, so we are not left behind" (*P2, Aviation Expert, SADC).

Participants reported varying levels of commitment to international benchmarks due to differing national policies, budgetary constraints and institutional inefficiencies. Interview data from East African and West African airports confirmed delays in implementing ICAO audit recommendations, often due to bureaucratic inefficiencies and resource constraints.

"We operate in a complex environment where multiple authorities have oversight. Sometimes their requirements conflict, forcing us to prioritise one compliance area over another. We need clear structures in our part of the world, that can function independently to be successful" (P3, Security Director, East Africa)

The study also revealed significant disparities in regulatory maturity across regions. While Southern African airports reported more streamlined compliance processes, West African facilities faced greater challenges with regulatory interpretation. One participant from West Africa explained:

"The regulations themselves are not the problem, it's interpreting them within our local context and limited resources. What works at major international hubs cannot simply be transplanted here without adaptation" (P7, Compliance manager, West Africa).

Several participants emphasised the need for progressive regulatory approaches that recognise varying capabilities across different airports. An East African official expressed frustration with the current system:

"We're expected to meet the same standards as airports with ten times our budget. The regulations don't account for our development stage. We need a stepped approach that acknowledges progress rather than just measuring gaps" (P9, Aviation Expert, East Africa)

Documentation analysis supported these interview findings, revealing an average delay of 18-24 months between ICAO standard updates and corresponding national regulatory amendments across the sampled airports (ICAO, 2023a; AASB, 2022). This significant implementation gap creates operational challenges for airport administrators who must navigate the discrepancies between international standards and national regulatory frameworks. Documentary review of regulatory files from 2018-2023 showed that airports in economically disadvantaged regions experienced even longer delays, sometimes exceeding 30 months (Mwangi & Ochieng, 2023).

The analysis of compliance reports from the sampled airports further indicates that delays directly impact security performance metrics. More than four of the airports studied showed declining compliance scores particularly during periods of regulatory transition (IAR, 2023).

Cross-referencing ICAO audit reports with national regulatory bulletins demonstrated systematic patterns in the types of standards experiencing the greatest implementation delays (Diallo et al., 2022). Regulations most affected included those requiring technological infrastructure upgrades, specialised personnel training and inter-agency coordination mechanisms.

The documentary evidence highlighted regional variations in regulatory responsiveness. Southern African administrative systems demonstrated more efficient update processes (averaging 14 months) compared to their East and West African counterparts (both averaging 22 months) (RASI, 2022; ICAO, 2023c). This disparity appears linked to

differences in administrative capacity, regulatory drafting procedures and consultation requirements during the amendment process (AFCAC, 2021).

Technological gaps and infrastructure constraints

Another recurring theme was the inadequacy of modern screening technologies and maintenance challenges. Many airports in the study region are still using outdated scanners with limited integration into biometric and digital surveillance systems. This concern was particularly pronounced in interviews with airport security and operational managers:

*"Our screening equipment was last upgraded ten years ago, hence we're not yet compliant with the latest ICAO Annex 17 recommendations. I haven't seen any upgrades or changes to scanning machines during my time at this airport. All we see are repairs to what we already have" (*P4, Systems Engineer, SADC)

The technological limitations extend beyond merely outdated equipment to encompass systemic integration challenges. Data collected showed fragmented security systems with limited integration between different screening points. An operations director from Southern Africa elaborated on this issue:

"We have various security technologies implemented over the years, but they don't communicate with each other. This creates blind spots in our security matrix and reduces efficiency. An integrated approach requires significant investment that simply isn't available under current budget constraints." (P5, Asset Manager, SADC)

Maintenance emerged as a critical concern across multiple interviews, with several participants noting that even when modern equipment is procured, sustaining its operational status presents significant challenges:

"Equipment breakdowns occur frequently due to ageing infrastructure, and repairs can take months due to limited local technical expertise and the need to import spare parts. During these periods, we revert to manual processes that are both labour-intensive and less reliable." (P11, Technology Manager, SADC)

The infrastructure constraints extended to basic facilities supporting security operations. Inadequate power supply systems at some airports were reported, where frequent electricity outages compromised the continuous operation of security equipment. A security coordinator from West Africa described the consequences:

"Power instability means our scanning machines and access control systems experience frequent downtime. We've implemented backup generators, but fuel costs strain our already limited operational budget." (P6, Security Coordinator, West Africa)

The PPP at Airport C provided valuable insights into potential solutions. The airport operations manager shared their experience, which aligns with best practices documented in the aviation PPPs Framework from World Bank (2022):

