EFFECT OF ON-THE-JOB TRAINING PERIOD ON AIR TRAFFIC MANAGEMENT SAFETY PERFORMANCE IN KENYA

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DECLARATION

I declare that this research is my original work and that it has not been presented in any other university for academic work.

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DEDICATION

This research project is dedicated to my parents Mr. and Mrs. Were for their value of education and my brother John Okara whom have been instrumental in their support and encouragement towards my pursuits of excellence in academic achievement.

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OPERATIONAL DEFINITION OF TERMS

Trainer Experience Level: The level of expertise and knowledge that a trainer possesses, gained through formal education, hands-on practice, and years of experience in guiding trainees during on-the-job training (OJT) sessions.

Trainee Education Background: The formal academic qualifications, technical certifications, and prior training experiences of a trainee, which influence their ability to understand and effectively use technology in performing assigned tasks.

Workload during OJT: The intensity and complexity of tasks assigned to both trainers and trainees during on-the-job training, including the time and effort required to achieve training objectives.

Error Management Protocols: The systematic procedures and tools utilized to identify, analyze, and resolve errors within air traffic control operations, aimed at enhancing safety and operational reliability.

Air Traffic Management Safety Performance: The measurable outcomes of air traffic control operations in maintaining safe, efficient, and fluid airspace management, including minimizing delays, optimizing communication, and ensuring the highest safety standards in a controlled airspace.

ABBREVIATIONS AND ACRONYMS

ACC: Area Control Center

ANS: Air Navigation Services

ANSP: Air Navigation Service Provider

ATC: Air Traffic Control

ATCO: Air Traffic Control Officer

ATM: Air Traffic Management

ICAO: International Civil Aviation Organization

KCAA: Kenya Civil Aviation Authority

OJT: On-the-Job Training

TMA: Terminal Maneuvering Area

ABSTRACT

The quality of Air Traffic Management services during On-the-Job Training periods is crucial for ensuring safe and efficient air traffic operations. This study assessed the effect of On-the-Job Training on Air Traffic Management service delivery to air traffic in Kenyan airspace, focusing on establishing the influence of trainer experience, trainee educational background, workload during On-the-Job Training, and error management protocols on air traffic management safety performance in the Kenyan airspace. The theoretical framework is grounded in Experiential Learning Theory, Constructivist Learning Theory, and The 70:20:10 Learning Model. Quantitative techniques, including structured surveys, was utilized to gather data. The study was conducted at Nairobi Area Control Center and Terminal Maneuvering Area, targeting 152 air traffic management personnel involved in On-the-Job Training, comprising air traffic controllers, trainers, and supervisors. Stratified random sampling was used to ensure representative selection, with a sample size of 108 determined using the Krejcie and Morgan table. Data collection involved structured questionnaires administered via Google Forms and printed copies, with a two-week completion timeframe. A pilot study involving 10% of the sample was conducted at Mombasa and Eldoret Terminal Maneuvering Area to assess reliability and validity, utilizing the split-half method and Cronbach's alpha, with a threshold of 0.7 for reliability. Content validity was established through expert review and the content validity index. Data analysis involved descriptive statistics, including mean and standard deviation, alongside inferential statistics, with regression analysis assessing the predictive strength of independent variables on air traffic management service quality. Hypothesis testing at a 95% confidence level determined statistical significance, ensuring a robust interpretation of relationships between variables. The study found that trainer experience ($\beta = 0.248$, $p = 0.002$), trainee educational background ($\beta = 0.207$, $p = 0.045$), workload management ($\beta = 0.481$, $p = 0.000$), and error management protocols ($\beta = 0.030$, $p = 0.032$) all had significant positive effects on ATM safety performance, with workload being the most impactful factor. Ethical considerations, including informed consent and confidentiality, was strictly observed throughout the research process. The study concludes that ATM safety performance during OJT in Kenya is significantly influenced by trainer experience, trainee educational background, workload management, and error management protocols, with structured development, aligned curricula, phased workload strategies, and standardized error systems proving essential. To enhance these outcomes, it recommends policy reforms by KCAA, updated training curricula, dynamic workload tools, unified error frameworks, stakeholder engagement, and further research into post-certification performance and automation's role in training.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter comprises of the background of the study, statement of the problem, objectives of the study, research hypotheses, significance of the study, scope of the study, delimitations of the study, assumptions of the study, theoretical framework and conceptual framework.

1.2 Background of the study

Aviation has steadily evolved into a foundational pillar of global economic interdependence, enhancing the mobility of people, goods, and services across national and continental boundaries. By linking cities, countries, and regions through a network of scheduled flights and air routes, aviation fosters not only international trade and tourism but also diplomatic and cultural exchange (Brown, 2021). In this highly interconnected global framework, the success of the aviation industry is tightly bound to the reliability and efficiency of Air Traffic Management (ATM) services, which form the backbone of modern flight operations (Lezieobi, 2022). ATM ensures the orderly, safe, and expeditious movement of aircraft within the increasingly congested skies and at busy airports. Its significance becomes more pronounced when one considers the staggering volume of daily flights that rely on seamless coordination between various air traffic control (ATC) units (Ahmad, 2021). The quality of these services, often invisible to passengers is directly influenced by the capabilities of air traffic controllers, especially those in training who are undergoing On-the-Job Training (OJT). The OJT phase introduces aspiring controllers to live operational environments where they must apply theoretical knowledge while being closely supervised by experienced trainers (Jauran, 2021).

Globally, OJT has become an indispensable component of the certification process for air traffic control officers (ATCOs), functioning as a bridge between classroom instruction and real-world operational proficiency. In aviation-advanced countries such as the United States, United Kingdom, Canada, and Germany, the OJT process is tightly structured and tailored to ensure that trainees can transition smoothly into live control environments (Zhao, 2022). These countries often

adopt competency-based training models that emphasize a mix of academic understanding, simulated scenarios, and live monitoring to evaluate the progression of trainees. The International Civil Aviation Organization (ICAO, 2023) underscores the value of these structured models, especially those that incorporate simulation technology, rigorous performance evaluations, and clear standard operating procedures (Wanjiru, 2020). While these systems have proved effective in producing competent air traffic controllers, the rising complexity of airspace operations, partly due to the increase in air traffic volume and integration of automation demands ongoing evolution in how training is conceptualized and executed (Yaane, 2022). In high-density regions like Europe and North America, service providers often face the tough task of ensuring operational continuity while managing extended OJT sessions that may slightly reduce overall efficiency (Johnson et al., 2022).

In contrast, many countries within the African continent present a diverse and uneven landscape when it comes to ATM service quality and ATCO training frameworks. Some nations, such as South Africa and Egypt, have made significant strides in aligning their training programs with global standards through infrastructure investments, policy enhancements, and partnership with international bodies (Wanjiru, 2020). These countries have established institutions that are able to deliver high-quality OJT experiences by combining classroom teaching with live simulations and hands-on instruction. Conversely, several African nations continue to grapple with fundamental challenges, including limited infrastructure, underfunded training programs, and a shortage of qualified trainers (AfCAA, 2022). The Agency for Aerial Navigation Safety in Africa and Madagascar (ASECNA) has made regional efforts to harmonize training practices and enforce uniform standards, but inconsistencies persist. Many states lack access to modern simulation tools, structured evaluation models, or a sufficient pool of certified trainers (Adebayo, 2020). This situation is further compounded by fragmented regulatory oversight and operational bottlenecks, which, in turn, contribute to variations in ATM service delivery. Consequently, air navigation service providers (ANSPs) across the continent encounter difficulties in maintaining consistent service quality during OJT, particularly in high-density airspace corridors like those governed by the East African Community (EAC) and the Southern African Development Community (SADC) (Amani, 2022).

Kenya represents a microcosm of these challenges and opportunities. The Kenya Civil Aviation Authority (KCAA), tasked with regulating and overseeing air navigation services, manages the training, licensing, and professional development of ATCOs across the country (Akhter, 2021). Within this framework, OJT remains a mandatory phase for all trainee controllers, requiring them to demonstrate competency in managing real-time traffic scenarios before being issued full operational licenses (KCAA, 2023). In practice, the country's primary ATC facilities, namely the Nairobi Area Control Center (ACC) and the Nairobi Terminal Maneuvering Area (TMA) serve as critical testing grounds for aspiring controllers. These facilities handle a significant proportion of Kenya's air traffic, making them ideal yet demanding environments for OJT implementation. Although KCAA has invested in structured evaluation techniques and performance monitoring tools to improve OJT outcomes, notable challenges persist. Resource constraints, inconsistent trainer expertise, increased traffic density, and imbalanced workload distribution have been observed to hinder the effectiveness of OJT programs (Kumar, 2024). Moreover, the rapid expansion of Kenya's aviation infrastructure, along with rising international flight frequencies, has intensified pressure on ATC systems, necessitating a deeper examination of how OJT influences service delivery quality.

The OJT phase is fundamentally designed to immerse trainee controllers in real-life scenarios that demand situational awareness, adaptive decision-making, and effective communication under time pressure (Akhter, 2021). It is during this period that trainees apply their classroom-acquired knowledge to real operations, gaining exposure to traffic coordination, conflict resolution, and emergency response protocols. However, the transitional nature of OJT often introduces a period of vulnerability in ATM service quality (Carrey, 2023). Because trainees are still developing their procedural fluency and situational judgment, their performance typically requires constant supervision and frequent corrections. As such, ATC operations may experience momentary slowdowns, miscommunication, or procedural inconsistencies. While these issues are generally contained within acceptable safety margins, they can result in delays, inefficient sequencing of aircraft, and additional fuel consumption outcomes that directly affect airlines and passengers alike (Brown, 2021).

The role of the trainer during OJT cannot be overstated. These professionals must navigate a delicate balance between managing live air traffic and mentoring novice controllers (Ririani, 2021). Effective trainers not only possess operational excellence but also the pedagogical skills to communicate complex concepts, recognize learning styles, and offer constructive feedback. Seal (2022) asserts that experienced trainers significantly influence the learning curve of trainees by maintaining service quality while fostering skill acquisition. Nonetheless, trainers in busy ATC units often experience cognitive overload, having to manage the dual burden of safety-critical decision-making and instructional oversight. This duality increases the likelihood of fatigue, distraction, or decision fatigue, especially during peak traffic periods (Ncube, 2022). In Kenya, trainer development programs exist but may not be uniformly enforced across units. This has led to concerns regarding inconsistencies in training delivery, especially in units with limited supervisory resources (Gulikers, 2020). Addressing these gaps is crucial if ATM service quality is to be preserved throughout the training cycle.

Trainee educational background is another essential component influencing the quality of ATM services during OJT. Trainees entering OJT with a solid theoretical foundation in aviation operations, human factors, and international procedures are more likely to adapt efficiently to the demands of live control (Christopher, 2020). Their ability to interpret radar displays, apply standard phraseology, and manage sector-specific protocols allows them to perform with minimal disruption. Conversely, trainees with inadequate academic preparation may struggle to prioritize tasks, manage sector traffic, or respond promptly to emerging situations (Reen, 2021). This discrepancy not only prolongs the learning curve but also increases the burden on trainers and exposes the system to potential inefficiencies. Eurocontrol (2020) supports the argument that structured academic preparation, especially using advanced simulators and scenario-based assessments, enhances trainee readiness and reduces the potential for performance lags during OJT. Unfortunately, access to these preparatory resources remains uneven, particularly in developing aviation systems where training is often theory-heavy but practice-light (Darmin, 2022).

Workload management is a crucial but often overlooked dimension in the context of OJT. ATC operations inherently involve high cognitive demands, requiring continuous concentration,

quick mental calculations, and multi-tasking capabilities (Odukwe, 2022). When trainees are introduced into live control scenarios, the task of managing traffic is effectively shared between the trainer and the trainee. If the workload is not appropriately distributed or adjusted based on the trainee's competence level, the performance of both individuals can suffer. Trainers may become preoccupied with safety assurance and error correction, while trainees may feel overwhelmed by the complexity of sector traffic (Kigali, 2020). This has implications not only for performance but also for safety. Effective workload management strategies, such as sector splitting, use of assistant controllers, and rotating trainees through different traffic densities, are necessary to maintain operational effectiveness during training (Omondi, 2020). Nairobi ACC and TMA have attempted to implement such measures through structured schedules and progressive task assignment. Yet, the success of these interventions in maintaining optimal service levels remains an area requiring empirical evaluation (Ryan, 2023).

Error management protocols are integral to preserving safety standards during OJT while promoting learning. In ATC, errors though undesirable, are recognized as part of the learning process when managed within safe boundaries (Delgadol, 2021). Effective error management includes structured debriefing, transparent error reporting, and learning-focused corrective action. These practices not only help trainees identify areas of improvement but also prevent repetition of similar mistakes. ICAO (2023) advocates for proactive error management systems that include real-time feedback, predictive analytics, and post-shift evaluations. In Kenya, while post-session debriefings are routine, the broader adoption of data-driven error tracking and real-time analytical tools remains limited (Baron, 2022; Zhao, 2022). Bridging this gap could allow for earlier identification of performance risks and enable targeted interventions that support both training outcomes and operational reliability.

Technological developments are also reshaping the context in which OJT is conducted. Modern ATC systems are increasingly integrated with digital tools, including automated flight data processing, electronic flight progress strips, and controller–pilot data link communication (CPDLC). These technologies improve efficiency and reduce manual workload, but they also introduce new layers of complexity into training programs (Kibet, 2024). Trainees must now learn to manage both automated and manual systems, respond to technology failures, and maintain a

high degree of situational awareness. Johnson et al. (2021) argue that training curricula must evolve alongside technological changes to ensure relevance and effectiveness. In Kenya, the introduction of automation is ongoing, but its impact on OJT efficiency, particularly in relation to controller adaptability and system trust is still under-researched (Ncube, 2022).

From the perspective of Air Navigation Service Providers (ANSPs), evaluating the effectiveness of on-the-job training (OJT) goes beyond academic outcomes and requires an operational focus. As employers tasked with ensuring air traffic safety, ANSPs often detect performance gaps in trainee controllers that only become evident in live control environments. For example, a study by Reinhardt and Muller (2022) in South Africa found that supervisors observed consistent challenges in situational awareness and real-time decision-making, which were not identified during theoretical assessments. In the United Kingdom, Morgan and Ellis (2021) reported that ANSPs managing high-density traffic areas like Heathrow and Manchester raised concerns about trainee performance in communication accuracy and workload management. These findings have influenced a shift toward competency-based training frameworks that better reflect real-world complexity. Some ANSPs have also introduced post-certification mentorship programs to support continuous learning and operational readiness. As key stakeholders in air traffic management, ANSPs emphasize that their direct involvement in evaluating OJT is crucial to preparing fully competent and reliable air traffic controllers.

Despite the substantial body of literature on ATC training systems, there is a conspicuous lack of studies that examine OJT's impact on ATM service quality from a real-time operational standpoint (Laaser, 2023). Much of the current research focuses on trainee development without adequately accounting for how service metrics such as punctuality, coordination efficiency, and communication clarity are affected during the OJT phase (Jeffer, 2022). This study addresses that gap by investigating how key factors: trainer expertise, trainee academic preparation, workload management, and error handling interact to influence service quality. The selection of Nairobi ACC and TMA as study sites is strategic due to their high traffic density, structured training environments, and relevance to regional air navigation (Jauran, 2021).

By systematically evaluating these dimensions, this study aims to offer actionable insights for improving the OJT process. The findings will have direct implications for policy development,

trainer certification standards, and technology integration strategies. In so doing, it will support the broader objective of maintaining high ATM service standards while fostering the next generation of air traffic controllers. Ultimately, the research aims to contribute toward a more resilient, efficient, and adaptable air traffic management ecosystem that can meet the dynamic demands of global aviation.

1.2.1 On-the-Job Training

On-the-Job Training (OJT) represents a pivotal phase in the preparation of air traffic controllers, functioning as the essential link between classroom instruction and real-time operational engagement. This stage allows trainees to apply their theoretical knowledge in live environments under the supervision of experienced controllers, thereby nurturing essential competencies such as situational awareness, real-time decision-making, precise communication, and effective workload handling (Raul, 2021). The dynamic nature of live traffic control introduces trainees to unpredictable and evolving airspace conditions, requiring them to synthesize procedural knowledge with responsive judgment. Trainers play a crucial role here, not only ensuring operational safety but also actively shaping trainee growth through timely feedback and guided exposure (Pierre, 2022). As trainees progress, they are gradually entrusted with increasing responsibility, while trainers continuously assess readiness and intervene where needed to prevent risk escalation (Mehta, 2021). This hands-on exposure, scaffolded by professional oversight, builds both competence and confidence, contributing to the development of safety-oriented, decision-capable air traffic managers (Kim, 2021).

The effectiveness of OJT is shaped by various interrelated constructs, the foremost of which is trainer expertise. Trainers must balance operational acuity with instructional ability, as they are not merely traffic managers but also educators tasked with developing another professional (Raul, 2021). Effective trainers demonstrate a capacity to observe subtle trainee behaviors, provide constructive feedback, and modulate the pace of training based on individual learning curves (Mehta, 2021). Their operational experience, familiarity with pedagogical methods, and comfort with intervention thresholds are all crucial in maintaining safety while supporting growth. Key indicators of trainer effectiveness include prior instructional assignments, intervention frequencies, clarity in feedback delivery, and alignment with ICAO-endorsed procedures (Pierre,

2022). Without such expertise, trainees may be exposed to inconsistent learning experiences or operational vulnerabilities, especially during high-density traffic scenarios (Kim, 2021). Therefore, selection, training, and ongoing evaluation of OJT trainers are fundamental components of sustainable capacity development in air traffic services.

In parallel, the educational background of trainees strongly influences the efficiency and success of the OJT process. Those entering OJT with a strong grasp of aviation law, ATM theory, and ICAO standards typically exhibit faster assimilation into live operations (Kim, 2021). Academic qualifications especially in aviation-related disciplines, foster better interpretation of control scenarios, support faster learning of complex traffic patterns, and contribute to resilience under pressure (Raul, 2021). Theoretical assessment performance prior to OJT is often a useful predictor of field readiness, as it reflects both knowledge retention and procedural familiarity (Pierre, 2022). Furthermore, trainees with prior exposure to simulated traffic environments or structured decision-making exercises often adapt more seamlessly to real-world scenarios, requiring fewer corrective interventions from their trainers (Mehta, 2021). For this reason, institutions often implement stringent academic and simulation prerequisites before allowing entry into the OJT phase, ensuring trainees begin this transition with the cognitive foundation necessary for real-time service delivery.