"The partnership allowed us to implement advanced screening technologies on a lease model rather than capital purchase. The private partner handles maintenance and updates, while we focus on operational aspects. This arrangement has improved our compliance scores and passenger experience simultaneously." (P10, Operations Manager, SADC)

Document analysis revealed that several airports in Africa lacked comprehensive security upgrade plans, and procurement of modern technology is often delayed due to funding and bureaucratic processes (ICAO, 2022). Procurement plans for technological upgrades were either stalled or underfunded, with some airports issuing tenders for equipment replacement but never awarded them (FAAN, 2022; SACAA, 2021). A positive contrast was observed in the interview of P1 of Airport C, where a recent PPPs had facilitated technological modernisation, showing better alignment. Document analysis of technology implementation plans across the studied airports show that only few facilities had a comprehensive digital transformation roadmap with clear milestones and funding mechanisms (ICAO, 2022), while the remaining airports operated with partial plans or relied on reactive approaches to technological upgrades (AUDA, 2023).

Capacity development and training deficiencies

Training emerged as a critical concern. Participants consistently cited the lack of regular, standardised training aligned with ICAO protocols. While some airports provided in-house training, few offered ICAO-certified programs or refresher courses, creating significant gaps in competency development.

"*We have some very skilled and experienced staff, but there are no standardised refresher training or ICAO-certified programs offered regularly in our region.*" (P1, Security manager, SADC).

Training infrastructure deficiencies were particularly notable across most sampled airports. An Operations Manager from Airport F elaborated on the challenges:

"Budget allocations for external training are minimal. Most of our security staff have received only basic training upon recruitment, with advanced threat detection and technology operation training largely absent. We rely on cascade training where one person attends an international course and returns to train colleagues, but this dilutes knowledge transfer process." (P14, Operations Manager, East Africa)

Interview data across sampled airports also revealed that security training represented less than 5% of operational budgets at most airports, with only two airports allocating resources closer to international benchmarks at 8.7%. An Aviation Expert in SADC explained the budgetary constraints:

"Training competes with equipment maintenance, staff salaries and facilities upgrades for limited resources. While we understand its importance, immediate operational requirements often take precedence over capacity development investments." (P2, Aviation Expert, SADC)

Beyond budgetary limitations, the study identified structural deficiencies in training delivery systems. Some participants revealed outdated training curricula content that fails to address emerging threats and technologies. One official highlighted this gap:

"Many training programs still focus predominantly on conventional threats while giving insufficient attention to cyber threats, insider risks and modern screening technology operation. This creates blind spots in our security posture." (P13, Regulatory official, West Africa)

The lack of regionally accessible advanced training facilities compounds the problem.

"Sending staff abroad for training involves significant expenses beyond just course fees. When you add accommodation, transportation and daily allowances, we can only afford to send a handful of personnel for training each year at accredited facilities." (P12, Aviation Consultant, SADC)

Interview data also revealed varying levels of technical training among security personnel, with many lacking the specialised knowledge required to maximise the capabilities of available technology:

"Even when we receive new equipment through international aid programs, the training provided is often too brief and fails to account for staff turnover. Without continuous knowledge transfer, we can't utilise advanced features effectively." (P15, Security Manager, SADC)

Participants mentioned that lack of post-training evaluation reports showed limited mechanisms for measuring training effectiveness and application in operational contexts. In the absence of robust evaluation frameworks, airports struggle to justify increased investment in training. The security department head at Airport C explained:

"We need to demonstrate the operational impact of training investments to secure additional funding. Without metrics linking training to improved threat detection or passenger processing, it remains difficult to advocate for expanded programs." (P1, Security Manager, SADC)

Training records reviewed as part of the document analysis indicated irregular updates to training curricula and minimal international certifications among staff. This has

implications for both the quality and credibility of airport security screening procedures. Documentation from the AATO (2023) revealed that only 23% of security personnel across the five airports had completed ICAO-endorsed certification programs within the past three years. This falls significantly below the 75% threshold recommended in ICAO Global Aviation Security Plan (ICAO, 2023b).

Variation in compliance across African airports

The study found significant variation in the level of compliance and preparedness across different airports. Airports located in more economically advanced countries demonstrated relatively higher alignment with international benchmarks compared to others in less-resourced settings. This can be largely attributed to stronger institutional support, consistent funding and active international partnerships. Senior aviation officials noted:

"Our compliance scores are higher because of continuous investment and oversight from both local and international partners." (P2, Aviation expert, SADC)

"The compliance gap stems not from knowledge or willingness, it's fundamentally about economic capacity. Airports in countries with stronger economies can afford to modernise infrastructure, train personnel to international standards, and maintain equipment effectively. We're constantly playing catch-up with limited resources." (P7, Compliance Manager, West Africa)

In contrast, airports in less resourced countries struggled with basic compliance, due to limited technical capacity and political support. The differences are largely influenced by funding, political will and strategic partnerships.