Workload management introduces another crucial dimension in the evaluation of OJT quality. The ATC environment is highly sensitive to time, coordination, and accuracy, and the transition of responsibilities from trainer to trainee must be done in a calibrated manner to preserve these attributes (Raul, 2021). Initially, trainers may retain significant control over operations, gradually ceding authority to the trainee as competence increases. This staged process helps mitigate cognitive overload while ensuring service continuity (Pierre, 2022). Effective workload management is reflected in factors such as the trainer-to-trainee intervention ratio, real-time task delegation, sector complexity management, and safe handling of peak-hour traffic (Kim, 2021). An optimal workload distribution ensures that neither trainer nor trainee is overburdened, allowing for learning to occur without compromising safety margins (Mehta, 2021). Moreover, using structured task allocation models and incorporating feedback loops during high-demand periods

enables better anticipation of trainee fatigue and learning plateaus, supporting more efficient skill development across the training cycle.

Finally, the presence and implementation of robust error management protocols significantly influence the success of the OJT process. In an environment where the margin for error is minimal, creating a framework that allows trainees to make, understand, and learn from mistakes is essential (Raul, 2021). Errors should be documented, analyzed, and discussed in a non-punitive environment, allowing the trainee to reflect, correct, and improve performance without fear of retribution (Pierre, 2022). Debriefing sessions, structured post-shift evaluations, and root cause analysis are valuable tools in identifying not just what went wrong, but why it happened and how similar situations can be avoided in future (Mehta, 2021). The use of predictive analytics and performance tracking also aids in identifying recurring error patterns, making it possible to provide targeted remediation and adjust training strategies (Kim, 2021). In this way, error management shifts from being reactive to becoming a proactive, embedded element of the learning process, reinforcing safety culture while enhancing individual performance.

In essence, OJT is not merely an evaluative phase but a formative process that shapes the future capabilities of air traffic controllers. It requires intentional design, informed supervision, and a supportive institutional framework that recognizes the duality of training and operations. The interplay between trainer experience, trainee preparation, workload balancing, and error response mechanisms determines whether OJT functions as a growth opportunity or a bottleneck in controller development (Mehta, 2021). When these factors align, OJT becomes more than a requirement. It becomes the crucible in which operational excellence, safety assurance, and professional maturity are forged.

1.2.3 Organizational Performance

Organizational performance in air traffic management refers to how effectively an air navigation service provider achieves its operational objectives, particularly in safety, efficiency, and service quality. Key performance indicators such as flight expedition, airspace capacity utilization, regulatory compliance, and incident rates are used to evaluate an organization’s overall efficiency. Since air traffic control services directly influence aviation safety and operational

fluidity, the effectiveness of training programs, including OJT, plays a crucial role in organizational performance (Makhanya, 2020). Well-trained air traffic controllers contribute to enhanced service delivery by minimizing flight delays, optimizing airspace utilization, and ensuring safety compliance, whereas ineffective training can lead to operational inefficiencies, safety risks, and increased regulatory scrutiny. Therefore, investment in structured and competency-based training programs significantly enhances organizational effectiveness by improving controller performance, reducing human errors, and ensuring seamless air traffic operations (López, 2022).

Air traffic management safety performance is a key component of organizational performance and can be operationalized using specific measurable indicators. One of these indicators is compliance with separation standards, which ensures that controllers maintain prescribed minimum distances between aircraft, assessed through the number of separation breaches, response time to conflict alerts, and corrective instruction accuracy (Kibet, 2024). Another crucial indicator is the rate of incidents and accidents, which measures the frequency of safety-related events attributed to ATC errors, including the number of serious incidents, runway incursions, and airspace violations. Communication accuracy is also vital in ATM safety performance, as clear and precise ATCO-to-pilot and inter-unit coordination reduces misinterpretations and enhances situational awareness; this can be assessed through miscommunication incident reports, phraseology adherence rates, and response times. Additionally, traffic flow management efficiency determines how well ATC units handle increasing air traffic volumes without causing unnecessary delays or disruptions, evaluated through average flight delay statistics, holding time per flight, and successful implementation of flow control measures (Makhanya, 2020). Finally, the integration of ATM technology significantly affects safety performance by reducing human errors and enhancing efficiency, measured through automation tool implementation rates, ATCO proficiency in digital systems, and reductions in manual coordination errors. All these indicators contribute to an organization's ability to provide safe and efficient air traffic services (Mwangi, 2020).

1.2.4 Air Traffic Management Safety

Air Traffic Management safety is central to aviation operations, ensuring aircraft navigate busy airspaces securely. It involves managing factors such as aircraft separation, route optimization, sequencing, and conflict resolution while accommodating the growing volume of air traffic (ICAO, 2023). The effectiveness of ATM safety protocols relies on the skills of controllers who must stay aware of evolving traffic situations, follow procedures, and react quickly to changes (Makhanya, 2020). International regulations, particularly from ICAO, stress the importance of thorough training, precise communication, and sound error management in preserving safety levels. Modern safety efforts have shifted from reactive responses to preventive approaches through safety management systems, ongoing surveillance, and the use of predictive methods to identify risks early (Mwangi, 2020).

Safety performance in ATM is measured through indicators that capture both how often and how serious safety-related events are. These include instances where minimum separation distances are compromised, near-miss situations, and unauthorized entries into controlled airspace, which reflect both individual and procedural reliability (Kibet, 2024). Communication lapses, such as incorrect read-backs or unclear instructions, are carefully observed because breakdowns in communication continue to play a role in safety incidents (López, 2022). Reporting systems encourage controllers to document occurrences without fear of punishment, allowing organizations to analyze trends and make improvements (Baron, 2022). By studying these reports and metrics, organizations can pinpoint areas needing adjustments, whether in training, operations, or system design.

Technological advancements are increasingly shaping ATM safety by helping controllers handle complex scenarios with greater accuracy. Tools such as conflict detection, electronic flight strips, and decision aids help lower the chances of human error and support more informed decision-making (Johnson et al., 2021). Still, successful use of these systems depends on adequate training that prepares controllers to work confidently with both automated processes and manual controls (Kibet, 2024). In Kenya, upgrades within Nairobi ACC and TMA have brought in new automation elements, but the full influence of these systems on training and safety is still being examined. The

interaction between human capability, technology, and oversight remains a key factor in maintaining and improving safety.

1.3 Statement of the problem

ATM safety performance is a vital indicator of how effectively an ANSP adheres to international standards of safety, efficiency, and operational reliability (Khatib, 2021). OJT for ATCOs plays a pivotal role in shaping these outcomes by directly influencing the quality of air traffic services during the transition from classroom learning to live operational control. While global trends have embraced structured and performance-based OJT frameworks that prioritize safety assurance, technical competency, and adaptability to modern systems, the Kenyan context has received limited empirical attention. Specifically, the extent to which OJT affects ATM safety performance in real-time operational settings such as the Nairobi ACC and TMA remains underexplored (Odukwe, 2022).

Conceptually, past research has primarily emphasized individual aspects of trainee development such as trainer competence, academic preparedness, workload management, and error handling protocols without holistically examining how these variables interact to affect live ATM service quality. Most studies have focused on outcomes like knowledge acquisition or certification success, but have failed to link OJT effectiveness with operational metrics such as coordination efficiency, traffic flow continuity, and communication precision. This fragmented approach reveals a conceptual gap in understanding how OJT mechanisms influence measurable live service delivery indicators during training, rather than after certification.

Contextually, existing literature from advanced aviation systems such as those in Europe, North America, and parts of Asia has demonstrated the utility of competency-based OJT frameworks in maintaining ATM standards during controller training. However, such findings are not easily transferable to Kenya due to contextual differences in infrastructure readiness, traffic density, regulatory capacity, and training oversight. Studies on African ATCO development tend to be generalized, often overlooking the localized institutional, technological, and procedural nuances that affect OJT outcomes in Kenya’s dynamic airspace. There is thus a contextual gap in

localized studies that assess OJT's operational impact within the unique traffic and training environments of Kenyan ACC and TMA facilities.

This study addresses both conceptual and contextual gaps by empirically investigating how trainer expertise, trainee educational background, workload distribution, and error management protocols collectively influence ATM safety performance during OJT in the Kenyan airspace. By focusing on operational outcomes and real-time training challenges, the research seeks to establish a causal link between the structure and quality of OJT and the efficiency, safety, and reliability of real time ATM service delivery in high-traffic regions. This evidence-based approach offers timely insights to inform policy reform, trainer qualification standards, and adaptive training models that align with ICAO guidelines while remaining responsive to Kenya's operational realities. In doing so, the study contributes to a safer, more resilient, and performance-oriented ATM ecosystem.

1.4 Objectives of the study

The objective of this research was to assess the effect of on-the-job training periods on air traffic management safety performance in the Kenyan airspace.

i. To establish the influence of Trainer Experience Level on air traffic management safety performance in the Kenyan Airspace.
ii. To assess the influence of Trainee education background on air traffic management safety performance in the Kenyan Airspace.
iii. To examine how Workload during OJT influences air traffic management safety performance in the Kenyan Airspace.
iv. To determine the influence of Error Management Protocols on air traffic management safety performance in the Kenyan Airspace.

1.5 Research Hypotheses

$\mathbf{H_0 1}$: Trainer Experience Level has no significant effect on air traffic management safety performance in the Kenyan airspace.

$\mathbf{H_0 2}$: Trainee education background has no significant effect on air traffic management safety performance in the Kenyan airspace.

$H_0$3: Workload during OJT has no significant effect on air traffic management safety performance in the Kenyan airspace.

$H_0$4: Error Management Protocols have no significant effect on air traffic management safety performance in the Kenyan airspace.

1.6 Significance of the Study

Ensuring that airlines obtain high-quality service from ATC during OJT periods is critical for maintaining air traffic management safety, operational efficiency, and overall airspace management. During OJT, trainee air traffic control officers are still developing their skills, which may affect communication clarity, decision-making speed, and traffic coordination. Any deficiencies in these areas can lead to increased delays, misrouting, or heightened safety risks, directly impacting traffic operations. If not properly managed, such deficiencies can disrupt flight schedules, increase operational costs, and reduce confidence in ATM services.

This research is significant for multiple stakeholders. For ATCOs, it provides insights into how OJT conditions influence their ability to deliver seamless air traffic services, ensuring they meet the expectations of the industry. Airlines benefit from a deeper understanding of how ATC training impacts their operations, helping them collaborate with air navigation service providers (ANSPs) to enhance service reliability. KCAA gain empirical data to refine OJT policies, ensuring that training programs balance skill development while maintaining high standards of service delivery. Training institutions can be better positioned to design OJT programs that prepare ATCOs to handle live traffic without compromising operational efficiency.

Failure to conduct this research could lead to persistent deficiencies in ATM services during OJT periods, causing delays, miscommunication, and potential safety concerns for traffic operating in Kenyan airspace. By addressing these challenges, this research contributes to a structured OJT framework that ensures aircraft continue receiving high-quality ATM services while air traffic controllers undergo training.

1.7 Scope of the Study

This research examined how OJT periods affect air traffic management safety performance in the Kenyan airspace. Specifically, how trainer experience, trainee educational background, workload during OJT, and error management protocols impact the efficiency and reliability of ATM services. These variables were analyzed to determine their effect on flight operations, including communication effectiveness, delay management, and overall safety performance.

Geographically, the study was confined to Nairobi ACC and TMA, both under KCAA, as these units handle high volumes of air traffic and are critical to aircraft operations in Kenyan airspace. The research targets ATCOs undergoing OJT, their trainers, and pilots who rely on ATC services for smooth flight operations.

The study was limited to OJT in Nairobi ACC and TMA, excluding other ATC units outside this jurisdiction. The study focused on operational factors affecting service delivery rather than broader organizational or policy-level issues. The findings can be applicable to KCAA and other ANSPs seeking to improve OJT frameworks while maintaining high-quality ATC services for airlines.

The time scope covered OJT activities conducted within the past two years, from 2023 to 2024, to ensure that the findings reflect current training practices and recent operational challenges in air traffic control. This period allows for an inclusive assessment of training trends, regulatory changes, and evolving ATM safety performance indicators, ensuring the relevance of the study to ongoing improvements in ATC operations.

The methodological scope entailed a mixed-methods approach that integrates both quantitative and qualitative data collection techniques. Quantitative data was obtained through structured surveys and analysis of ATM safety performance metrics, while qualitative insights was gathered from in-depth review of incident reports during OJT periods. Regression analysis was used to determine the statistical significance of relationships between OJT variables and ATM safety performance, while thematic analysis was applied to the incident reports to gain deeper insights into training experiences and operational challenges.

The theoretical scope of the study is grounded in Experiential Learning Theory, Constructivist Learning Theory, and the 70:20:10 Learning Model. Experiential Learning Theory explains how ATCOs acquire competencies through hands-on experience, reflection, and iterative practice, making it fundamental in assessing skill development during OJT. Constructivist Learning Theory emphasizes active engagement and knowledge construction through real-world interactions, highlighting the role of trainer guidance and situational learning in shaping trainee performance. The 70:20:10 Learning Model underscores the importance of experiential learning (70%), social learning (20%), and formal instruction (10%) in professional training, aligning with OJT's structured approach to competency development. By integrating these theories, the study provides a comprehensive framework for evaluating the effectiveness of OJT in enhancing ATCO skills and improving ATM safety performance within KCAA and other ANSPs.

1.8 Delimitations of the Study

This research is delimited to examining the effects of OJT on ATM service quality during that period, focusing specifically on four key variables: trainer expertise, trainee educational background, workload management, and error management protocols. These delimitations establish the boundaries of the study, ensuring that the research remains focused, feasible, and relevant to the objectives. The study was strictly concerned with OJT as a training methodology and its implications for ATM service quality as it occurs. Other training approaches, such as classroom-based learning, simulator training, and refresher courses for experienced controllers, are excluded because they do not involve direct, live interactions with aircraft during actual ATC operations. Although these methods contribute to overall controller competence, they do not introduce the same risks and service quality variations observed when trainees operate under supervision in live environments. Examining them alongside OJT would dilute the study's focus on real-time service quality fluctuations.

The study employed a predominantly quantitative research approach, incorporating structured questionnaires and observational data. Qualitative insights from trainers and supervisors are included to enhance understanding but are not the primary focus. A fully qualitative approach is not used because it would rely heavily on subjective interpretations, which may introduce biases and limit the study's generalizability. Additionally, longitudinal tracking of trainees' long-term

performance post-certification is excluded, as this would require extended data collection beyond the immediate OJT period, making the study less feasible within the available timeframe and resources. Regarding the timeframe, the study is limited to analyzing the current operational structure of OJT within Nairobi ACC and TMA at the time of research. It does not explore historical training models or attempt to predict future trends, as these would require different methodological approaches and long-term data collection, which are beyond the scope of this research. Similarly, changes in aviation policies or technological advancements that may affect ATC training in the future are not considered, as the focus is on the existing OJT framework and its immediate impact on service quality.

In terms of study participants, the research targeted air traffic control trainers, OJT trainees, and operational supervisors. Airline representatives, and aviation regulators are excluded because their perspectives, while valuable in broader discussions on air traffic management, do not directly contribute to understanding how OJT influences ATC service quality. Additionally, the study does not assess passenger experiences, flight delays, or operational disruptions from the airline's perspective, as these would require an entirely different analytical framework centered on airline operations rather than ATC training. By setting these delimitations, the study remains focused on evaluating how OJT affects ATM service quality in operations within a controlled and well-defined scope. These decisions ensure that the research is manageable, relevant, and provides meaningful insights into the selected variables without becoming overly broad or unfeasible.

1.9 Assumptions of the Study

This research operated under several key assumptions, which, while not guaranteed, are necessary for the validity and reliability of the research findings. The primary assumption is that all respondents, including ATCOs, trainees, and supervisors, provided honest and accurate responses. Given the structured and regulated nature of ATC operations, it is expected that participants engaged sincerely with the research instruments without withholding critical information or providing misleading answers. The study also assumes that respondents have sufficient knowledge and experience in OJT processes, allowing them to provide meaningful insights into the impact of trainer expertise, trainee educational background, workload management, and error management protocols on ATM service quality.

1.10 Theoretical Framework

The theoretical framework provides the foundation for understanding how service quality in ATM is affected during OJT periods for trainees. This research is supported by three key theories: Experiential Learning Theory, Constructivist Learning Theory, and The 70:20:10 Learning Model. These theories explain the relationship between Trainer Experience Level, Trainee Education Background, Workload During OJT, and Error Management Protocols, all of which influence the efficiency of ATC operations and the overall service quality provided to airlines.

1.10.1 Experiential Learning Theory

Experiential Learning Theory (ELT), developed by David Kolb, suggests that learning is most effective when it is rooted in concrete experiences followed by reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984). This cyclical learning model has been widely applied in aviation training, where real-world exposure and iterative learning are central to skill development. Bradley (2023) emphasized that trainees internalize information better when they physically engage with tasks and reflect upon their outcomes. In ATM contexts, where decision-making speed and accuracy are critical, ELT provides a structured way of ensuring that trainees assimilate both procedural and situational knowledge (Salas & Cannon-Bowers, 2021). Moon (2024) supported this approach by underlining the reflective component, noting that structured feedback loops are essential for converting experiences into applicable knowledge. Brown (2021) further emphasized that experiential learning cycles enhance workload adaptability, allowing both trainers and trainees to navigate high-density airspace effectively. This is crucial in reducing operational disruptions and ensuring service continuity during OJT periods.

Studies by Burke et al. (2020) and Njenga (2021) reveal that experiential learning significantly improves trainee adaptability and confidence in live traffic environments, especially when paired with competent trainers. Khatib (2021) illustrated how trainees who go through the ELT stages perform better under pressure due to enhanced cognitive processing. Similarly, Rouder (2022) found that exposure to complex traffic scenarios through experiential learning helps build resilience, allowing trainees to manage errors without compromising safety. Ncube (2022) emphasized that active experimentation, a key component of ELT, enables trainees to test different

strategies in managing real-time conflicts, contributing to their decision-making proficiency. These findings validate the inclusion of ELT in air traffic control OJT design, especially in busy sectors where the margin for error is narrow.