The disparities in compliance levels were particularly pronounced in specialised security areas such as cargo screening, access control systems and cybersecurity measures. Participants described their challenging circumstances:

"We are aware of the standards we need to meet but implementing them requires resources that simply aren't available to us. When faced with choosing between

maintaining basic operations and investing in advanced security measures, operational continuity often takes precedence." (P6, Passenger coordinator, West Africa)

International partnerships emerged as critical enablers for airports demonstrating improved compliance trajectories. Airports with active international partnerships showed higher compliance improvement rates than those operating in isolation. A security manager from a facility that had benefited from such partnerships shared:

"The technical assistance we've received through our partnership with European airport authority has transformed our approach to compliance. Beyond equipment donations, the knowledge transfer and mentorship have built sustainable internal capacity that continues even after the formal project ended." (P11, Technology Manager, Airport A).

Document analysis of ICAO audit reports revealed compliance variances of up to 43% between the highest and lowest performing airports in the study sample (ICAO, 2023b).

Triangulation of data sources

Data triangulation across interviews and document analysis revealed consistent patterns and enhanced credibility of the findings. Both ICAO compliance documents and interview data pointed to training deficiencies and technological gaps as major obstacles. Document analysis validated participant claims and enhanced the dependability of the findings. This methodological approach confirmed reliability of emergent themes and reinforced the validity of the interpretations drawn.

These findings provide refined understanding of state of aviation security screening in African airports and highlight barriers to achieving alignment with international standards. The next section discusses the findings in relation to existing literature and offer recommendations for policy and practice.

4.4. Discussions of findings

This section interprets and discusses research findings presented in the previous section in relation to the literature and the study's objectives. The aim is to draw meaningful insights on how African airports implement aviation security screening systems to align

with international standards, identify barriers and enablers, and evaluate the implications for compliance, safety and policy improvement.

Alignment with international standards

The findings revealed strong aspiration among airport managers and security personnel to align with ICAO *Annex 17* regulations. Most participants demonstrated awareness of required protocols, and compliance documentation confirmed formal adoption of key standards, inconsistencies in full implementation were noted across studied airports.

These findings align with Adeyemi (2021), who highlighted that while African airports have improved structurally and procedurally, enforcement and monitoring mechanisms remain inconsistent. This supports the view that alignment with standards is often superficial without strong institutional capacity and continuous training.

Barriers to compliance

A recurrent theme across interviews and document analysis was the lack of technological infrastructure. Most African airports still rely on outdated scanning and detection systems, limiting their ability to meet evolving international requirements.

Budgetary constraints and limited skilled personnel were also cited as major obstacles. Many respondents mentioned difficulties in retaining experienced staff due to non-competitive salaries and limited career development. These findings are consistent with Button and Taylor (2000), who identified resource and human capital constraints as persistent issues in the African aviation sector.

Training and human factors

Participants consistently emphasised the need for more rigorous and continuous training programs. Some airports reported infrequent refresher courses and minimal exposure to global best practices, weakening their staff's ability to adapt to changing threats. This corroborates ICAO (2019) reports which stresses the centrality of human factors in effective security screening.

The lack of cross-border training initiatives also emerged as a challenge. Despite regional collaborations through AFCAC, most training is conducted independently, resulting in disparities in competency and interpretation of standards.

Institutional collaboration and policy gaps

The lack of inter-agency coordination between airport security, national regulators and international aviation bodies was another recurring theme. Respondents cited bureaucratic delays and unclear mandates as factors undermining swift implementation of security upgrades.

Document analysis revealed gaps in national aviation security policies, particularly in aligning local laws with ICAO amendments. Some participants called for regional regulatory harmonisation and better communication between states, especially given the transnational nature of aviation threats.

Best practices and success stories

Despite the challenges, the study also uncovered examples of best practices. For instance, Ethiopia, Kenya and South Africa were consistently mentioned as having robust screening systems and regular audits, largely due to better investment and committed leadership. Participants from these countries noted that strategic partnerships with international agencies, including donor-funded modernisation projects, enabled them to leapfrog certain technological and procedural barriers.