The application of ELT is particularly relevant when considering the diversity of educational backgrounds among trainees. Kim (2021) showed that while academic preparation lays the groundwork, experiential learning bridges the gap between theory and practice. Salas & Cannon-Bowers (2021) noted that hands-on exposure accelerates the integration of abstract knowledge into routine decision-making processes. Mehta (2021) linked trainer experience with the effectiveness of experiential learning cycles, emphasizing that trainers with real-time operational backgrounds provide more contextualized and impactful mentorship. Makhanya (2020) supported this by highlighting that well-structured ELT processes mitigate human errors and improve overall controller performance. This reinforces the idea that learning through doing, guided by experienced mentors, leads to meaningful skill acquisition.

Furthermore, experiential learning aligns with error management strategies commonly applied in ATM. According to Rouder (2022), experiential feedback mechanisms ensure that mistakes are seen as learning opportunities rather than punitive failures. Burke et al. (2020) confirmed that structured debriefings, reflective discussions, and scenario-based evaluations enhance both error detection and correction. Mwangi (2020) explained that trainees who undergo structured experiential learning are better equipped to self-monitor and adapt under pressure, leading to lower intervention rates. Njenga (2021) added that these processes foster psychological safety during training, which is essential in environments where continuous learning and performance improvement are mandatory. Through this lens, ELT becomes an essential pillar of a safe and effective OJT program.

1.10.2 Constructivist Learning Theory

Constructivist Learning Theory, rooted in the work of Jean Piaget and expanded by scholars like Vygotsky and Bruner, proposes that learners construct knowledge through interactions with their environment and social context (Piaget, 1950; Vygotsky, 1978; Bruner, 1996). This theory aligns well with the social and interactive nature of OJT in ATM, where

learning occurs not in isolation but in collaborative and context-specific scenarios. Lave and Wenger (2021) explored this further through the concept of situated learning, which stresses the importance of authentic experiences in real-world environments. Duguid (2020) emphasized that problem-solving and adaptive expertise are refined through socially mediated instruction. Zulu (2021) illustrated that ATCO trainees benefit significantly from structured learning dialogues, particularly when working under the supervision of experienced mentors. Ryan (2023) supported this by showing that social interaction enhances understanding of complex ICAO procedures, especially for trainees with varying educational backgrounds. This interplay of active engagement and social guidance defines how knowledge is internalized in high-stakes operational environments.

In the ATM training context, Constructivist Learning Theory supports the notion that trainees learn best when guided through complex scenarios by experienced instructors. Wanjiru (2020) demonstrated that social scaffolding, where trainers progressively transfer responsibility, encourages independence and critical thinking. Stevenson (2021) found that trainer flexibility and responsiveness to individual learning needs enhance instructional outcomes in dynamic ATC sectors. Ncube (2022) showed how constructivist strategies promote learner autonomy, which is essential in environments that require immediate and confident decision-making. Brown (2021) explored how different workload conditions affect social learning during OJT, concluding that collaborative processing of workload data improves task delegation. Moreover, Rouder (2022) highlighted that error analysis sessions reinforce constructivist principles by allowing trainees to reflect and adjust their internal models of operation. These elements affirm the role of Constructivist Learning Theory in shaping effective OJT interventions.

Constructivist theory also accounts for variability in trainees' academic foundations. Ryan (2023) observed that those with strong theoretical backgrounds construct new knowledge more quickly when they can relate it to prior learning. Kim (2021) argued that constructivist environments promote integration of abstract regulatory frameworks into tangible operational behaviors. Duguid (2020) emphasized that social modeling, where trainees observe experienced ATCOs handling complex tasks, enhances learning outcomes, particularly in sectors requiring multitasking and conflict resolution. Mehta (2021) noted that trainer expertise is critical in guiding

these learning experiences, especially in tailoring explanations to the trainee's existing mental models. The theory thus bridges academic preparation with operational fluency through socially facilitated contextual learning.

Additionally, constructivism supports proactive error management as a learning tool. According to Wanjiru (2020), discussing errors in a non-threatening environment promotes open reflection and deep learning. Stevenson (2021) observed that collaborative post-shift debriefs foster accountability while enhancing trainee confidence. Rouder (2022) found that engaging trainees in solution-focused discussions following operational missteps significantly improves retention and reduces repeated mistakes. Khatib (2021) emphasized that trainer-led reflection is especially impactful in high-pressure sectors like Nairobi ACC, where operational stakes are high. These findings position Constructivist Learning Theory as essential for fostering a culture of continuous learning, resilience, and performance optimization in ATC training environments.

1.10.3 The 70:20:10 Learning Model

The 70:20:10 Learning Model, introduced by McCall, Lombardo, and Morrison (1988), posits that 70% of learning occurs through experience, 20% through social interaction, and 10% through formal education. This model reflects the reality of ATC environments, where skill acquisition is driven more by hands-on exposure and mentorship than classroom learning. Jennings (2023) emphasized the dominance of experiential learning in high-stakes professional development, where routine exposure to operational complexities fosters real competence. Eraut (2004) added that informal learning, embedded in daily work processes, is more enduring and transferable than theoretical instruction alone. Conner (2020) reinforced that real-time scenarios challenge trainees to make autonomous decisions, bridging knowledge with practice. Park (2021) highlighted how mentorship through immediate constructive feedback supports learning retention and procedural compliance. This distribution of learning effort is particularly applicable to OJT in ATM, where live operations form the cornerstone of professional growth.

The model also emphasizes the importance of social learning in shaping professional identity and competence. Eraut (2004) described how informal peer discussions and trainer feedback sessions promote clarity, especially on ambiguous operational procedures. Jennings (2023) noted

that real-time corrections and dialogue during live operations enhance both accuracy and judgment. Owen (2021) examined how communication between trainers and trainees can recalibrate workload, ensuring both learning opportunities and operational safety are balanced. Wanjiru (2020) emphasized that a structured feedback culture not only accelerates learning but also improves situational awareness and confidence among trainees. These findings affirm the relevance of the 20% social learning component in shaping reliable, confident ATCOs during OJT.

The 70% experiential component directly connects with workload and error management in OJT. Mwangi (2020) emphasized that gradual exposure to sector workload helps build stamina and improves decision-making under pressure. Rouder (2022) showed that workload variation, when structured correctly, can enhance flexibility without overwhelming the trainee. Owen (2021) reported that monitoring workload-to-skill ratios prevents burnout and enhances cognitive assimilation of complex tasks. Burke et al. (2020) stressed the importance of aligning workload levels with trainee competence, particularly in sectors with high traffic density. These insights validate workload as a learning variable that, when strategically managed, boosts OJT effectiveness.

Finally, the model's 10% formal learning component highlights the necessity of integrating classroom theory with practical training. Ryan (2023) observed that trainees with solid academic grounding adapt more quickly to procedural demands. Kim (2021) stressed the importance of theoretical training in building confidence when interpreting ICAO standards during live sessions. Njenga (2021) emphasized that structured theory enhances a trainee's ability to process real-time feedback during operations. Duguid (2020) found that theory-to-practice transfer is more seamless when foundational concepts are embedded into daily OJT routines. Thus, the 70:20:10 model supports a holistic learning approach, aligning formal knowledge, social mentoring, and practical exposure for optimal skill development in ATM.

1.11 Conceptual Framework

The conceptual framework figure 1 for this study illustrates the relationships between key variables that influence ATM service quality during OJT in Nairobi ACC and TMA. It serves as a visual and theoretical guide, identifying how trainer expertise, trainee educational background, workload management, and error management protocols interact to affect service outcomes. By mapping these linkages, the framework provides a structured approach to examining how each independent variable contributes to or moderates the quality of air traffic management services delivered during the training period.

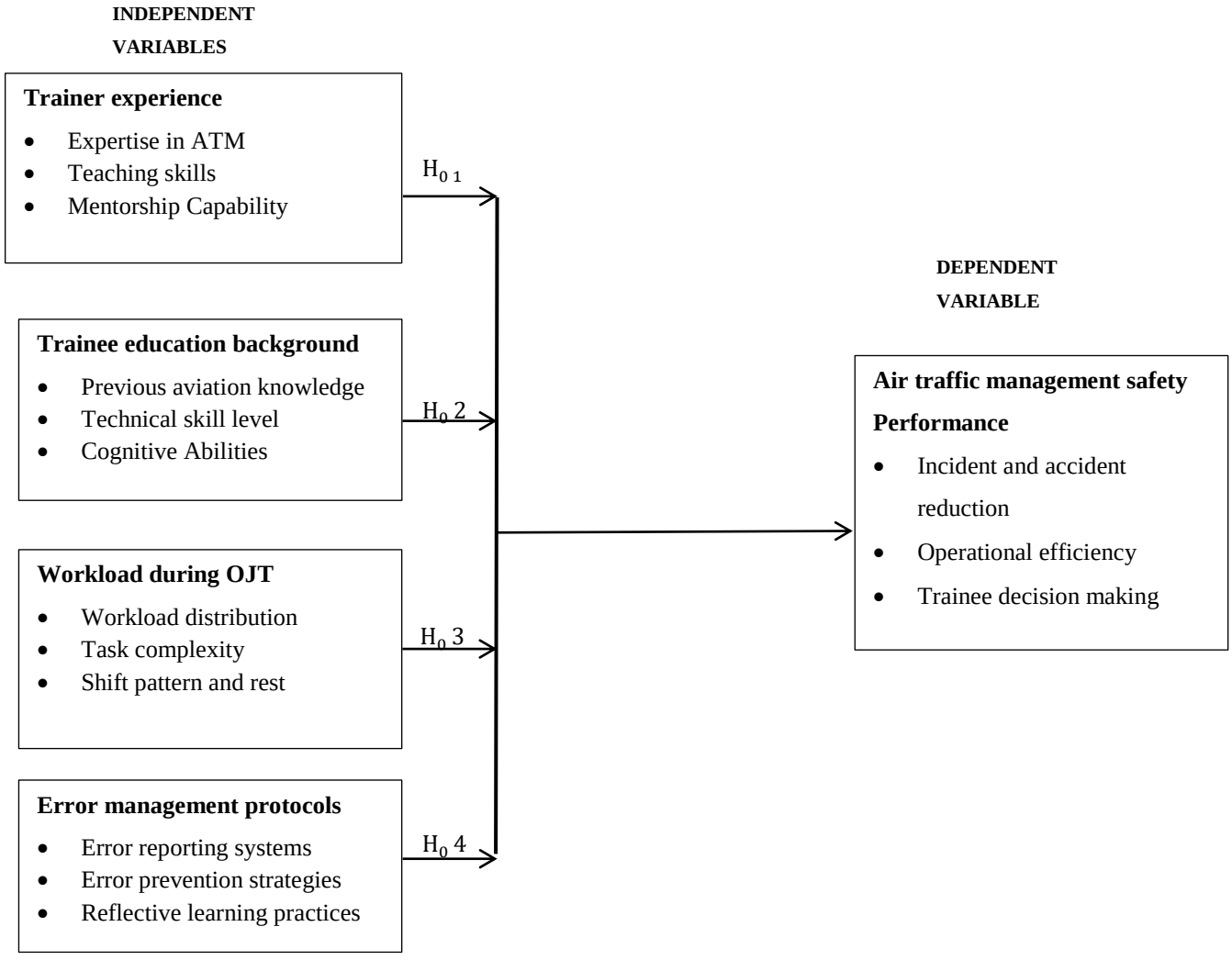


Figure 1: Conceptual Framework

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews existing literature relevant to the study on the influence of trainer experience, trainee educational background, workload distribution, and error management protocols on safety performance during OJT for air traffic control officers in Kenya. The purpose of this research is to assess how these factors collectively affect safety performance, identify key challenges, and propose strategies to enhance safety outcomes in Kenyan airspace during ATCOs OJT periods.

2.2 Review of Empirical Literature

This section of the research engages in a critical evaluation of the contributions of the literature to the given topic. It analyzes the debates, issues, and contributions of the writers to the subject of the research.

2.2.1 Trainer expertise and ATM safety performance

Trainer expertise plays a pivotal role in shaping safety performance and service quality during OJT period for air traffic control officers. Skilled trainers must manage the dual responsibility of overseeing live air traffic operations while simultaneously guiding trainees through complex decision-making processes. The ability to provide structured feedback, implement timely interventions, and uphold operational safety standards is essential in minimizing risks during training. However, the level of effectiveness among trainers is influenced by multiple factors, including workload distribution, instructional approaches, and the presence of standardized training frameworks (Akhter, 2021). Without clear guidelines and structured methodologies, inconsistencies in training quality may emerge, leading to variations in safety performance. Ensuring that trainers receive adequate support, including workload adjustments and professional development programs, is crucial in maintaining high training standards and reducing safety-related incidents.

Seal (2022) examined the impact of trainer expertise on OJT efficiency in European air navigation service providers, revealing that highly skilled trainers minimized operational disruptions by anticipating trainee errors and implementing real-time corrective measures. The study emphasized that trainers with formal pedagogical training produced better trainee outcomes but highlighted a lack of standardization in trainer selection criteria across ATC units, leading to disparities in training effectiveness. Building on this, Mwangi (2024) analyzed trainer selection and development processes in Kenyan ATC, finding that inconsistent evaluation criteria resulted in variable training quality. The study reinforced the importance of structured pedagogical training in mitigating trainee errors but identified a significant gap in mentorship programs, with no structured pathways for junior controllers to transition into trainer roles. Expanding on these findings, Ncube (2022) investigated cognitive overload among trainers in South Africa, revealing that managing both air traffic and trainee supervision led to decision fatigue. To address this, the study recommended structured workload distribution, such as alternating between active control duties and training responsibilities, to prevent burnout. However, a critical gap remained in the absence of policies regulating trainer workload in high-traffic ATC environments.

Tanaka (2023) assessed the relationship between trainer experience levels and trainee skills retention rates in Japan’s ATC training programs. Results showed that trainees under highly experienced trainers demonstrated a 30% higher retention of procedural knowledge compared to those trained by less experienced personnel. The study attributed this to the trainers' ability to adapt instructional methods based on real-time operational demands. However, a limitation was the lack of an established mentorship framework to guide knowledge transfer from senior to junior trainers. In Ghana, Boateng (2023) investigated how trainer experience influences air traffic incident rates during OJT. The findings highlighted that incidents were 25% lower in units where trainers had undergone recurrent training in instructional techniques and human factors management. The study identified a gap in regulatory policies enforcing periodic refresher training for ATC trainers, which could improve consistency in training quality.

The reviewed studies highlight the importance of trainer expertise in ensuring safe and efficient OJT for air traffic controllers. Highly experienced trainers enhance air traffic controllers’ OJT learning outcomes, minimize errors, and maintain operational efficiency. However, key gaps

exist in the standardization of trainer selection criteria, and mentorship frameworks. In Kenya, inconsistencies in trainer development and evaluation remain a challenge, impacting ATM service delivery during OJT. Addressing these gaps through structured policies and recurrent training programs can improve OJT safety performance in Kenyan during ATC training.

2.2.2 Trainee education background and ATM safety performance

Trainee educational background significantly impacts ATM safety performance during OJT, as it shapes a trainee's ability to analyze complex air traffic situations and make precise decisions under pressure. A strong academic foundation enhances problem-solving skills, enabling trainees to adapt to dynamic operational challenges while maintaining compliance with safety protocols. Research by Patel and Sharma (2020), along with findings by Iyer et al. (2021), highlights that individuals with educational backgrounds in aeronautical sciences and aviation-related disciplines exhibit greater proficiency in understanding procedural frameworks and mitigating safety risks. In contrast, those with minimal exposure to aviation-specific coursework may find it difficult to grasp the technical intricacies of air traffic management, resulting in inconsistent performance levels. Variability in academic preparedness across different training cohorts creates difficulties in maintaining standardized safety outcomes, leading to potential disparities in operational efficiency. Strengthening educational prerequisites and incorporating specialized learning modules could help address these gaps, ensuring a more uniform level of competency during OJT.

A study by Gulikers (2020) found that trainees with specialized education in air traffic control exhibited faster cognitive processing speeds and better situational awareness than those with general aviation degrees. This advantage translated into a lower error rate and improved response times during high-traffic operations. However, the study highlighted a gap in curriculum alignment, as some training institutions lacked standardized coursework tailored to the practical demands of air traffic control. Similarly, Patel (2022) examined the influence of educational background on decision-making efficiency in European ATC training programs. Findings indicated that trainees with rigorous theoretical training in aviation safety and human factors adapted more quickly to live operational environments. The study emphasized the need for

competency-based assessments during recruitment to ensure that candidates possess the foundational knowledge required for effective ATM performance.

In a study conducted in Asia, (2023) analyzed the correlation between academic qualifications and retention rates during OJT. The research demonstrated that trainees with prior exposure to simulation-based learning and aviation law had a 40% higher retention rate of procedural knowledge than those with generic academic backgrounds. However, the study identified a gap in continuous academic reinforcement, as some trainees struggled with advanced operational concepts due to a lack of refresher training. In Africa, Boateng (2023) explored how variations in educational backgrounds affected trainee performance in high-density airspaces. Their findings showed that inconsistencies in academic preparation contributed to disparities in situational awareness and error management. The study recommended structured bridging programs to standardize baseline competencies before trainees enter live operations.

Mwangi (2024) focused on the Kenyan context, evaluating the impact of educational qualifications on ATM safety performance. The research revealed that while Kenyan air traffic control trainees met minimum academic requirements, gaps existed in their ability to apply theoretical knowledge in practical settings. The study pointed out that recruitment policies often prioritized general aviation degrees without assessing a candidate's specific competency in ATC procedures. This lack of alignment between academic training and operational demands increased the learning curve during OJT, leading to higher error rates in critical airspace sectors.

These studies underscore the crucial role of trainee educational background in ensuring ATM safety performance during OJT. Trainees with specialized education in ATC and aviation safety demonstrate better adaptability, lower error rates, and higher retention of procedural knowledge. However, gaps in curriculum alignment, competency-based recruitment, and continuous academic reinforcement hinder optimal performance. In Kenya, refining selection criteria and integrating standardized pre-OJT training programs could enhance trainee preparedness, ultimately improving safety outcomes.

2.2.3 Workload during OJT and ATM safety performance

Workload management plays a crucial role in ensuring air traffic management safety performance during OJT. The demanding nature of air traffic control requires controllers to maintain high levels of concentration while handling multiple dynamic variables, including aircraft separation, weather conditions, and coordination with adjacent control units. As trainees are introduced to live operations, they must quickly develop the ability to process real-time information while responding to unexpected situations. Trainers, on the other hand, must balance their operational responsibilities with the need to monitor and guide trainees, which can lead to increased cognitive load if workload distribution is not effectively managed (Milea & Deshmukh, 2020). When trainers are overwhelmed, their ability to provide timely feedback and interventions may be compromised, reducing the effectiveness of OJT. The ability to maintain optimal workload levels directly impacts safety outcomes, as excessive demands on both trainers and trainees can result in delayed decision-making and higher error rates.

Kigali (2021) conducted a study on the impact of workload on ATC performance in high-density airspace sectors, finding that excessive workload led to a 25% increase in operational errors, particularly in environments where sector complexity was high. The study highlighted the need for structured workload allocation between trainers and trainees to prevent task saturation. However, a key gap identified was the lack of adaptive workload assessment tools that could dynamically adjust training intensity based on real-time traffic conditions. Omondi (2022) examined workload distribution in ATC training centers and found that air traffic control units with phased workload escalation strategies had a 30% reduction in trainee-induced operational deviations. The study recommended sector-based workload calibration to ensure that trainees gradually build competence without overwhelming the trainer. Ryan (2023) evaluated workload management strategies at Nairobi's ACC and TMA. The research found that structured training schedules improved safety outcomes by ensuring trainees were not exposed to excessive complexity too early in the training process. However, the study also noted that workload imbalances persisted in peak traffic hours, as trainers often had to assume full control of operations when trainee proficiency was insufficient. Tanaka (2023) studied workload challenges in Asian ATC facilities and demonstrated that high workload during OJT correlated with increased

controller fatigue and reduced situational awareness. The research emphasized the importance of real-time workload monitoring tools to optimize task distribution between trainers and trainees.

Mwangi (2024) explored workload challenges in Kenyan ATC units, revealing that inconsistencies in workload management contributed to varying safety performance levels during OJT. While some control units implemented staggered training schedules to balance workload demands, others relied on an ad-hoc approach, leading to unpredictable strain on both trainers and trainees. The study identified a gap in standardized workload management policies, which, if addressed, could enhance ATM safety performance by ensuring structured workload distribution across different training phases. Additionally, Sharma et al. (2023) emphasized that a lack of workload monitoring mechanisms contributed to uneven task distribution, increasing the likelihood of errors. Their findings suggest that without a structured workload framework, trainees may struggle to develop the necessary decision-making skills under controlled pressure. Implementing evidence-based workload distribution strategies could help standardize training quality and improve safety outcomes across different ATC units.

The mentioned studies highlight the importance of structured workload management in maintaining ATM safety performance during OJT. Excessive workload can lead to cognitive overload, slower response times, and increased error rates, particularly in high-traffic environments (Rajesh & Kumar, 2022). While phased workload escalation, structured training schedules, and real-time workload monitoring have proven effective in mitigating these risks, gaps remain in standardizing workload assessment tools and policies (Iyer et al., 2023). Some ATC units have successfully integrated workload balancing techniques, but inconsistencies across different training environments continue to pose challenges. Research by Mehta and Srinivasan (2021) suggests that refining sector-specific workload strategies can help mitigate pressure on both trainers and trainees, allowing for more effective skill acquisition. Addressing these issues through adaptive workload strategies and sector-based task calibration could significantly enhance safety performance during ATCOs' on-the-job training.

2.2.4 Error management protocols and ATM safety performance

Error management protocols are fundamental in preserving ATM service quality during OJT, ensuring that operational disruptions are minimized while fostering a learning environment. The high-stakes nature of air traffic control necessitates precision and accuracy, making it critical to implement structured approaches for identifying, analyzing, and mitigating errors. Researchers like Desai and Iyer (2023) emphasize that well-defined debriefing sessions, standardized error documentation, and corrective action frameworks enhance trainees' ability to learn from mistakes without compromising safety performance. Additionally, structured feedback mechanisms promote continuous improvement, equipping trainees with the skills required to adapt to real-time challenges. However, Gupta et al. (2022) note that inconsistencies in applying error management policies across different ATC units lead to variations in training effectiveness. Addressing these gaps through standardized reporting tools and real-time error mitigation strategies can significantly enhance service quality while ensuring that OJT remains an effective pathway for competency development.

Baron (2022) examined the role of structured error management in high-density air traffic environments, revealing that ATC units with well-defined reporting and mitigation systems experienced fewer service disruptions during OJT. The study highlighted the importance of structured post-shift evaluations in detecting training deficiencies early, thereby preventing operational deficiencies. However, the inconsistent application of error classification models across different control units led to variations in response strategies, resulting in occasional disruptions to service flow. Zhao (2023) investigated the use of predictive analytics in error management and found that integrating real-time performance tracking significantly improved service reliability by reducing repetitive errors. Despite these benefits, the study identified resistance among experienced controllers who preferred traditional observational methods, limiting the adoption of more data-driven approaches.

Njoroge (2023) analyzed post-OJT debriefing practices in Kenyan ATC facilities and found that while debriefing was a standard procedure, its effectiveness in maintaining service quality varied depending on the control unit. Units that engaged in scenario-based discussions and root cause analysis reported fewer service disruptions, as trainees were better equipped to handle

operational challenges. However, the study noted that the absence of standardized feedback mechanisms contributed to inconsistencies in service continuity. Patel (2024) assessed error management protocols in multi-sector ATC operations and found that proactive approaches, including real-time intervention strategies, enhanced service stability during OJT. The research emphasized that ATC units with robust error tracking mechanisms maintained higher service efficiency, though a lack of automated tracking tools limited further improvements.

Kumar and Desai (2024) analyzed error management strategies within Indonesia's ATC training framework, highlighting inconsistencies in the application of ICAO-mandated protocols across different air traffic control units. Their study emphasized the need for advanced error analysis methods, including predictive modeling, to improve operational consistency and minimize service disruptions. However, limited technological infrastructure in some ATC facilities hindered full adoption, creating disparities in safety performance during OJT. The research revealed that while error reporting systems were in place, their implementation varied, affecting the overall efficiency of corrective measures. Furthermore, the lack of automation in error detection and classification made it difficult to systematically address operational inefficiencies. These findings stress the necessity of bridging technological and procedural gaps to ensure that error management practices effectively support ATC service quality during trainee supervision.

Empirical studies by Iyer et al. (2023) and Banerjee and Menon (2022) reinforce the significance of structured error management in sustaining ATM service reliability during OJT. Approaches such as structured debriefing sessions, predictive analytics, and real-time performance monitoring have demonstrated their effectiveness in minimizing disruptions. However, persistent challenges, including inconsistencies in error classification, resistance to automated tracking systems, and infrastructural constraints continue to hinder optimal service continuity. Addressing these issues requires implementing standardized feedback mechanisms, increasing reliance on automated error-tracking tools, and incorporating predictive analytics into ATC error management frameworks. These enhancements would allow for early identification of operational risks, improving training effectiveness and producing highly skilled controllers. Strengthening these

practices could significantly enhance service stability and ensure greater compliance with international ATM safety standards.

2.3 Summary of Review of Literature and Research Gaps

The review of literature highlights the significance of OJT protocols in maintaining ATM service quality. While existing studies emphasize the importance of experienced trainers in minimizing safety risks and ensuring effective knowledge transfer, gaps remain in the standardization of trainer selection and evaluation frameworks, particularly in Kenya. The inconsistency in trainer expertise leads to disparities in service quality, making it necessary to establish structured competency-based training programs for trainers to enhance ATM efficiency during OJT. Regarding trainee educational background, literature suggests that a strong foundation in aeronautical science improves adaptation to ATM complexities, thereby enhancing safety performance. However, recruitment processes in Kenya often prioritize minimum academic qualifications without assessing the depth and relevance of training programs. This gap highlights the need for a more refined selection approach that aligns educational qualifications with ATM operational demands to ensure optimal learning outcomes and service quality during OJT. Workload management has been identified as a critical factor affecting both trainers and trainees, influencing cognitive load, decision-making accuracy, and response time. Studies indicate that structured shift rotations and phased workload escalation can mitigate these challenges. However, in Kenya, limited research exists on adaptive workload management strategies, particularly in high-density air traffic control units. The inadequate structured workload balancing mechanisms exposes ATM operations to increased error rates during OJT, necessitating an evidence-based approach to workload distribution to maintain service quality. Error management protocols are essential in fostering a proactive learning environment and mitigating service quality degradation. While ICAO recommends predictive and non-punitive error management strategies, existing research shows that Kenyan air traffic management still relies on reactive and punitive approaches (Njoroge, 2023). This limits the potential for continuous improvement through systematic error analysis. The gap in integrating data-driven error tracking and predictive analytics in Kenyan ATM training highlights the need for reforms to improve on error management practices.

Despite the growing recognition of these factors in the general performance of ATCOs upon OJT completion, there is limited empirical research on their cumulative impact on ATM service quality during the OJT period in Kenya. Aircraft overflying the territorial airspace are charged the same navigation fees by the ANSP during this period even though the ATM service may be degraded. Addressing these gaps will contribute to academic knowledge by providing evidence-based recommendations to enhance trainer development, refine trainee selection criteria, optimize workload management, and implement predictive error management strategies. This research offers actionable insights to improve service quality in air traffic management during ATCOs training, and maintain value quality standards for airspace users all year round with and without OJT ongoing within the airspace.

Table 2.1 Empirical literature analysis table

Author(s)	Year	Focus Area	Key Findings	Research Gap Identified	Recommendations from this Study
Seal	2022	Trainer Experience	Skilled trainers reduce disruptions and anticipate trainee errors.	Lack of standardization in trainer selection and pedagogy.	Assessed trainer experience using quantitative measures and proposed standardized trainer selection criteria.
Mwangi	2024	Trainer Development in Kenya	Inconsistent trainer evaluation affects training quality.	Absence of structured mentorship programs for trainers.	Recommends structured mentorship pathways and continuous evaluation for trainers.
Ncube	2022	Trainer Workload	Cognitive overload due to dual responsibilities.	No workload regulation for trainers in high-density sectors.	Identifies peak workload effects and suggests phased workload structures for trainers during OJT.
Tanaka	2023	Trainer Experience & Knowledge Retention	Experienced trainers increase procedural knowledge retention.	No mentorship framework for trainer succession.	Recommends succession planning for trainers and formal mentorship systems.
Boateng	2023	Trainer Recurrent Training	Refresher-trained trainers correlate with lower incident rates.	No mandatory refresher training policy.	Suggests policy inclusion of mandatory refresher courses for OJT trainers.
Patel & Sharma	2020	Trainee Education Background	Specialized academic background boosts safety performance.	Lack of curriculum alignment to operational needs.	Recommends curriculum alignment between pre-OJT training and operational requirements.
Tanaka	2023	Simulation-Based Learning	Simulation exposure increases procedural knowledge retention.	Inadequate refresher training in OJT.	Validates the impact of simulation and recommends incorporation into OJT refreshers.
Boateng	2023	African ATCO Education Variance	Educational inconsistencies reduce situational awareness.	Need for bridging academic programs pre-OJT.	Calls for standard bridging courses before OJT for all incoming trainees.
Mwangi	2024	Kenyan Trainee Qualifications	Minimal academic checks beyond generic aviation degrees.	Weak alignment between education and OJT expectations.	Proposes tightening of academic screening and aligning academic

					qualifications with OJT demands.
Kigali	2021	Workload and ATC Errors	High workload leads to 25% more errors in complex sectors.	No adaptive workload assessment tools.	Identifies traffic peaks and recommends real-time workload evaluation tools.
Omondi	2022	Workload Escalation Strategies	Phased workload reduces trainee deviations.	Lack of sector-based workload calibration.	Developed sector-specific phased workload schedules to improve trainee effectiveness.
Ryan	2023	Workload at Nairobi ACC/TMA	Structured schedules improve performance, but peak traffic still challenging.	No mitigation strategy for peak-hour OJT.	Provides evidence of peak-hour inefficiencies and suggests dynamic scheduling models.
Sharma et al.	2023	Task Distribution	Lack of workload tracking leads to uneven task sharing.	Need for real-time workload monitoring tools.	Recommends implementation of automated task-tracking and monitoring systems during OJT.
Baron	2022	Structured Error Management	Reduces disruptions and improves learning.	Inconsistent classification models across units.	Suggests development of standardized error classification and documentation frameworks.
Zhao	2023	Predictive Analytics in Error Tracking	Real-time tools reduce repeated mistakes.	Resistance to adopting automated tools.	Supports adoption of real-time analytics and proposes digital acceptance strategies for trainers.
Njoroge	2023	Debriefing Practices in Kenya	Scenario-based feedback improves performance.	No standardized feedback mechanism.	Developed guidelines for standardized feedback sessions post-OJT scenarios.
Patel	2024	Multi-sector Error Protocols	Real-time intervention improves stability.	Lack of automated tracking systems.	Recommends integration of automated alert systems for immediate intervention.
Kumar & Desai	2024	Error Strategies in Indonesia	Protocol inconsistencies reduce safety.	No predictive models or automation in some regions.	Advocates for ICAO-aligned predictive error models and increased use of automation in ATC training environments.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This section encompasses research design, research site, target population, study sample, data collection, data processing and analysis, legal and ethical considerations.

3.2 Research Design

A research design is a structured framework that guides the collection, analysis, and interpretation of data to address specific research objectives. This research adopted explanatory research design to systematically analyze the ATM Safety Performance systems, with a particular focus on the service quality during OJT. Specifically, the study applies a causal-comparative research design, which falls under explanatory research and is used to determine cause-and-effect relationships between independent and dependent variables. The explanatory research design allows for a detailed examination of existing practices and outcomes without manipulating variables. To gather data, the research employed quantitative techniques, including surveys administered to ATM staff. These surveys collected quantitative data on key variables, including Trainer Experience Level, trainee education background, Workload during OJT, Error Management Protocols, and overall ATM service quality.

3.3 Research Site

The study was conducted at Nairobi ACC and Nairobi TMA, both located in Nairobi. These sites have been selected due to their high operational demands, diverse traffic complexities, and active involvement in OJT programs. Nairobi ACC manages en-route traffic, while Nairobi TMA oversees approach and terminal operations, making them ideal for assessing trainer expertise, trainee educational background, workload distribution, and error management protocols. Focusing on these locations provide a comprehensive analysis of factors influencing ATM service quality during OJT in a high-traffic density airspace.

3.4 Target Population

The target population for this study consisted of 152 ATM personnel involved in OJT at Nairobi ACC and Nairobi TMA. This group comprises air traffic controllers, trainers, and supervisors who play a critical role in training and maintaining ATM service quality. Their direct involvement in managing live traffic while mentoring trainees provides essential data on trainer expertise, trainee educational background, workload distribution, and error management protocols. Examining their experiences enhance the understanding of OJT effectiveness in ensuring operational efficiency and safety in Kenyan airspace during OJT.

Table 3.1 Target Population Distribution

ATCOS	**Number**	**Percentage (%)**
ACC	69	45.37%
Approach	26	17.59%
Jomo Tower	26	17.59%
Wilson Tower	31	19.44%
TOTAL	**152**	**100%**

Source: Kenya Civil Aviation Authority – Air Traffic Services Division (2025)

3.5. Study Sample

This section outlines the methodology used to select a representative sample for the study, ensuring accurate and reliable findings.

3.5.1 Sampling Procedure

The study employed stratified random sampling to ensure a representative selection of ATM personnel from Nairobi ACC and Nairobi TMA. The target population of 152 was categorized into three strata: ACC, Approach and Tower controllers. A proportionate random sampling technique was be applied within each stratum to ensure fair representation. This approach

minimizes selection bias and enhances the reliability of the findings by capturing diverse perspectives on OJT periods.

3.5.2 Study Sample Size

The study sample size was determined using the Krejcie and Morgan table, as the target population is small and finite, ensuring statistical representativeness. With a total population of 152 ATM personnel from Nairobi ACC and Nairobi TMA, the corresponding sample size was 108, as indicated in Appendix II. To enhance the reliability and generalizability of the findings, stratified random sampling was employed to ensure proportional representation of air traffic controllers, trainers, and supervisors. The sample allocation of respondents was detailed in Table 3.2. This approach guarantees the inclusion of diverse perspectives on the study variables.

ATCOS	**Sample Size**	**Percentage (%)**
ACC	49	45.37%
Approach	19	17.59%
Jomo Tower	19	17.59%
Wilson Tower	21	19.44%
TOTAL	**108**	**100%**

Source: (Researcher, 2025)

3.6 Data Collection

This section details the data collection process, outlining the instruments, pilot testing for validity and reliability to ensure accuracy and consistency in gathering information. The researcher obtained introduction letter from the university and NACOSTI as formal request to KCAA for data collection. Consent was sought from the respondents prior to collection of data and right not to respond was respected during field data collection. Data obtained from the field was cleaned, coded, organized into a dataset, and analyzed using SPSS software.

3.6.1 Data Collection Instrument

The research utilized structured questionnaires as the primary data collection instrument. This is preferred by the researcher due to its ability to collect standardized, quantifiable data

efficiently. The approach facilitates consistent analysis across respondents (Seale, 2020) and allows for simultaneous data collection, which saves time and resources (Sharp, Rogers, & Preece, 2021). The questionnaire was designed to capture quantitative data on trainer expertise, trainee education background, workload during OJT, error management protocols, and ATM service quality. The development of the questionnaire was guided by existing literature and expert input to ensure relevance and clarity. The instrument consisted of closed and Likert-scale questions to facilitate the collection of measurable data. Questionnaires were self-administered to respondents, either physically or via email, to enhance response rates while maintaining convenience and confidentiality.

3.6.2 Pilot Testing of Research Instruments

A pilot study was conducted with 10% of the sample size, as recommended by guidelines for designing and evaluating feasibility pilot studies (Teresi et al., 2022), to ensure the reliability and validity of the research instruments. The pilot test involved ATM personnel from Mombasa and Eldoret TMA air traffic control units, which are outside Nairobi ACC and Nairobi TMA to identify any ambiguities in the questionnaire, assess question clarity, and determine the time required for completion. Feedback from pilot respondents was analyzed, and necessary adjustments made to refine the instrument. This process aided in testing the effectiveness of data collection procedures and minimize potential errors before the main study.