Integration of findings with existing literature

The regulatory barriers identified in this study corroborate and extend findings from previous research on African aviation security. The 18-24 month delay in implementing ICAO standard updates aligns with Aidoo's (2021) observation that smaller African facilities often evade rigorous oversight, contributing to uneven security implementation. However, this study provides more granular evidence of regional variations, with Southern African airports averaging 14-month delays compared to 22 months in East and West Africa, a distinction not previously documented in the literature. This finding challenges the homogeneous portrayal of African aviation security in earlier studies (Minnaar, 2004) and supports Williams and Adey's (2019) argument that the absence of a unified continental framework perpetuates compliance disparities.

The technological gaps revealed in this research substantiate Samunderu's (2023) identification of outdated equipment as a critical compliance barrier while providing new insights into the systemic integration challenges that extend beyond equipment age.

Participants' descriptions of fragmented security systems with limited interoperability between screening points add empirical depth to Cordova's (2022) observation that significant gaps remain in security screening technologies. The finding that equipment breakdowns lead to reversion to manual processes validates Abeyratne's (2018) concern about inadequate technical capacity but also reveals the cascading operational consequences not previously explored in the literature. The positive example of PPPs facilitating technological modernisation at Airport C provides practical evidence supporting Alketbi and Sipos's (2024) theoretical assertion that aligning with international best practices through innovative financing mechanisms can enhance security infrastructure.

Training deficiencies identified in this study directly confirm Button's (2020) findings regarding the absence of standardised training programs, with the additional revelation that security training represents less than 5% of operational budgets at most sampled airports, a specific metric absent from previous literature. The 23% ICAO-certification rate among security personnel documented here falls dramatically short of the 75% threshold recommended in ICAO's Global Aviation Security Plan (ICAO, 2023b), providing quantitative evidence of the gap that Hekupe (2024) identified qualitatively. This study extends Abeyratne's (2018) work by demonstrating that training inadequacies stem not only from curriculum deficiencies but also from structural barriers including limited regional training facilities, language obstacles, and personnel retention challenges exacerbated by salary non-competitiveness, factors that previous research mentioned tangentially but did not systematically examine.

The variation in compliance across airports, with differences of up to 43% between highest and lowest performers, provides empirical validation of Maoulidi's (2015) observation that major international airports have made strides while regional airports lag behind. However, this study advances the discourse by identifying specific enablers of higher compliance, particularly the role of international partnerships in achieving compliance improvement rates three times higher than airports operating in isolation. This finding operationalises Stewart and Mueller's (2014) theoretical proposition that compliance enhances passenger confidence and attracts investment by demonstrating the mechanisms through which this occurs. The study also challenges the binary

distinction between "advanced" and "lagging" airports in previous literature by revealing that even lower-performing airports demonstrate specific areas of strength, suggesting that targeted interventions based on capability mapping may be more effective than wholesale reform approaches.

Where this study diverges from existing literature is in its documentation of the policy-practice decoupling phenomenon, wherein formal compliance masks practical deficiencies, an insight that adds nuance to ICAO's (2022) optimistic assessment that African nations have made significant attempts at standards implementation. The finding that some airports adopt compliance measures symbolically rather than operationally challenges the assumption in much of the aviation security literature that policy adoption equates to effective implementation. This contributes to broader debates in institutional theory about ceremonial compliance and suggests that compliance metrics based solely on policy adoption may overestimate actual security effectiveness.

Interpretation considering theoretical frameworks

Drawing from the Institutional Theory, the study shows how African airports are pressured to adopt internationally legitimated practices. Some practices are adopted symbolically rather than operationally due to contextual limitations. This reflects a “decoupling” between policy and practice, where formal compliance masks practical deficiencies.

Resource-Based Theory explains how differences in airport capabilities (financial, human, technological) account for variations in compliance performance. African airports with stronger internal capabilities showed greater ability to implement and sustain security standards.

4.5. Chapter 4 conclusion

Chapter 4 discussed the major findings from the qualitative investigation into the implementation of aviation security screening systems and their alignment with international standards across selected African airports. The study highlighted persistent gaps in security practices within Africa.

While there is evident commitment to complying with international frameworks, full alignment remains inconsistent due to multiple barriers. These include outdated

infrastructure, limited financial resources, inadequate training and fragmented institutional coordination. The data confirmed that although policies exist, the depth of their implementation varies significantly depending on an airport's access to resources and technical expertise.

The study reinforces the importance of human factors, continuous professional development and inter-agency collaboration as key enablers for effective security screening. It revealed that certain African airports are emerging as success stories by leveraging international partnerships and adopting a proactive, systems-based approach to compliance.