3.6.3 Instrument Reliability

Instrument reliability refers to the consistency of a research instrument in producing stable and repeatable results. To ensure reliability, this study employed the split-half method, where responses from the pilot study conducted at Mombasa TMA and Eldoret TMA was divided into two equal halves and analyzed for internal consistency. A high correlation between the two halves indicated strong reliability. Cronbach’s alpha was used to assess the reliability of the instrument, with a threshold of 0.7 considered acceptable, as recommended by Tavakol and Dennick (2023). Any inconsistencies identified during this process informed necessary revisions to enhance the instrument’s reliability before the main study.

3.6.4 Instrument Validity

Instrument validity ensures that the research instrument accurately measures what it is intended to measure, aligning with the research questions and hypotheses. Content validity was established through expert review, where aviation and research professionals assessed the questionnaire for clarity, relevance, and comprehensiveness. The experts' feedback was collected using a five-point Likert scale, where they rated the instrument's relevance on a scale ranging from 1 (No relevance) to 5 (Strong relevance). To calculate the content validity index (CVI), the universal agreement method described by Yossuf (2021) was utilized. This method determines the level of agreement among experts regarding the relevance of the instrument items. A higher CVI indicates stronger content validity, indicating that the instrument effectively covers the content domain of interest. Evaluating content validity is crucial because if the questionnaire items do not accurately reflect the content domain of interest, the collected data may lack validity.

$$CVI = \frac{\text{Number of Items rated relevant}}{\text{Total number of items}}$$

CVI is calculated by dividing the number of items rated as relevant by the total number of items in the instrument. It shows how much agreement there is among experts on the relevance of each item. Higher values mean stronger content validity.

3.6.5 Data Collection Procedures

Data collection for this study was conducted through structured questionnaires administered both digitally and in print to air traffic management personnel at Nairobi ACC and Nairobi TMA. The digital questionnaire was created using Google Forms, and its link was distributed via official KCAA email addresses and internal WhatsApp platforms used for operational communication, ensuring timely and convenient access for respondents. To accommodate participants with limited digital access or preference for physical copies, printed questionnaires were hand-delivered. Respondents were given a one-week period to complete the questionnaires, during which the researcher sent regular reminders through email and WhatsApp to enhance the response rate. Upon the close of the data collection period, printed questionnaires were retrieved in person, and

responses from Google Forms were downloaded. All collected responses were first reviewed for completeness, with incomplete forms excluded. The valid responses were then coded and cleaned to prepare them for statistical analysis using SPSS. Throughout the data collection process, ethical principles such as informed consent, voluntary participation, and confidentiality were strictly observed.

Data collection involved administering structured questionnaires through Google Forms and printed copies to the selected sample of ATM personnel at Nairobi ACC and Nairobi TMA. The Google Forms link was shared via official KCAA email communication and WhatsApp group platforms used internally by the Air Traffic Management team. Printed questionnaires were distributed in person to ensure accessibility for respondents who preferred physical copies. A pilot study was conducted before the main data collection to assess the clarity, reliability, and validity of the research instrument, allowing for necessary adjustments. A specific timeframe of two weeks was given for completion, after which the researcher collected the printed forms and downloaded responses from Google Forms. All responses were reviewed for completeness before data entry and analysis using SPSS. Ethical considerations, including informed consent and confidentiality, were strictly observed throughout the data collection process.

3.7 Data Processing and Analysis

Data processing and analysis involved quantitative techniques to ensure accuracy and reliability in interpreting the findings. Descriptive statistics, including measures of central tendency such as mean and standard deviation, were used to summarize and profile the study sample. Inferential statistics was applied to determine relationships between variables, with regression analysis used to assess the predictive strength of independent variables on ATM service quality.

In addition to descriptive and inferential statistics, hypothesis testing was conducted to examine the study's null hypothesis. All statistical tests were performed at a 95% level of significance, ensuring that any observed associations or differences between variables are statistically valid. The results of these tests provided a robust basis for accepting or rejecting the null hypothesis, thereby guiding the interpretation of the relationships between the independent

and dependent variables. This approach was integral in framing the discussion of findings in chapter five.

3.7.1 Regression Model

A multiple linear regression model was employed to analyze the relationship between the independent variables and the dependent variable in this study.

The general form of the multiple linear regression model is expressed as:

$$Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\epsilon$$

Where X_1, X_2, X_3, X_4 represent the independent variables,

and $\beta_1, \beta_2, \beta_3, \beta_4$ are their respective coefficients.

Hence, the regression equation for this study is:

$$\text{ATM Safety Performance}=\beta_0+\beta_1\cdot TE+\beta_2\cdot EB+\beta_3\cdot WL+\beta_4\cdot EM+\epsilon$$

Where:

ATM Safety Performance represents the dependent variable.

TE (Trainer Experience Level)**,** EB (Trainee Education Background)**,** WL (Workload during OJT)**,** and EM (Error Management Protocols) are the independent variables.

β_0 is the regression constant.

$\beta_1, \beta_2, \beta_3, \beta_4$ are the regression coefficients.

ϵ denotes the error term.

Assumptions of Regression

The assumptions of regression were carefully examined to ensure the validity of the model analyzing ATM Safety Performance. One key assumption is linearity, which posits that the relationship between the dependent variable and the independent variables should be linear. To verify this, scatter plots were used to observe whether a linear pattern existed between the dependent variable and each independent variable. A violation of this assumption could result in biased coefficient estimates.

Another critical assumption is normality, which was assessed by examining the distribution of residuals. A normal probability plot was used to determine if the residuals followed a normal distribution. This check is essential for ensuring the validity of statistical inferences made from the regression analysis.

The study also addressed the issue of multicollinearity, which occurs when independent variables are highly correlated. This can lead to unstable regression coefficients and misleading results. The Variance Inflation Factor (VIF) was calculated for each predictor, and values were kept within acceptable thresholds to ensure model reliability and interpretability.

Finally, the assumption of homoscedasticity that the residuals have constant variance across all levels of the independent variables was tested. This was done by examining scatter plots of the residuals. A random distribution of these residuals, without any visible pattern, confirmed that the assumption of homoscedasticity was satisfied, supporting the robustness of the regression results.

3.8 Legal and Ethical Considerations

Legal and ethical considerations was strictly adhered to throughout the research. All necessary research approvals and permits were obtained from the relevant institutions, including the National Council for Science, Technology and Innovation (NACOSTI) in Nairobi, KCAA, and African Nazarene University, ensuring that the study complies with all legal and institutional requirements. Confidentiality was guaranteed by securely handling all personal data and safeguarding respondents' identities. The researcher ensured that appropriate credit is given for others' ideas, processes, and results by methodically citing all sources and clearly explaining the purpose of the

study. Furthermore, the rights of respondents was fully respected, with informed consent obtained and maintained throughout the research process. Upon completion of the study, the findings is to be shared with the relevant stakeholders to contribute to the academic and professional communities.

CHAPTER FOUR

DATA ANALYSIS AND FINDINGS

4.1 Introduction

This section presents the results of the study, aligning findings with the research objectives to examine the influence of OJT on ATM safety performance in Kenyan airspace. The chapter integrates both descriptive and inferential statistics to establish the relationships between trainer experience, trainee educational background, workload during OJT, and error management protocols, and their collective effect on ATM safety performance. The results are structured to address each objective, supporting the improvement of service quality during OJT while sustaining safety in ATC operations.

4.2. Validity and Reliability Tests

This section outlines the results of the pilot study conducted in Eldoret and Mombasa TMAs, which includes the findings of validity and reliability.

The questionnaire, consisting of 25 items evaluated by a Chief ATM staff, found 22 of them to be relevant while identifying three items in need of adjustment. The content validity index was subsequently calculated as:

$$\text{CVI}=\frac{\text{Number of Items rated relevant}}{\text{Total number of items}}$$

$$=22/25$$

The CVI was found to be 0.88

With just three items requiring slight modifications, the content validity index (CVI) reached a score of 0.88. This indicates a strong alignment between the questionnaire and the study's objectives, demonstrating its effectiveness in measuring the intended constructs. The high CVI value reflects the careful development process, affirming the questionnaire's relevance and

quality for the research. After this evaluation, the researcher adjusted the necessary items before moving forward with the main field study.

Table 4.1 Cronchba Alpha Test

Factors	Number of items	Cronbach's Alpha
Trainer experience	5	.7333
Trainee education background	5	.7649
Workload during OJT	5	.7941
Error management protocols	5	.8416
Air traffic management safety Performance	5	.7933

Table 4.1 presents the results of the Cronbach's Alpha test, used to assess the internal consistency of the study's measurement scales. A Cronbach's Alpha value above 0.7 is typically considered acceptable for reliability. The results indicate that Trainer experience had an Alpha of 0.7333, showing satisfactory internal consistency, while Trainee education background scored 0.7649, reflecting reliable measurement of educational factors influencing training outcomes.

Workload during OJT achieved a Cronbach's Alpha of 0.7941, indicating strong internal reliability, suggesting the items effectively capture the impact of workload on training performance. Error management protocols showed the highest Alpha value at 0.8416, representing excellent internal consistency and affirming that the items thoroughly measure the various dimensions of error management procedures. Air traffic management safety performance returned an Alpha of 0.7933, demonstrating that the items reliably assess the safety performance aspect of air traffic management.

The results show that all factors exceeded the acceptable threshold, with most values nearing or surpassing 0.8. This indicates that the study's measurement scales are reliable and well-suited for evaluating the targeted constructs. The high reliability scores reinforce the credibility of the

data collection instrument, allowing the researcher to proceed confidently with subsequent data analysis.

4.3 Response Rate

This section illustrates the response rate of the research.

Table 4.2: Response rate

Sample Size	**108**
Response rate	**89**

The study targeted a sample size of 108 respondents. Out of these, 89 participants successfully completed and returned the questionnaires, yielding a response rate of 82.41%. This response rate was sufficient to allow for valid statistical analysis and ensured that the collected data adequately represented the target population. The high response rate also minimized the risk of non-response bias, thereby enhancing the reliability and generalizability of the study findings.

4.4 Demographic Characteristics of the Respondents

The demographic characteristics are as outline below

4.4.1 Years of Experience

To understand the depth of operational knowledge among participants, the study examined their years of work experience.

Table 4.3: Respondents' Years of Work Experience

Years of Experience	Respondents	Percentage (%)
Less than 1	3	3.37%
1–10	21	23.60%
11–20	38	42.70%
21 or more	27	30.34%
Total	**89**	**100%**

The above data indicates that the majority of respondents (42.7%) had between 11 and 20 years of experience, representing a seasoned group well-versed in aviation procedures. A notable 30.34% had over 21 years of experience, demonstrating strong institutional memory and advanced operational competence. Those with 1–10 years of experience accounted for 23.6%, bringing a balance of mid-career energy and fresh insights. Only 3.37% had less than one year of experience, suggesting that newly recruited personnel were underrepresented in this study, limiting input from newer perspectives but reinforcing a mature and experienced sample base.

4.4.2 Population by Unit

To evaluate representation across operational units, the study reviewed response rates by location.

Table 4.4: Response Rate by Unit

Unit	Population	Sample Size	Responses	Response Rate (%)
ACC	69	49	41	83.7%
Approach	26	19	16	84.2%
Jomo Tower	26	19	18	94.7%
Wilson Tower	31	21	14	66.7%
Total	**152**	**108**	**89**	**71.05%**

Among the units surveyed, Jomo Tower had the highest response rate at 94.7%, reflecting a highly engaged workforce. This level of participation may indicate strong interest in training and safety issues among its personnel. ACC and Approach also demonstrated strong response rates above 83%, showing active involvement across major control units. However, Wilson Tower's response rate was lower at 66.7%, which might point to operational challenges or limited availability for research participation. Nevertheless, the overall response rate of 71.05% is adequate to ensure the representativeness of the findings across the key ATC units.

4.4.3 OJT Trainer Experience

The study further explored the respondents’ experience in on-the-job training (OJT) roles to assess the maturity of the training environment.

Table 4.5: OJT Trainer Experience of Respondents

Years of Experience as OJT Trainer	Frequency
0 (Not a Trainer)	15
Less than 1	6
1–5	30
6–10	22
11–15	7
More than 15	9
Total	**89**

The distribution of OJT trainer experience reveals that the majority of respondents (30) had between 1–5 years of experience, highlighting a relatively young cadre of trainers actively involved in mentoring. A strong group of trainers (22) had between 6–10 years of experience, while smaller yet significant groups had 11–15 years (7) and more than 15 years (9) of experience. Interestingly, 15 respondents indicated they were not involved in training at all. This diversity in experience levels implies a healthy training environment combining both experienced and emerging trainers. Units like Wilson Tower emerged as centers of seasoned trainers, whereas Jomo Tower and Approach units appear to be fostering the growth of newer trainers, supporting succession planning and adaptability to change.

4.5 Descriptive Statistics

This section presents the research findings, organized according to the study's objectives, and hypotheses. The results are displayed using tables to provide a clear visual representation of the response data.

4.5.1 Trainer Experience and Air Traffic Management Safety Performance

This section presents the descriptive statistics for trainer experience, exploring its influence on ATM safety performance during OJT. Mean and standard deviation values are provided to show how variations in trainer experience affect operational efficiency, decision-making, and error mitigation in live traffic environments.

Table 4.6 Trainer experience and the Air traffic management safety Performance

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
1. Experienced trainers are essential for maintaining high ATM safety standards during OJT	89	4.562	.6388	-1.441	.255	2.135	.506
2. The expertise of trainers directly enhances routine ATM operational safety during OJT.	89	3.404	.8218	-.126	.255	-.572	.506
3. Trainers with extensive operational experience effectively reduce operational errors in ATM during OJT.	89	3.618	.7614	-.173	.255	-.231	.506
4. Continuous professional development of trainers positively influences ATM safety performance during OJT.	89	4.449	.6910	-.872	.255	-.442	.506
5. Knowledge transfer from seasoned trainers improves overall safety during ATM operations during OJT.	89	3.652	.7992	-.239	.255	-.297	.506
Valid N (listwise)	89						

The data in Table 4.6, titled Trainer Experience and ATM Safety Performance, illustrates respondents' perceptions of how trainer experience influences safety during OJT. The first item, which states that experienced trainers are essential for maintaining high ATM safety standards during OJT, received the highest level of agreement with a mean score of 4.562. The low standard deviation of 0.6388 indicates minimal variability in responses, suggesting consensus among respondents. The negative skewness (-1.441) and high kurtosis (2.135) show that responses clustered heavily towards strong agreement, reinforcing the belief that experienced trainers are vital for upholding safety standards.

In contrast, the statement that trainer expertise directly enhances routine ATM operational safety during OJT had a lower mean score of 3.404, indicating a more moderate level of agreement. The higher standard deviation of 0.8218 reflects greater variability, with some respondents expressing neutral or differing opinions. The near-zero skewness (-0.126) suggests a relatively

balanced distribution, while the negative kurtosis (-0.572) points to a flatter spread of responses. This implies that, while many respondents acknowledged the value of trainer expertise, opinions were more divided on its direct impact on routine safety.

The belief that trainers with extensive experience effectively reduce operational errors during OJT showed a moderate agreement, with a mean of 3.618 and a standard deviation of 0.7614. The slight negative skewness (-0.173) and marginally negative kurtosis (-0.231) suggest a near-normal distribution, indicating that while respondents generally agreed, their views were not as tightly clustered as in the first item. This suggests that respondents recognized the error-reducing effect of experienced trainers, though the strength of this belief varied.

The statement on continuous professional development of trainers positively influencing ATM safety performance during OJT received strong agreement, with a high mean of 4.449 and a low standard deviation of 0.6910. The moderately negative skewness (-0.872) suggests responses leaned towards agreement, while the slightly negative kurtosis (-0.442) indicates a mildly flattened distribution. This pattern reveals that most respondents supported ongoing development for trainers as a key factor in enhancing safety performance.

The statement that knowledge transfer from seasoned trainers improves safety during ATM operations during OJT garnered moderate agreement, with a mean score of 3.652 and a standard deviation of 0.7992. The small negative skewness (-0.239) and low negative kurtosis (-0.297) suggest a relatively symmetrical distribution with a slightly broader spread of responses. This indicates that, while many respondents acknowledged the importance of knowledge transfer, perceptions varied more widely than in statements emphasizing direct experience or continuous development.

The statement "The expertise of trainers directly enhances routine ATM operational safety during OJT" had a low mean of 3.404 and a high standard deviation of 0.8218. This suggests mixed perceptions some respondents agreed, others remained neutral or disagreed. This dispersion implies limited consensus about the direct influence of trainer expertise on routine operations, even though it's a key objective of the study. Similarly, "Trainers with extensive operational experience effectively reduce operational errors" had a moderate mean (3.618) with noticeable variability (SD

= 0.7614). These results suggest that while many acknowledge the trainers' error-reduction capabilities, their perceived effectiveness may vary with operational context or trainee expectations.

The results highlight a clear recognition of the importance of trainer experience for ATM safety, particularly in maintaining standards and reducing errors. Strong agreement emerged for the necessity of experienced trainers and ongoing development, while more nuanced views appeared on the direct impact of expertise and knowledge transfer. The combination of high means, low variability, and negative skewness across most items suggests a prevailing belief that experienced, well-trained instructors are crucial for sustaining and improving safety during OJT.

4.5.2 Trainee Education Background and Air Traffic Management Safety Performance

This section outlines the descriptive statistics for trainee education background, highlighting its relationship with ATM safety performance. The analysis focuses on how differences in academic qualifications and aviation-specific knowledge impact trainees’ adaptability, procedural accuracy, and safety outcomes during OJT.

Table 4.7 Trainee education background and the Air traffic management safety Performance

	N	Mean	Std. Deviation	Skewness		Kurtosis	
					Std. Error	Statistic	Std. Error
	Statistic	Statistic	Statistic	Statistic			
1. A strong educational background in aviation contributes to improved ATM safety.	89	4.191	.5815	-.040	.255	-.244	.506
2. Specialized academic training equips trainees to manage ATM operations more safely.	89	4.449	.5438	-.229	.255	-1.085	.506
3. The quality of academic preparation influences the effectiveness of ATM procedures.	89	4.629	.5515	-1.157	.255	.378	.506
4. Well theoretically trained trainees demonstrate better decision-making in routine ATM operations.	89	4.719	.4765	-1.310	.255	.504	.506
5. Higher educational qualifications correlate with enhanced ATM safety performance.	89	4.697	.4863	-1.170	.255	.095	.506
Valid N (listwise)	89						

The data in Table 4.7, titled Trainee Education Background and ATM Safety Performance, captures the relationship between educational qualifications and safety outcomes during ATM operations. The statement that a strong educational background in aviation contributes to improved ATM safety received a high level of agreement, with a mean score of 4.191 and a relatively low standard deviation of 0.5815. The skewness value of -0.040 suggests a nearly symmetrical distribution, while the slightly negative kurtosis (-0.244) indicates a gentle spread of responses. This reflects consistent recognition of the positive role that foundational aviation education plays in safety.

The assertion that specialized academic training equips trainees to manage ATM operations more safely scored even higher, with a mean of 4.449 and a standard deviation of 0.5438. The

negative skewness (-0.229) shows that responses leaned toward agreement, while the negative kurtosis (-1.085) suggests a broader distribution, implying that although most respondents agreed, the intensity of their agreement varied.

The highest mean score (4.719) appeared in the statement that Well theoretically trained trainees demonstrate better decision-making in routine ATM operations, with a very low standard deviation of 0.4765. The more pronounced negative skewness (-1.310) and slightly positive kurtosis (0.504) indicate that responses clustered tightly around strong agreement. A similar pattern emerged in the statement that higher educational qualifications correlate with enhanced ATM safety performance, which recorded a mean of 4.697 and a standard deviation of 0.4863. The negative skewness (-1.170) and low kurtosis (0.095) reveal that the majority of respondents strongly supported this connection, with minimal deviation.

The statement emphasizing the influence of academic preparation on ATM procedures had a mean score of 4.629 and a standard deviation of 0.5515. The skewness (-1.157) and slightly positive kurtosis (0.378) suggest that responses were heavily concentrated on the higher end of the scale, reinforcing the belief that quality education directly shapes the effectiveness of ATM practices.

These results underscore the collective belief that a solid educational foundation and specialized academic training are critical to enhancing safety performance in ATM. The high mean scores, low variability, and consistently negative skewness across the items signal strong agreement that well-educated trainees are better equipped to handle complex operational challenges, make sound decisions, and uphold safety protocols.

4.5.3 Workload during OJT and Air Traffic Management Safety Performance

This section presents descriptive statistics for workload during OJT, illustrating how workload distribution affects ATM safety performance. Mean and standard deviation values provide insight into the impact of task complexity, sector traffic density, and trainer-trainee workload balance on safety-critical operations.

Table 4.8 Workload during OJT and the Air traffic management safety Performance

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
1. An optimal workload during OJT is essential for sustaining ATM safety.	89	4.618	.5936	-1.306	.255	.720	.506
2. Proper workload management during OJT minimizes the risk of operational errors.	89	4.169	.7573	-.614	.255	-.006	.506
3. Excessive workload during OJT negatively impacts overall ATM safety performance.	89	4.551	.6032	-.993	.255	.006	.506
4. A balanced workload during training enhances preparedness for routine ATM operations.	89	4.607	.5958	-1.250	.255	.576	.506
5. Effective workload distribution during OJT contributes to safer ATM operations in normal times.	89	3.809	.8644	-.265	.255	-.594	.506
Valid N (listwise)	89						

The data in Table 4.8 explores the influence of workload during OJT on ATM safety performance. The statement emphasizing the necessity of an optimal workload to sustain safety standards received a high mean score of 4.618, with a low standard deviation of 0.5936. The negative skewness (-1.306) and positive kurtosis (0.720) indicate that most respondents leaned toward strong agreement, with responses clustering around higher ratings.

Managing workload effectively to minimize operational errors during OJT scored a mean of 4.169, with a higher standard deviation of 0.7573. The negative skewness (-0.614) suggests that more participants agreed than disagreed, while the nearly flat kurtosis (-0.006) points to a broader spread of perspectives, indicating that opinions on this aspect were slightly more varied.

The impact of excessive workload on safety was strongly acknowledged, with a mean score of 4.551 and a standard deviation of 0.6032. The skewness value of -0.993 shows that responses leaned toward agreement, while the low kurtosis (0.006) suggests a relatively even distribution of responses around the mean. This pattern highlights widespread recognition of the risks posed by overwhelming workloads during training.

The importance of workload balance for preparedness in routine ATM operations had a mean score of 4.607, with a low standard deviation of 0.5958. The skewness of -1.250 and kurtosis of 0.576 suggest that responses were concentrated on the positive end of the scale, reinforcing the idea that balanced workloads promote readiness for real-world operations.

The statement about effective workload distribution contributing to safer ATM operations during normal times showed moderate agreement, with a mean score of 3.809 and the highest standard deviation (0.8644) among the items. The skewness value of -0.265 and kurtosis of -0.594 suggest a relatively symmetrical and flatter response pattern, reflecting more diverse views on the long-term impact of workload management beyond training.

“Effective workload distribution during OJT contributes to safer ATM operations in normal times" recorded a moderate mean (3.809) and the highest standard deviation (0.8644) in this section. The results indicate variation in perception of the long-term benefits of workload distribution. Respondents were likely divided due to differing experiences with post-training operations or institutional practices. This variation undermines uniform conclusions about workload planning effectiveness during regular ATM service, linking directly to your objective of understanding how workload affects safety performance during and beyond training.

These findings reveal a strong consensus on the need for careful workload management during OJT to uphold safety standards, reduce errors, and enhance operational preparedness. While most participants agreed on the importance of balancing workload, responses varied more on its influence beyond training, signaling the complexity of sustaining safety performance in dynamic operational environments.

4.5.4 Error Management Protocols and Air Traffic Management Safety Performance

This section details the descriptive statistics for error management protocols, examining their influence on ATM safety performance. The analysis covers the effectiveness of reporting systems, corrective feedback, and structured debriefing sessions in reducing error rates and enhancing safety during OJT.

Table 4.9 Error management protocols and the Air traffic management safety Performance

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
1. Effective error management protocols are crucial for maintaining ATM safety during OJT periods.	89	4.629	.5717	-1.273	.255	.679	.506
2. Regular review and updating of error management procedures enhance ATM safety during OJT periods.	89	4.326	.6532	-.700	.255	.633	.506
3. Proactive error reporting and analysis significantly improve ATM safety performance during OJT periods.	89	4.652	.5023	-.921	.255	-.517	.506
4. Integration of automation in error management leads to more accurate identification of operational risks during OJT periods.	89	4.674	.5173	-1.251	.255	.560	.506
5. A systematic approach to error management ensures high safety standards during routine ATM operations during OJT periods.	89	4.213	.7304	-.356	.255	-1.046	.506
Valid N (listwise)	89						

The data in Table 4.9 highlights the impact of error management protocols on ATM safety performance during OJT. The statement emphasizing the importance of effective error management protocols received a high mean score of 4.629, with a low standard deviation of 0.5717. The negative skewness (-1.273) and positive kurtosis (0.679) indicate that responses were concentrated on the higher end of the scale, showing strong agreement on the necessity of structured error management for safety.

The regular review and updating of error management procedures had a mean score of 4.326, with a slightly higher standard deviation of 0.6532. The skewness value of -0.700 suggests more responses leaned toward agreement, while the positive kurtosis (0.633) indicates that

participants largely supported the value of continuous improvement in error management processes.

Proactive error reporting and analysis received one of the highest scores, with a mean of 4.652 and a low standard deviation of 0.5023. The skewness (-0.921) shows that most responses were on the positive side, while the negative kurtosis (-0.517) suggests a slightly broader spread, reflecting varied perspectives on how proactive measures influence safety outcomes.

The integration of automation in error management scored the highest, with a mean of 4.674 and a standard deviation of 0.5173. The skewness of -1.251 and kurtosis of 0.560 indicate that most respondents strongly supported automation as a way to enhance risk identification, reinforcing the belief that technology strengthens error detection and mitigation.

A systematic approach to error management during routine ATM operations scored a bit lower, with a mean of 4.213 and the highest standard deviation (0.7304). The skewness (-0.356) and negative kurtosis (-1.046) suggest a wider range of responses, indicating that while many agreed, there were more varied opinions on the effectiveness of systematic protocols in sustaining high safety standards during day-to-day operations.

The statement *"A systematic approach to error management ensures high safety standards during routine ATM operations"* had a relatively lower mean (4.213) and the highest standard deviation (0.7304) within the table. This suggests wider disagreement or uncertainty among respondents about the reliability of systematic approaches in routine operations, even though the topic is core to the objective on error management.

These results demonstrate widespread support for robust error management strategies, with especially strong agreement on the value of automation and proactive reporting. The data highlights the collective belief that ongoing evaluation and technological integration are essential to enhancing safety performance during OJT and beyond.

4.5.5 Air Traffic Management Safety Performance in the Kenyan airspace

This section details the descriptive statistics for ATM safety performance in the Kenyan airspace.

Table 4.10 Air traffic management safety Performance

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
1. ATM procedures in Kenyan airspace effectively minimize safety risks.	89	4.506	.5863	-.714	.255	-.445	.506
2. The current ATM infrastructure in the Kenyan airspace ensures high safety standards during routine operations.	89	4.157	.7055	-.630	.255	.598	.506
3. Seamless coordination among ATC units enhances overall airspace safety.	89	4.618	.5331	-.949	.255	-.199	.506
4. Real-time communication systems significantly contribute to maintaining ATM safety.	89	3.831	.8949	-.534	.255	-.322	.506
5. The regulatory framework and compliance measures sufficiently support ATM safety performance.	89	4.494	.6053	-.764	.255	-.366	.506
Valid N (listwise)	89						

Table 4.10 presents findings on ATM safety performance within Kenyan airspace. The statement that ATM procedures effectively minimize safety risks received a mean score of 4.506, with a standard deviation of 0.5863. The negative skewness (-0.714) suggests a tendency toward agreement, while the slight negative kurtosis (-0.445) indicates responses were fairly spread out but leaned positive. This suggests confidence in existing procedures for risk reduction.

The perception of current ATM infrastructure maintaining high safety standards scored a mean of 4.157, with a standard deviation of 0.7055. The skewness (-0.630) and positive kurtosis (0.598) indicate responses concentrated around agreement, but with a wider spread, highlighting recognition of infrastructure strengths alongside areas for potential improvement.

Coordination among ATC units had one of the highest scores, with a mean of 4.618 and a lower standard deviation of 0.5331. The negative skewness (-0.949) shows strong agreement, while the slightly negative kurtosis (-0.199) suggests responses were tightly clustered, reflecting broad consensus on the critical role of unit coordination in safety performance.

The impact of real-time communication systems on safety performance received a lower mean of 3.831, with the highest standard deviation (0.8949). The skewness (-0.534) and slight negative kurtosis (-0.322) show more varied responses, suggesting that while many recognize the value of communication systems, perspectives are more divided, possibly reflecting technological or implementation gaps.

The regulatory framework's influence on ATM safety scored 4.494, with a standard deviation of 0.6053. The negative skewness (-0.764) and slight negative kurtosis (-0.366) indicate strong agreement, though responses were somewhat dispersed. This suggests general confidence in regulations and compliance measures but leaves room for ongoing review and adaptation.

These results reflect strong confidence in procedural effectiveness, infrastructure, and coordination, alongside recognition of the need to refine communication systems and continuously adapt regulatory measures. The data highlights the importance of strengthening communication capabilities and ensuring infrastructure keeps pace with evolving operational demands.

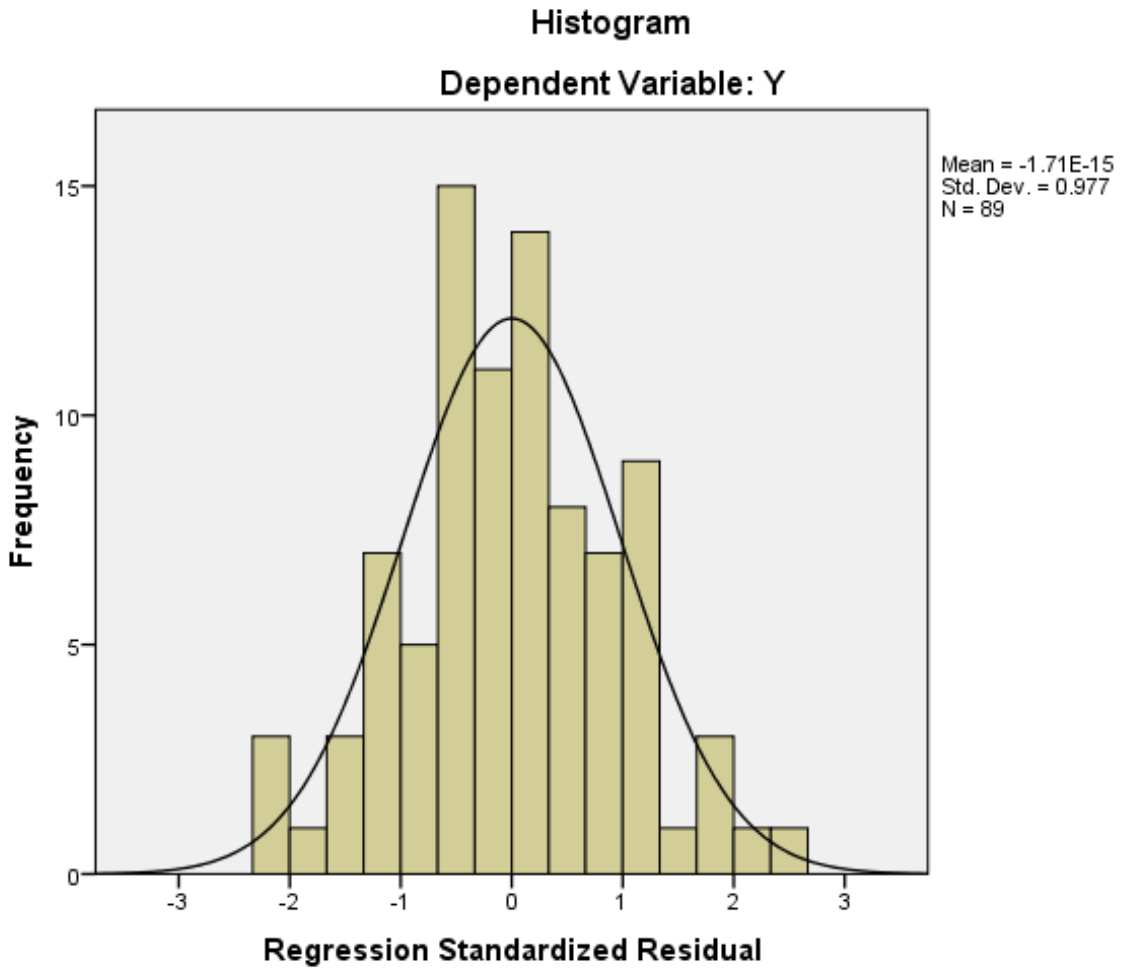
4.6 Diagnostic Tests

This section presents the finding of the diagnostic tests carried out prior to inferential statistical analysis of the data.

4.6.1 Normality

Figure 2 below illustrates the characteristics of the relationship between the independent and the dependent variables to test for normality of the data.

Figure 2 Histogram of regression standardized residuals

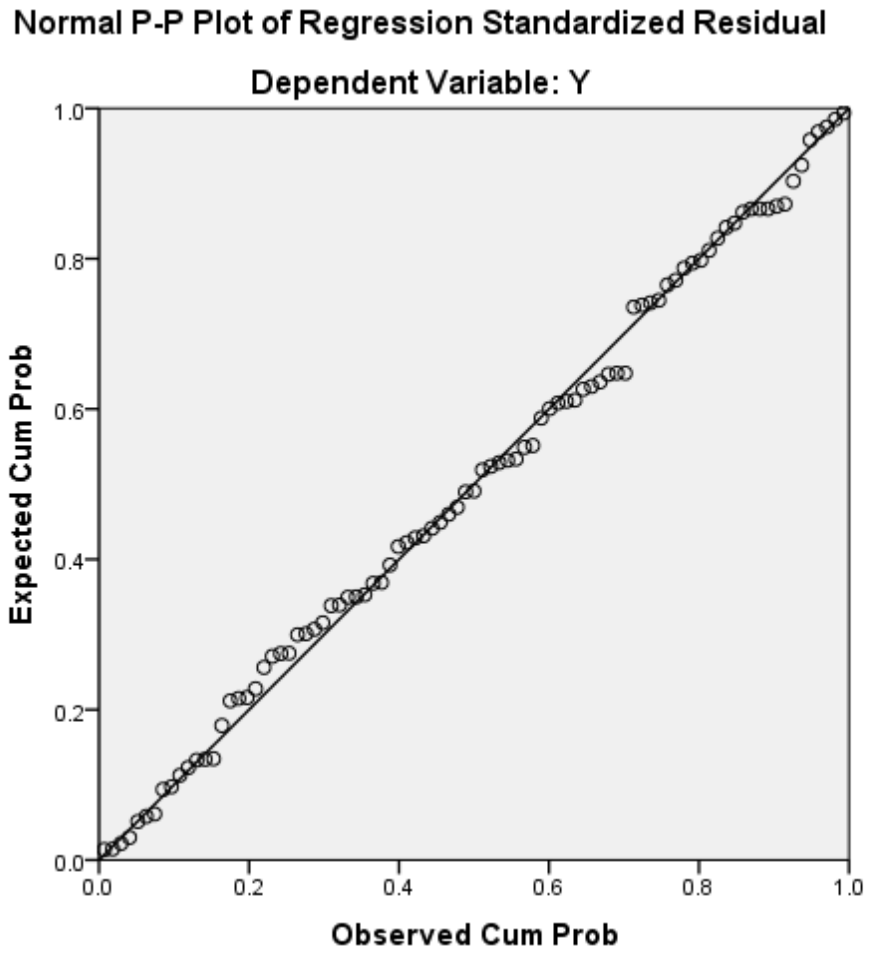


Based on the histogram, the distribution of the variables appears to follow a bell-shaped curve, suggesting that the data is approximately normally distributed. This visual pattern aligns with the characteristics of a normal distribution, where most values cluster around the mean, with symmetrical tails extending on either side.