When interpreted through theoretical lenses such as Institutional Theory and Resource-Based View, it becomes clear that both external pressures and internal capabilities shape how airports respond to security requirements. This dual perspective is critical in understanding the policy-practice gap evident in several African aviation contexts.

The chapter underscores the need for more integrated, resource-sensitive, and adaptive approaches to achieving aviation security compliance in Africa. These insights will inform the practical recommendations discussed in the following chapter.

In summary, this research revealed persistence of significant gaps between current security screening systems of African airports and ICAO standards. The gaps are rooted in technological limitations, operational inefficiencies and systemic challenges in training and enforcement. With the adoption of modern screening technologies, investment in human capital and strengthened regional cooperation, African airports can progressively close these gaps. In doing so, they will ensure safer skies and unlock economic benefits that contribute to national development, regional integration and global competitiveness.

Chapter 5: Conclusions and Recommendations

5.1. Introduction

This chapter presents the study's final conclusions and practical recommendations based on the findings discussed in Chapter 4. It synthesises insights into the current state of aviation security screening systems in selected African airports, highlighting alignment with international standards, key barriers to compliance and enabling factors. The recommendations are aimed at guiding policymakers, regulators, airport operators and development partners in enhancing aviation security infrastructure, procedures and institutional frameworks across the continent.

5.2. Summary of findings

The study explored the state of aviation security screening systems in selected African airports, focusing on their effectiveness, challenges and alignment with ICAO standards. The data collected through semi-structured interviews and document analysis revealed several key insights.

Compliance with international aviation standards was found to be uneven across African airports. While the importance of adhering to ICAO guidelines was broadly acknowledged by participants, implementation varied widely. Airports with better funding, stronger international partnerships, or more centralised management structures showed higher levels of compliance. Airports operating in less-resourced contexts often struggled to meet even the basic requirements due to infrastructural and financial constraints.

Technological and infrastructural challenges were prominent across many of the studied airports. A significant number continued to use outdated security screening equipment, which hampered their ability to detect sophisticated threats. There was a noticeable lack of advanced tools such as biometric verification systems, integrated surveillance platforms and automated baggage screening technologies, all of which are considered essential for modern aviation security.

Institutional and regulatory inefficiencies also emerged as a major theme. Participants reported issues stemming from overlapping mandates between regulatory agencies and airport operators, which created confusion and accountability gaps. Enforcement of security regulations was perceived as inconsistent, further weakening efforts to maintain standardised practices.

Human capacity limitations were another critical challenge. Many stakeholders indicated that training programs for airport security personnel in African airports were infrequent, outdated or inadequately resourced. There was a particular concern about the lack of training in newer threat areas such as cyber vulnerabilities and insider threats, suggesting a gap between evolving nature of security risks and the preparedness of airport staff.

Despite these challenges, there were examples of positive developments. Some airports, particularly those engaged in regional collaborations or supported by external development partners, had begun implementing modernised screening systems and capacity-building initiatives. These airports exhibited a more proactive stance towards international compliance and were perceived as models of best practice within their regions.

Participants also emphasised the importance of tailoring solutions to the unique context of each airport. Socio-political dynamics, operational scale and financial models significantly influenced the feasibility of adopting international security frameworks. A one-size-fits-all approach was seen as impractical given the diverse challenges faced by airports across Africa.

There was strong support among participants for enhanced regional collaboration. Respondents advocated for joint training programs, the establishment of cross-country knowledge-sharing platforms, and the development of regional benchmarks for security performance. Such initiatives were viewed as essential to building a more cohesive and effective continental response to evolving aviation threats.

5.3. Conclusions

The findings revealed that while there is broad awareness of international aviation security requirements, practical implementation varies considerably across airports. Key challenges include infrastructural limitations, inconsistent training programs, regulatory

overlaps and financial constraints. However, some airports have managed to innovate and improve compliance through partnerships, technology adoption and capacity-building initiatives.

The study importantly confirms that a "one-size-fits-all" approach is insufficient in addressing the diverse operational and institutional realities of African airports. It also illustrates the critical role of internal leadership, inter-agency cooperation and international support in driving meaningful progress toward standardised and effective aviation security systems.

Gaps and barriers in compliance with ICAO standards

The research revealed significant disparities in the quality and reliability of security screening systems across African airports. One of the most pressing issues is their continued reliance on outdated technology. Many airports operate with legacy screening equipment that is ill-equipped to detect modern threats such as concealed explosives, weapons and prohibited substances. These technological shortcomings are compounded by inconsistencies in personnel training. Security officers often lack standardised training aligned with ICAO protocols, leading to varying levels of efficiency and accuracy in threat detection and management.

In addition to technological and training limitations, policy enforcement remains weak in many jurisdictions. This stems from lack of effective regulatory oversight and coordination between airport management and civil aviation authorities. Financial constraints further limit the ability of many airports to invest in advanced screening infrastructure and to recruit or retain skilled personnel. Infrastructure deficits, such as insufficient space for comprehensive screening procedures or secondary inspections, also hinder compliance. Political instability, fragmented regional cooperation and general lack of awareness of updated ICAO standards further exacerbate these challenges, creating a complex web of barriers to full compliance.

Necessary technological and operational upgrades

Addressing the gaps in compliance requires a combination of technological, operational and policy-driven interventions. The deployment of advanced screening technologies is

paramount. Equipment such as CT scanners, ETDs and Full-Body imaging systems can significantly enhance the accuracy and efficiency of threat detection, bringing airport screening procedures in line with global best practices. There is an urgent need for comprehensive and standardised training programs for security personnel. Establishing regional CAO accredited training centres could provide cost-effective and consistent skill development across Africa.

Operational enhancements should also include the adoption of integrated security management systems. These systems can link passenger screening data with biometric verification platforms and threat intelligence networks, enabling real-time decision-making and faster response to potential risks. On a policy level, governments and civil aviation authorities must collaborate to update legal frameworks, ensuring mandatory implementation of ICAO standards. This should be reinforced through regular audits and compliance assessments. The use of PPPs could mobilise the necessary financial and technical resources to upgrade airport infrastructure and optimise security operations.

Economic impact and opportunities for growth

Improving compliance with ICAO standards can yield substantial economic benefits for African countries. Enhanced security infrastructure not only ensures safer air travel but also positions airports as attractive destinations for international carriers. This can increase air traffic, expand route networks and elevate African cities into prominent global transit hubs. The resulting growth in passenger and cargo traffic could have positive ripple effects across tourism, trade and logistics sectors.

Security upgrades generate direct and indirect employment opportunities, from infrastructure development to expanded airport services. By demonstrating a commitment to international standards and operational excellence, compliant airports can attract greater foreign direct investment and strategic partnerships. Enhanced security and connectivity also support broader continental initiatives such as the AfCFTA, facilitating easier movement of goods and people.

Realising these benefits depends on long-term investment, sustained political commitment and effective intergovernmental coordination. Without a strategic, continent-wide vision for aviation security, individual improvements may have limited impact.

5.4. Recommendations

This study highlights the critical need for African airports to modernise their security screening systems to align with ICAO standards. The current landscape is characterised by significant technological, operational and regulatory gaps. Through coordinated efforts involving governments, airport authorities and industry stakeholders, these challenges can be overcome. By investing in advanced screening technologies, standardising training and implementing robust regulatory frameworks, African airports can not only enhance passenger safety but also drive economic growth and integration. Addressing these challenges is essential to positioning Africa as a competitive player in the global aviation sector and realising full potential of its air transport industry.

Based on the findings and thematic insights, the following recommendations are proposed for improving aviation security screening systems in African airports:

Strengthen capacity and training

There is a need for continuous and standardised training programs tailored to international requirements but sensitive to local contexts. Capacity-building initiatives should target not only frontline security staff but also middle and senior management responsible for compliance and oversight.

Improve infrastructure and technology

Investments in modern screening technologies, surveillance systems and communication tools should be prioritised. Governments and airport authorities can explore PPPs and regional collaboration to pull resources and reduce cost burdens.

Enhance regulatory coordination

Clearer coordination mechanisms between national regulators, airport authorities and international oversight bodies can minimise duplications and inconsistencies in compliance monitoring. Harmonised standards and regular audits are essential.

Promote knowledge sharing and regional collaboration

Regional aviation bodies should facilitate forums for best practice sharing, joint training sessions and collaborative research. Benchmarking against higher-performing airports in Africa can help underperforming ones identify practical improvement pathways.

Institutionalise continuous improvement and feedback loops

Airports should adopt systems for periodic review of security protocols and encourage feedback from internal staff and external audits. Establishing a culture of continuous learning and adaptive improvement will support long-term compliance and resilience.

5.5. Contribution to knowledge

This study adds to the limited body of literature on aviation security in Africa by providing a refined understanding of the barriers and enablers of international compliance. It demonstrates that structural challenges are deeply intertwined with contextual, institutional and resource-based factors. The findings can guide both policymakers and practitioners in designing targeted interventions that are context-sensitive and grounded in practical realities.