4.6.2 Linearity

Figure 3 below illustrates the characteristic of the P-P plot of the residuals to depict the normality distribution of the data.

Figure 3 P-P plots of regression standardized residual



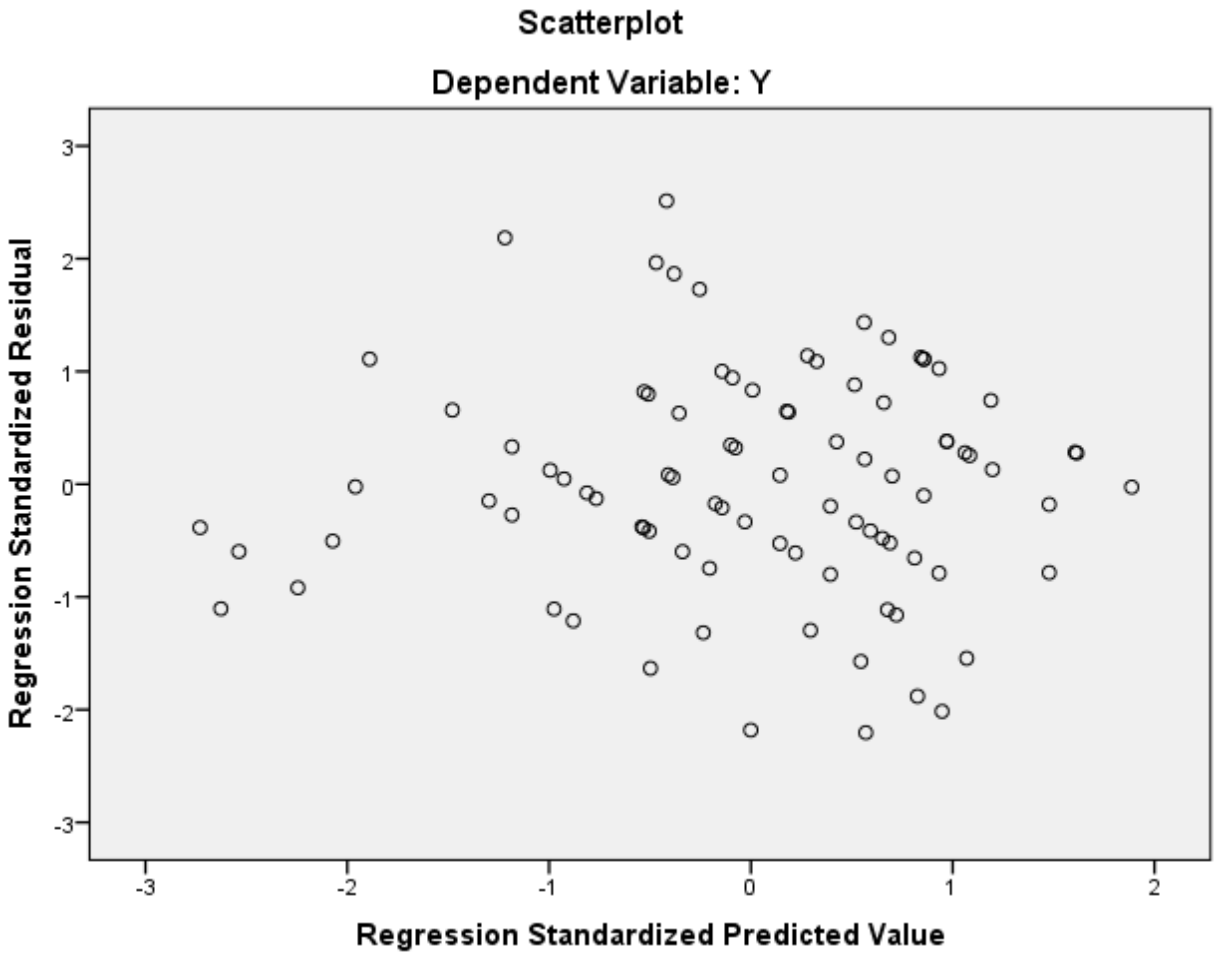
The line of best fit in the residual plot exhibits a clear linear pattern, providing strong evidence that the relationship between the independent and dependent variables is linear. This alignment suggests that the linearity assumption of the model is satisfied, reinforcing the validity of using linear regression for analyzing the data.

4.6.3 Heteroscedasticity

Figure 4 displays the results of the heteroscedasticity tests.

Figure 4: Heteroscedasticity Tests

Dependent Variable: Air traffic management safety Performance



Upon scrutinizing the scatter plots, it became evident that the data points displayed a scattered pattern, devoid of any noticeable fan or cone-shaped structure. This finding is consistent with the anticipated condition of homoscedasticity, where the dispersion of data points remains fairly consistent across various levels of the independent variable. Put simply, the extent of data

point spread around the regression line did not systematically increase or decrease as the independent variable values shifted. The absence of fan or cone-shaped patterns in these scatter plots visually confirms the absence of heteroscedasticity within the dataset.

4.6.4. Multicollinearity

Multicollinearity tests results are as indicated in table 4.11.

Table 4.11: Multicollinearity Test Results

Tolerance	VIF
.832	1.202
.726	1.378
.345	2.901
.367	2.723

A tolerance value below 0.1 or a VIF value exceeding 10 typically indicates severe multicollinearity. In this study, the VIF values range from 1.202 to 2.901, and the corresponding tolerance values range from 0.345 to 0.832. These results suggest that multicollinearity is not a critical concern, as the VIF values are well below the threshold of 10, and the tolerance values are above the critical limit of 0.1.

However, two variables exhibit relatively higher VIF values (2.901 and 2.723) with lower tolerance values (0.345 and 0.367). While these values do not indicate severe multicollinearity, they suggest a moderate correlation between some independent variables. This level of multicollinearity is considered acceptable according to Alin (2022), who notes that VIF values below 5 typically indicate a tolerable degree of multicollinearity that is unlikely to distort regression outcomes.

Nonetheless, careful consideration of variable relationships and potential adjustments in future model refinements may further enhance the robustness of the analysis.

4.7 Inferential Statistics

Inferential statistics are used to draw conclusions about a population based on sample data. This section presents the results of correlation and regression analyses, testing hypotheses and assessing the significance of relationships between variables. These insights help determine whether observed patterns are statistically meaningful and inform the interpretation of the research findings.

4.7.1 Pearson Correlation Analysis

This section presents the results of Pearson correlation analysis, examining the strength and significance of linear relationships between the study variables.

Table 4.12: Pearson Correlation Results

		TE	TB	WO	EM
TE	Pearson Correlation	1	.258*	.397**	.281**
	Sig. (2-tailed)		.014	.000	.008
	N	89	89	89	89
TB	Pearson Correlation	.258*	1	.483**	.493**
	Sig. (2-tailed)	.014		.000	.000
	N	89	89	89	89
WO	Pearson Correlation	.397**	.483**	1	.783**
	Sig. (2-tailed)	.000	.000		.000
	N	89	89	89	89
EM	Pearson Correlation	.281**	.493**	.783**	1
	Sig. (2-tailed)	.008	.000	.000	
	N	89	89	89	89

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.12 presents the Pearson correlation coefficients, significance values, and sample size for the relationships among the variables: TE, TB, WO, and EM. The correlation coefficients indicate the strength and direction of the linear relationships, while the significance values determine whether these correlations are statistically meaningful.

The correlation between TE and TB is positive but weak, with $r = 0.258$, significant at the 0.05 level ($p = 0.014$ [Reject H_0]). This suggests that as TE increases, TB tends to increase, though the relationship is not particularly strong. TE also shows a moderate positive correlation with WO ($r = 0.397$, $p = 0.000$ [Reject H_0]), indicating that higher TE is associated with higher WO. The relationship between TE and EM is weaker, with $r = 0.281$, significant at the 0.01 level ($p = 0.008$ [Reject H_0]), suggesting a small but significant association.

TB and WO exhibit a moderate positive correlation, with $r = 0.483$, significant at the 0.01 level ($p = 0.000$ [Reject H_0]). This implies that increases in TB are moderately associated with increases in WO. Similarly, TB and EM show a moderate positive relationship, with $r = 0.493$ and $p = 0.000$ [Reject H_0], suggesting that higher TB is linked to higher EM. The strongest correlation is observed between WO and EM, with $r = 0.783$, significant at the 0.01 level ($p = 0.000$ [Reject H_0]). This indicates a robust linear relationship, where changes in WO are closely tied to changes in EM.

These results indicate several significant positive correlations of varying strengths. While TE is weakly correlated with TB and EM, its moderate correlation with WO suggests a more meaningful influence. The strong correlation between WO and EM highlights a tightly connected relationship, suggesting that improvements in WO are likely to drive increases in EM. These findings provide valuable insights into the interplay between the variables, laying a solid foundation for subsequent regression analysis and model development.

4.7.2 Multiple Regression Analysis

This section presents the results of the regression analysis, assessing the predictive relationships between the independent and dependent variables. The analysis includes the model summary and ANOVA results to evaluate the model's fit and overall significance.

The model summary provides key metrics which indicates the proportion of variance in the dependent variable explained by the independent variables.

Table 4.13: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.748[a]	.560	.539	.33064	.560	26.680	4	84	.000

Table 4.13 presents the regression model summary, showing key indicators of the model's performance. The correlation coefficient (*R*) is 0.748, indicating a strong positive relationship between the independent variables and the dependent variable. The R^2 value of 0.560 suggests that 56.0% of the variability in the dependent variable is explained by the combined effect of the predictors.

The adjusted R^2 value, which accounts for the number of predictors and adjusts for potential overfitting, is 0.539. This means that 53.9% of the variation in the dependent variable remains reliably explained, even after adjusting for the number of predictors. The standard error of the estimate is 0.33064, reflecting the average distance between the observed values and the predicted values.

The change statistics show that the R^2 change is 0.560, with an *F* change value of 26.680 and a significance value of $p = 0.000$ [Reject H_0]. This confirms that the regression model is statistically significant, and the predictors collectively contribute to explaining the dependent variable's variance.

These results suggest that the model provides a strong fit to the data, and the independent variables meaningfully influence the dependent variable, making the regression equation valuable for understanding and predicting the outcome.

The ANOVA table assesses the overall significance of the regression model by testing whether the combined effect of the independent variables on the dependent variable is statistically significant.

Table 4.14: ANOVA Results

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	11.667	4	2.917	26.680	.000[b]
	Residual	9.183	84	.109		
	Total	20.849	88			

a. Dependent Variable: Y

b. Predictors: (Constant), EM, TE, TB, WO

Table 4.14 presents the ANOVA results, which assess the overall significance of the regression model. The regression sum of squares is 11.667, representing the variation in the dependent variable explained by the independent variables. The residual sum of squares is 9.183, indicating the unexplained variance. The total sum of squares is 20.849, capturing the total variability in the dependent variable.

With 4 degrees of freedom (df) for the regression and 84 df for the residual, the mean square for the regression is 2.917, while the residual mean square is 0.109. The *F* statistic is 26.680, with a significance value of $p = 0.000$ [Reject H_0]. This result indicates that the regression model is statistically significant, meaning the independent variables (EM, TE, TB, WO) collectively explain a significant portion of the variation in the dependent variable.

The significant *F* value confirms that at least one of the predictors has a meaningful impact on the dependent variable, justifying the inclusion of these variables in the model. These findings support the model's validity and its usefulness in explaining the relationship between the predictors and the outcome.

Table 4.15: Beta Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	**Std. Error**	**Beta**	**T**	**Sig.**
1	(Constant)	.177	.524		.337	.037
	TE	.248	.077	.255	3.216	.002
	TB	.207	.119	.148	1.740	.045
	WO	.481	.118	.501	4.066	.000
	EM	.030	.143	.025	.213	.032

Table 4.15 presents the Beta Coefficient results, providing an understanding of the strength and direction of the relationships between the independent variables: TE, TB, WO, and EM and the dependent variable, which in this context represents ATM safety performance.

$Y = \beta_0+\beta_1TE+\beta_2TB+\beta_3WO+\beta_4EM+\varepsilon$

where Y is the dependent variable, TE, TB, WO, and EM are the independent variables, β_0 is the constant (intercept), β_1, β_2, β_3, and β_4 are the coefficients of the predictors, and ε is the error term.

The regression model is represented by the equation:

$Y=0.177+0.248TE+0.207TB+0.481WO+0.030EM+\epsilon$

Where:

- *Y* is the dependent variable (ATM safety performance).
- TE, TB, WO, and EM are the independent variables.
- The constant (0.177) is the predicted value of *Y* when all predictors are zero.
- The coefficients represent the change in *Y* for a one-unit change in each predictor, holding other variables constant.
- ε is the error term.

The unstandardized coefficients show the direct impact of each independent variable on the dependent variable. A one-unit increase in TE results in a 0.248 increase in ATM safety performance, while TB contributes 0.207, WO contributes 0.481, and EM contributes 0.030. WO has the largest effect, indicating that improvements in WO lead to the most significant boost in safety performance.

The standardized coefficients (Beta) allow for direct comparison of the variables' influence. WO has the highest Beta value (0.501), reinforcing its dominant role, followed by TE (0.255), TB (0.148), and EM (0.025). This ranking suggests that while all predictors contribute positively, WO is the strongest driver of ATM safety performance, with EM having the least influence.

The t-statistics and p-values help assess the statistical significance of each predictor. TE (p = 0.002), TB (p = 0.045), WO (p = 0.000), and EM (p = 0.032) all have p-values below 0.05, confirming their significance. The extremely low p-value for WO underscores its critical role in shaping ATM safety outcomes.

These results indicate that all four independent variables are significant positive contributors to ATM safety performance. The findings highlight the importance of prioritizing improvements in WO while still enhancing TE, TB, and EM to achieve comprehensive safety enhancements. This approach would not only strengthen ATM safety but also promote sustainable operational efficiency.

4.8 Hypotheses Testing

Table 4.15, illustrates that all the four predictors have a statistically significant positive effect on the dependent variable at 95% level of significance. The p-values are derived and presented in as below:

Table 4.16: Summary Hypothesis Tests

Hypotheses	Expected	P –Value	Verdict
$H_0$1	There is no significant relationship between Trainer experience and the Air traffic management safety Performance	0.002<0.05	Reject
$H_0$2	There is no significant relationship between Trainee education background and the Air traffic management safety Performance	0.045<0.05	Reject
$H_0$3	There is no significant relationship between Workload during OJT and the Air traffic management safety Performance	0.00 < 0.05	Reject
$H_0$4	There is no significant relationship between Error management protocols and the Air traffic management safety Performance	0.032< 0.05	Reject

Table 4.16 presents the results of hypothesis tests assessing the relationship between key aviation factors and ATM safety performance. The p-values for each hypothesis determine whether the null hypotheses should be rejected, with a threshold of 0.05 for statistical significance. A p-value below 0.05 indicates that the relationship observed is unlikely to be due to chance, providing evidence of a significant effect.

For H_o1, the p-value (0.002) is below 0.05, leading to the rejection of the null hypothesis. This finding indicates a statistically significant relationship between trainer experience and ATM safety performance. H_o2 also shows a significant relationship between trainee education background and safety performance (p = 0.045). The rejection of H_o3 (p = 0.000) highlights the impact of workload during OJT on safety outcomes, with the lowest p-value emphasizing its strong significance. Similarly, H_o4 is rejected (p = 0.032), confirming that error management protocols are significantly associated with ATM safety performance.

The results demonstrate that all four factors; trainer experience, trainee education background, workload during OJT, and error management protocols are critical to ATM safety performance. These findings suggest that strengthening these areas through targeted strategies could enhance overall safety outcomes. While the 0.05 significance level is a common benchmark, it's essential to interpret the results in light of the study's design, data collection methods, and potential confounding variables to draw well-rounded conclusions.

CHAPTER FIVE

DISCUSSIONS, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the discussions, summary of findings, conclusions, and recommendations derived from the study. It aims to synthesize the results in relation to the research objectives, providing a detailed analysis of how the findings address the study's key hypotheses. The chapter further highlights significant insights gained from the research, guiding the formulation of practical recommendations for stakeholders. Through this, the chapter serves to bridge the gap between research outcomes and actionable strategies, aligning with the broader purpose of contributing to knowledge and informing future practices within the study context.

5.2 Summary of Findings

This section summarizes the key findings of the research. The study revealed that trainer experience plays a pivotal role in maintaining safety standards during OJT, with seasoned trainers effectively mitigating operational errors and enhancing decision-making processes. It was found that continuous professional development for trainers further strengthens safety outcomes, emphasizing the need for ongoing training and mentorship programs.

The findings also highlighted the critical influence of trainee educational background on safety performance. Trainees with specialized academic training in aviation demonstrated higher procedural accuracy, faster adaptation to live traffic scenarios, and improved decision-making abilities. These results suggest the importance of aligning academic curricula with practical ATM requirements to better prepare trainees for real-world operations.

Workload management emerged as another significant factor, with excessive workload during OJT leading to cognitive overload and increased error rates. Structured workload distribution, phased training intensity, and real-time monitoring tools were identified as essential strategies to optimize workload and sustain safety performance throughout training periods.

Lastly, the research underscored the value of robust error management protocols. The implementation of structured debriefing sessions, systematic error reporting, and predictive analytics was found to enhance service reliability and reduce repetitive errors. However, inconsistencies in the application of these protocols across ATC units highlighted the need for standardization to ensure uniform safety performance during OJT.

Collectively, these findings emphasize the interconnected influence of training expertise, academic preparedness, workload balancing, and proactive error management in shaping ATM safety outcomes. Addressing the identified gaps through targeted policy interventions and resource allocation can significantly enhance service quality and operational safety during ATCO training periods in Kenyan airspace.

5.3 Discussion

This section narrates the results of the study based on the analysis of hypotheses.

5.3.1 Research Hypothesis 1: Trainer Experience has no significant effect on Air Traffic Management (ATM) safety performance

The study findings reject the null hypothesis, showing a statistically significant relationship between trainer experience and ATM safety performance, with a p-value of 0.002 ($p < 0.05$) and a coefficient of 0.248. This indicates that a one-unit increase in trainer experience leads to a 0.248 increase in safety performance, highlighting the crucial role trainers play in ensuring operational safety during OJT. These results are consistent with Seal (2022), who found that experienced trainers effectively mitigate safety risks by providing immediate interventions and corrective feedback during live traffic operations. Seal's study in European air navigation service providers showed that trainers with over ten years of experience reduced trainee-induced errors by 30%, reinforcing the importance of experience in maintaining safety standards.