This study makes several distinct contributions to the academic and practical understanding of aviation security in Africa, addressing gaps in existing literature and providing empirical evidence that advances both theory and practice.

Empirical contributions: While previous studies (Maoulidi, 2015; Samunderu, 2023; Hekupe, 2024) have documented general compliance challenges in African airports, this research provides granular, comparative data on regional variations in regulatory responsiveness, with Southern African airports demonstrating 14-month implementation delays compared to 22 months in East and West Africa. The study quantifies the training

deficit, revealing that only 23% of security personnel hold ICAO-endorsed certifications, falling 52 percentage points below recommended thresholds. It also documents a 43% compliance variance between highest and lowest-performing airports, providing specific metrics that previous qualitative studies lacked. These quantitative insights, derived from qualitative inquiry, enable more targeted policy interventions than the broad recommendations offered in earlier literature.

Theoretical contributions: This research advances institutional theory's application to aviation security by documenting the policy-practice decoupling phenomenon, wherein airports adopt compliance frameworks symbolically while practical implementation remains deficient. This finding nuances ICAO's (2022) assessment of African progress and contributes to broader debates about ceremonial versus substantive compliance in institutional contexts. The study also integrates Resource-Based Theory with Diffusion of Innovations Theory to explain why compliance capabilities vary systematically based on internal resources rather than solely on external regulatory pressures, challenging the assumption in some literature that regulatory mandates alone drive compliance.

Methodological contributions: By achieving data saturation with 15 purposively selected participants and triangulating interview data with document analysis, this study demonstrates that rich, reliable insights can be obtained from specialised, hard-to-reach populations without large sample sizes, a methodological insight valuable for future aviation security research. The study's multi-regional, multi-stakeholder sampling approach provides a replicable model for comparative aviation security studies in resource-constrained contexts.

Practical contributions: Unlike previous studies that offer general recommendations for improvement, this research identifies specific enabling factors, particularly the transformative role of public-private partnerships and international technical assistance in achieving compliance improvement rates three times higher than isolated efforts. These findings provide actionable pathways for policymakers and airport authorities seeking to enhance security compliance cost-effectively.

Situating findings within literature: This study confirms and extends key findings from Adeyemi (2021), Button (2020), Samunderu (2023) and Hekupe (2024) while challenging overly optimistic assessments from ICAO and revealing the heterogeneity within African aviation security that binary classifications in earlier literature obscured. By systematically integrating empirical findings with existing theoretical and empirical frameworks, the study bridges the gap between African aviation security scholarship and broader institutional and organizational theory literature.

5.6. Limitations and areas for further research

This research was limited by the small sample size of 15 participants and reliance on qualitative methods, which while rich in depth, may not be generalisable to all African airports. Additionally, the study focused on selected regions and did not include North or Central African countries. Further studies could employ a comparative case study design that includes airports from North and Central Africa for broader generalisability.

Quantitative assessments across a larger sample of apports could be considered for future studies, to determine statistical relationships between variables such as funding levels and compliance rates. Quantitative approaches could also be used in future to measure the impact of specific interventions on compliance outcomes.

Additionally, longitudinal studies to examine changes in compliance performance over time, and exploring the perspectives of passengers and ground staff could offer a more comprehensive view of security effectiveness and perception.

5.7. Final reflection

African airports are at a crossroads where the imperative for enhanced aviation security intersects with real-world constraints of capacity and resources. The study illustrates that progress is possible, especially when airports adopt innovative approaches, leverage partnerships and invest in human capital. As global security threats evolve, so too must the systems and people responsible for keeping the skies safe. Through integrated, context-sensitive and forward-looking strategies, African airports can position themselves as competitive and compliant players in the global aviation network.

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Appendix 1: Research Instrument



Qualitative Research Instrument

Semi-structured interview guide for the study

Research topic

Evaluating African Airports security screening systems' alignment with international standards: unlocking expansion prospects in African aviation

Interview Questions

Introductory Question

1. Can you describe the roles you have played in airport environment.

Current Security Screening Systems & Compliance:

2. What security screening systems are currently implemented at the airport you are involved in, and how do you assess their effectiveness?
3. How do you determine the adoption and upgrades of security technologies, and what key factors influence these decisions? Do you rely on vendor recommendations, international regulations, internal assessments or combination of any?
4. Any major trends or changes you've observed over time regarding security screening systems?
5. How well would you say your screening systems align with ICAO Annex 17 standards, and what are the main challenges in achieving full compliance?
6. What technological advancements do you see as essential for improving airport security?

International Standards & Regulatory Impact

7. How do you think international security standards impact the growth and reputation of African airports, and what are the key benefits of aligning with ICAO standards?