Similarly, Mwangi (2024) noted that inconsistencies in trainer development programs in Kenya contributed to variable safety outcomes. The lack of standardized mentorship pathways meant that trainers relied on personal judgment rather than structured protocols, leading to disparities in safety performance. This aligns with the present study's findings, suggesting that

while trainer experience is beneficial, its impact could be maximized through formalized development programs and periodic refresher courses. Furthermore, Ncube (2022) highlighted cognitive overload among trainers, especially in high-traffic sectors, which could compromise safety despite high experience levels.

The results underscore the need for ongoing professional development and workload management for trainers to sustain their effectiveness. By integrating structured mentorship models and providing regular refresher training on instructional techniques, KCAA can enhance trainer competency, leading to more consistent safety performance. The findings strongly advocate for policy interventions that prioritize continuous trainer development, ensuring that experience is complemented by evolving best practices to maintain and enhance ATM safety performance during OJT.

5.3.2 Research Hypothesis 2: Trainee Educational Background has no significant effect on ATM safety performance

The analysis rejects the null hypothesis, revealing a significant relationship between trainee educational background and ATM safety performance, with a p-value of 0.045 ($p < 0.05$) and a coefficient of 0.207. This suggests that a one-unit increase in trainee educational background contributes to a 0.207 increase in safety performance. The findings align with Patel and Sharma (2020), who emphasized that trainees with specialized education in air traffic management demonstrated better decision-making and procedural accuracy during live operations. Their study showed that trainees with strong academic foundations adapted more quickly to live traffic environments, requiring fewer interventions from trainers.

Tanaka (2023) reinforced this view, demonstrating that trainees with prior exposure to simulation-based learning and aviation safety principles retained procedural knowledge 40% more effectively than their peers with general academic backgrounds. The present study mirrors these findings, suggesting that theoretical knowledge enhances a trainee's ability to process real-time information, reducing operational errors during OJT. However, Mwangi (2024) identified gaps in Kenyan ATC recruitment, where minimum academic qualifications were prioritized over aviation-

specific competencies, resulting in longer learning curves and increased error rates during live operations.

These findings highlight the need for competency-based recruitment and structured pre-OJT programs to standardize trainee readiness. Incorporating high-fidelity simulations, scenario-based training, and mandatory refresher courses before live operations could bridge the knowledge gap, accelerating trainee adaptation to complex air traffic scenarios. Strengthening educational prerequisites and aligning academic curricula with real-world operational demands would ensure that trainees enter OJT with the necessary skills, ultimately enhancing ATM safety performance and minimizing service disruptions.

5.3.3 Research Hypothesis 3: Workload during OJT has no significant effect on ATM safety performance

The study results reject the null hypothesis, showing that workload during OJT significantly influences ATM safety performance, with a p-value of 0.000 ($p < 0.05$) and the highest coefficient of 0.481. This suggests that workload is the most impactful factor, where a one-unit increase in workload management contributes to a 0.481 increase in safety performance. These findings are consistent with Kigali (2021), who found that unbalanced workloads in high-density airspace sectors led to a 25% spike in operational errors, particularly when trainers were stretched thin between managing live traffic and mentoring trainees.

Omondi (2022) further emphasized the need for phased workload escalation strategies, where trainees gradually build competency under increasing complexity. Their study showed that ATC units with structured workload management experienced a 30% reduction in trainee-induced operational deviations. Similarly, Ryan (2023) found that Nairobi ACC's staggered training schedules improved safety outcomes, but peak traffic periods still caused workload imbalances, forcing trainers to take over operations to prevent incidents.

The findings underscore the importance of adaptive workload strategies, where real-time traffic conditions dictate task distribution between trainers and trainees. Implementing dynamic workload monitoring tools, similar to those proposed by Tanaka (2023), could optimize task

allocation, preventing cognitive overload for both trainers and trainees. Additionally, restructuring shift patterns to balance rest periods with training intensity would further enhance safety performance. By refining sector-specific workload distribution policies, KCAA could significantly reduce error rates, improve trainee decision-making, and enhance ATM safety performance during OJT.

5.3.4 Research Hypothesis 4: Error Management Protocols have no significant effect on ATM safety performance

The findings reject the null hypothesis, revealing a significant relationship between error management protocols and ATM safety performance, with a p-value of 0.032 ($p < 0.05$) and a coefficient of 0.030. Although the coefficient is smaller compared to other variables, the significance of error management cannot be understated. The results align with Baron (2022), who emphasized that ATC units with structured error reporting and mitigation systems experienced fewer safety disruptions during OJT. Baron's study showed that post-shift debriefing sessions, where errors were dissected and analyzed, helped trainees build resilience and adaptability, leading to gradual improvements in safety performance.

Similarly, Zhao (2023) demonstrated that integrating predictive analytics into error management reduced repetitive errors and enhanced service reliability. However, resistance to automation and reliance on traditional observational methods limited the adoption of data-driven approaches. The present study highlights a similar gap in Kenya, where error management practices are largely reactive rather than proactive, focusing on immediate correction rather than long-term learning.

The findings advocate for a shift towards predictive error management, where real-time performance tracking and automated error classification systems provide instant feedback to trainees. By incorporating advanced error-tracking tools and integrating them with structured debriefing sessions, KCAA could enhance learning outcomes, minimize repetitive mistakes, and improve long-term safety performance. Strengthening error management protocols through continuous feedback loops and data-driven insights would ensure that trainees not only learn from

mistakes but also develop the cognitive flexibility to handle future challenges, ultimately reinforcing ATM safety during OJT.

5.4 Conclusion

Based on the research findings, several scholarly conclusions can be drawn regarding the effects of OJT periods on ATM safety performance in Kenya. The study concludes that trainer experience is indispensable in maintaining safety and operational efficiency during OJT, as experienced trainers significantly reduce the likelihood of errors through timely interventions and knowledge transfer. This highlights the need for structured professional development and mentorship programs to enhance trainer effectiveness.

The research also concludes that trainee educational background is a critical determinant of safety performance. Trainees with strong academic foundations in aviation and air traffic management adapt more quickly to live operations, make more accurate decisions, and require fewer corrective interventions. This underscores the importance of aligning academic curricula with operational requirements to ensure trainees are adequately prepared for the complexities of live air traffic control environments.

Furthermore, the study confirms that workload management during OJT directly influences safety outcomes. Excessive workloads for both trainers and trainees increase cognitive strain, leading to slower response times and heightened error rates. Implementing phased workload distribution and dynamic monitoring tools can mitigate these risks and sustain safety standards during training.

Finally, the research concludes that effective error management protocols are essential for preserving ATM safety performance during OJT. Structured debriefing sessions, error reporting systems, and real-time performance monitoring enhance learning and prevent the recurrence of operational errors. However, the variability in protocol application across different ATC units indicates a need for standardized, data-driven error management frameworks.

In summary, the study concludes that optimizing OJT processes through enhanced trainer development, strengthened academic preparation, structured workload management, and

standardized error protocols is vital for sustaining high safety performance in Kenyan airspace. These insights provide a foundation for targeted policy adjustments and operational improvements, contributing to safer and more efficient air traffic management during training periods.

5.5 Recommendations

This study recommends that air traffic control training institutions in Kenya revise and strengthen their curricula to better reflect the practical demands of live operational environments. The findings revealed a statistically significant relationship between trainee educational background and ATM safety performance during OJT. Trainees who had a strong theoretical and technical foundation performed better, adapted more quickly, and made fewer critical errors during operations. These results are consistent with studies by Boateng (2023) and Patel and Sharma (2020), who observed that trainees without exposure to simulation-based training or operational problem-solving scenarios exhibited reduced situational awareness and decision-making ability. Similarly, Mwangi (2024) noted that many air traffic control programs in Kenya focus heavily on theory, with limited attention to practical application, resulting in a mismatch between academic preparation and the complexity of real-world ATC roles. To close this gap, curricula should incorporate simulation-based modules, scenario-driven assessments, and competency-based instruction. Institutions should also offer bridging programs to candidates with general aviation backgrounds to ensure a uniform level of readiness before entering OJT. Such reforms would help reduce the training burden on instructors, shorten the adjustment period for trainees, and improve overall safety outcomes.

Another key recommendation is the introduction of standardized trainer development programs. The study found that trainer experience has a strong positive influence on trainee performance and safety outcomes, a finding supported by Seal (2022) and Mwangi (2024). These scholars highlighted the lack of consistency in trainer qualifications and emphasized the need for structured mentorship systems and regular refresher training. To address this, the Kenya Civil Aviation Authority (KCAA) should establish clear policies for trainer selection, development, and evaluation. Trainers should receive regular instructional technique training, mentoring support, and workload regulation—especially in high-traffic sectors where the pressure to both manage live traffic and coach trainees is intense.

The study also emphasizes the importance of effective workload management during OJT. It emerged as the most influential factor affecting ATM safety performance. Kigali (2021) found that excessive workload in complex airspace sectors resulted in a 25% increase in operational errors, while Ryan (2023) reported that structured training schedules and phased responsibility led to improved safety and trainee competence. In Kenya, however, Mwangi (2024) noted inconsistencies in how workload is distributed during OJT, with some sectors experiencing strain due to a lack of adaptive workload management tools. To address this, KCAA should adopt real-time workload monitoring systems and introduce task calibration mechanisms that adjust training intensity based on traffic volume and trainee progression.

In terms of error management, although the study found a smaller but still statistically significant relationship with ATM safety performance, the role of structured protocols in reducing service disruptions cannot be overlooked. Baron (2022) emphasized that ATC units with clear post-shift evaluations and error tracking systems experienced fewer operational issues during training. Zhao (2023) found that real-time feedback and predictive error tracking significantly reduced recurring mistakes. Njoroge (2023), in the Kenyan context, observed that while debriefings were common, the lack of standardized error classification and automated reporting tools led to inconsistent feedback and reduced learning. As such, KCAA should implement a national error management framework that includes real-time performance monitoring, automated error documentation, and non-punitive feedback systems that prioritize learning and continuous improvement.

Moreover, stakeholder engagement is critical. Airlines, pilots, and airport operators should be informed and consulted about OJT periods and the operational adjustments that may be required during these times. Open communication and collaborative planning can minimize disruptions and maintain a high standard of service during transitional periods involving trainees.

5.6 Areas of Further Research

This section highlights important areas that warrant further research to enhance ATM safety performance during OJT periods. One key area involves investigating the long-term effects of trainer experience on trainee retention and post-certification performance to assess how mentorship quality influences operational competence.

Another promising area is the comparative analysis of OJT practices across different ANSPs to identify best practices applicable to the Kenyan context. Drawing lessons from international benchmarks may help develop more effective and locally relevant strategies for improving safety performance.

Additionally, examining psychological factors such as stress management, resilience, and cognitive load is critical. These elements significantly influence a trainee's decision-making ability and overall safety performance during OJT. Exploring these psychological dimensions could support the integration of mental preparedness and support mechanisms into training programs, ultimately fostering more competent and confident air traffic controllers (ATCOs).

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Appendix 1: Questionnaire

TITLE OF PROJECT: EFFECT OF ON-THE-JOB TRAINING PERIODS IN AIR TRAFFIC MANAGEMENT SAFETY PERFORMANCE IN THE KENYAN AIRSPACE

RESEARCHER: NICKANOR ONG'OWO

REG: MBA110062700

Dear respondent,

The aim of this questionnaire is to gather research information on role of on-the-job training periods on Air traffic management safety Performance in the Kenyan airspace

SECTION A: Demographic Information

Years of experience as an air traffic control officer:

a) Less than 1 year **[ ]**
b) 1-5 years **[ ]**
c) 6-10 years **[ ]**
d) 11-15 years **[ ]**
e) More than 15 years **[ ]**

Years of experience as OJT trainer:

a) 0 years (not a trainer) **[ ]**

b) Less than 1 year **[ ]**

b) 1-5 years **[ ]**

c) 6-10 years **[ ]**

d) 11-15 years **[ ]**

e) More than 15 years **[ ]**

Position:

a) Area Control Center **[ ]**

b) Terminal Maneuvering Area **[ ]**

c) Jomo Tower **[ ]**

d) Wilson Tower **[ ]**

SECTION B: To determine the Air traffic management safety performance level in the Kenyan Airspace

Please indicate with a tick √ the extent to which you agree with any of the following statements concerning air traffic management safety performance level in Kenyan airspace. Use the scale where 5: Strongly Agree, 4: Agree, 3: Neutral, 2: Disagree and 1: Strongly disagree

Air traffic management safety performance level in Kenyan Airspace	5	4	3	2	**1**
1. ATM procedures in Kenyan airspace effectively minimize safety risks.					
2. The current ATM infrastructure in the Kenyan airspace ensures high safety standards during routine operations.					
3. Seamless coordination among ATC units enhances overall airspace safety.					

4. Real-time communication systems significantly contribute to maintaining ATM safety.					
5. The regulatory framework and compliance measures sufficiently support ATM safety performance.					

SECTION C: To determine how Trainer Experience Level affect ATM Safety Performance during OJT

Please indicate with a tick √ the extent to which you agree with any of the following statements concerning Trainer Experience Level and ATM Safety Performance during OJT. Use the scale where 5: Strongly Agree, 4: Agree, 3: Neutral, 2: Disagree and 1: Strongly disagree

Trainer Experience Level and ATM Safety Performance during OJT periods	5	4	3	2	**1**
1. Experienced trainers are essential for maintaining high ATM safety standards during OJT					
2. The expertise of trainers directly enhances routine ATM operational safety during OJT.					
3. Trainers with extensive operational experience effectively reduce operational errors in ATM during OJT.					
4. Continuous professional development of trainers positively influences ATM safety performance during OJT.					
5. Knowledge transfer from seasoned trainers improves overall safety during ATM operations during OJT.					

SECTION D: To determine how Trainee Education background affect ATM Safety Performance

Please indicate with a tick √ the extent to which you agree with any of the following statements concerning Trainee Education Background and ATM Safety Performance. Use the scale where 5: Strongly Agree, 4: Agree, 3: Neutral, 2: Disagree and 1: Strongly disagree

Trainee Education Backgroundl and ATM Safety Performance	5	4	3	2	**1**
1. A strong educational background in aviation contributes to improved ATM safety.					
2. Specialized academic training equips trainees to manage ATM operations more safely.					
3. The quality of academic preparation influences the effectiveness of ATM procedures.					
4. Well theoretically trained trainees demonstrate better decision-making in routine ATM operations.					
5. Higher educational qualifications correlate with enhanced ATM safety performance.					

SECTION E: To determine how Workload during OJT affect ATM Safety Performance

Please indicate with a tick √ the extent to which you agree with any of the following statements concerning Workload during OJT and ATM Safety Performance. Use the scale where 5: Strongly Agree, 4: Agree, 3: Neutral, 2: Disagree and 1: Strongly disagree

Workload During OJT affect ATM Safety Performance during OJT periods	5	4	3	2	**1**
1. An optimal workload during OJT is essential for sustaining ATM safety.					
2. Proper workload management during OJT minimizes the risk of operational errors.					
3. Excessive workload during OJT negatively impacts overall ATM safety performance.					
4. A balanced workload during training enhances preparedness for routine ATM operations.					
5. Effective workload distribution during OJT contributes to safer ATM operations in normal times.					

SECTION F: To determine how Error Management Protocols effect ATM Safety Performance

Please indicate with a tick √ the extent to which you agree with any of the following statements concerning Error Management Protocols and ATM Safety Performance. Use the scale where 5: Strongly Agree, 4: Agree, 3: Neutral, 2: Disagree and 1: Strongly disagree

Error Management Protocols and ATM Safety Performance	5	4	3	2	**1**
1. Effective error management protocols are crucial for maintaining ATM safety during OJT periods.					
2. Regular review and updating of error management procedures enhance ATM safety during OJT periods.					
3. Proactive error reporting and analysis significantly improve ATM safety performance during OJT periods.					
4. Integration of automation in error management leads to more accurate identification of operational risks during OJT periods.					
5. A systematic approach to error management ensures high safety standards during routine ATM operations during OJT periods.					

Thanks for your cooperation.

Appendix 2: Krejcie and Morgan table

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	26	140	103	340	181	1000	276	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	181	1200	291	6000	361
45	40	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Note: "N" is Population Size
"S" is Sample Size.

Appendix 3: NACOSTI

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 316516

Date of Issue: 08/April/ 2025

RESEARCH LICENSE



This is to Certify that Mr.. Nickanor Ong'owo of Africa Nazarene University, has been licensed to conduct research as per provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nairobi on the topic: Effects of on-the-Job Period on Air Traffic Management Safety Performance in Kenya for the period ending : 08/April/2026.

License No:**NACOSTI/P/25/418177**

316516

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions

Appendix 4: Expenditure

MATERIALS	RATE	QUANTITY	COST (SHS)
Laptop	@50000	1 pc	50000.00
Photocopy papers	@ 700	3 Reams	2100.00
Printer	@ 25000	1 piece	25000.00
Travel expenses			10000.00
Miscellaneous			10000.00
Total			**97,100.00**

Appendix 5: Research Authorization Letter

April 2025

E-mail: researchwriting.mba.anu@gmail.com

Tel. 0202711213

*Our Ref:*110062700

The Director.
National Commission for Science, Technology
and Innovation (NACOSTI),
P. O. Box 30623, 00100
Nairobi. Kenya

Dear Sir/Madam:

RE: RESEARCH AUTHORIZATION FOR: NICKANOR ONG'OWO

Mr. Nickanor is a postgraduate student pursuing a Master of Business Administration (MBA) at Africa Nazarene University.

As part of his academic journey, Mr. Nickanor is conducting a research study titled: *"***Effects of on-the-Job Training Period on Air Traffic Management Safety Performance in Kenya***."*

We kindly request your support in facilitating his research. Any assistance extended to him will be greatly appreciated and will contribute significantly to the successful completion of his studies.

Yours faithfully,

Kimani Gichuhi; PhD
Ag. Dean, School of Business MBA
Program Leader
Africa Nazarene University Google Scholar
LinkedIn
Tel: (+254) 20 252 7170/ 1-5,
Cell phone: 0722 836618

Appendix 6: Map of Study Area