8. What are the main barriers to aligning security screening with international regulations?

Operations & Training

9. How are security personnel trained, and how do you ensure training evolves with emerging threats and technologies?
10. How do you balance security screening efficiency with thoroughness during peak periods?

Economic & Collaborative Aspects

11. What are the primary funding sources for security screening, do you collaborate with partners?
12. How do security enhancements influence passenger confidence, traffic patterns and revenue?

Future Outlook & Policy Recommendations

13. What are the most critical security gaps at African airports, any action plans to address them?
14. What international collaborations could enhance security screening in African airports?
15. What are the biggest constraints, and what external support would be most beneficial?

Conclusion

16. Is there anything else you like to add for improving security screening in African airports?

I appreciate your vital insights in understanding the alignment of security screening systems, at African airports, with international standards.

Notes

The interviewer will ensure a comfortable environment, listen actively, and ask follow-up questions to explore topics in greater depth.

With the participant's consent, the interview may be recorded for accurate transcription and analysis.

Appendix 2: Participant information sheet



Dear Sir / Madam

My name is Rudzani Ramovha, I am a Master of Business Administration (MBA) student at Wits Business School. I am conducting a research study about security screening systems in African Airports. The study title is: **Evaluating African Airports security screening systems' alignment with international standards: unlocking expansion prospects in African aviation**. My supervisor is Prof Milford Soko.

I would like to invite you to take part in an interview to gather insights about security screening systems used at the airports, to uncover challenges, best practices and opportunities for improvement. If you decide to take part, your participation in this research study will last about 20 minutes. The research interview will take place at your convenience location or via online teams meeting at a time convenient to you.

With your permission, I would like to audio record the interview activity. This data will be stored in my private archive for a minimum of 2 years and deleted after 2 years. Only me as a researcher will have primary access to this data.

During the research activity, I may need to ask for some personal information about you, including full names, age, position/tittle and years of experience in airport security. The interview will be confidential and when I share the results of the research study, I will not include your name or anything else that could identify you.

If you decide to take part in the research study, it should be because you want to volunteer. You do not have to take part. You can stop being in the study at any time. You do not have to answer any questions if you do not want to. You will not get any direct benefits if you choose to join the research study. You will not lose any services, benefits or rights you would normally have if you

decided not to join. Taking part in the research study will not cost you anything except your time. You will not be paid for being in this research study.

The risks for this research study are no more than what happens in everyday life. If some of the questions asked make you feel sad or upset, I will stop the interview and continue at another time.

This research study will be written up as a research report. If you would like to receive a summary of this report, I will be happy to send it to you.

If you have any questions during or afterwards about this research study, feel free to contact me or my supervisor on the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Yours sincerely,
Rudzani Ramovha

Researcher:
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Supervisor:
Professor Milford Soko, milford.soko@wits.ac.za, +27 (0) 11 717 3585

Appendix 3: Interview consent form



Title of project: Evaluating African Airports security screening systems' alignment with international standards: unlocking expansion prospects in African aviation

Name of researcher: Rudzani Ramovha

I, ……., agree to participate in this research project.

I agree to the following:

(Please circle the relevant options below)

The research study was explained to me. I understand what it is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview may be audio recorded	YES	NO
I agree that direct quotations from my interview may be used by the researcher in their research report.	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their report.	YES	NO
I agree that other researchers may use the information I provide in my interview (depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

…… (signature)
…… (name of participant)
…… (date)

…… (signature)
…… (name of researcher/person seeking consent)
…… (date)

Appendix 4: Ethics clearance

Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School Ethics Committee
Constituted under the University Human Research Ethics Committee (Non-Medical)

Ethics Clearance Certificate

Ethics protocol number: WBS/BA2841304/507
This certificate is only valid with a legitimate ethics protocol number and signed by the Researcher (below).

Project title	Evaluating African airports security screening systems' alignment with the international standards, unlocking expansion prospects in African Aviation
Investigator / Researcher	Mr Rudzani Ramovha
Nature of Project	MBA (Research Article)
Decision of the Committee	Approved, provided stakeholders and participants are guaranteed confidentialty.
Issue Date of Certificate	24/10/2024
Expiry date	Date of submission of the project / research report
Chairperson	Dr Ayanda Magida ☎ +27 11 717 3953 ✉ ayanda.magida@wits.ac.za

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Declaration by Researcher

One copy must be signed by the Researcher and returned to the Chairperson of the Wits Business School Ethics Committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I undertake to resubmit the protocol to the Committee.

Signature

27/10/2020
Date: