FACTORS AFFECTING FIRE SAFETY MANAGEMENT PERFORMANCE AT INTERNATIONAL AIRPORTS IN KENYA

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Factors Affecting Fire Safety Management Performance at International Airports in Kenya

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University

Signature……………………………………………….Date …………………………

Philip Otieno

This thesis has been submitted for examination with our approval as the University Supervisors

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DEDICATION

This research work is dedicated to my wife Sophy, and our children—Cynthia, Joseph and John for their love, care, support, encouragement, understanding and prayers during the entire study period.

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ACRONYMS AND ABBREVIATIONS

AEP	Aerodrome Emergency Plan
ARFFS	Aerodrome Rescue and Firefighting Service
BOWEC	Building Operations and Works of Engineering Construction
CCTV	Closed Circuit Television
DCA	Directorate of Civil Aviation
DCP	Dry Chemical powder
Doc	Document
DOSHS	Directorate of Occupational Safety and Health Services
EADCA	East African Directorate of Civil Aviation
FRRR	Fire Risk Reduction Rules
GOK	Government of Kenya
ICAO	International Civil Aviation Organization
JKIA	Jomo Kenyatta International Airport
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KAA	Kenya Airports authority
KCAA	Kenya Civil Aviation Authority

KCARS	Kenya Civil Aviation Regulations
LN	Legal Notice
OSHA	Occupational Safety and Health Act
SARPS	Standard and Recommended Practices
TNA	Training Needs Analysis
TRA	Task Resource Analysis
WGS-84	World Geodetic System-84

ABSTRACT

Fire outbreaks are global hazard with a potential to cause injuries, loss of life and damage to properties. To mitigate against these fires, fire safety of the building should be considered during the design and construction phases of a building, supported by effective implementation of fire safety management which plays an important role in enhancing safety of buildings against unforeseen fires in complex occupancies like airports. This study aimed to assess fire safety awareness among management and employees, investigate compliance with relevant sections of Building Operations and Works of Engineering Construction, Fire Risk Reduction Rules and International Civil Aviation Organization Standards and Recommended Practices and determine adequacy of fire protection systems at international airports in Kenya. Stratified and simple random sampling methods were adopted to select employees and management at international airports in Kenya to be included in the study. Cross-sectional survey design was adopted and from a population of 1900, a sample of 310 and 169 employees and management respectively were selected from eight Kenya's international airports namely Jomo Kenyatta, Moi, Kisumu, Wilson, Malindi, Eldoret, Wajir and Lokichoggio airports. Data was collected through observation and structured questionnaires, then coded, tabulated and analyzed using SPSS version 20. Descriptive statistics including arithmetic means, standard deviation and frequencies were used, alongside inferential statistics was carried out using t-test and results presented in tables and charts. Pearson's correlation and simple linear regression was used to test linear and statistical relationships between independent variables and dependent variable respectively. Regression coefficients showed strong positive relationships between each of the independent variables and Performance of fire safety management. T-test was used to test research null hypothesis for the regression coefficients for each variable. The prediction factors were 0.69, $p<0.05$ for Employees' fire safety awareness; 0.30, $p<0.05$ for Management's fire safety awareness; and 0.67, $p<0.05$ for compliance with relevant sections of BOWEC, FRRR and ICAO SARPS. The null hypothesis was rejected in the *t*-test. The study concluded that inadequate fire safety awareness among Management and employees, non-compliance with fire safety standards and inadequacy of fire protection systems had negative impact on performance of fire safety management at International Airports in Kenya and recommended that both Management and employees undergo basic fire safety training to empower them in managing fire safety hazards, and that fire protection systems be adequately provided, maintained and tested to ensure their serviceability and reliability.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Fire safety involves design, construction, and management of an occupancy to avoid fire outbreaks and reduce damage if a fire occurs. It includes training occupants, providing fire protection equipment, means of escape, maintaining of fire systems, and promoting awareness among occupants (Onyekwere, 2022; Kodur *et al.,* 2020).

The fire safety measures should match the building's use and occupancy (Glasgow Caledonian University, 2020). Fire safety requires knowledge of how fire systems work. This includes how to inspect, test, and maintain them properly (Zhong *et al.,* 2022).

Effective fire safety management reduces loss, protects lives, and keeps operations running—especially in critical places like airports (Government of Kenya Fire Risk Reduction Rules [GOK-FRRR], 2007; Yildirim & Demirel, 2019). Fires can lead to death, business disruptions, data loss, reputational damage, and long-term consequences (Kodur *et al.,* 2020).

Due to increasing use of hazardous materials, fire safety is a growing global concern in workplaces (Hafeez *et al.,* 2025). According to Salukele *et al.* (2024), fire safety is an independent variable affected by the following factors among others: -

1) Status and adequacy of fire protection systems
2) Fire safety awareness
3) Adequate and unobstructed means of escape
4) Fire prevention

For effective firefighting, it's important to understand fire behavior. This means knowing the physical and chemical processes behind fire. Occupants should learn basic fire chemistry to understand the science of fire prevention, control, extinguishment and how firefighting equipment works (Onyekwere, 2022).

Employers are responsible for managing fire risks. Success depends on cooperation between workers, employers, and governments (Mujtaba *et al.*, 2023).

Several tragic fires that included the great Chicago fire of 1871 and 1903 that killed 300 and 602 people respectively, the 1911 Triangle Shirtwaist Factory that killed 147 workers and the 1942 Boston, Massachusetts's Coconut Grove Night Club Fire that claimed 492 lives have helped shape fire safety regulations (Koorsen Fire & Security, 2020). These led to better and stricter fire safety codes (Rocha, 2021).

The Chicago Convention of 1944 which, aims to promote and develop safer and more orderly international civil aviation requires all contracting States to provide Rescue and Firefighting Services (RFFS), reliable equipment, and trained firefighters at airports to protect lives during aircraft emergencies at or near an aerodrome (ICAO, 2022, Annex 14, Volume I). Despite these international requirements, fires at airport facilities have caused significant casualties and damages worldwide.

In Europe, for instance, fires at Dusseldorf Airport in 1996 claimed 17 lives and injured 62 people, with other notable incidents occurring at Fiumicino Airport (2015), Alicante Airport (2020), and Catania Airport (2023) (Szeto, 2022). Similarly, in Asia, Hong Kong International Airport experienced fires at its air cargo terminal in November 2017 and at Terminal 1 in December 2017 (Szeto, 2022).

In Kenya, property losses due to fire between 2014 and 2022 were estimated at USD 600,000 (Ongoro & Muiya, 2023), with the most recent outbreaks occurring at Jomo Kenyatta International Airport and Moi International Airport (Berre, 2023). These incidents highlight the critical threat that fires pose to both airport infrastructure and human life (Ongoro & Muiya, 2023), emphasizing the ongoing need for effective fire safety management and compliance with international standards.

1.2 Statement of the Problem

The Kenyan Government and the International Civil Aviation Organization (ICAO), through the Fire Risk Reduction Rules (FRRR) and Standards and Recommended Practices (SARPs), respectively mandates occupier to ensure and maintain high standards of fire safety in workplaces, including airport facilities. These frameworks outline provisions for the design, installation, maintenance of fire protection systems, and the promotion of fire safety awareness, all intended to safeguard lives and critical infrastructure. Despite the existence of these regulations and fire safety standards, fire incidents continue to be reported, and potential hazards—such as unevenly distributed fire loads—remain prevalent within airport terminals, creating a high-risk situation in a possible fire outbreak (O'Connor, 2020). Such occurrences are often attributed to non-compliance by occupiers, including inadequate provision or untimely maintenance of fire protection systems, as well as insufficient fire safety awareness among building occupants (Lehna *et al.*, 2024). The Moi International Airport fire in 2012 and the Jomo Kenyatta International Airport terminal building fire in 2013 underscore the vulnerability of airport infrastructure and operations to fire hazards. These events not only disrupted airport functions but also exposed gaps in emergency preparedness, operational resilience, regulatory compliance, and the adequacy of fire protection systems in Kenya's international airports (Ongoro & Muiya, 2023; Berre, 2023). It is in this background, that this research was undertaken to identify gaps in existing fire safety management systems at Kenya's international airports, and to publish the findings as a contribution to the existing body of knowledge while also providing practical guidance for stakeholders in aviation safety management.

1.3 Justification of the Study

Airports are complex sociotechnical systems within civil aviation (Iseri & Yasar, 2025) making air transport a crucial system for any country especially for its ability to promote the development of both national and local economy, including employment opportunities, industrial upgrading, and social welfare improvement and interconnectivity (ICAO,2023) but with numerous potential hazards (O' Connor, 2020).

The numerous potential hazards include mixed use and occupancies, uneven distribution of occupant density, high fuel load and a considerable number of passengers with different mental and physical abilities almost every day irrespective of time, carrying combustible loads in the form of luggage (O' Connor, 2020).

Therefore, it is prudent that lives and properties within airport terminal buildings are protected against unforeseen fire outbreaks through provision of adequate, serviceable and reliable fire protection system, and trained personnel to operate them (Ibrahim *et al.*, 2020).

The study aimed to identify gaps in the level of fire safety awareness among employees and management, compliance with relevant sections of BOWEC, FRRR, ICAO SARPS and adequacy of fire protection systems at International airports in Kenya and help Kenya Airports Authority plan and review for improvement fire safety strategies within the airports.

The outcome of the study and associated interventions shall inform KCAA and ICAO who are aviation safety oversight agencies on the need to develop and implement appropriate measures aimed at ensuring and maintaining fire safety standards within aviation system in Kenya.

1.4 Hypothesis (Ho)

Fire safety management performance at international airports in Kenya is not affected by fire safety awareness among management and employees, compliance with fire safety standards, and adequacy of fire protection systems.

1.5 Objectives of the Study

1.5.1 Main Objective

To evaluate factors affecting performance of fire safety management at International Airports in Kenya.

1.5.2 Specific Objectives

i. To assess fire safety awareness among employees and management at international airports in Kenya
ii. To investigate compliance with relevant sections of Building Operations and Works of Engineering Construction (BOWEC), Fire Risk Reduction Rules

(FRRR) and International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARPS) at international airports in Kenya

iii. To determine adequacy of fire protection systems at international airports in Kenya

1.6 Research Questions

i. To what extent are employees and management at international airports in Kenya aware of fire safety?
ii. To what extent are international airports in Kenya compliant with relevant sections of BOWEC, FRRR and ICAO SARPS?
iii. To what extent are fire protection systems at international airports in Kenya adequate?

1.7 Scope of the Study

International Civil Aviation Organization (ICAO) describes international airport as airport used for international operations (i.e. entry and departure for international air traffic). This study focused on eight (8) international airports' terminal buildings in Kenya namely Jomo Kenyatta, Moi, Kisumu, Wilson, Malindi, Wajir, Eldoret and Lokichoggio (International Civil Aviation Organization [ICAO Annex 14 Volume 1], 2022; International Civil Aviation Organization [ICAO Annex 9], 2022) to assess fire safety awareness, investigate compliance with relevant sections of Building Operations and Works of Engineering Construction (BOWEC), Fire Risk Reduction Rules (FRRR) and ICAO Standards and Recommended Practices (SARPs) and determine adequacy of fire protection systems. Only Kenya Airports Authority's management and employees based at the above eight (8) airports were included in the study.

1.8 Conceptual Framework

This is a pictorial diagram depicting interdependence among variables in the study (Sale & Carlin, 2025). This study conceptualized that fire safety awareness among management and employees; compliance with relevant sections of BOWEC, FRRR and ICAO SARPS; adequacy of fire protection systems are determinants to performance of Fire Safety Management at international airports in Kenya. These however, may be intervened by GOK-FRRR, 2007, ICAO SARPS and other relevant Laws and Regulations. (Fig 1.1).

Independent variables

Employer and Employees Fire Safety awareness:

- Training and workshops attended
- Knowledge, use and operation of installed fire protection systems
- Knowledge of emergency and evacuation procedures
- Refresher trainings and workshops attended
- Fire safety inspections and audits conducted
- Fire safety information communicated

Compliance with relevant sections of BOWEC, FRRR and ICAO SARPS

- Establishment of airport emergency plan
- Provision of Rescue and Firefighting Services
- Training of Rescue and Firefighting Personnel
- Provision of adequate and unobstructed means of escape
- Serving and maintaining fire protection system
- Inspections and audits conducted to airport facilities and equipment

Adequacy of Fire Protection Systems

- Provision of fire protection systems
- Establishment of preventive and corrective maintenance program
- Servicing and maintenance conducted
- Establishment of fire prevention program
- Allocation of a fire prevention responsibilities

Fire Safety Standards:

- GOK-FRRR, 2007
- International laws
- Other relevant laws

Intervening variable

Fire Safety Management Performance

Dependent variable

Figure 1.1: Conceptual Framework

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical Principles

Fire has been with humankind since time immemorial (Thompson *et al.,* 2021). It is a fundamental element in human lives, serving as both a source of comfort and potential disaster. Scientifically, fire is an exothermic chemical reaction that gives off light and heat in varying intensities (National Fire Protection Association [NFPA 921] (2021b). It is a burning process involving heat, fuel, oxygen, and chemical chain reaction as illustrated in Fig. 2.1 (Underhill, 2021).

When appropriately controlled, fire serves numerous beneficial purposes including heating, cooking and industrial use (Lawal *et al.,* 2023). However, its misuse and poor handling has led to severe accidents particularly in the workplace (Khan *et al.*, 2021). Fires can occur any time if fire safety measures are not consistently observed or practiced regularly (Taylor *et al.,* 2019). In such instances, safe evacuation time is restricted, posing great risk to building occupants (Ngwoke & Bolaji, 2021).

Historically, several catastrophic fire incidents have highlighted the devastating consequences of inadequate fire safety. Major disasters have resulted in extensive loss of life and property, including the fires in San Francisco (1906), Boston, Massachusetts (1942), and Manchester Airport in the United Kingdom (1985) (Rocha, 2021). These events have underscored the critical need to improve fire safety protocols across all types of facilities.

The impact of fire-related disasters can be significantly minimized when buildings are designed, constructed, equipped, maintained, and operated with the primary objective of safeguarding human life and preventing property damage (Taylor *et al.,* 2019). Fire safety management thus becomes an essential component of organizational responsibility, especially since many fires are preventable through proactive measures (Luga Jr. *et al*., 2025).

An effective Fire Safety Management System (FSMS) is vital in averting accidental fires within any occupancy (Luga Jr. *et al.*, 2025). The effectiveness of fire safety practices is influenced by several key factors, including proper maintenance of fire protection systems, fire safety training received by occupants, and the implementation of robust mitigation strategies (Salukele *et al.*, 2024). These factors collectively determine an organization's preparedness to prevent and respond to fire emergencies.

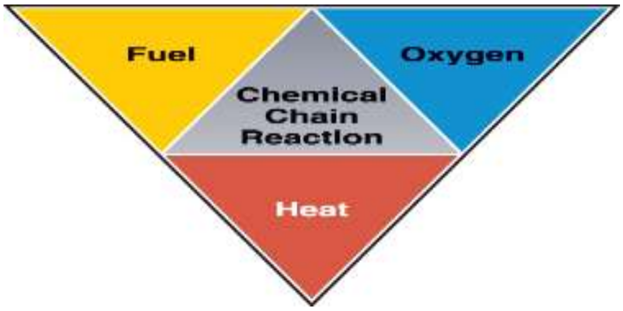

Figure 2.1: Fire Tetrahedron

Source: NFPA 921(2021b)

2.1.1 Fire Propagation within a Building

Fire will normally occur when the above four components illustrated in Fig. 2.1 are present (Underhill, 2021).

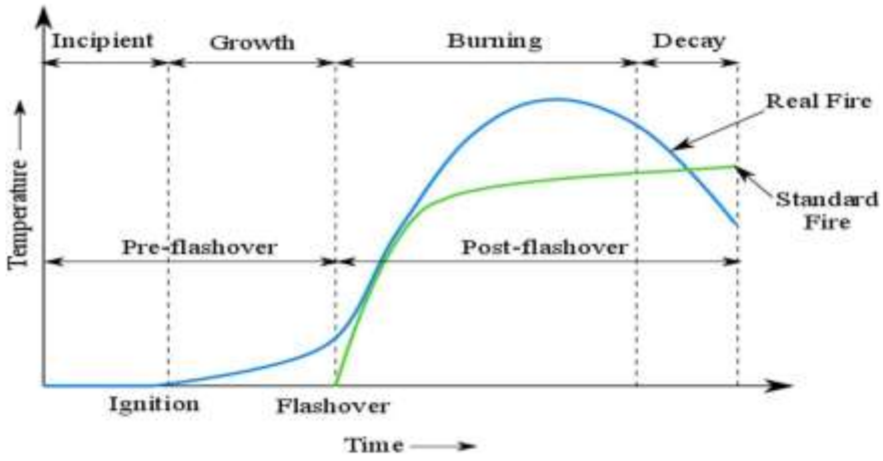

Figure 2.2: Stages of Fire Development

Source: Kodur et al. (2020)

At the incipient stage, fuel, oxygen, and heat are present and eventually the fuel is heated to its ignition temperature (Kodur *et al.*, 2020). During growth stage, additional fuel is involved, and convection draws more air into the fire forming thermal layers; leading to collection of hot gases at ceiling and eventually banking downwards while at fully developed stage, heat is produced at maximum rate and temperature can be more than 1,000°C and finally at decay stage fuel is nearly exhausted and heat intensity reduces (Kodur *et al.*, 2020).

2.1.2 Fire Prevention

This is a key principle of fire safety, alongside detection and communication, protection, containment, and extinguishment (International Fire Safety Standards [IFSS], 2020). It encompasses a range of activities aimed at preventing fire occurrences and minimizing its impact. An effective fire prevention strategy is essential for overall fire protection framework (Luga Jr. *et al.*, 2025). To extinguish fire, only one of the four elements in the fire tetrahedron (heat, fuel, oxygen or chemical chain reaction) must be removed (Underhill, 2021). Fire prevention functions as part of a broader risk management strategy commonly categorized as Engineering, Education, Emergency Response, Economic Incentive and Enforcement (Clark *et al.*, 2023).

Fire safety engineering applies scientific principles (human behavior and statistics) and various engineering fields (mechanical, electrical, civil, and chemical) to protect life and, properties from the destructive effects of fire (Terence, 2019). It involves designing and implementing fire detection system, both active and passive fire protection, means of escape facilities, fire prevention program, and human behavior during fire emergency (Terence, 2019).

Knowledge about fire is crucial in preventing fire emergencies. understanding fire safety limitations within the building, and knowing the appropriate actions to take during fire outbreak are critical components of a robust safety culture (Onyekwere, 2022). Education plays a central role in changing bahaviour, discouraging unsafe practices, and encouraging proactive fire prevention strategies in the workplace (Onyekwere, 2022).

According to International Civil Aviation Organization Document [ICAO Doc. 9137 part 1], 2015), the main goal for establishing Aerodrome Rescue and Firefighting Service (ARFFS) at the airports is to save lives through achievement of a response time of 3 minutes (Kenya Civil Aviation (Aerodromes) Regulations [KCARS], 2013). To realize this, airport operator must to establish comprehensive emergency plans in collaboration with stakeholders, clearly assigning responsibilities and ensuring that trained personnel and appropriate equipment are available (Onyekwere, 2022).

Creating a safer airport environment also involves investing in infrastructure that supports fire Safety. Economic incentives such as fines and penalties for non-compliance with fire safety standards can enhance awareness and improve adherence to regulations (Onyekwere, 2022). Ensuring compliance with fire codes during the design and construction phases through regular inspections is vital (Onyekwere, 2022). The Fire Risk Reduction Rules [FRRR] mandate that the occupier of any workplace must commission an annual fire safety audit by an approved auditor (GOK-FRRR, 2007). ICAO Doc. 9774 (2001), adds that enforcement-whether administrative or legal, is the last resort, implemented when education, training efforts have failed to secure compliance.

2.1.3 Fire Safety Management System

This is a structured set of policies, procedures and activities aimed at preventing fire incidents and ensuring fire safety within the workplace (Luga Jr. *et al.,* 2025). Such activities include training, scheduled periodic inspection, and maintenance of fire systems and good housekeeping (Luga Jr. *et al.,* 2025). This is likely to happen with management commitment, employees' involvement, effective risk assessment, effective communication, and continuous training (Mujtaba *et al.,* 2023) Management commitment to safety reflects the extent to which organization's senior management prioritizes safety in decision making and adequate resource allocation (Njogu *et al.,* 2019).

Good housekeeping is critical and involves measures such as separating combustible materials from ignition sources, storing flammable liquids in appropriate containers, recognition of potential hazards and ensuring that escape routes remain clear and unobstructed (GOK-FRRR, 2007).

Alao *et al.* (2021), notes that a well-designed Fire Safety Management System should address fire safety in the workplace through planning, emergency procedures and maintenance and its main objectives include the following: -

- Defining staff roles and responsibilities on fire safety
- Identification of fire prevention activities
- Training of all staff (including employer and employees)
- Clear emergency procedure and
- Identification of competent and qualified personnel to install and maintenance fire systems

According to Kodur *et al* (2020), most fire safety strategies are based on prescriptive approach, combining both active and passive fire system. Fire safety management at the airport entails the following as illustrated in Fig. 2.3.

- Fire protection features
- Regulations and enforcement
- Common/ civic sense
- Technology and firefighting resources

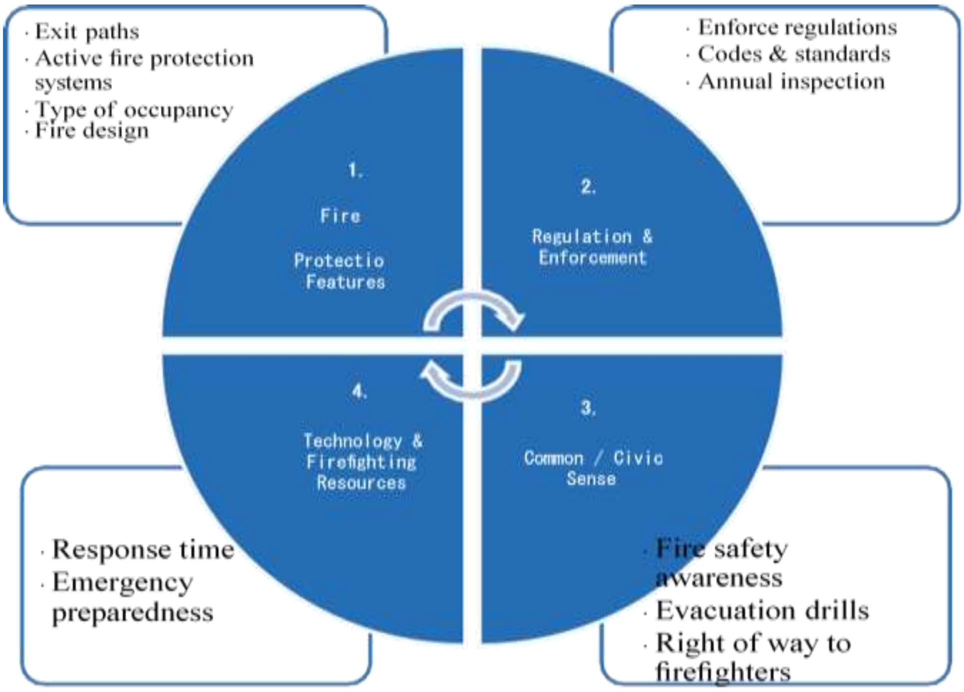

Figure 2.3: Integrated Framework Strategies to Improve Fire Safety in Buildings

Source: Kodur et al (2020)

2.1.3.1 Technology and Firefighting Resources

It is the responsibility of an aerodrome operator to provide firefighting services at the airport which is equivalent to the published aerodrome level of protection as specified in the aeronautical Information Publication (Kenya Civil Aviation Regulations

[KCARS], 2013). This includes availing adequate number of qualified and skilled firefighters to perform firefighting duties at the airport (KCARS, 2013).

According to ICAO Doc. 9137 part 1 (2015), saving lives in an emergency which is the principal objective of ARFFS is dependent on achievement of response time by ARFFS. Response time is the time between the initial call to ARFFS and the time the first responding foam tender is in position to discharge foam at a rate of at least 50 per cent (ICAO Doc. 9137, part 1, 2015). This time should be three (3) minutes at the end of each runway and any part of the movement area under optimum visibility and surface conditions (ICAO Doc. 9137 part 1, 2015).

To facilitate achievement of response time of 3 minutes, the airport operator should construct emergency access road where terrain permits and maintain them to ensure they are effectively available in all weather conditions (ICAO Doc. 9137 part 1, 2015).

To protect airports against fire outbreaks, the airport management must establish an emergency plan, commensurate with the activities of the airport to mitigate the effects of emergencies and additionally, form a committee to review and implement the plan (International Civil Aviation Organization Document (ICAO Doc. 9137 part 7, 1991). For the plan's adequacy, and continual improvement, it should contain procedures for periodic testing (KCARS, 2013).

2.1.3.2 Common/ Civic Sense

The design of emergency exits in a typical airport is based on fire codes, which considers the number of exits and proximity of the exit during emergency (Chen *et al*, 2019). Determination of the number of exits and their location is based on prescriptive rules aimed at minimizing congestion of people using any individual exit but rather to distribute the evacuation of people during emergency as well as the travel distance (Chen *et al*, 2019).

Emergency exits should be well illuminated and equipped with directional signage to guide occupants towards safe escape routes (Gyu *et al.,* 2019; Taylor *et al.,* 2019). The provision of safe and adequate means of escape is a critical aspect of a building's safety (Kodur *et al.,* 2020).

Occupier are required to conduct fire drills at least once in a period of 12 months (GOK-FRRR, 2007). Additionally, airport operators must establish airport emergency plan, which shall include procedures for carrying out various tests (ICAO Doc. 9137, part 7, 1991) namely:

a) Full-scale emergency drill, which is conducted after every 2 years
b) Partial emergency drill, one year after the full-scale drill to address the deficiencies found during full-scale drill
c) Tabletop exercise which is conducted after every 6 months

2.1.3.3 Regulations and Enforcement

Fire safety can be greatly improved through robust fire protection systems, adherence to building codes, and regular training (Kodur *et al.,* 2020). A structured and organized fire safety management within a building is essential to ensuring implementation of a comprehensive evacuation procedures (Alao *et al.,* 2021).

ICAO member States are required to certify airports used for international operations (ICAO Annex 14 Volume 1, 2022). According to article 15 of ICAO Doc. 7300 (2006), certification aims to: -

a) Guarantee the safety, regularity, and efficiency of operations of air transport operations
b) Establish benchmarks for continuous monitoring of compliance with ICAO SARPS

2.1.3.4 Fire Protection Features

The main reason for the provision of fire safety in an occupancy is to minimize deaths, injuries, and properties losses due to fire outbreaks (Sagun & Zahmatkesh, 2019). This requires a combination of active and passive fire protection system along with adequate and unobstructed means of escape. Active protection refers to controlling the fire emergency by some actions while passive system controls are in-built into the structure (Sagun & Zahmatkesh, 2019).

Automatic fire sprinklers, especially in the terminal buildings, are effective in suppressing fire by discharging water over specific areas when triggered (Sagun & Zahmatkesh, 2019). Additional provision includes fire detection system, fire alarms, safe means of escape, heat and smoke containment measures and structural integrity of buildings under fire exposure (Sagun & Zahmatkesh, 2019).

2.1.4 Fire Safety Awareness among Employees and Management

Training is an important component of safe and healthy workplace, equipping employees with knowledge and skills necessary for fire emergencies. (Alao *et al.,* 2021). Fire safety awareness involves educating occupants on fire causes, prevention, use of equipment, and evacuation procedures (Onyekwere, 2022) Training should be delivered by qualified and competent person (GOK-FRRR, 2007).

It is important that this training starts with induction of newly appointed employees, followed by refreshers once a year to ensure that employees are constantly reminded of the actions to be taken in an emergency and be familiar with fire precautions in the workplace (Alao *et al.,* 2021).

The effectiveness of fire system will largely depend on their status, maintenance, and training on how to use them (Bose *et al.,* 2019). It is therefore important that occupier train employees on what is required of them during fire outbreaks because lack of knowledge in fire safety and inadequate training delays quick intervention (Bose *et al.,* 2019).

According to Lawal *at al.* (2023), installation of fire extinguishers and fire systems in a building will not improve its fire safety; but sufficient training on use and operation offered to the occupants. An effective training will empower occupants in identifying sources and causes of fire within the building and be able to deal with them (Lawal *et al.*, 2023).

According to Sherifah *et al*. (2022), employees are important assets to an organization and so is their safety and hence should be made aware of working safe through training.

Omunagbe and Kaseem (2023), cites implementation of fire safety management to largely depend on training and on-going information provision to the staff. According to British Standard Institution [BSI], 2000), fire extinguishers installed will only be useful if occupants are instructed on their use and be able to demonstrate their operations.

Omar (2023), cited lack of funds and training as major barriers to implementation of fire safety management. According to Lawal *et al.* (2023), lack of knowledge on fire hazard identification and use of firefighting equipment renders containment of fire outbreak at the incipient stage difficult. It is important for the employer to educate occupants of fire safety through identifying potential fire hazards, this way the employer will be preventing the fire; before the fire (Taylor *et al.*, 2019).

To improve on the level of safety, all workers must be well informed. They should be regularly updated on operational changes that might impact on their overall safety and be made to understand the hazards in their line of duty (Campbell Institute, 2024). Training should be continuous and include practical components to enhance decision-making during emergencies (Alao *et al.,* 2021). The level of training and effectiveness of firefighting equipment will impact on effective evacuation during fire emergency (ICAO Doc. 9137 part 1, 2015).

2.1.5 Fire Safety Practice in the Workplace

Fire safety management is a legal responsibility bestowed to the occupier to prevent fires and protect lives the workplace (Government of Kenya Occupational Safety and Health Act [GOK-OSHA], 2007).

According to Alao *et al.* (2021), effective fire safety involves availability, reliability and serviceability of all firefighting facilities, a free and unobstructed flow of occupants to safety and, elaborate fire safety management system. It is therefore essential to have a basic knowledge of available resources and fire safety organization which includes knowing what to do and who to contact during fire emergencies (Alao *et al.*,2021).

According to Luga Jr. *et al.* (2025), effective fire safety management plays a very important role in an occupancy as most fire outbreaks are preventable.

Sufficient fire safety must be provided in a workplace to ensure continuous airport operations and life safety (Kodur *et al.,* 2020).

Regular fire drills and safety audits, conducted at least once annually, test emergency readiness and identify areas for improvement (GOK-FRRR, 2007; Salukele *et al*., 2024). These exercises help evaluate evacuation procedures and occupant familiarity with the environment (Jasztal *et al.,* 2022). Fire safety audit is an effective tool for assessing fire safety standards of an organization, which should help in addressing the inherent fire safety hazards associated with daily activities in the occupancy and recommend measures to reduce the potential fire hazards (Nugroho *et al.,* 2020).

2.1.6 Adequacy of Fire Protection Systems

It is the obligation of the occupier to provide adequate and effective fire protection system in the workplace (GOK-OSHA, 2007) and ensure that they are well maintained to avoid hidden failures from developing due to longer inactive state of these equipment, which are often detected through periodic inspections and tests (Kodur *et al.,* 2020).

Besides being a legal requirement to have fire protection system installed and maintained, they play a very important role of detecting and putting off fires at the initial stage and therefore should be operational when required (Kodur *et al.,* 2020).

According to Tongthong *et al*. (2023), fire extinguishers should be placed in easily accessible locations in plain view of all staff to be used during emergencies because they act as first aid to incipient fire. Fire systems are important part of the building and hence require care and maintenance to ensure they perform as expected during any fire emergency by providing safe and healthy working condition (Kodur *et al.,* 2020) further, top level management must commit to allocating adequate and readily available resource to support emergency plan (Zhang & Lee, 2024). According to (Kumar, 2021), equipment must be routinely checked to ensure safety during their use. Maintenance of firefighting system is key in ensuring their operational readiness when required (Alao *et al*., 2020) and that the corrective and preventive maintenance plan should be established and implemented (Kodur *et al.,* 2020). It is recommended to provide suitable firefighting system appropriate for the class of occupancy and regular servicing to be conducted according to equipment manufacturer's recommendations and local regulations (Alao *et al.,* 2021)

Effectiveness of fire protection system is not determined by installation, but care, maintenance, adequate provision of fire systems and effective training to assure their optimum reliability and achievement of fire safety (Alao *et al.,* 2021). A good corrective and preventive maintenance plan should include fault detection, inspection and testing of firefighting system and creation of awareness of maintenance operations (Kodur *et al.,* 2020).

For fire protection system to function effectively during the hour of need then they should be properly maintained (Kodur *et al.,* 2020) hence the need for adequate fire safety management in an occupancy (Alao *et al.,* 2021). It is worth noting that fire safety is a comprehensive strategy that can be achieved through hazard identification, installation of appropriate and adequate fire systems, integrating these systems with other systems within the building and ensuring that they are coordinated with human interface during emergency evacuation (Jasztal *et al.,* 2022).

2.2 Legal Framework

2.2.1 International Civil Aviation Organization (ICAO) SARPS on Fire Safety at Aerodrome

The convention on International Civil Aviation, also known as the Chicago Convention of 1944, established the International Civil Aviation Organization (ICAO) in 1947 as a specialized agency of the United Nations to promote safe and orderly development of international civil aviation through the formulation of global standards and regulations concerning aviation safety, security, efficiency and environmental protection in order to secure International cooperation and highest degree of uniformity in regulations and standards, procedure and organization regarding civil aviation matters (ICAO, 2018).These standards are applicable to all the contracting States, including Kenya.

The main objective of the Chicago Convention is to provide guidance for the development and operation of International Civil Aviation in a safe and orderly manner, while ensuring equal opportunity among member States. The Convention emphasizes the importance of standardization, safety, and law in international air transport (ICAO Doc. 7300, 2006). According to Articles 28 and 37 of ICAO Doc. 7300 (2006), contracting States are required to provide airports and air navigation facilities in their territories in accordance with the International Civil Aviation Organization Standards and Recommended Practices (SARPS).

ICAO is a permanent body charged with the responsibilities of administering the principles of the Chicago Convention. Through its technical and non-technical bodies, ICAO develops, adopts SARPS and incorporates them as annexes to the convention (www.icao.int).

Kenya ratified the Chicago Convection in 1964, thus becoming a member of the International Civil Aviation Organization (ICAO) and hence obliged to comply with the ICAO SARPS in accordance with article 37. As part of this obligation, Kenya is required to establish and implement an effective safety oversight system (www.icao.int) guided by the eight (8) critical elements (CEs) (International Civil Aviation Organization Document [ICAO Doc. 9734], 2017).

The ICAO annex 14 volume 1(2022) provides specific requirements regarding rescue and firefighting service at aerodromes. It requires that all contacting States to ensure availability of adequate rescue and firefighting equipment and services, with the principal objective of saving lives in the event of an aircraft accident or incident at or within the vicinity of an aerodrome.

Furthermore, the annex requires that all rescue and firefighting personnel be properly trained, including participation in live fire drills involving pressure-fed fuel fires, to ensure operational effectiveness. The speed and efficiency with which rescue and firefighting personnel and equipment respond during emergency are directly linked to the quality of training provided.

The annex also provides guidance on determination of level of protection to be provided at an aerodrome which, is based on the dimensions (i.e. overall length and maximum fuselage width) of the largest aircraft using the aerodrome, as well as frequency of operations, defined as at least 700 movements within the busiest three consecutive months as illustrated in Table 2.1 column 3.

Table 2.1: Airport Category for Rescue and Firefighting

Aerodrome Category	**Aeroplane overall length**	**Maximum fuselage width**
(1)	(2)	(3)
1	0 m up to but not including 9 m	2 m
2	9 m up to but not including 12 m	2 m
3	12 m up to but not including18 m	3 m
4	18 m up to but not including 24 m	4 m
5	24 m up to but not including 28 m	4 m
6	28 m up to but not including 39 m	5 m
7	39 m up to but not including 49 m	5 m
8	49 m up to but not including 61 m	7 m
9	61 m up to but not including 76 m	7 m
10	76 m up to but not including 90 m	8 m

Source: ICAO Doc. 9137 Part 1, 2015

Having determined the level of protection to be provided at an aerodrome, the annex further specifies the minimum number of serviceable foam tenders to be availed at the airport for effective delivery and deployment of the agent and the minimum usable amount of extinguishing agents as specified in tables 2.2 and 2.3 respectively.

Table 2.2: Minimum Number of ARFFS Vehicles

Airport Category	ARFF vehicles
1	1
2	1
3	1
4	1
5	1
6	2
7	2
8	3
9	3
10	3

Source: ICAO, 2015

Table 2.3: Minimum Usable Amount of Extinguishing Agents

	Foam meeting performance level A		Foam meeting performance level B		Foam meeting performance level C		Complementary agents	
Aerodrome category	Water [1] (L)	Discharge rate foam solution/ minute (L)	Water [1] (L)	Discharge rate foam solution/ minute (L)	Water [1] (L)	Discharge rate foam solution/ minute (L)	Dry chemical powders (kg)	Discharge rate kg/sec
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	350	350	230	230	160	160	45	2.25
2	1 000	800	670	550	460	360	90	2.25
3	1 800	1 300	1 200	900	820	630	135	2.25
4	3 600	2 600	2 400	1 800	1 700	1100	135	2.25
5	8 100	4 500	5 400	3 000	3 900	2200	180	2.25
6	11800	6 000	7 900	4 000	5 800	2900	225	2.25
7	18200	7 900	12100	5 300	8 800	3800	225	2.25
8	27300	10 800	18200	7 200	12 800	5100	450	4.5
9	36400	13 500	24300	9 000	17 100	6300	450	4.5
10	48200	16 600	32300	11 200	22 800	7900	450	4.5

Source: ICAO, 2015

In determining the minimum number of ARFFS personnel required, ICAO (2015) gives guidance through application of a Task Resource Analysis (TRA). This methodology enables aerodrome operator to determine appropriate staffing levels based on the operational requirements of rescue and firefighting tasks.

The Annex also emphasizes the importance of maintaining ARFFS facilities including vehicle in a condition that does not impair safety. This is to be achieved through establishment and implementation of a preventive and corrective maintenance program. Additionally, it recommends the establishment of a fire prevention program, incorporating proactive measures to mitigate against possible fire at the terminal building and a designation of a responsible person to oversee the program's maintenance and implementation.

To ensure comprehensive safety within the aerodrome, ICAO Annex 14, Volume 1 (2022) requires States to establish an emergency plan that is commensurate with aircraft operations and any other operations carried out at the aerodrome. This plan should contain procedure for periodic testing to assess and review aimed at improving its effectiveness.

To help States meet the minimum requirements specified in ICAO Annex 14 volume 1(2022), ICAO Doc. 9774, (2001) gives guidance in establishing regulatory framework for certification of aerodromes used for international operations. Complementing this, ICAO Doc. 9734 (2017) outlines duties and responsibilities of the ICAO contracting States, offering guidance on establishment of aviation safety oversight systems.

These systems are designed to ensure effective implementation of safety related Standard and Recommended Practices and associated procedures contained in the annexes to the Convection. The document identifies eight Critical Elements (CEs) as essential components for a safety system, supporting the implementation of safety related policies and procedures.

Additionally, ICAO Doc. 9735 (2023) defines oversight as an active control of the aviation industry by Civil Aviation Authority-in Kenya's case, the Kenya Civil Aviation Authority (KCAA) - to ensure that both State's International obligations and national requirements are fulfilled.

This oversight is structured around the aforementioned eight Critical Elements, which Contracting States must consider to ensure compliance with ICAO SARPs and maintain robust aviation safety systems. The critical elements are shown in the Fig 2.4 below: -

Figure 2.4: Critical Elements

Source: (ICAO Doc. 9735, 2023)

2.2.2 The Civil Aviation Act: The Civil Aviation (Amendment) Act, 2016

Historically, civil aviation in Kenya was regulated under a regional framework managed by the East African Directorate of Civil Aviation (EADCA). EADCA was established by the then colonial Government administration through the East African

High Commission, with the mandate to regulate civil aviation and provide air navigation services across Kenya, Uganda, Tanganyika, and Zanzibar. The joint aviation regulatory framework functioned effectively until June 1977. When the East African Community collapsed, prompting each member State to form her own independent civil aviation authorities.

Following this regional dissolution, the Directorate of Civil Aviation (DCA) was established in Kenya on 16th December 1977, under the Ministry of Transport. The DCA assumed responsibility for regulating and overseeing the orderly development of Kenya's civil aviation industry. However, the DCA, as a department within the civil service, faced significant limitations in effectively carrying out aviation safety oversight, particularly given global trends and increasing safety requirements in the sector.

In response to these limitations and in line with ICAO recommendations, the Kenyan Government recognized the need to de-link DCA from the mainstream civil service and establish autonomous entities to operate national civil aviation systems. A cabinet paper on this effect was prepared and approved in 1997, paving the way for new legislation. This resulted in the enactment of the Civil Aviation (Amendment) Act, 2002, which received presidential assent on 24th October 2002. The amendment formally established the Kenya Civil Aviation Authority (KCAA) as an autonomous corporate body, tasked to take over the functions of DCA and Civil Aviation Board (CAB).

Subsequently, the regulatory framework was updated through The Civil Aviation Act, 2013, which was later amended by the Civil Aviation (Amended) Act, 2016. After the establishment of the Civil Aviation Authority and for this case Kenya Civil Aviation Authority (Section 4 of the Civil Aviation Act, 2013), civil aviation in Kenya has continued to use most of the regulations promulgated under the repealed Civil Aviation Act (Sejpal *et al*., 2021).

The primary purpose of the Civil Aviation (Amendment) Act, 2016 is to enable Kenya as a signatory to the Chicago convention, to effectively oversee and manage civil aviation safety in Kenya in accordance with ICAO SARPS (ICAO Doc. 9734, 2017).

The Act empowers KCAA (as provided under Section 4 of the Civil Aviation Act, 2013) to proactively regulate civil aviation operations in the country and exercise independent oversight of safety, security and compliance (ICAO Doc. 9734, 2017).

Furthermore, the Act delegates authority to the Minister, Commissioner, or any designated person responsible for Civil Aviation to develop subsidiary air legislation, commonly referred to as the Kenya Civil Aviation Regulations (KCARs). These regulations are intended to address national requirements that emanates from the Civil Aviation Act to ensure standardized operational procedure and infrastructure within Kenyan aviation sector conforms with Annexes to the Chicago convention (ICAO Doc. 9734, 2017). Examples of subsidiary air legislation include but not limited to the following: -

i. The Civil Aviation (Aerodromes) Regulations, 2013
ii. The Civil Aviation (Certification, Licensing and Registration of Aerodromes) Regulations, 2018.

2.2.2.1 The Civil Aviation (Certification, Licensing & Registration of Aerodromes) Regulations, 2018.

The Civil Aviation (Certification, Licensing & Registration of Aerodromes) Regulations, 2018 (Kenya Civil Aviation Regulations [KCARS], 2018) provides comprehensive guidance on certification, licensing, and registration requirements for aerodromes in Kenya. These Regulations categorizes aerodromes into five classes—A through E— based on their operational capacity and the nature of air traffic they serve.

Category 'A'- aerodromes available for both International and domestic air traffic

Category 'B'- aerodromes available for domestic air traffic only

Category 'C'- aerodromes handling only domestic air traffic of maximum certificated take-off mass less than 30,000kg

Category 'D'- aerodromes designated solely for domestic helicopters operations

Category ‘E’- aerodromes serving domestic air traffic with aircraft of a maximum certificated take-off mass of less than 5,700kg.

Under these regulations, Category A aerodromes are subject to certification, category B to D require licensing, and Category E requires registration. For the purpose of this study, focus is directed exclusively towards Category ‘A’ aerodromes due to their relevance in international operations.

These Regulation further require that aerodrome operators to report the level of rescue and firefighting provided, including details on available rescue and firefighting facilities, equipment, trained personnel, extinguishing agents, and emergency procedures. The regulation also requires particulars of the aerodrome emergency plan, specifically provisions for dealing with structural fires, testing protocols, and the frequency of such tests.

2.2.2.2 The Civil Aviation (Aerodromes) Regulations, 2013

The Civil Aviation (Aerodromes) Regulations, 2013 (KCARS, 2013) outlines the responsibilities of the aerodrome operators concerning rescue and firefighting service. These regulations stipulate that facilities must correspond to the declared aerodrome category, as defined in Table 2.1. Kenya Airports Authority (KAA) is mandated under the Kenya Airports Authority Act (KAA-Act, 1991) to implement these requirements.

Training is emphasized as a critical determinant for effective performance of rescue and firefighting personnel. The regulation requires that all personnel be adequately trained to execute their duties efficiently and effectively. Additionally, a preventive and corrective maintenance program must be established to ensure operational reliability and safety, including the mechanical soundness of aerodrome rescue and firefighting vehicles.

Furthermore, this regulation mandates the establishment of a fire prevention program within terminal buildings. This includes preventive measures against potential fires and appointment of a responsible person to oversee the program. The regulation also requires operators to develop and maintain an emergency plan, establish an emergency committee, and regularly test the plan's adequacy through emergency exercises aimed at review and improvement.

2.2.3 The Kenya Constitution, 2010

The enactment of a regulatory framework system for certification of aerodromes used for international operations is anchored in the constitution of Kenya (Government of Kenya Laws [GOK-Laws], 2010). As a signatory to the Chicago Convention of 1944, Kenya has embedded her international aviation obligations within her supreme law. Article 2, sub-articles 5 and 6, provides that the general rules of international laws, treaties, and ratified conventions form part of Kenyan laws. This constitution provision affirms Kenya's commitment to international standards, including those related to aviation safety.

2.2.4 The Occupational Safety and Health Act, 2007

The Occupational Safety and Health Act, 2007 (GOK-OSHA, 2007), applies to all workplaces in Kenya, regardless of their terms of engagement of workers i.e., whether permanent or temporary. The Act's purpose is to secure safety, health, and welfare of all workers and to protect other persons against the risks attributed from work related activities. Under, this Act, employers are obligated to provide and maintain a safe and healthy working environment.

With regard to fire safety, the Act outlines several key provisions. Highly flammable substances must be stored safely outside the building, and appropriate containment measures must be in place to prevent spillage. In the event of a spill, suitable containers should be used to contain the substance. Employers must also prohibit smoking in areas where flammable materials are present and display clear "No Smoking" signage.

The Act requires occupiers of workplaces to design and regularly test evacuation procedures, ensuring that employees are familiar with them. Fire safety measures must include the provision of adequate, suitable, and well-maintained fire extinguishers that are conspicuously displayed, easily accessible, and free from obstruction.

Additionally, employers must train employees on the proper use and operation of fire extinguishers.

The Act also requires that means of escape must be kept clear and properly maintained. All exits affording means of escape must be designed to open outwards, with the exception of sliding doors, which must meet specific standards.

2.2.5 Fire Risk Reduction Rules LN No.59, 2007)

The Fire Risk Reduction Rules, 2007 (GOK-FRRR, 2007), which, is a subsidiary legislation under the Occupational Safety and Health Act (GOK-OSHA, 2007) apply to every workplace, operations, and processes, and are designed to enhance fire prevention and response mechanism within occupational settings.

The legislation requires employers to provide safe working environments for both employees and individuals who might be affected by workplace activities. Each workroom must be equipped with an emergency exit, distinctively and conspicuously marked in green of a least 15cm in height, located away from ordinary exits, and not less than 90cm wide. Emergency exits must not lead people to trap in the event of fire emergency. External staircase leading to emergency exit must be adequately aerated, well-lit and of at least 1m in width and unobstructed.

Furthermore, emergency exit routes must be clearly marked in writing or in signs clearly indicating their direction of exit, and evacuation maps must be displayed prominently in the workplace.

Employers must provide training and instructions on the safe use of firefighting equipment and establish firefighting team responsible for evacuation coordination, fire drills, training and maintenance of fire systems.

Fire drills are required at least once annually, and designated fire assembly points must be identified for use during emergency. Employers must also establish communication systems for alerting employees in the event of a fire, and these systems must be clearly communicated to employees.

The legislation requires that fire protection system to be properly maintained, connected to both audible and visual warning devices Maintenance and inspections must be conducted annually by qualified professionals. Portable fire extinguishers must be mounted at a minimum height of 60 cm from the floor, and hose reels should be accessible within a 30 m radius.

Additionally, employers must ensure that approved Fire Safety Auditors conduct annual fire safety audits of workplaces. These audits are essential tools for continual improvement of the Fire Management System and require top management's commitment to implement the recommendations provided (Zhang & Lee, 2024).

2.2.6 National Construction Authority Act, 2011

The National Construction Authority Act, 201, established the National Construction Authority (NCA), tasked with regulating the construction industry, coordinating its developments, and registering contractors in Kenya. Under Section 42, the Cabinet Secretary, in consultation with the NCA (Section 7) may enact regulations to support the Authority's mandate.

During the colonial era, Kenya adopted the 1968 Building Code. However, this code proved inadequate in ensuring safe, secure, and well-maintained built environment. Consequently, it was replaced by the National Building Regulations (2015), which came into force in 2017 (Government of Kenya National Building Regulations [GOK-NBR], 2017). These Regulations serves as construction guidelines for industry professionals, setting the minimum acceptable safety and health standards in building design, construction and maintenance (World Bank Group [WBG], 2019).

The Regulations requires building owners to provide adequate means of escape for use during emergencies., The escape routes must be sufficiently wide to facilitate quick evacuation and kept clear of obstructions. The buildings must also be equipped with fire suppression systems to control fires and mitigate their effects, thereby facilitating safe evacuation of occupants.

Further, firefighting systems, including suitable portable fire extinguishers for relevant occupancy type and flow area must be maintained in serviceable condition. Additionally, water supply systems supporting fire hydrants, hose reels, and sprinkler systems must maintain adequate quality, pressure and flow rates.

Evacuation procedures and coordination protocols must be established and teste through annual evacuation drills, conducted in accordance with the building's fire and evacuation plan. Stairways should be designed to provide firefighters with safe, direct, and unobstructed access to the building, protecting them from fire during rescue operations. The regulations also stipulate the minimum number of emergency exits based on the building's population, a factor critical in influencing overall evacuation time (Chen *et al.*, 2019) as indicated in the Table 2.4.

Table 2.4: Number of Emergency Exit *Doors*

Number of persons	Minimum number of exit doors in occupancy
50-240	2
241-500	3
501-750	4
751-1000	5
Above 1000	6

Source: National Building Regulations, 2015

2.2.7 The National Building Code, 2022

The (Government of Kenya National Building Code [GOK-NBC], 2022), aims to ensure order and safety in construction activities and safeguard the, safety and health of the persons potentially affected by construction works. The Code mandates compliance with established fire safety standards and requires that all buildings be designed, constructed, and equipped to enable protection and safe evacuation of occupants in the event of an emergency.

In accordance with the Code, any wall enclosing an emergency route must have a fire resistance of at least two (2) hours or an equivalent duration necessary to maintain structural integrity during evacuation. The emergency routes must be clearly marked and illuminated with emergency lighting source connected to a backup power supply capable of sustaining operation for a minimum of at least one (1) hour in the event of power failure. Directional signage must be posted to indicate evacuation routes, which should include at least one of the following: an emergency door, internal or external passage, staircase, or lobby leading directly to a safe discharge point.

Emergency exit doors must be designed to open in the direction of egress. Additionally, every public building is required to be equipped with appropriate firefighting equipment that is always accessible and readily available for use, and be capable of providing water at the recommended pressure and flow rate National Construction Authority, 2022).

2.2.8 Kenya Standard KS 2517:2014

The (Kenya Bureau of Standard [KEBS], 2014) establishes criteria for the selection, minimum requirements, location, and distribution of portable fire extinguishers. The standard takes into account factors such as fire classification and rating, travel distance, floor area and hazard classification.

Portable fire extinguishers are essential fire suppression tools designed for use during the initial stages of a fire and serves as the first line of defense against small fires. Their importance remains critical even in buildings equipped with more advanced fire protection systems (Singapore Standard, 2022).

Part 5 of the standard focuses on the selection of; portable fire extinguishers, emphasizing the need to consider the specific hazard classification of the occupancy when determining extinguishers type and capacity.

Part 6 of the standard addresses the location of portable fire extinguishers, recommending that they be positioned in a conspicuous and readily accessible areas—typically along the travel paths near the exits and mounted at appropriate height of 2m above floor level or to a height visible and reachable by persons of average height.

Part 7 of the standard outlines the distribution of portable fire extinguishers, which must be based on the type and degree of hazard present within the building. Proper distribution ensures that extinguishers are adequately spaced and accessible across all relevant areas of the occupancy

2.2.9 Building Operations and Works of Engineering Constructions (BOWEC), 1984

This govern construction, structural alteration, repair, and building maintenance. These regulations require that, no electric power circuit, bare wire or unprotected conductors should be located 4m on any surface where employee work, thus minimizing fire hazards during building operations. According to Rathnayake *et al.*, (2020), building codes and fire safety regulations significantly influence fire safety performance, which is a function of the building structure, occupancy characteristics, and fuel load. For instance, proper exit signage guides occupants to safety during emergencies, while means of escape and fire system form essential building characteristics that enhance safety (Rathnayake *et al.,* 2020).

It is critical that every building, especially those with high occupancy like airport terminals to be equipped with adequate fire safety facilities to allow occupants to safely evacuate to an It is `open air' area, before they are prevented from doing so by the effects of the fire e.g., smoke and heat (Omar, 2023).

Airport terminal buildings typically accommodate high occupancy (Philpott, 2022), making rapid and unobstructed exit from the building a vital consideration in building design hence the emergency exits must be free and clear of any obstruction as evacuation process is dependent of their performance in terms of facilitating speedy and effective flow of occupants to safer haven (Li & Zhang, 2020) and wide enough to enhance safe evacuation (Adeleye *et al*., 2020).

According to standards by the Government of the United Kingdom (GOV-UK, 2005), a minimum one exit width of 525 millimeters allows approximately 40 people per minute while a width of 750 millimeters can accommodate 80 people per minute. To prevent loss of life because of this high occupancy levels and longer discharge distance to the nearest exit, fire systems must be operational and well maintained (Ma *et al.*, 2025).

Type and effectiveness of any means of escape is also influenced by the occupants' mental and physical capabilities including the cognitive abilities related to vision, sound, and haptic sense (Akashah *et al.*, 2020). This include the cognitive abilities related to vision, sound, and haptic senses as this is dependent on the characteristics of the occupants and their interaction with the building (Li & Zhang, 2020). Hence, evacuation planning must consider individuals with disabilities (Chen & Wang, 2023) A universally safe escape is often impractical, making it vital to install fire systems that mitigate smoke and heat propagation within the building (Luga Jr. *et al.,* 2025).

Alao *et al.* (2021), concludes that effective implementation of a maintenance program is key to safe operation of fire systems within an occupancy. Fire safety must be embedded into architectural design through interactive fire safety codes, which should be implemented during the design process prior to construction and operations (NFPA 220, 2021a). When fire safety design is neglected, buildings remain highly vulnerable to fire incidents (Kodur *et al.,* 2020).

Fire engineering design minimizes potential loss of life and ensures an acceptable level of safety in a building (Terence, 2019). Terence (2019), also noted that most fire-related deaths are due to inhalation of toxic gases; therefore, mechanical ventilation and unobstructed means of escape are necessary.

The design and construction of a building must incorporate early fire warning systems, means of escape and alternative means of escape (GOV-UK, 2020).

The coordination between engineers and fire safety specialists is essential for selecting appropriate fire protection systems and maintaining high safety standards in public infrastructure such as airports (Iseri & Yasar, 2025). According to Benson and Elsmore (2021), fire professionals play a critical role in interpreting and enforcing fire codes, thereby ensuring protection of lives and property. According to NFPA 10 (2018) and British Standard Institution [BSI], 2003), portable fire extinguishers must be mounted except wheeled types at accessible heights (not more than 153cm and 107cm, depending on weight) and be reachable within a maximum travel distance of 15m (Singapore Standard, 2022).

2.3 Previous Studies Related to the Study

Several previous studies have examined the challenges and gaps in fire safety management, particularly in high occupancy and institutional settings. A recurring theme is the perception among management that fire incidents are highly unlikely or seldom, resulting in reactive rather than proactive implementation of fire safety measures (Ibrahim *et al.*, 2020); for instance, the 2013 fire at Jomo Kenyatta International Airport prompted significant improvements in fire safety protocols, underscoring how major incidents often drive reforms

Limited awareness and inadequate training are consistently cited as barriers to effective fire safety management. Li and Zhang (2020) identified human factors such as congestion, panic, and lack of adherence to emergency guidance as major challenges to effective evacuation. These can be addressed through fire safety training and awareness campaigns. Similarly, Alao *et al.* (2021) argued that fire safety education equips occupants with the necessary skills to manage emergencies effectively.

Yatim and Ahmad (2023) cited rapid increase in fire incidences to lack of fire safety awareness among Malaysian healthcare workers and further recommended development of structured institutional frameworks, enhancement of emergency response teams, regular training, and adoption of modern fire protection technologies to improve fire preparedness. These findings underscore the urgent need for comprehensive fire safety awareness to mitigate fire risks effectively.

Similarly, Johannes and Koray (2025), assessed fire safety knowledge and emergency preparedness among healthcare workers in Namibia and cited lack of sufficient knowledge on fire safety and emergency preparedness among healthcare workers. This highlighted the need for comprehensive training programs to improve healthcare workers' readiness in fire emergencies. While Anyanwu *et al.* (2021) in a study of fire safety management at Port Harcourt University in Nigeria observed that lack of knowledge on different types of portable fire extinguishers, inadequate provision and inspection of firefighting equipment, lack of inspection and review of past fire outbreak and inadequate information, instruction, and training on fire safety among the staff and students causing low implementation of fire safety management in the institution.

Kishoyian *et al.* (2021) emphasized the failure to conduct regular fire drills as a major setback in fire disaster preparedness in Kenya Medical Training College in Eastern Kenya.

Several studies highlight the inadequacy, poor maintenance, or absence of firefighting equipment. Adeleye *et al*. (2020) and Alao *et al*. (2021) cited inadequate firefighting facilities, their poor state because of poor or lack of maintenance and limited awareness on fire safety among the users as leading factors to high fire risks in public building in Nigeria. Another study in Nigeria, (Alao *et al*., 2021) claimed that knowledge in fire safety, equipment maintenance, well-structured fire safety organization, fire safety communication, fire safety audits, fire risk assessment and emergency planning are among the factors to consider when implementing fire safety within a building. While Ibrahim *et al.* (2020) also highlighted gaps fire training among firefighters and inadequate firefighting facilities.

Suharyo *et al*. (2023), in an Indonesian context, emphasized that the effectiveness of fire protection system depends not only on their installation but also on continuous maintenance and the training offered to occupants on the use and operation of the installed fire protection systems in ensuring fire protection systems remain reliable and functional. Ngwoke and Bolaji (2021) identified electrical faults due to overloading of electrical energized equipment and poor fittings as major causes of building fire in Ghana. Adeleye *et al.* (2020) further linked fire disasters in the workplace to poor escape route designs, obstruction of fire escape routes, and lack or malfunction of early warning systems leading to delays in evacuation of a building.

A study in Emirates, UAE’s commercial high-rise buildings (Omar, 2023) observed that lack of fire safety training, including knowledge on types of hazards and types of fire extinguishers for various classes of fire are the major factors constituting to insufficient and unsuitable fire extinguishers provision in a building.

Nambuya (2021) found that while fire drills, equipment maintenance, and training were implemented at Wilson Airport, inadequate policy frameworks and poor inter-agency coordination significantly constrained effective fire emergency preparedness. Similarly, Kinyua (2020) emphasized that personnel training and effective communication primarily drove safety oversight at Jomo Kenyatta International Airport, while weak regulatory enforcement and limited stakeholder engagement may constrain overall safety performance.

Qiu *et al.* (2023) concluded that the reliability of fire training and protection system is strongly influenced by structural maintenance and optimized system design. Similarly, Kumar and Paul (2022) highlighted that dependable fire protection systems—including automatic sprinklers, fire alarms, smoke detectors, and emergency suppression systems—can significantly reduce structural vulnerability during fire incidents, thereby lowering the likelihood of collapse and minimizing repair costs. Moreover, comprehensive training programs cover fire safety fundamentals, hazard identification, prevention strategies, and emergency response procedures. Regular training sessions reinforce knowledge and skills, ensuring that individuals are equipped to respond appropriately in different fire-related situations (Martin, 2024). Beyond awareness and adequacy of fire protection system, institutional and regulatory gaps also contribute to poor fire safety management.

Ngenyi *et al.* (2018) observed that persistent gaps in fire safety information, policy frameworks and limited management support for training and procurement significantly undermine the effective implementation of fire risk reduction rules paint industry in Nairobi County. Additionally, Ibrahim *et al*. (2020) highlighted that weak regulatory oversight and ineffective implementation of airport emergency plans significantly undermine fire safety, underscoring the need for stronger enforcement and systematic emergency preparedness in Nigerian airports.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Design

This study adopted descriptive cross-sectional research design to assess the performance of fire safety management at Kenya's International airports. The design was appropriate as it allowed for systematic data collection at a single point in time, enabling the identification and description of current fire safety practices and conditions.

Descriptive cross-sectional studies are effective for surveys and fact-finding investigations, where the goal is to describe existing conditions as they are without manipulating variables (Kothari & Garg, 2019). This approach enabled the researcher to gather objective data on the state of fire safety infrastructure, awareness, and preparedness across the selected airports.

Data collection tools included tape measure to record linear measurements such as emergency exit door widths, mounting heights fire extinguisher on the walls, checklists and photography was used to verify availability, accessibility, and the condition of fire safety equipment and to document physical features and compliance with fire safety standards respectively, questionnaire with Likert-scaled questions were also administered through face to face interview with the respondents.

The purpose of this study was to gain an in-depth understanding of the status and effectiveness of fire management systems within Kenya's international airports, with a focus on training, compliance, adequacy and performance.

3.2 Study Area and Population

The study was carried out at eight (8) international airports managed by Kenya Airports Authority whose population was estimated to be 1900 employees. The airports included in the study were JKIA, Kisumu International airport, Eldoret

International airport, Moi International airport, Wilson airport, Malindi airport, Wajir airport and Lokichoggio.

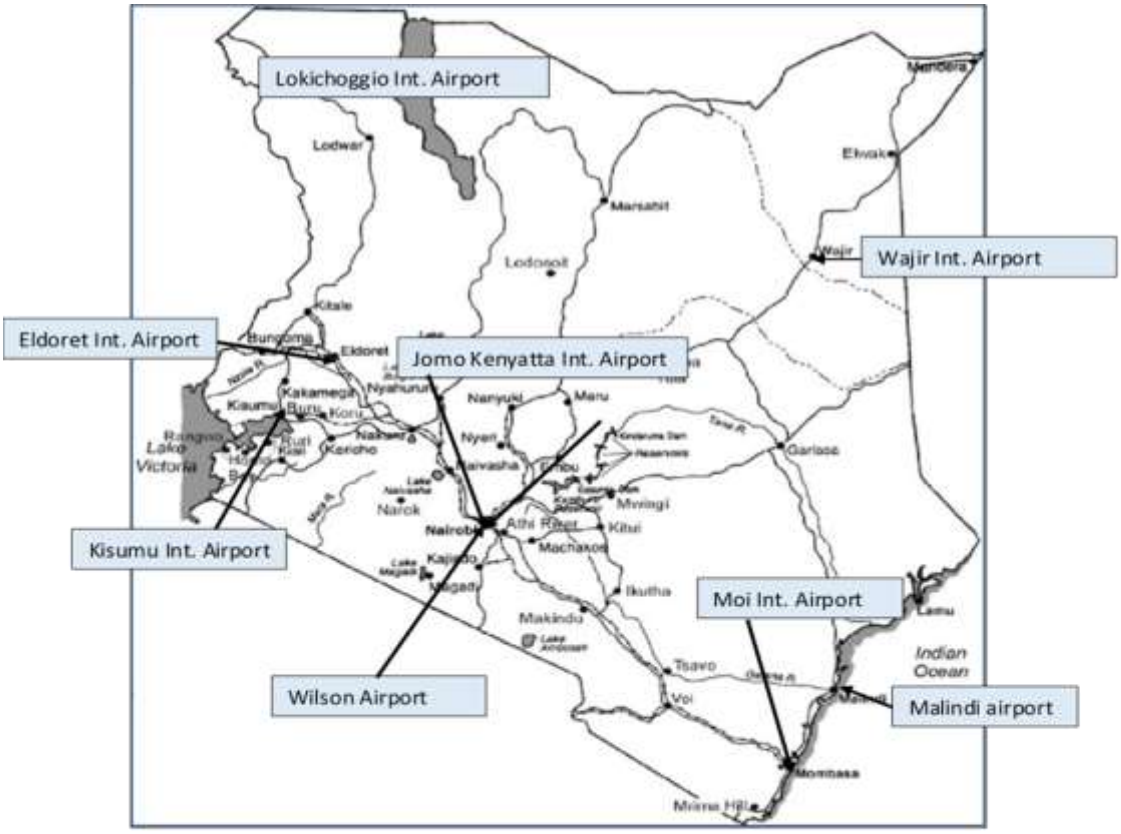

Figure 3.1: Map Showing Study Area

Source: https://www.google.com/

Jomo Kenyatta International Airport

Jomo Kenyatta International Airport is located about 13km South of Nairobi, the capital City of Kenya in Nairobi County within geographical coordinates (in WGS-84 format) 1°19'52.90''S 36°55'26.50''E at an elevation of 5330 feet above mean sea level (Kenya Civil Aviation Authority [KCAA], 2022; Kenya Airports Authority Integrated Urban Development Master Plan [KAA], 2014). It is the main airport in Kenya, the regional aviation hub, and the busiest airport in East and Central Africa, connecting Africa to the rest of the world and vice versa (Kenya Airports Authority [KAA], 2012).

The airport was constructed in 1978 and named after Kenya's first president Mzee Jomo Kenyatta.

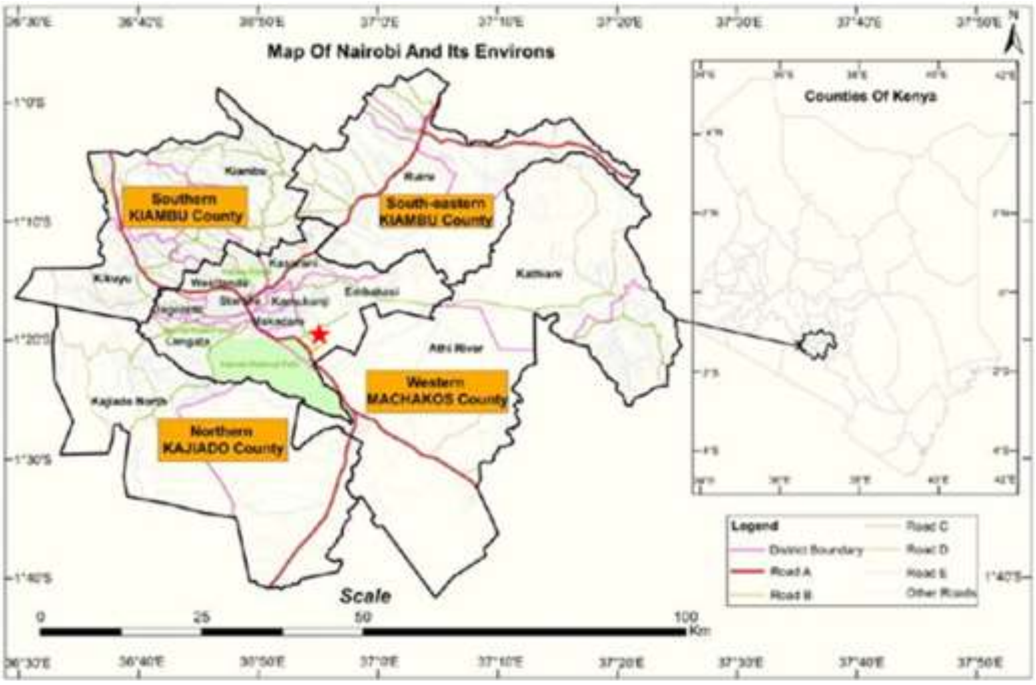

Figure 3.2: Location of JKIA

Source: (KAA IUDMP, 2014)

Wilson airport

Wilson Airport popularly known as Nairobi Wilson (KCAA, 2022) is located to the South of Nairobi of Langata Road at 5 km from the City within Nairobi County at an elevation of 1690m (KCAA, 2022). The name "Nairobi" comes from the Maasai word Enkare Nyirobi, meaning "the place of cool waters" (KAA IUDMP, 2014). It is the oldest airport in Kenya and Africa and third busiest general aviation airport in Africa (KAA IUDMP, 2014). The airport has a total area of 13.3 ha enclosed within a perimeter fence (KAA IUDMP, 2014). Its geographical coordinates (in WGS-84 format) are 01°19'6.12"S 36°48'48.10"E. In 1962, the airport was named after Florie Wilson, the founder of Wilson airways limited formed in July 1929 (KAA, 2012).

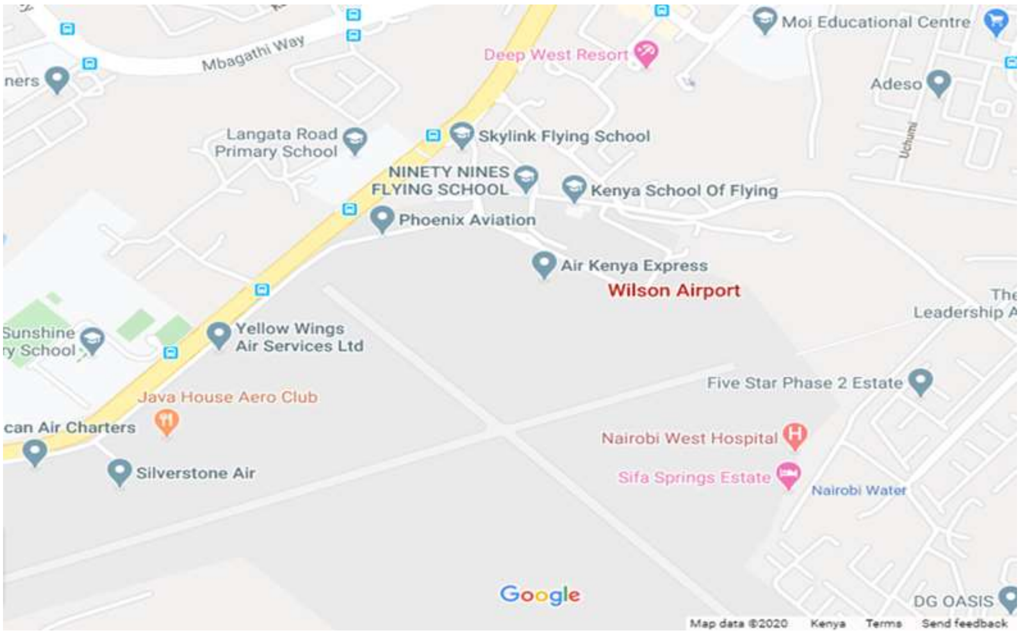

Figure 3.3: Location of Wilson Airport

Source: https://www.google.com/

Eldoret International Airport

Eldoret International airport is located 16km South of Eldoret town within Uasin Gishu County on a land measuring about 762 ha (KAA IUDMP, 2014). It is the south of the Cherangani Hills, at an elevation of 6945 feet above sea level at the airport (KCAA, 2022). The name “Eldoret” was derived from the Masaai word “Eldare” meaning “Stony River” because of the stony bed nearby Sosiani River. Due to pronunciation difficulties, the white settlers then decided to call it Eldoret to make it easier for them to pronounce (KAA IUDMP, 2014). The airport was built in 1995 to serve as a cargo terminal for the region and to open it up to global markets (KAA, 2012). Its geographical coordinates (in WGS-84 format) are 0°24'18.02"N 35°13'25.95"E.

Figure 3.4: Location of Eldoret Airport

Source: https://www.google.com/

Moi International Airport

It is located 10km West of Mombasa City on the Mombasa mainland off Port Reitz in Vikombani area of Mombasa City in Mombasa County. The airport lies South of the Mombasa-Nairobi highway between Jomvu Kuu and Miritini estates to the West, Mikindani to the North, Changamwe, Magongo and Chaani to the East and Southeast of the airport while Port Reitz estate to the south. The airport has approximate land measuring 539 ha (KAA IUDMP, 2014). The approximate geographical location of the airport (in WGS-84 format) is 04°01'59.1"S 039°36'10.5"E at an elevation of about 199.6 feet above sea level (KCAA, 2022). The airport, formerly known as Port Reitz airport, begun as a small airstrip, and developed after the second World War to become Kenya’s second largest airport after JKIA (KAA, 2012), it is located in a region attractive to tourists from all over the world who specifically come for the scenic coastal destinations. It receives 60% of tourist to Kenya (KAA, 2012). Following its expansion to handle international flights and construction of the modern passenger terminal, the airport was renamed Moi International airport in 1978 after the Second Kenya's President Daniel Toroitich Arap Moi (KAA, 2012).

Figure 3.5: Location of Moi Airport

Source: https://www.google.com/

Malindi Airport

Malindi airport is located 2.5km West of Malindi town (better known as Melinde) in Kilifi County. It is to the North of Mombasa-Malindi highway road. The airport is located at an elevation of 88 feet above mean sea level (KCAA, 2022). The geographical location of the airport (in WGS-84 format) is 03°13'51.91"S 040°5'59.84"E. The airport started in 1950s as a private airstrip at the present Eden Rock Hotel and serves as a major tourism industry of North Coast including Lamu and Masai Mara (KAA, 2012). The existing terminal building was constructed in 1957 (KAA, 2012).

Figure 3.6: Location of Malindi Airport

Source: https://www.google.com/

Kisumu Airport

The third busiest airport in Kenya and the Country’s fourth international airport. It is located about 2.5 km from Kisumu City in Kisumu County. The airport started in 1930s when Kisumu city was served by seaplane flights (KAA, 2012). The geographical location of the airport (in WGS-84 format) is 0°4'54.71"S 034°43'42.47"E. The airport has a land coverage of about 762 ha (KAA, 2012). The airport is located at an elevation of 3795 feet above mean sea level (KCAA, 2022).

Figure 3.7: Location of Kisumu Airport

Source: https://www.google.com/

Wajir Airport

Wajir Airport is an airport located in the North- eastern Kenya, Wajir County on a land measuring about 566.48 ha (KAA, 2012). It is located at an elevation of 756.9 feet (KCAA, 2022) about 5km east of Wajir town. The geographical location of the airport (in WGS-84 format) is 1°43'56.10"N 040°5'14.79"E. The airport was established as a military airbase for Kenya Air force, constructed by an Israeli company HZ and completed in 1978 (KAA, 2012). It remained purely military airfield until 2007 when it was commissioned to handle both passenger and cargo flights (KAA, 2012). It is the only airport in Kenya that is used for both Military and commercial purposes (KAA, 2012). Because of its strategic location at the northern part of Kenya, it is considered an international gateway for passengers from Somalia into Kenya (KAA, 2012).

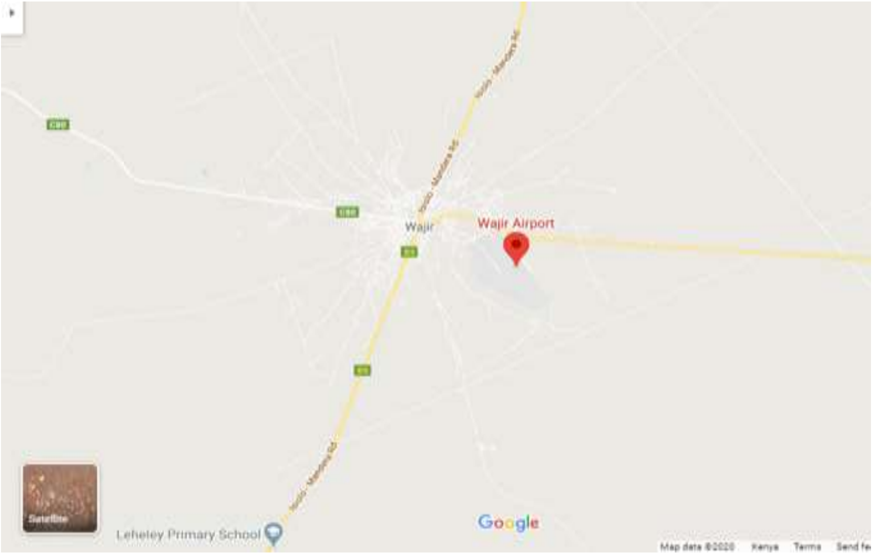

Figure 3.8: Location of Wajir Airport

Source: https://www.google.com/

Lokichoggio Airport

Lokichoggio airport often referred to as Loki by the residents is located about 30 km from the international border with Sudan within Turkana County at an elevation of 2115 feet (KCAA, 2022). The geographical location of the airport (in WGS-84 format) is 4°12'9.41"N 034°20'58.17"E. The airport is home to one of the world's largest and longest running humanitarian aid projects (KAA IUDMP, 2014). It was established in 1970s as an airstrip for Christian Missionaries working in the remote areas of Turkana (KAA, 2012). According to KAA (2012), the Kenyan Government, the Sudan People's Liberation Movement (SPLM) and the United Nations signed a tripartite agreement in 1989 allowing UN agencies and non-Government organization to use Lokichoggio airport especially for the supplies of food and medicine to the affected Sudanese refugees.

Figure 3.9: Location of Lokichoggio Airport

Source: http://www.google.com/

3.3 Sampling Methods

The study used stratified and simple random sampling in selecting respondents to ensure that sample size is distributed proportionately between employees and management of Kenya Airports Authority. The management comprised of managers and supervisors while employees comprised individuals from different departments within the identified eight international airports. This formed two categories (Management and Employees) classified as separate strata, and from each strata simple random sampling was applied.

3.4 Sample Size Determination

In determining the sample size Krejcie and Morgan (1970) formula was used.

s= $X^2NP(1-P) \div d^2(N-1) + X^2P(1-P)$

s= required sample size.

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841) = [1.96x 1.96]

N = the population size (1600). The population of airport employees.

P = the population proportion (assumed to be 0.5 since this would provide the maximum sample size).

d = the degree of accuracy expressed as a proportion (0.05).

Therefore

s= $X^2 NP (1-P) \div d^2 (N-1) + X^2 P (1-P)$

s=3.841 x 1600 x 0.5(1-0.5)/ [0.05^2 (1600-1) + 3.841 x 0.5 (1-0.5)]

s=1536.4 / 4.95775= 310

To get the sample size of each study area use

n1= $X_n/N*n$

Where n = desired sample size in the whole population

X_n= the number of the targeted population in the category

N= the total study population in the study area.

Table 3.1: Distribution of Airports by Names

Airport	Population	Sample size
Jomo Kenyatta	1051	204
Moi	217	42
Wilson	111	22
Kisumu	85	16
Eldoret	73	14
Malindi	27	5
Wajir	24	5
Lokichoggio	12	2
Total	**1600**	**310**

The total population (1900) is comprised of both the employees and Management team, whose population is estimated to be 300. In determining the sample size of the management population, Krejcie and Morgan (1970) formula was used.

s= $X^2 NP (1-P) \div d^2 (N-1) + X^2 P (1-P)$

s= required sample size.

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841) = [1.96x 1.96]

N = the population size (300).

P = the population proportion (assumed to be 0.5 since this would provide the maximum sample size).

d = the degree of accuracy expressed as a proportion (0.05).

Therefore

s= $X^2NP(1-P) \div d^2(N-1) + X^2P(1-P)$

s=3.841 x 300 x 0.5(1-0.5)/ [0.05^2 (300-1) + 3.841 x 0.5 (1-0.5)]

s=288.075 / 1.70775= 169

To get the sample size of each study area use (Airport Management team)

$$n1= X_n/N*n$$

Where n = desired sample size in the whole population

X_n= the number of the targeted population in the category

N= the total study population in the study area

Table 3.2: Distribution of Management Team per Airport

Airport	Population	Sample size
Jomo Kenyatta	149	84
Moi	63	35
Wilson	30	17
Kisumu	25	14
Eldoret	15	9
Malindi	8	5
Wajir	6	3
Lokichoggio	4	2
Total	**300**	**169**

3.5 Research Instruments

3.5.1 Assessing Fire Safety Awareness

In assessing the level of fire safety awareness among employees and management, respondents were presented with structured self-administered questionnaires (Likert-scaled questions) in the form of positive statements. The respondents i.e. employees and management were presented with different sets of questionnaires and requested to indicate their agreement level with each of the listed statements using the scale of (1=Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree).

Further, the respondents were requested to indicate the frequency (number of times) upon which each of the listed practices had been effected using the scoreboard of (5-at least four, 4-three, 3-two, 2- one, 1-zero) provided, and answering other structured questions. Checklists and photography were used to record observations in the airports. All the data collected were summarized, analyzed and presented in tables and charts.

3.5.2 Compliance with Relevant Fire Safety Regulations

In determining compliance with relevant fire safety regulation within the airports, employees were presented with structured self-administered questionnaires (Likert-scaled questions) in the form of positive statements. The respondents i.e. employees were presented with questionnaires and requested to indicate their agreement level with each of the listed statements using the scale of (1=Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree).

Additionally, the respondents were requested to indicate the frequency (number of times) upon which each of the listed practices had been effected using the scoreboard of (5-at least four, 4-three, 3-two, 2- one, 1-zero) provided, and answering other structured questions. Checklists and photography were used to collect data and record observations such as presence of fire protection systems including right types portable fire extinguishers for the class of fire in the occupancy. All the data collected were summarized, analyzed and presented in tables and charts.

3.5.3 Adequacy of Fire Protection System

In assessing adequacy of fire protection system, a tape measure was used to record linear measurements of emergency exit door width, mounted portable fire extinguisher heights on walls, Checklists and photography were also used to record observations in the workplace. The observation recorded included emergency signage, emergency exits, housekeeping, fire hydrants, fire protection systems installed. This was done through physical assessment while width of emergency doors and height of mounted portable fire extinguishers were measured using tape measure.

The collected data were summarized, analyzed and presented in tables. The results of assessed element compared with the relevant section requirements of BOWEC, FRRR and ICAO SARPS, to determine compliance.

3.6 Data processing and Analysis

The data collected was coded, tabulated and analyzed using Statistical Package for Social Science (SPSS) version 20. Both descriptive and inferential statistics were employed. Descriptive statistics included the arithmetic mean, standard deviation and frequencies. The mean, which is a representative of a data set, and relatively stable measure of central tendency, was preferred over other averages, while standard deviation used as a satisfactory measure of dispersion (Kothari & Garg, 2019).

The inferential statistics was carried out to establish the nature of the relationship between the study variables using t-test and results presented using tables and charts. Karl Pearson’s product- moment correlation and simple linear regression was used to test linear and statistical relationships between independent and dependent variables respectively with the assumption that dependent variable Y is predicatively linked to the independent variable X.

A significance level of $p < 0.05$ was used throughout to assess the statistical significance of the results.

3.7 Data Validation

For reliability of data collection tools, a pilot survey of the study was conducted at Malindi airport to validate the tools and ensure consistence of the instruments in achieving the study objectives; this involved a sample of 20 employees of Kenya Airports Authority. According to Chhetri and Khanal (2024), pilot survey helps researcher to decide on the best way to conduct the final research study.

All the eight international airports were coded i.e. their names held for confidentiality, the respondents too were required not to write their names or provide personal information in the questionnaires.

The questionnaires were reviewed and revised before they were used in the actual research data collection. The questions in the research instruments were as simple and clear as possible to enhance clarity to respondents with the aim of ensuring that respondents understood the questions well so as to get the most plausible information from them.

The quality of the data collected was further ensured by establishing reliability of the research questionnaires. Reliability is the measure of the extent to which data collection instruments yield consistent results (Andersson *et al*., 2024). In order to determine the internal consistency of the data collection tools, an assessment was undertaken using Cronbach’s alpha value attributed to Cronbach (1951) whose ranges from 0 to 1. Where 0 implies non- internal reliability and 1 implies perfect internal reliability. *Cronbach’s* formula used was:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

Where:

N = the number of items,

C-bar = the average inter-item covariance among the items and

V-bar = the average variance

The Cronbach alpha for each variable based on the average of inter-item correlation was above 0.70 with the highest Cronbach alpha value observed in confidence (0.9940) while the lowest value was 0.9645 as shown in in Table 3.3

Any Cronbach alpha value of at least 0.70 is therefore, regarded as a reliable measure and satisfactory consistency (Olaniyi & Adeniran, 2024) for the construct under consideration. Evidently, the present study results as outlined in the Table 3.3 demonstrated that all variables had a Cronbach alpha value of more than 0.70 thus stability and consistency of measurement was upheld. The questionnaires, therefore, met the acceptable level of reliability for all the variables. Both singly and collectively, the items in the research instruments were found to represent what they were intended to measure. The empirical measures of the variables being tested were found to represent the variables. The reliability coefficients in Table 3.3 were obtained for the constructs.

Table 3.3: Computed Cronbach's Coefficient for Constructs

Constructs	N of Items	Cronbach's Alpha
Fire Safety awareness- Employee	8	0.9940
Compliance with relevant sections of BOWEC, FRRR & ICAO SARPS	10	0.9901
Fire Safety awareness- Management team	7	0.9645

3.8 Ethical Considerations

The required approval that included research approval (Appendix IV), introductory letter (Appendix V) and Ethical approval to conduct the research were obtained from JKUAT Institutional Scientific and Ethics Review Committee (Appendix VI).

Additionally, research permit (Appendix VII) was obtained from the National Commission for Science, Technology and Innovation and written authorizations from Kenya Airports Authority (Appendix VIII) before engaging the international airports' employees and management on the study.

Participants in the study were informed of the purpose and objectives of the study, assurance of their anonymity, confidentiality of the information given and their rights through an informed consent was obtained before commencement of the interview; this was to ensure that all respondents participating are aware and willing to be involved in the study. The questionnaires were assigned unique codes and response kept in strict confidence. Further, the study was voluntary and participants informed of the option to participate or not to and to withdrawing from the study at will at any stage without suffering any harm for their decision.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Response Rate

All selected respondents (employees and management) were issued with questionnaires for data collection Out of 310 questionnaires administered to employees, 270 were completed and returned, translating to a response rate of 87.1%, as indicated in Table 4.1. Similarly, 120 out of 169 questionnaires administered to management were completed and returned translating to 71.0%, as presented in Table 4.2.

Mugenda and Mugenda (2003) postulated that a response rate of 50% and above is considered good, 60% sufficient and 70% and above excellent in survey-based research. Furthermore, Pielsticker and Hiebl (2020) emphasized that a higher response rate is an indicator of confidence in the representativeness, reliability, and validity of data in a survey study.

Given that the response rates among both employees and management was above 70%, they were considered excellent and thus the data collected was deemed suitable for further analysis and reporting.

Table 4.1: Employees' Response Rate

Questionnaire	Frequency	Percentage
Returned	270	87.1
Not returned	40	12.9
Total	310	100

Table 4.2: Management's Response Rate

Questionnaire	Frequency	Percentage
Returned	120	71.0
Not returned	49	29.0
Total	**169**	**100**

4.2 Demographic Information

4.2.1 Employees Demographic Information

4.2.1.1 Distribution of Employees by Gender

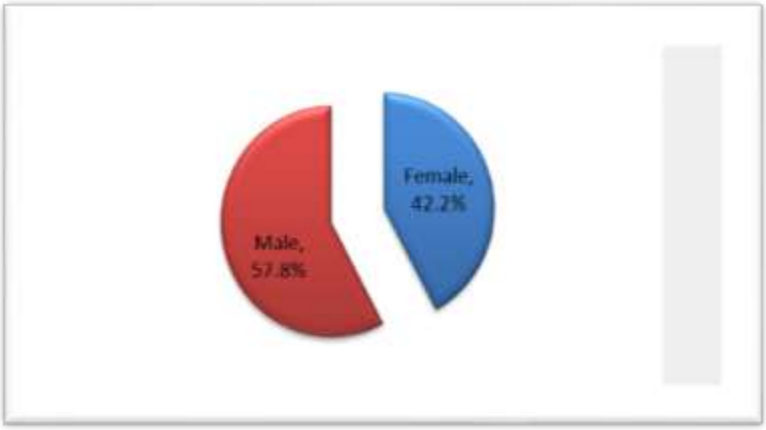

Figure 4.1: Gender Distribution among Employees

Referring to figure 4.1, a portion of the respondents, 57.8% were male whereas 42.2% were female. Both genders (male and female) were adequately represented in the study, though male gender were more. For this reason, it was deduced that airport workers at Kenya’s International airports is male dominated. These results agree with Acker and Ng (2020) that more men than women work in high-risk exposure jobs.

4.2.1.2 Distribution of Employees by Age

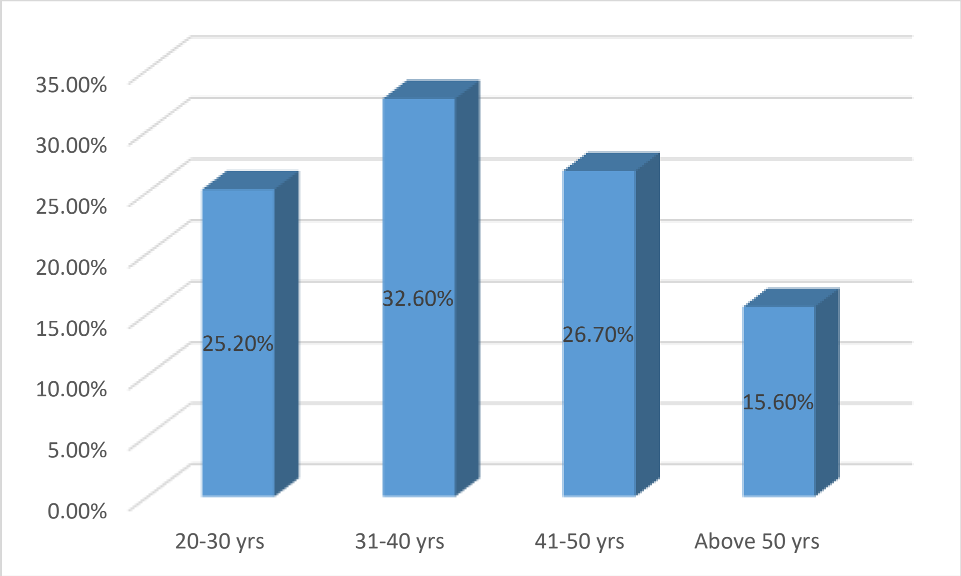

Figure 4.2: Age Distribution among Employees

From figure 4.2, majority of respondents (32.6%) were aged between 31-40 years. 26.7% of the respondents were aged between 41-50 years and 15.6% of the respondents were above 50 years of age. The age of the respondents shows in general that, 57.8% of the employees at Kenya' International airports are within the age bracket of 20 to 40 years. It is evidence from the chart, that 57.8% of the employees are at their active working age; this can be attributed to the recent recruitments to replace those who left service due to natural attrition.

4.2.1.3 Distribution of Employees by Education Level

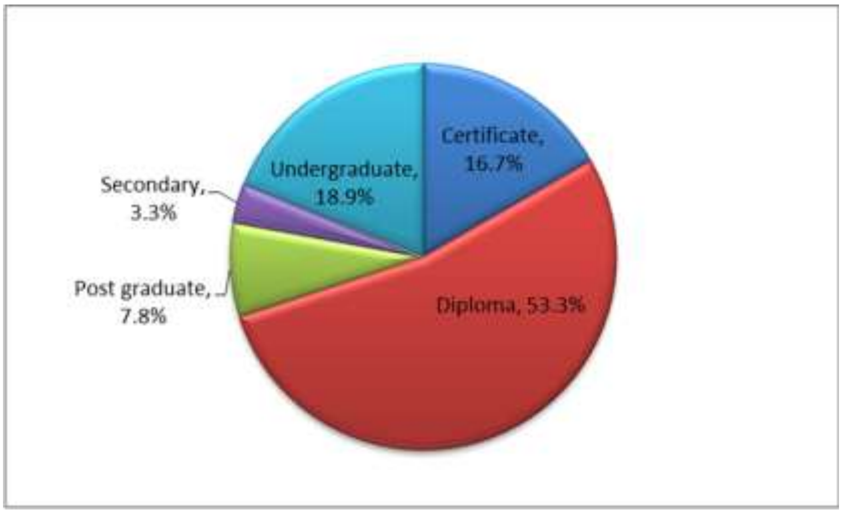

Figure 4.3: Level of Education Distribution among Employees

From figure 4.3, the results showed that 53.3% of the respondents had diploma education, 18.9% had undergraduate degree, 16.7% had certificates and 7.8% had post graduate degrees. This is an indicator that airport employees are knowledgeable and can be easily trained to handle fire safety matters at their respective international airports and that the respondents were competent enough to understand and provide the research information sought.

4.2.1.4 Distribution of Employees by Work Experience

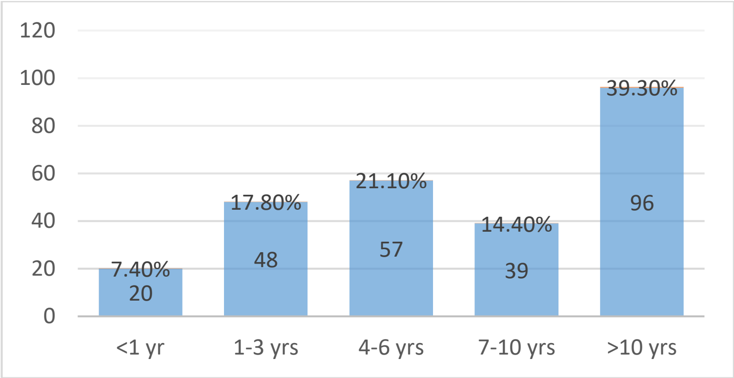

Figure 4.4: Working Experience at the Airport among Employees

Referring to figure 4.4, 39.3% of the respondents had worked in their respective airports for more than ten (10) years, 21.1% between 4 to 6 years, 17.8% between 1 to 3 years, 14.4% between 7 to 10 years while 7.4% had been in the airports for less than one (1) year. This is an indication that the respondents experience is sufficient to provide reliable and accurate information.

4.2.2 Management Team Demographic Information

4.2.2.1 Distribution of Management by Gender

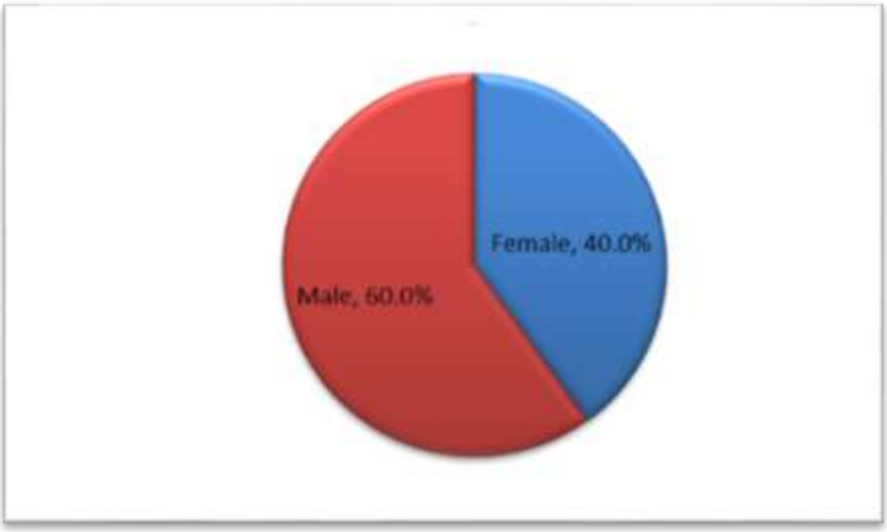

Figure 4.5: Gender Distribution among Management

Referring to figure 4.5, a portion of the respondents, 60% were male whereas 40% were female. Both genders (male and female) were adequately represented in the study, though male gender were more. For this reason, it was deduced that airport workers at Kenya's International airports is male dominated. These results agree with Acker and Ng (2020) that air transport is a male dominated sector.

4.2.2.2 Distribution of Management by Age

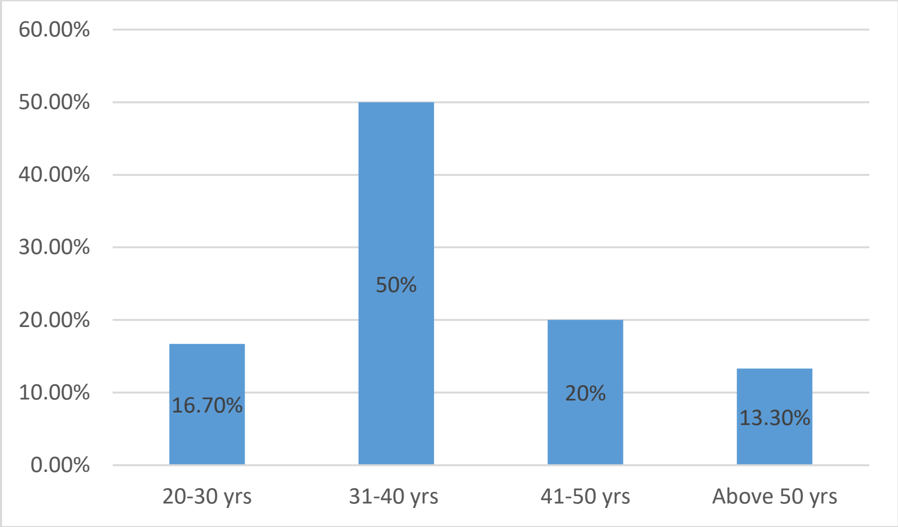

Figure 4.6: Age Distribution among Management

From figure 4.6, majority of respondents (33.3%) were aged between 20-40 years. 20% of the respondents were aged between 41-50 years and 13.3% of the respondents were above 50 years of age. The age of the respondents shows in general that, most of the respondents in management team at Kenya' International airports are within the age bracket of 20 to 40 years. The young workforce is as a result of the absorption of young contactors who were involved in the recent expansion and refurbishment of the airport facilities.

4.2.2.3 Distribution of Management by Level of Qualification

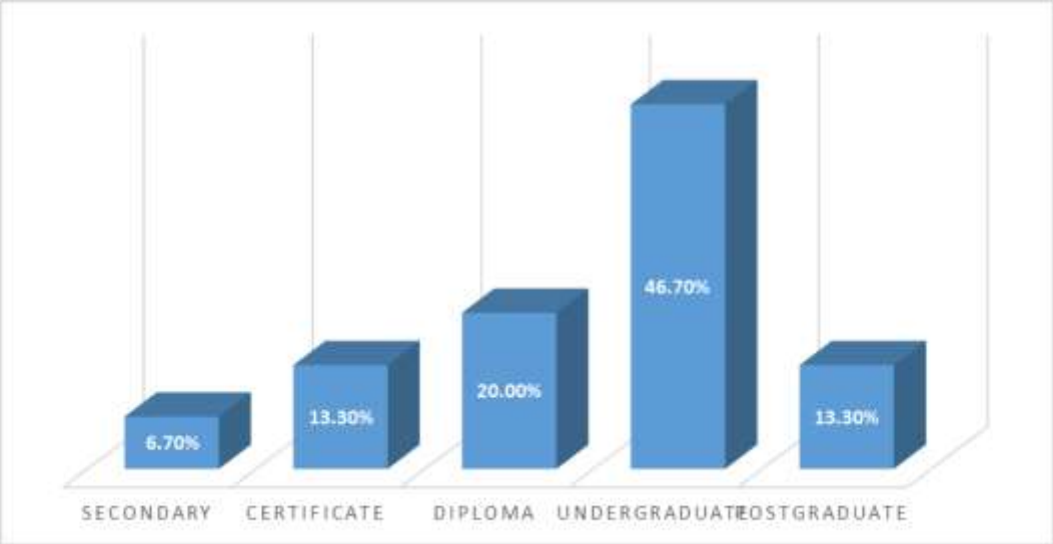

Figure 4.7: Education Level among Management

From figure 4.7, the results showed that 46.7% of the respondents had undergraduate degree, 20% had diploma, 26.6%.had both post graduate degree and certificates while 6.7% had secondary certificate. This is an indicator that airport management team are knowledgeable and can be easily trained to handle fire safety matters at their respective international airports and that the respondents were competent enough to understand and provide information sought regarding the research study.

4.2.2.4 Distribution of Management by Work Experience

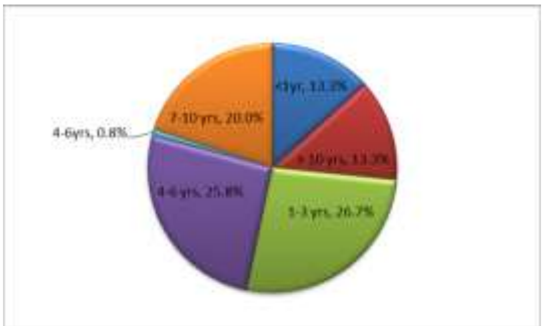

Figure 4.8: Working Experience at the Airport among Management

Referring to figure 4.8, 26.7% of the respondents had worked in their respective airports for 1 to 3 years, 25.8% between 4 to 6 years, 20% between 7 to 10 years, 13.3% for more than 10 years while another 13.3% had been in the airports for less than one (1) year. This is an indication that the respondents experience is sufficient to provide reliable and accurate information. However, it is also important to acknowledge that long-term experience, while valuable can sometimes foster entrenched perceptions or organizational biases, which may influence how information is reported or interpreted (The Strategy Institute, 2019).

4.3 Fire Safety Awareness among Employees and Management

Table 4.3 below shows level of agreement with various statements relating to fire safety awareness among employees.

Table 4.3: Fire Safety Awareness among Employees

	Statements	**5**	**4**	**3**	**2**	**1**	**Mean**	**SD**
a	I have received basic fire safety training including type & use of fire extinguishers	21	45	34	84	86	2.37	0.839
b	Information on fire safety are adequately communicated to all at the airport	32	30	38	83	87	2.39	0.871
c	I am aware of actions to take during fire emergency situation at the airport	27	44	34	78	87	2.43	0.864
d	Regular recurrent fire safety training are conducted to all employees	30	42	28	89	81	2.44	0.863
e	Every staff has access to fire safety policy	24	45	40	72	89	2.42	0.855
f	I am aware of the emergency number to call in the event of fire outbreak at the airport	36	30	42	70	92	2.44	0.889
g	I am clearly understand fire hazards at the airport	38	36	30	70	96	2.44	0.915
h	I am aware of the evacuation procedure at the airport	36	48	34	54	98	2.32	0.968
	Aggregate						**2.41**	**0.883**

(1=Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree)

Table 4.4 shows performance of fire safety awareness among employees.

Table 4.4: Performance of Fire Safety Awareness among Employees

	Performance key indicators	**5**	**4**	**3**	**2**	**1**	**Mean**	**SD**
a	Training on basic fire safety attended	18	24	36	90	102	2.13	0.824
b	Fire safety information communicated at the airport	12	18	48	105	87	2.12	0.737
c	Action to take during fire emergency known	9	24	51	66	120	2.02	0.798
d	Re-current fire safety training attended	3	21	57	72	117	1.97	0.732
e	Fire safety policy copies provided	12	27	39	123	69	2.22	0.719
f	Emergency number to call during fire emergency is known	27	30	53	59	101	2.34	0.875
g	Fire hazards at the airport known	27	36	45	50	112	2.29	0.913
h	Evacuation procedure provided at the airport known	9	9	45	93	114	1.91	0.729
	Aggregate						**2.13**	**0.791**

Scoreboard

Implementation frequency (Number of times)	≥4	3	2	1	0
Scale	**5**	**4**	**3**	**2**	**1**

Table 4.5 below shows level of agreement with various statements relating to fire safety awareness among the management team.

Table 4.5: Fire Safety Awareness among Management

	Statements	**5**	**4**	**3**	**2**	**1**	**Mean**	**SD**
A	I have received basic fire safety training including type and use of fire extinguishers	10	18	10	46	36	2.33	0.834
B	Information on fire safety are adequately communicated at the airport	14	10	16	42	38	2.33	0.859
C	I am aware of actions to take during fire emergency situation at the airport	17	11	9	48	35	2.39	0.881
D	Regular refresher fire safety training are conducted to all	12	16	14	38	40	2.35	0.866
E	I am aware of the emergency numbers to call during fire outbreak at the airport	16	12	8	40	44	2.30	0.919
F	I clearly understand fire hazards at the airport	10	24	8	32	46	2.33	0.899
G	I am are aware of the evacuation procedure at the airport	18	15	6	37	44	2.38	0.943
	Aggregate						**2.34**	**0.886**

(1=Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree)

Table 4.6 shows performance of fire safety awareness among management

Table 4.6: Performance of Fire Safety Awareness among Management

	Performance key indicators	5	4	3	2	1	Mean	SD
A	Training on basic fire safety including type and use of fire extinguishers attended	8	6	7	44	56	1.91	0.814
B	Fire safety information communicated at the airport	12	8	6	34	60	2.12	0.905
C	Action to take during fire emergency known	16	10	9	35	50	2.14	0.962
D	Regular re-current fire safety training attended	11	7	7	44	51	2.03	0.872
E	Emergency numbers to call during emergency at the airport known	9	6	10	40	55	1.95	0.852
F	Fire hazards at the airport known	13	9	5	35	58	2.03	0.941
G	Evacuation procedure at the airport known	10	14	6	39	51	2.11	0.974
	Aggregate						**2.04**	**0.903**

Scoreboard

Implementation frequency (Number of times)	**≥4**	**3**	**2**	**1**	**0**
Scale	**5**	**4**	**3**	**2**	**1**

4.3.1 Basic Fire Safety and Re-Current Training among Employees and Management

From the results in Table 4.3, 7.8% (n=21) of the employees strongly agreed to have received basic fire safety training, including types and use of portable fire extinguishers. Conversely, 31.9% strongly disagreed with this statement. Additionally, 16.7% of the respondents agreed, while 31.1% disagreed to have received the training. Basic fire safety training among employees recorded a mean of 47.4% (2.37), suggesting that the level of basic fire safety training among employees was below average. Furthermore, regular recurrent fire safety training posted a mean of 48.8% (2.44).

From Table 4.4, the frequency of participation in basic fire safety training varied among employees. Only 6.7% (n=18) of the employees reported attending four basic fire safety training sessions, 8.9% of them attended three, 13.3% attended two, 33.3% of them indicated to have attended one training session, Notably, 37.8% indicated they had not attended any basic fire safety training. According to these results, the performance level of this fire safety element was 42.6% (mean=2.13) with a standard deviation of 0.824, reflecting a good agreement of the results among the respondents.

The results in Table 4.4 also indicated 43.3% (n=117) employees were unaware of any recurrent fire safety training. 1.1% (n=3) of the employees attended four such sessions, while 7.8% of them attended three, 21.1% attended two, and 26.7% of them attended one. The performance level of this fire safety element was 39.4% (mean=1.97) with a standard deviation of 0.732, reinforcing the observation that recurrent fire safety training among employees remains significantly under-implemented.

Among the management, Table 4.5, reveals similarly low levels of training. The mean response for basic fire safety training, including knowledge on the types and use of fire extinguishers was 46.6% (2.33), while recurrent training had a slightly higher mean of47.0% (2.35). These figures suggest that safety training among management was also below average.

Table 4.6 indicated 42.5% (n=51) of management were unaware of any recurrent fire safety training held. 9.2% (n=11) of the employees had attended four re-current fire safety training sessions, 5.8% of them had attended two and three sessions respectively, and 36.7% of them attended one.

Additionally, From Table 4.5, only 8.3% (n=10) of the management strongly agreed to having received basic fire safety training including types and use of portable fire extinguishers whereas 30.0% strongly disagreed. The respondents who agreed and disagreed to have received similar training constituted 15.0% and 38.3% respectively. According to these results, the performance level of this fire safety element was 46.6% (mean=2.33) with a standard deviation of 0.834. Physical inspection and document review further revealed absence/lack of documented training records for both basic and recurrent fire safety training among the management.

These findings highlight a critical gap in fire safety preparedness, especially in training and documentation. The FRRR (2007) require occupiers to ensure that workers are trained and instructed on safe use of firefighting appliances. These results were in consistent with the conclusions of Adedayo (2021) who found that training and functionality of infrastructures were correlated. In other words, provision of adequate and modern firefighting facilities without skilled and qualified personnel to operate them; then firefighting facilities cannot achieve optimal levels of their functionality. Alao *et al. (*2021). Similarly emphasized that modern firefighting equipment is ineffective without adequately trained personnel to operate them, and that proper training imparts essential knowledge and skills for safe use.

Shokouhi *et al*. (2019) found out that inadequate training on fire safety coupled with poor attitude to fire safety affected safety related efforts and activities in any occupancy.

4.3.2 Communication of Fire Safety Information among Employees and Management

From the results in Table 4.3, 11.9% (n=32) of the employees strongly agreed that fire safety information was adequately communicated to all at the airport, whereas 32.2% strongly disagreed. Additionally, 11.1% agreed and 30.7% disagreed with the statement. From the results, communication of fire safety information recorded a mean and a standard deviation of 47.8% (2.39) and 0.871respectively.

From Table 4.4 provides further insight into the quantity of fire safety information communicated. Only 4.4% (n=12) of the employees reported receiving at least four pieces of fire safety information, 6.7% of them reported three, 17.8% reported two, and 38.9% of them indicated one. Alarmingly, 32.2% indicated that no fire safety information had been communicated at all. According to these results, the performance level of this fire safety element was 42.4% (mean=2.12) with a standard deviation of 0.737, which is considered below average.

According to Table 4.5, the management also reported low levels of fire safety communication, with a mean of 46.6% (2.33). Among management respondents,11.7% (n=14) strongly agreed that fire safety information was adequately communicated, while 31.7% strongly disagreed. A further 8.3% agreed and 35% disagreed with the adequacy of fire safety information dissemination.

Table 4.6, 28.3% (n=34) of management indicated that one fire safety information was communicated, while 5.0% and 6.7% of them indicated two and three messages respectively, 10.0% of them reported receiving four pieces of fire safety information, while 50% indicated receiving none. According to these results, the performance level of this fire safety element was 42.4% (mean=2.12) with a standard deviation of 0.905.

On-site inspection on the airports revealed that although some fire safety information was visibly displayed in the airport premises, certain directional signage was misleading or unclear (Plate 4.1)

Plate 4.1: Misleading Staircase Signage (IA1)

According to the FRRR (2007), occupiers are required to provide suitable and known means of communication to alert occupants in the event of fire emergency. These findings align with previous studies. For instance, Chen *et al.* (2019), concluded that there is a direct relationship between the number of passengers and the available unobstructed emergency exit doors, noting that an increase in the number of passengers necessitates a corresponding increase in accessible exits. Similarly, Jasztal *et al.* (2022) affirmed that the distribution of occupants in a building significantly affected evacuation time and procedures. Omunagbe and Kaseem (2023), alluded that effective fire safety communication and information enhances occupants' knowledge and confidence, thereby improving their preparedness in the event of a fire outbreak.

4.3.3 Actions to Take during Fire Emergency among Employees and Management

From the results in Table 4.3, 10.0% (n=27) of the employees strongly agreed that they are aware of the appropriate actions to take during a fire emergency at the airport, while 32.2% strongly disagreed. An additional 16.3% agreed and 28.9% disagreed. From the results, awareness of actions to take during emergency recorded a mean and a standard deviation of 48.6% (2.43) and 0.864 respectively, indicating a moderate level of agreement among the respondents.

From Table 4.4 provides further insights, revealing that 7.5% (n=9) of the employees reported knowing more than four actions to take during fire emergency, 8.9% of them knew three actions, 18.9% knew two, 24.4% of them indicated one. Alarmingly, 44.4% had no idea what action to take during fire emergency at the airport. The performance of this fire safety element was 40.4% (mean=2.02) with a standard deviation of 0.798, indicating below average preparedness among employees.

Among the management, Table 4.5, awareness of actions to take during fire emergency at the airport posted a mean of 47.8% (2.39) and a standard deviation of 0.881. 14.2% (n=17) of the respondents strongly agreed that they knew the correct actions to take during fire emergency at the airport, while 29.2% strongly disagreed. The respondents who agreed and disagreed to be knowing actions to take during fire emergency at the airport were 9.2% and 40.0% respectively.

Table 4.6 indicated 13.3% (n=16) of management knew more than four fire emergency actions, 8.3% (n=10) of them knew three, 7.5% indicated two, 29.2% indicated one, and 41.7% had no knowledge of appropriate emergency actions. According to these results, the performance level of this fire safety element was 42.8% (mean=2.14) with a standard deviation of 0.962. Combined employees and management responses (Table 4.4 and 4.6) yielded a mean of 41.6% (2.08).

On-site inspection on the airports confirmed that fire action notices were conspicuously displayed in several areas of the airport. The GOK-FRRR (2007) requires occupier to provide appropriate instructions to workers on emergency procedures in the workplace. These findings are consistent with Suparto and Erwandi (2024), who concluded that human behavior and action during emergency are significantly influenced by knowledge and experience to act appropriately during emergency.

4.3.4 Knowledge of Emergency Numbers to Call during Fire Emergency and Evacuation Procedures at the Airport among Employees and Management

From the results in Table 4.3, 13.3% (n=36) of the employees strongly agreed that they aware of emergency numbers to call during a fire emergency, while 34.1% strongly disagreed. The respondents who agreed and disagreed to be aware of emergency numbers to call during fire emergency were 11.1% and 25.9% respectively. Awareness of emergency contact numbers to call among employees recorded a mean of 48.8% (2.44), indicating below average awareness. In terms of evacuation procedures, 13.3% (n=36) of the employees strongly agreed that they were familiar with evacuation procedures at the airport, while 36.3% strongly disagreed. A further 17.8% agreed and 20.0% disagreed. Awareness of evacuation procedures among employees recorded a mean of 46.4% (2.32) and a standard deviation of 0.968, also reflecting below average awareness.

From Table 4.4, 10.0% (n=27) of the employees knew more than four emergency numbers to call, 11.1% of them knew three, 19.6% knew two, 21.9% of them knew one, and 37.4% were unaware of any emergency number to call. According to these results, the performance level of this fire safety element was 46.8% (mean=2.34) with a standard deviation of 0.875.

Regarding evacuation procedures (Table 4.4), 3.3% (n=9) of the employees knew more than four steps in evacuation procedure, 3.3% of them knew three, 16.7% knew two, 34.4% of them knew one, and 42.2% knew none. According to these results, the effect of fire safety element on performance of fire safety management was 38.2% (mean=1.91), indicating poor awareness. Although evacuation procedures are documented, there were no evidence that occupants were conversant with them.

GOK- FRRR (2007) requires occupier to inform all occupants on the contents of fire safety policy including evacuation procedures and map of evacuation routes prominently displayed in the workplace. These findings were in agreement with Li and Zhang (2020), who identified lack of guidance, panic, confusion, adequate unobstructed exits as factors that hindered evacuation.

Akashah *et al.* (2020) also noted that physical and mental capabilities of occupants influenced evacuation success in a workplace and can be improved through training the occupants on what to do when and how. Chang *et al.* (2023) concluded that evacuation maps, when clearly posted in corridors leading to emergency exits, significantly reduces evacuation time. Further, Menzemer *et al.* (2024) concluded that effectiveness of evacuation training or fire drills are often undermined by lack of perceived seriousness and urgency of the simulated scenarios among occupants.

From the results in Table 4.5, 13.3% (n=16) of the management strongly agreed to be aware of emergency numbers to call during fire emergency, while 36.7% strongly disagreed. The respondents who agreed and disagreed to be aware of emergency numbers to call during fire emergency were 10.0% and 33.3% respectively. Awareness of emergency numbers to call among management recorded a mean of 46.0% (2.30) an indicator that this awareness among management was below average.

Regarding evacuation procedures (Table 4.5), 15.0% (n=18) of the management strongly agreed to be aware of evacuation procedures at the airport, while 36.7% strongly disagreed. The respondents who agreed and disagreed to be aware of evacuation procedures were 12.5% and 30.8% respectively. Awareness of evacuation procedures among management recorded a mean of 47.6% (2.38) an indicator that this awareness among management team was below average.

From Table 4.6 revealed that7.5% (n=9) of the management knew more than four emergency numbers to call, 5.0% of them knew three, 8.3% knew two, 33.3% knew one, while 45.8% knew no emergency number to call. According to these results, the performance level of awareness of emergency numbers to call was 39.0% (mean=1.95) with a standard deviation of 0.852 an indicator of good agreement of the results among the respondents.

In terms of evacuation procedures (Table 4.6), 8.3% (n=10) of the management knew more than four steps in evacuation procedure, 11.7% of them knew three, 5.0% knew two, 32.5% of them knew one, while 42.5% knew none. According to these results, the performance level of awareness of evacuation procedures was 42.2% (mean=2.11).

Combining responses from Tables 4.4 and 4.6, employees and management knowledge of emergency numbers and evacuation procedures within the airport posted a mean of 43.0% (2.15) and 40.2% (2.01) respectively indicating below average awareness. Documents reviews revealed availability of fire drill records in a few airports, which is not consistent with GOK- FRRR (2007) requirement to conduct fire drills at least every twelve (12) months and keep records for such drills for inspection by DOSHS.

These findings were in agreement with the previous studies. Chen *et al.* (2019) concluded that there is a direct relationship between the number of passengers and available unobstructed emergency exit doors; if the number of passengers increases, more emergency exit doors will be required. Jasztal *et al.* (2022) affirmed that distribution and number of occupants in a building affected the overall estimated evacuation time and procedure. Ukegbu *et al.* (2022) highlighted that poor knowledge of emergency contacts to call in cases of fire emergency was the reason for poor response at Nigeria's healthcare facilities.

4.3.5 Understanding of Fire Hazards among Employees and Management at the Airport

As shown in Table 4.3, 14.1% (n=38) of the employees strongly agreed that they understood fire hazards at the airport, while 35.6% strongly disagreed. A further 13.3%

agreed and 25.9% disagreed. From the results, knowledge of fire hazards at the airport among employees recorded a mean and a standard deviation of 48.8% (2.44) and 0.915 respectively which, is an indicator of good agreement of the results among the respondents.

From Table 4.4, 10.0% (n=27) of the employees correctly identified at least four fire hazards, 13.3% of them identified three, 16.7% correctly identified two, 18.5% of them correctly identified one, while 41.5% could not identify any fire hazard at the airport. According to these results, the performance level of understanding fire hazards was 45.8% (mean=2.29), with a standard deviation of 0.913, reflecting that knowledge of fire hazards in the workplace was below average. Document review revealed that some of the fire hazards are documented in the risk registers.

For the management, Table 4.5, knowledge of fire hazards at the airport posted a mean of 46.6% (2.33) and a standard deviation of 0.899. Only 8.3% (n=10) of the respondents strongly agreed that they understood fire hazards at the airport, while 38.3% strongly disagreed. An additional 20% agreed and, 26.7% disagreed.

Further Table 4.6 indicated that 10.8% (n=13) of management correctly mentioned four fire hazards at the airport, 7.5% (n=9) of them mentioned three, 4.2% mentioned two, 29.2% mentioned one, while 48.3% mentioned none. According to these results, the performance level of knowledge of fire hazards among management was 40.6% (mean=2.03) with a standard deviation of 0.941, indicating poor understanding of fire hazards.

KCARS (2013) requires airport operators to establish and maintain fire prevention program with preventive measures against possible fire and designated fire safety personnel knowledgeable on risk assessment and fire hazard identification.

According to Kodur *et al.* (2020), the program if effectively implemented will ensure availability and reliability of fire protection system through identification of hidden failures. These findings were in agreement with the previous studies. Alwaqfi *et al.* (2022), who concluded that awareness of fire hazards, associated risk factors and their consequences prompts occupier to pay more attention and efforts in reducing potential fire risks through fire risk assessment and implementation of fire safety measures. According to Omar (2023) also emphasized that training on fire hazards fosters a positive safety culture and reduces fire risks.

4.4 Compliance with Relevant Sections of BOWEC, FRRR and ICAO SARPS

Table 4.7 below shows level of agreement with various statements relating to compliance with relevant sections of BOWEC, FRRR and ICAO SARPS.

Table 4.1: Compliance with Relevant Sections of BOWEC, FRRR and ICAO SARPS

	Statements	**5**	**4**	**3**	**2**	**1**	**Mean**	**SD**
a	Fire protection systems (smoke, heat and sprinkler systems) are installed at the airport	10	45	23	132	60	2.31	0. 725
b	Inspection of fire protection systems are done as stipulated by FRRR LN No. 59	14	20	33	113	90	2.09	0.760
c	Fire hydrants installed at the airport	18	34	25	93	100	2.17	0.841
d	Fire safety audits conducted annually at the airport by competent and qualified fire safety auditors	24	20	27	112	87	2.19	0.822
e	AEP established at the airport	34	35	21	93	85	2.39	0.889
f	Aerodrome Emergency Plan tested periodically	25	18	10	91	126	1.79	0.956
g	ARFFS established is commensurate with the airport category	18	16	20	98	118	1.96	0.829
h	Emergency Access roads provided where terrain conditions permit	29	34	13	123	71	2.36	0.837
i	ARFFS personnel trained to perform their duties efficiently	102	113	27	18	10	4.03	0.517
j	ARFFS personnel participate in live fire drills including pressure-fed fuel fires	15	21	34	86	114	2.03	0.819
	Aggregate						**2.33**	**0.799**

(1=Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree)

Table 4.8 shows performance of Compliance with relevant sections of BOWEC, FRRR and ICAO SARPS on implementation of fire safety management at international airports.

Table 4. 2: Performance of Compliance with Relevant Sections of BOWEC, FRRR and ICAO SARPS on Implementation of FSM

	Performance key indicators	5	4	3	2	1	Mean	SD
a	Availability of fire protection system	12	27	15	90	126	1.92	0.827
b	Regular inspection of fire protection system conducted	21	36	18	94	101	2.19	0.864
c	Fire hydrants with water available at the airport	16	22	9	123	100	2.00	0.794
d	Fire safety audits conducted at the airport by approved persons	27	30	14	101	98	2.21	0.881
e	Establishment of AEP and revision	17	20	16	116	101	2.02	0.800
f	Periodic testing of AEP conducted	15	7	13	126	109	1.86	0.746
g	Provision of ARFFS that is commensurate with airport category	13	5	16	128	108	1.84	0.715
h	Provision of all-weather emergency access road	18	27	19	119	87	2.15	0.798
i	Training of ARFFS personnel conducted	120	79	27	18	26	3.92	0.653
j	Participation of ARFFS personnel in live fire drills including pressure-fed fuel fires	9	15	12	105	129	1.78	0.748
	Aggregate						**2.19**	**0.783**

Scoreboard

Implementation frequency Number of times)	**≥4**	**3**	**2**	**1**	**0**
Scale	**5**	**4**	**3**	**2**	**1**

4.4.1 Installation of Fire Protection System and Fire Hydrants

From the results in Table 4.7, 3.7% (n=10) of the employees strongly agreed that fire protection systems are installed at the airport, while 22.2% strongly disagreed. The respondents who agreed and disagreed that fire protection systems are installed at the airport were 16.7% and 48.9% respectively.

From the results, installation of fire protection system at the airport among employees recorded a mean and a standard deviation of 46.2% (2.31) and 0.725 respectively. This was below average perception. Similar trends were noted for fire hydrants, with only 6.7% (n=18) of the employees strongly agreeing that fire hydrants are installed at the airport. The respondents who agreed and disagreed that fire hydrants are installed at the airport were 12.6% and 34.1% respectively while 37.0% strongly disagreed. From the results, installation of fire hydrants at the airport among employees recorded a mean and a standard deviation of 73.4% (2.17) and 0.841 respectively.

From Table 4.8, 46.7% (n=126) of the employees indicated unavailability of fire protection systems at the airport, 33.3% of them indicated one, 5.6% indicated two, 10.0% of them indicated three, while 4.4% indicated at least four fire protection system at the airport. According to these results, the performance level of installation of fire protection system was 38.4% (mean=1.92) with a standard deviation of 0.827, this was below average. Physical inspection of the airport facilities revealed absence of fire protection systems at some of the airports under study and most of those available are unserviceable.

From Table 4.8, 5.9% (n=16) of the employees indicated at least four fire hydrants at the airport had water, 8.1% of them indicated three, 3.3% indicated two, 45.6% indicated one while 37.0% of them indicated none of fire hydrants at the airport had water. According to these results, the performance level of availability of fire hydrants with water was 40.0% (mean=2.00) with a standard deviation of 0.794. Physical inspections of the airport facilities validated these perceptions, confirming the absence or poor maintenance of fire protection systems and hydrants.

According to ICAO, (2015) and BOWEC regulations, airports must have functional hydrants to support expeditious replenishment of foam tenders to ensure continuous application of the media, and maintenance of survival conditions. These findings were in agreement with the previous studies. Hutapea and Martanti (2023) who, concluded that insufficient fire hydrants within the airports hindered effective provision of rescue and firefighting service.

4.4.2 Regular inspection of Fire Protection System as a Requirement by Law

From the results in Table 4.7, 5.2% (n=14) of the employees strongly agreed that inspection of fire protection systems occur as required by law. The respondents who agreed and disagreed that fire protection systems are regularly inspected as required by law were 7.4% and 41.9% respectively, while 33.3% strongly disagreed. From the results, regular inspection of fire protection system as a requirement at the airport among employees recorded a mean and a standard deviation of 41.8% (2.09) and 0.760 respectively which, is an indicator of good agreement of the results among the respondents.

From Table 4.8, 7.8% (n=21) of the employees reported that at least four inspections were done on fire protection system at the airport by competent person, 13.3% of them indicated three, 6.7% indicated two, 34.8% of them reported one, while 37.4% indicated that no inspection was conducted on fire protection system at the airport. According to these results, the performance level of regular inspection of fire protection system was 43.8% (mean=2.19) with a standard deviation of 0.864. Based on the result, inspection of fire protection system was below average and document review revealed irregularities in inspection records, highlighting non-compliance with legal requirements. This reflects systemic failures in fire safety management, suggesting the need for more rigorous oversight and scheduled inspection and maintenance.

4.4.3 Annual Fire Safety Audits Conducted by DOSH Approved Persons

From the results in Table 4.7, 8.9% (n=24) of the employees strongly agreed that fire safety audits were done by approved persons while 32.2% strongly disagreed. The respondents who agreed and disagreed that fire safety audits were done by approved persons were 7.4% and 41.5% respectively. From the results, annual fire safety audits recorded a mean and a standard deviation of 63.0% (2.19) and 0.822 respectively which, is an indicator of good agreement of the results among the respondents.

From Table 4.8, 10.0% (n=27) of the employees identified at least four fire safety audits that were done by approved persons, 11.1% of them identified three, 5.2% identified two, 37.4% of them identified one, while 36.3% could not identify any fire safety audit done by approved persons at the airport.

According to these results, the performance level of regular fire safety audits by approved persons was 44.2% (mean=2.21) with a standard deviation of 0.881, indicating low compliance with the requirements for audits to be conducted by DOSH approved persons.

Document review revealed sporadic audit records and poor implementation of audit findings. This finding was consistent with Nugroho *et al.* (2022) who concluded that neglecting fire safety audit recommendations had significant effect on fire safety management.

4.4.4 Establishment of Aerodrome Emergency Plan and Periodic Testing of the Plan

From the results in Table 4.7, 12.6% (n=34) of the employees strongly agreed that aerodrome emergency plan is established at the airport while 31.5% strongly disagreed. The respondents who agreed and disagreed that aerodrome emergency plan is established at the airport were 12.9% and 34.4% respectively.

From the results, establishment of aerodrome emergency plan at the airport among employees recorded a mean and a standard deviation of 47.8% (2.39) and 0.889 respectively which, suggests a generally low awareness or involvement in the emergency planning process.

From the results in Table 4.7, 9.3% (n=25) of the employees strongly agreed that aerodrome emergency plan is periodically tested while 46.7% strongly disagreed. The respondents who agreed and disagreed that aerodrome emergency plan is periodically tested at the airport were 6.7% and 33.7% respectively. From the results, periodic testing of aerodrome emergency plan at the airport among employees recorded a mean and a standard deviation of 35.8% (1.79) and 0.956 respectively which, is an indicator that Airport Emergency Plan is not periodically tested.

ICAO Annex 14 volume 1 (2022) requires airport operators to regularly test the Aerodrome Emergency Plan through a structures schedule exercises. Specifically, a full-scale aerodrome emergency exercise must be conducted at least once every two (2) years, while partial emergency exercises are to be held during the intervening years.

Additionally, a series of modular tests must commence in the first year and continue at intervals not exceeding three (3) years. These exercises aim to identify and correct any deficiencies found during such exercises.

According to ICAO Annex 14, the purpose of these periodic tests is to evaluate the adequacy of the plan in handling different types of emergencies, the performance of each responding agency, and the effectiveness communication systems, with particular focus on components of the plan. According to Bujang *et al.* (2023), full-scale emergency exercises are the most effective means to evaluate multi-agency and multi-jurisdictional readiness, as they provide a comprehensive evaluation of inter-agency coordination and operational capabilities.

According to KCARS (2013), airport operators are responsible for establishing aerodrome emergency plan, including procedures for its periodic testing of the plan, planning and conducting aerodrome emergency exercises at prescribed intervals.

As shown in Table 4.8, 6.3% (n=17) of the employees reported to having seen at least four revised versions of the aerodrome emergency plan, 7.4% of them had seen three versions, 5.9% had seen two, while 42.9% indicated to have seen only one version. Notably, 37.4% of the respondents could not recall having seen any revised version of the aerodrome emergency plan at the airport. According to these results, the performance level of establishing an aerodrome emergency plan at airport was 40.4% (mean=2.02) with a standard deviation of 0.800. A physical inspection and document review revealed that only 37.5% of the airports had approved AEP by KCAA while 62.5% were still using outdated versions.

In terms of participation in aerodrome emergency drills (Table 4.8), 5.6% (n=15) of the employees had taken part in at least four aerodrome emergency drills, 2.6% of them had participated in three, 4.8% in two, and 46.7% of them had participated in one. However, 40.4% of the employees could not remember participating in any aerodrome emergency drill at the airport. According to these results, the performance level of participating in emergency drill at airport was 43.8% (mean=1.86) with a standard deviation of 0.746, which is below average. Documents review further revealed that only 37.5% of the airports-maintained records of periodic emergency drills, and these were not consistently conducted as required KCARS (2013).

Ukegbu *et al*. (2022) emphasized that regular fire drills significantly improve responders' readiness and effectiveness during fire emergencies. Similarly, Ibrahim et al. (2020) concluded that inadequate implementation of emergency exercises and inadequate first aid facilities negatively impacted fire safety management at Mallam Aminu Kano International airport. Additionally, the ILO (2021), concluded that lack of emergency procedures, insufficient training on the established procedures and lack of routine testing of these emergency procedures are some of the factors that affects implementation of fire safety within an occupancy.

4.4.5 Establishment of ARFFS Commensurate with Declared Airport Category

From the results in Table 4.7, 6.7% (n=18) of the employees strongly agreed that the established ARFFS is commensurate with the declared airport category while a significant 43.7% strongly disagreed. Additionally, 5.9% of the respondents agreed, and 36.3% disagreed with the statement. From the results, establishment of ARFFS commensurate with declared airport category recorded a mean and a standard deviation of 39.2% (1.96) and 0.829 respectively, suggesting a relatively consistent perception among respondents regarding the inadequacy of the established ARFS across the airports.

From Table 4.8, 4.8% (n=13) of the employees reported at least four airports that has ARFFS commensurate with the declared category, 1.9% of them mentioned three airports, 5.9% mentioned two, 47.4% of them identified one. Notably, 40.0% of the respondents indicated that none of the airports had established ARFFS that is commensurate with the declared category. These results translated to a performance level of 36.8% (mean=1.84) with a standard deviation of 0.715, further highlighting concerns about compliance with required ARFFS standards.

Physical inspection corroborated these findings, revealing that that none of the assessed airports had fully established ARFFS commensurate with the declared category. All the airports were operating below their declared category in terms of recue and firefighting capacity. This reflects a substantial gap in compliance with ICAO Annex 14 volume 1 (2022), which requires airport operators to provide rescue and firefighting equipment and services at the airport used for commercial air transport appropriate with the declared and published airport category. The Annex further stipulates that all international airports must be certificated and staffed with adequate number of qualified and skilled ARFFS personnel capable of performing rescue and firefighting operations.

Similarly, KCARS (2013), obligates airport operators to provide rescue and firefighting facilities commensurate with the declared and published airport category. Document review revealed that only three (3) airports i.e. IA1, IA2, and IA3 —37.5% of the assessed facilities, held valid aerodrome certificate issued by KCAA. However, none of the eight international airports assessed met the minimum personnel requirements needed to operate the equipment at maximum capacity and be deployed in a way to sustain continuous agent application. These results are indicators to non-compliance with ICAO SARPS and KCARS (2018) concerning provision of adequate fire cover and certification of airports.

These findings were in agreement with previous studies. Adedayo (2021) concluded that although Nigeria's Aerodrome Rescue and Firefighting Service (ARFFS) plays a critical role in rescue operations, it is grossly affected by inadequacy of skilled and qualified ARFFS personnel and firefighting facilities. Kodur *et al.* (2020) alluded that many developing countries struggle to provide adequate firefighting service due to inadequate resources (both human and capital) and poor state of existing firefighting facilities. Similarly, Shokouhi *et al.* (2019) concluded that insufficient firefighting equipment significantly affected implementation of fire safety management. According to Lawal *et al.* (2023), efficient and reliable rescue and firefighting service is best achieved through investing in human resource, firefighting infrastructure, regular testing and evaluation of airport emergency plans.

4.4.6 Provision of Emergency Access Roads where Terrain Conditions Permit

From the results in Table 4.7, 10.7% (n=29) of the employees strongly agreed that emergency access roads are adequately provided at airports where terrain conditions permit, while 26.3% strongly disagreed. An additional 12.6% agreed, and 45.6% disagreed with the statement. From the results, provision of emergency access roads at the airport among employees recorded a mean and a standard deviation of 47.2% (2.36) and 0.837, indicating a relatively of good agreement of the results among the respondents regarding the inadequacy of emergency access roads across most airports.

From Table 4.8, 6.7% (n=18) of the employees identified at least four airports where emergency access roads are established. Meanwhile, 10.0% of them identified three airports, 7.0% identified two, and 44.1% of them identified one airport. Notably, 32.2% of the respondents could not identify any airport with such infrastructure. According to these results, the performance level of providing emergency access roads at the airport was 43.0% (mean=2.15) with a standard deviation of 0.798. These figures reflect moderate awareness and limited establishment of emergency access roads at airports.

Physical inspection of the facilities revealed that although most airports had some form of emergency access roads, they were not all-weather. As a result, accessibility is severely affected during rainy seasons, when these roads are rendered impassable. This negatively affects response time of the responders.

ICAO Annex 14 volume 1 (2022) requires airport operators to provide all weather emergency access roads at an aerodrome where terrain conditions allow. These roads must capable of supporting the heaviest vehicles likely to use them during an emergency. Absence of such infrastructure not only constitute non- compliance with ICAO SARPS but also affects the operational readiness and effectiveness of rescue and firefighting service.

These findings were in agreement with previous studies. Wan *et al.* (2023), concluded that poor or inadequate emergency access roads significantly delay emergency response time, thus undermining the principle objective of saving lives of occupants and overall implementation of fire safety management. Similarly, Shokouhi *et al*. (2019) observed that poor emergency access roads led to poor response time and disruption of optimal firefighting service provision.

4.4.7 Training of ARFFS Personnel Including Pressure Fed-Fuel Fires

From the results in Table 4.7, 37.8% (n=102) of the respondents strongly agreed that ARFFS personnel were adequately trained to perform their duties, while only 3.7% strongly disagreed. An Additional 41.9% agreed, and 6.7% disagreed with this statement. Training of ARFFS personnel among employees recorded a mean of 80.6% (4.03), indicating that, in general, fire safety training among ARFFS personnel was perceived to be above average. Document review conducted during interview supported this perception, with certification records confirming that ARFFS personnel had received appropriate training aligned with their operational responsibilities.

However, when the focus shifted specifically to training on pressure fed-fuel fires, the results were less favorable. From Table 4.7, only 5.5% (n=15) of the respondents strongly agreed while 42.2% strongly disagreed that ARFFS personnel were adequately trained including training on pressure fed-fuel fires to perform their duties. The respondents who agreed and disagreed that ARFFS personnel were adequately trained including training on pressure fed-fuel fires to perform their duties were 7.8% and 31.9% respectively. ARFFS Pressure fed-fuel fires Training recorded a mean of 40.6% (2.03). This is below average, indicating a gap in specialized training. Document reviews revealed that only 1.9% of ARFFS personnel had received training on pressure fed-fuel fires, and this was conducted outside Kenya.

Further analysis from Table 4.8 revealed that 44.4% (n=120) of the respondents had participated in at least four ARFF trainings, 29.3% of them had attended three, 10.0% had attended two, 6.7% had attended one, while 9.6% reported not having attended any training formal ARFFS training. According to these results, the performance level of ARFFS training was 78.4% (mean=3.92) which was above average.

However, in contrast, training specifically involving pressure fed-fuel fires was limited. From Table 4.8, only 3.3% (n=9) of the respondents had four such specialized trainings, 5.6% of them had attended three, 4.4% had attended two, 38.9% of them indicated to have attended one.

A significant portion 47.8% had not attended any ARFFS training involving pressure fed-fuel fires. According to these results, the performance level of ARFFS training that included pressure fed-fuel fires was 35.6% (mean=1.78) which was below average and standard deviation of 0.748 an indicator of good agreement of the results among the respondents on the limited availability or access to this critical type of training.

These findings indicate serious shortfall in specialized training despite compliance with general ARFFS training requirements. According to ICAO Annex 14 volume 1 (2022) airport operators are obligated to ensure that ARFFS personnel participate in live fire drills, including those simulating pressure fed-fuel fires, commensurate with the types of aircraft and firefighting equipment in use at the airports. Similarly, KCARS (2013) requires that Aerodrome Rescue and firefighting service (ARFFS) personnel to undergo training in human performance and team coordination, as well as participate in specialized fire scenarios, such as pressure fed-fuel fires simulations, to reflect realistic operational challenges.

These findings were in agreement with previous studies. Mwikya *et al*. (2019) emphasized the importance of specialized training in improving air transport performance at Kenyan airports, noting that the speed and effectiveness of ARFFS response are heavily dependent on the level and type of training received (ICAO Doc. 9137 Part 1, 2015). Martin *et al.* (2024) further concluded that firefighting is a unique occupation requiring not only technical knowledge but also significant physical fitness because it is characterized by sudden high intensity workloads hence requiring endurance as a prerequisite for firefighting in extreme conditions similar to those experienced in pressure fed-fuel fires mock simulators. These findings collectively underscore the importance of investment in both general and specialized training programs to ensure ARFFS personnel are equipped to manage diverse and complex fire emergencies at airports.

4.5 Adequacy of Fire Protection Systems

The results of assessment and computed data on adequacy of fire protection within eight (8) International airports are presented in Tables 4.9 to 4.16 below.

Table 4.9: Fire Protection System at IA1

Fire Protection	No. Assessed	% Compliance
1. Portable fire ext. with safety pins	434	69.1%
2. Portable fire ext. with updated inspection sticker	434	43.8%
3. Portable fire ext. not obstructed	434	46.1%
4. Portable fire ext. with gauge on green portion	434	85.3%
5. Portable fire ext. mounted above 60cm on the wall	434	45.4%
6. Portable fire ext. protected against adverse wx	434	89.2%
7. Right selected portable ext. for fire load	434	88.2%
8. Portable fire ext. hydro testing	434	0%
9. Hose reel charged with water	164	46.3%
10. Hose reel not obstructed	164	40.9%
11. Hose reel with opening knob	164	48.2%
12. Fire hydrant with sufficient pressure	26	34.6%
13. Fire hydrant with hydrant cover	26	46.2%
14. Fire hydrants with water	26	30.8%
15. Fire hydrant not obstructed	26	38.5%
16. Emergency Exit not obstructed	35	37.1%
17. Width of Emergency Exit door ≥ 90cm	35	71.4%
18. Unobstructed Fire Assembly point	13	76.9%
19. Emergency door opening direction of egress	35	71.4%
20. Availability of serviceable automatic sprinkler	6	83.3%
21. Alternative means of escape provided	35	34.3%
Aggregate Mean of adequacy		**53.7%**

Table 4.10: Portable Fire Extinguishers. (N= 434)

Portable Fire Ext	Frequenc	% Compliance
1) With Safety pins	320	68.9
2) With updated insp. sticker	203	43.8
3) Not obstructed	214	46.1
4) With gauge on green portion	396	85.3
5) Mounted more than 60cm on the wall	211	45.5
6) Protected against adverse weather	414	89.2
7) Right for fire load	409	88.1
8) Hydro tested	0	0

Table 4.11: Hose Reels. (N= 164)

Hose reels	Frequency	% Compliance
1) With water	76	46.3
2) Unobstructed	67	40.9
3) With opening knob	79	48.2

Table 4.12: Fire Hydrants. (N= 26)

Fire hydrants	Frequency	% Compliance
With sufficient pressure	9	34.6
With hydrant cover	12	46.2
Unobstructed	10	38.5
With water	8	30.8

Table 4.13: Emergency Exits. (N= 35)

Emergency Exits	Frequenc	% Compliance
1) Unobstructed	13	37.1
2) With width ≥ 90 cm	25	71.4
3) Opening in the direction of egress	25	71.4
4) Alternative means of escape provided	12	34.3

Table 4.14: Fire Protection System at IA2

Fire Protection	No. Assessed	% Compliance
1. Portable fire ext. with safety pins	118	67.8%
2. Portable fire ext. with up to date inspection sticker	118	40.7%
3. Portable fire ext. not obstructed	118	47.5%
4. Portable fire ext. with gauge on green portion	118	93.2%
5. Portable fire ext. mounted above 60 cm on the wall	118	39.8%
6. Portable fire ext. protected against adverse wx	118	87.3%
7. Right selected portable ext. for fire load	118	77.9%
8. Portable fire ext. hydro testing	118	0%
9. Hose reel charged with water	28	39.3%
10. Hose reel not obstructed	28	32.1%
11. Hose reel with opening knob	28	35.7%
12. Fire hydrant with sufficient pressure	5	40.0%
13. Fire hydrant with hydrant cover	5	60.0%
14. Fire hydrants with water	5	60.0%
15. Fire hydrant not obstructed	5	40.0%
16. Emergency Exit not obstructed	8	37.5%
17. Width of Emergency Exit door ≥ 90cm	8	75.0%
18. Unobstructed Fire Assembly point	6	66.7%
19. Emergency door opening direction of egress	8	75.0%
20. Availability of serviceable automatic sprinkler	2	0%
21. Alternative means of escape provided	8	0%
Aggregate Mean of adequacy		**48.8%**

Table 4.15: Portable Fire Extinguishers. (N=118)

Portable Fire Exit	Frequency	% Compliance
1) With Safety pins	80	67.8
2) With updated insp. sticker	48	40.7
3) Not obstructed	56	47.5
4) With gauge on green portion	110	93.2
5) Mounted more than 60cm on the wall	47	39.8
6) Protected against adverse weather	103	87.3
7) Right for fire load	91	77.1
8) Hydro tested	0	0

Table 4.16: Hose Reels. (N=28)

Hose reels	Frequency	% Compliance
1) With water	11	39.3
2) Unobstructed	9	32.1
3) With opening knob	10	35.7

Table 4.17: Fire Hydrants. (N=5)

Fire hydrants	Frequency	% Compliance
1) With sufficient pressure	2	40.0
2) With hydrant cover	3	60.0
3) Unobstructed	2	40.0
4) With water	3	60.0

Table 4.18: Emergency Exits. (N=8)

Emergency Exits	Frequency	% Compliance
1) Unobstructed	3	37.5
2) With width ≥ 90 cm	6	75.0
3) Opening in the direction of egress	6	75.0
4) Alternative means of escape provided	1	12.5

Table 4.19: Fire Protection System at IA3

Fire Protection	No. Assessed	% Compliance
1. Portable fire ext. with safety pins	100	70.0%
2. Portable fire ext. with up to date inspection sticker	100	30.0%
3. Portable fire ext. not obstructed	100	60.0%
4. Portable fire ext. with gauge on green portion	100	80.0%
5. Portable fire ext. mounted above 60cm on the wall	100	60.0%
6. Portable fire ext. protected against adverse wx	100	70.0%
7. Right selected portable ext. for fire load	100	80.0%
8. Portable fire ext. hydro testing	100	0%
9. Hose reel charged with water	4	25.0%
10. Hose reel not obstructed	4	75.0%
11. Hose reel with opening knob	4	50.0%
12. Fire hydrant with sufficient pressure	13	38.5%
13. Fire hydrant with hydrant cover	13	53.8%
14. Fire hydrants with water	13	38.5%
15. Fire hydrant not obstructed	13	30.8%
16. Emergency Exit not obstructed	7	42.9%
17. Width of Emergency Exit door ≥ 90cm	7	57.1%
18. Unobstructed Fire Assembly point	10	70.0%
19. Emergency door opening direction of egress	7	71.4%
20. Availability of serviceable automatic sprinkler	1	0%
21. Alternative means of escape provided	7	28.6%
Aggregate Mean of adequacy		**49.1%**

Table 4.20: Portable Fire Extinguishers. (N=100)

Portable Fire Ext	Frequency	% Compliance
1) With Safety pins	70	70.0
2) With updated insp. sticker	30	30.0
3) Not obstructed	60	60.0
4) With gauge on green portion	75	75.0
5) Mounted more than 60cm on the wall	62	62.0
6) Protected against adverse weather	66	66.0
7) Right for fire load	71	77.0
8) Hydro tested	0	0

Table 4.21: Hose Reels. (N=4)

Hose reels	Frequency	% Compliance
1) With water	1	25.0
2) Unobstructed	3	75.0
3) With opening knob	2	50.0

Table 4.22: Fire Hydrants. (N=13)

Fire hydrants	Frequency	% Compliance
1) With sufficient pressure	5	38.5
2) With hydrant cover	7	53.8
3) Unobstructed	4	30.8
4) With water	6	46.2

Table 4.23: Emergency Exits. (N=7)

Emergency Exits	Frequency	% Compliance
1. Unobstructed	3	42.9
2. With width ≥ 90 cm	4	57.1
3. Opening in the direction of egress	5	71.4
4. Alternative means of escape provided	2	28.6

Table 4.24: Fire Protection System at IA4

Fire Protection	No. Assessed	% Compliance
1. Portable fire ext. with safety pins	60	63.3%
2. Portable fire ext. with up to date inspection sticker	60	38.3%
3. Portable fire ext. not obstructed	60	43.3%
4. Portable fire ext. with gauge on green portion	60	81.7%
5. Portable fire ext. mounted above 60cm on the wall	60	46.7%
6. Portable fire ext. protected against adverse wx	60	90.0%
7. Right selected portable ext. for fire load	60	88.3%
8. Portable fire ext. hydro testing	60	0%
9. Hose reel charged with water	6	33.3%
10. Hose reel not obstructed	6	66.7%
11. Hose reel with opening knob	6	50.0%
12. Fire hydrant with sufficient pressure	0	0%
13. Fire hydrant with hydrant cover	0	0%
14. Fire hydrants with water	0	0%
15. Fire hydrant not obstructed	0	0%
16. Emergency Exit not obstructed	10	30.0%
17. Width of Emergency Exit door ≥ 90cm	10	70.0%
18. Unobstructed Fire Assembly point	5	60.0%
19. Emergency door opening direction of egress	10	70.0%
20. Availability of serviceable automatic sprinkler	1	0%
21. Alternative means of escape provided	10	30.0%
Aggregate Mean of adequacy		**41.0%**

Table 4.25: Portable Fire Extinguishers. (N= 60)

Portable Fire Ext	Frequency	% Compliance
1) With Safety pins	38	63.3
2) With updated insp. sticker	23	38.3
3) Not obstructed	26	43.3
4) With gauge on green portion	49	81.7
5) Mounted more than 60cm on the wall	28	46.7
6) Protected against adverse weather	54	90.0
7) Right for fire load	52	86.7
8) Hydro tested	0	0

Table 4.26: Hose Reels. (N= 6)

Hose reels	Frequency	% Compliance
1) With water	2	33.3
2) Unobstructed	4	66.7
3) With opening knob	3	50.0

Table 4.27: Emergency Exits. (N= 10)

Emergency Exits	Frequency	% Compliance
1) Unobstructed	3	30.0
2) With width ≥ 90 cm	7	70.0
3) Opening in the direction of egress	7	70.0
4) Alternative means of escape provided	2	20.0

Table 4.28: Fire Protection System at IA5

Fire Protection	No. Assessed	% Compliance
1. Portable fire ext. with safety pins	39	71.8%
2. Portable fire ext. with up to date inspection sticker	39	38.5%
3. Portable fire ext. not obstructed	39	35.9%
4. Portable fire ext. with gauge on green portion	39	82.1%
5. Portable fire ext. mounted above 60cm on the wall	39	41.0%
6. Portable fire ext. protected against adverse wx	39	79.5%
7. Right selected portable ext. for fire load	39	84.6%
8. Portable fire ext. hydro testing	39	0%
9. Hose reel charged with water	4	25.0%
10. Hose reel not obstructed	4	50.0%
11. Hose reel with opening knob	4	50.0%
12. Fire hydrant with sufficient pressure	7	0%
13. Fire hydrant with hydrant cover	7	0%
14. Fire hydrants with water	7	0%
15. Fire hydrant not obstructed	7	42.9%
16. Emergency Exit not obstructed	5	40.0%
17. Width of Emergency Exit door ≥ 90cm	5	80.0%
18. Unobstructed Fire Assembly point	7	71.4%
19. Emergency door opening direction of egress	5	60.0%
20. Availability of serviceable automatic sprinkler	1	0%
21. Alternative means of escape provided	5	40.0%
Aggregate Mean of adequacy		**42.5%**

Table 4.29: Portable Fire Extinguishers. (N=39)

Portable Fire Ext	Frequency	% Compliance
1) With Safety pins	28	71.8
2) With updated insp. sticker	15	38.5
3) Not obstructed	14	35.9
4) With gauge on green portion	32	82.1
5) Mounted more than 60cm on the wall	16	41.0
6) Protected against adverse weather	31	79.5
7) Right for fire load	33	84.6
8) Hydro tested	0	0

Table 4.30: Hose Reels. (N=4)

Hose reels	Frequency	% Compliance
1) With water	1	25.0
2) Unobstructed	2	50.0
3) With opening knob	2	50.0

Table 4.31: Fire Hydrants. (N=7)

Fire hydrants	Frequency	% Compliance
1) With sufficient pressure	0	0
2) With hydrant cover	3	42.9
3) Unobstructed	4	51.7
4) With water	0	0

Table 4.32: Emergency Exits. (N=10)

Emergency Exits	Frequency	% Compliance
1) Unobstructed	3	30.0
2) With width ≥ 90 cm	7	70.0
3) Opening in the direction of egress	7	70.0
4) Alternative means of escape provided	2	20.0

Table 4.33: Fire Protection System at IA7

Fire Protection	No. Assessed	% Compliance
1. Portable fire ext. with safety pins	30	73.3%
2. Portable fire ext. with up to date inspection sticker	30	33.3%
3. Portable fire ext. not obstructed	30	36.7%
4. Portable fire ext. with gauge on green portion	30	86.6%
5. Portable fire ext. mounted above 60cm on the wall	30	40.0%
6. Portable fire ext. protected against adverse wx	30	76.7%
7. Right selected portable ext. for fire load	30	83.3%
8. Portable fire ext. hydro testing	30	0%
9. Hose reel charged with water	0	0%
10. Hose reel not obstructed	0	0%
11. Hose reel with opening knob	0	0%
12. Fire hydrant with sufficient pressure	0	0%
13. Fire hydrant with hydrant cover	0	0%
14. Fire hydrants with water	0	0%
15. Fire hydrant not obstructed	0	0%
16. Emergency Exit not obstructed	7	71.4%
17. Width of Emergency Exit door ≥ 90cm	7	57.1%
18. Unobstructed Fire Assembly point	3	66.7%
19. Emergency door opening direction of egress	7	71.4%
20. Availability of serviceable automatic sprinkler	0	0%
21. Alternative means of escape provided	7	28.6%
Aggregate Mean of adequacy		**34.5%**

Table 4.34: Portable Fire Extinguishers. (N=30)

Portable Fire Ext	Frequency	% Compliance
1) With Safety pins	22	73.3
2) With updated insp. sticker	10	33.3
3) Not obstructed	11	36.7
4) With gauge on green portion	26	86.7
5) Mounted more than 60cm on the wall	12	40.0
6) Protected against adverse weather	33	76.7
7) Right for fire load	25	83.3
8) Hydro tested	0	0

Table 4.35: Emergency Exits. (N=7)

Emergency Exits	Frequency	% Compliance
1) Unobstructed	5	71.4
2) With width ≥ 90 cm	4	51.7
3) Opening in the direction of egress	5	71.4
4) Alternative means of escape provided	2	28.6

Table 4.36: Fire Protection System at IA8

Fire Protection	No. Assessed	% Compliance
1. Portable fire ext. with safety pins	22	59.1%
2. Portable fire ext. with up to date inspection sticker	22	40.9%
3. Portable fire ext. not obstructed	22	31.8%
4. Portable fire ext. with gauge on green portion	22	72.7%
5. Portable fire ext. mounted above 60cm on the wall	22	36.4%
6. Portable fire ext. protected against adverse wx	22	77.3%
7. Right selected portable ext. for fire load	22	81.8%
8. Portable fire ext. hydro testing	22	0%
9. Hose reel charged with water	0	0%
10. Hose reel not obstructed	0	0%
11. Hose reel with opening knob	0	0%
12. Fire hydrant with sufficient pressure	1	0%
13. Fire hydrant with hydrant cover	1	100%
14. Fire hydrants with water	1	0%
15. Fire hydrant not obstructed	1	100%
16. Emergency Exit not obstructed	5	40.0%
17. Width of Emergency Exit door ≥ 90cm	5	60.0%
18. Unobstructed Fire Assembly point	3	66.7%
19. Emergency door opening direction of egress	5	60.0%
20. Availability of serviceable automatic sprinkler	0	0%
21. Alternative means of escape provided	5	20.0%
Aggregate Mean of adequacy		**40.3%**

Table 4.37: Portable Fire Extinguishers. (N=22)

Portable Fire Ext	Frequency	% Compliance
1) With Safety pins	13	59.1
2) With updated insp. sticker	9	40.9
3) Not obstructed	7	31.8
4) With gauge on green portion	16	72.7
5) Mounted more than 60cm on the wall	8	36.4
6) Protected against adverse weather	17	77.3
7) Right for fire load	19	86.4
8) Hydro tested	0	0

Table 4.38: Fire Hydrants. (N=1)

Fire hydrants	Frequency	% Compliance
1) With sufficient pressure	0	0
2) With hydrant cover	1	100
3) Unobstructed	1	100
4) With water	0	0

Table 4.39: Emergency Exits. (N=5)

Emergency Exits	Frequency	% Compliance
1) Unobstructed	2	40.0
2) With width ≥ 90 cm	3	60.0
3) Opening in the direction of egress	3	60.0
4) Alternative means of escape provided	1	20.0

Table 4.40: Fire Protection System at IA6

Fire Protection	No. Assessed	% Compliance
1. Portable fire ext. with safety pins	33	60.6%
2. Portable fire ext. with up to date inspection sticker	33	33.3%
3. Portable fire ext. not obstructed	33	36.4%
4. Portable fire ext. with gauge on green portion	33	75.8%
5. Portable fire ext. mounted above 60cm on the wall	33	39.4%
6. Portable fire ext. protected against adverse wx	33	78.8%
7. Right selected portable ext. for fire load	33	84.8%
8. Portable fire ext. hydro testing	33	0%
9. Hose reel charged with water	4	0%
10. Hose reel not obstructed	4	50.0%
11. Hose reel with opening knob	4	50.0%
12. Fire hydrant with sufficient pressure	0	0%
13. Fire hydrant with hydrant cover	0	0%
14. Fire hydrants with water	0	0%
15. Fire hydrant not obstructed	0	0%
16. Emergency Exit not obstructed	14	28.6%
17. Width of Emergency Exit door ≥ 90cm	14	64.3%
18. Unobstructed Fire Assembly point	7	85.7%
19. Emergency door opening direction of egress	14	71.4%
20. Availability of serviceable automatic sprinkler	0	0%
21. Alternative means of escape provided	14	14.3%
Aggregate Mean of adequacy		**36.8%**

Table 4.41: Portable Fire Extinguishers. (N=33)

Portable Fire Ext	Frequency	% Compliance
1) With Safety pins	20	60.6
2) With updated insp. sticker	11	33.3
3) Not obstructed	12	36.4
4) With gauge on green portion	25	75.8
5) Mounted more than 60cm on the wall	13	39.4
6) Protected against adverse weather	26	78.8
7) Right for fire load	28	84.8
8) Hydro tested	0	0

Table 4.42: Hose Reels. (N=4)

Hose reels	Frequency	% Compliance
1) With water	0	0
2) Unobstructed	2	50.0
3) With opening knob	2	50.0

Table 4.43: Emergency Exits. (N=14)

Emergency Exits	Frequency	% Compliance
1) Unobstructed	4	28.6
2) With width $\geq$ 90 cm	9	64.3
3) Opening in the direction of egress	10	71.4
4) Alternative means of escape provided	2	14.3

4.5.1 Portable Fire Extinguishers

From Tables 4.10, 4.15, 4.20, 4.25, 4.29, 4.34, 4.37 and 4.41, a total of 836 portable fire extinguishers were assessed. Of these, 66.9% had safety pins intact, 81.6% had gauges on the green zone, 80.6% were protected against adverse weather, 83.5% were selected based on anticipated fire load (i.e. class of fire expected in the occupancy. However, none of the portable fire extinguisher had been subjected to hydrostatic testing.

Additionally, 56.1% of them were mounted above 60cm from the floor) though the requirement does not specify maximum mounting height. Furthermore, 57.8% were obstructed and 62.6% had not been inspected (i.e. they were overdue for inspection). According to GOK-FRRR (2007), portable fire extinguishers should be mounted at an easily accessible height of not less than 60cm from the floor, inspected and tested by a competent person at least once in annually, and subjected to hydraulic pressure testing at least once every five years. Based on this, firefighting appliance were not compliant with the law.

Plate 4.2: Portable Fire Extinguisher Mounted 120cm from the Floor (IA3)

These findings align with previous studies. Omunagbe and Kaseem (2023) concluded that inspection and maintenance of fire protection systems significantly influence the performance of fire safety management. They emphasized that enhancing the performance of these systems, along with providing adequate training for occupants, could minimize fire occurrences within the terminal buildings. Similarly, Kebut (2021) concluded that portable extinguishers serve as the first line of defense against small fires in an occupancy hence mounting them in inaccessible heights affected implementation of fire risk reduction rules.

Lehna *et al.* (2024) reported that scheduled maintenance and testing of fire protection system plays an important role in ensuring building's fire safety, highlighting the need for consistent implementation to assure their availability and reliability.

4.5.2 Emergency Exits

From Tables 4.13, 4.18, 4.23, 4.27, 4.32, 4.35, 4.39 and 4.43, assessed total of 96 emergency exits were assessed. Of these, 62.3% were obstructed (under lock and chain), 35.1% had a width less than 90cm, 30.0% of them opened inwards, and 77.7%

of them lacked an alternative means of escape. According to GOK-FRRR (2007), emergency exits should be of at least 90cm wide, unobstructed and located in a manner to lead occupants to safer haven. Based on these requirements, the results are an indicator that means of escape is not compliant with the legislation. These findings were in agreement with previous studies. Jasztal *et al.* (2022) concluded that emergency exits are best used during evacuation when they are unobstructed hence help in achievement of fire safety if integrated into a comprehensive fire safety management program. Similarly, Omunagbe and Kaseem (2023), the challenges to timely evacuation are associated with locking of emergency exits as a security measure, resulting in occupants being trapped in a dead end within the building.

Plate 4.3: Locked and Chained Emergency Exit (IA1)

4.5.3 Fire Hydrants, Hose Reels and Sprinkler System

From Tables 4.11, 4.12, 4.16, 4.17, 4.21, 4.22, 4.26, 4.30, 4.31, 4.32 and 4.38, the assessment revealed that 78.9% of hose reels were dry and 60.7% were obstructed Likewise, 82.9% of the fire hydrants assessed were dry, and 67.4% were. obstructed, while 85.9% of them had low water pressure. Additionally, three airports (IA4, IA6 and IA7) which accounts for 37.5% of the assessed airports, did not have fire hydrants installed. Although Legislation (GOK-FRRR, 2007) does not specify of the exact pressure required, it simply states that fire protection systems must maintain a pressure capable to raise water to the highest point of the workplace in the event of fire outbreak.

The same legislation - requires occupier to provide a water storage facility of at least 10,000L capacity, which must be kept full at all times for emergency use. These results are indicators to non-compliance with this legislation regarding provision of sufficient emergency water supply at the airport for expeditious replenishment.

According to ICAO Annex 14 volume 1 (2022), airport operators must provide supplementary water supplies at the airport for expeditious replenishment of foam tenders to ensure continuous application of the media and maintenance of survival conditions.

With regards to sprinkler system, only 37.5% of the airports (IA1, IA2 and IA4)) of the assessed eight airports had sprinkler system installed. Of these, only IA1 had serviceable sprinkler system hence accounting for 33.3% sprinkler system serviceability. According to National Building Code (2022), building exceeding 30m in height should have sprinkler system installed in them.

These findings were in agreement with previous studies. Lee *et al.* (2020) emphasized that a supplementary water supply for firefighting is essential for effective response and that its insufficiency posed additional threat to life. Kaseem *et al.* (2021) concluded that violation of fire safety regulations affected fire safety management in a building. Similarly, Pavithra and Perumal (2022) concluded that a well-maintained sprinkler systems offer rapid response capabilities, to reducing the risk of extensive fire damage and providing valuable evacuation time in a building.

Plate 4.4: Dry Hose Reel (IA1)

4.6 Pearson's Product Correlation Analysis

The computed Pearson's correlation coefficients for each of the research variables are shown in Table 4.45. It is a measure of linear correlation between two sets of data. In other words, it is the relationship covariance of two variables and the product of their standard deviations thus a normalized measurement of the covariance such that the results always have a value between -1 and +1. Covariance is a measure of the joint variability of two random variables. A value of zero (0) implies no relationship and a value of +1implies perfect relationship between two variables in a positive linear sense likewise -1 indicates perfect relationship between two variables but in a negative linear sense (Kothari & Garg, 2019).

Table 4.44: Pearson's Correlation Coefficients

	1	**2**	**3**	**4**
1. Employee FS awareness		1.00		
2. Management FS awareness	0.17	1.00		
3. Compliance with FS standards	0.01	0.53	1.00	
4. Implementation of FS	0.65	0.66	0.68	1.00

p < 0.05 for one-tailed tests

From Table 4.44, the three independent variables were positively correlated and hence had linear relationship with performance of fire safety management. Mean scores for the individual items in each of the independent variables were used to compute the correlation coefficients**.** The correlation coefficients (r) were 0.65 for employees' fire safety awareness, 0.66 for Management fire safety awareness and 0.68 for compliance with relevant sections of BOWEC, FRRR and ICAO SARPS. The correlation coefficients were fairly high an indicator that there existed significant statistical relationship between each of the independent variables and dependent variable (performance of fire safety management) meaning that each of the independent variables had direct effect on performance of fire safety management. The fairly high coefficients of correlation suggested a problem of multi-collinearity between the independent variables (Kothari & Garg, 2019). Multi-collinearity is unacceptable high level of inter-correlation between independent variables. This occurs when independent variables in a regression model are correlated causing a problem when fitting the model and interpreting the results; because independent variables should be independent. To test for multi-collinearity between the independent variables, variance inflation factors (VIF) were analyzed using the formula:

$$VIF = 1 / (1 - r^2).$$

The computed variance inflation factors were 1.73 for employees' fire safety awareness, 1.77 for Management fire safety awareness and1.86 for compliance with relevant sections of BOWEC, FRRR and ICAO SARPS. According to the results, these were far below the threshold of 10, (Field, 2024), hence there was no problem of multi collinearity.

4.7 Linear Regression Analysis

Simple linear regression is a statistical method that was used to determine relationships between the independent variables and dependent variable (Performance of fire safety management). In this model, the predictor, explanatory, or independent variable is denoted as x, while the response, outcome, or dependent variable is denoted as y (Moore *et al*., 2022).

It assumes that the dependent variable (Y) is linearly related to the independent variable (X) and hence attempts to predict the values of a continuous scaled dependent variable for the specified values of independent variables (Mugenda & Mugenda, 2003). The simple regression equation of Y on X was: $Y = \beta_0 + \beta_1 X_1 + e$ where Y denoted the estimated value of fire safety management performance for a given value of X (independent variable). This direct model tested each independent variable against the dependent variable.

Regression coefficients were computed for each of the independent variables using the regression equation:

$$\beta_1 = \Sigma [(x_i - x) (y_i - y)] / \Sigma [(x_i - x)^2].$$

Where:

β_1 = the slope of regression line i.e. changes in Y due to one unit change in X_1
x_i = the mean score for individual items in each of the independent variables
y_i = the mean score of fire safety management performance for individual practice in the measured variables
x = mean of each x_i value
y = mean of each y_i value

$\sum$ = Sum of

β_0 denoted the value of performance of fire safety management (Y) when the independent variable (X) was at zero. This is calculated using:

$$Y = \beta_0 + \beta_1 X + e$$

Y = the dependent variable (Performance of fire safety management)
X = the independent variable

e= unexplained constant/ the error

The results of linear regression analysis are shown in Table 4.45

Table 4.45: Linear Regression Outcome

Variable	Model 1		Model 2		Model 3	
	Unstd'zed	**Std'zed**	**Unstd'zed**	**Std'zed**	**Unstd'zed**	**Std'zed**
Constant	**1.34**		**2.60**		**2.70**	
FS AE	**0.6900**	0.7814				
FS AM			**0.3000**	0.3386		
Compliance					**0.6700**	0.8385
R	0.6500	0.7256	0.6600	0.6476	0.6800	0.6939
R^2	0.4225	0.5265	0.4356	0.4194	0.4624	0.4815

The relationship between the independent variables and the dependent variable (performance of fire safety management) was tested using linear regression. The results confirmed an existence of a direct and positive relationship between each of the independent variables and the dependent variable (Performance of fire safety management). The prediction factor for the independent variables were: fire safety awareness among the employees was 0.69, $p < 0.05$, fire safety awareness among the management was 0.30, $p < 0.05$, and compliance with relevant sections of BOWEC, FRRR and ICAO SARPS was 0.67, $p < 0.05$; an indication of a fairly strong relationships and therefore, all the independent variables were good predictors of performance of fire safety management. The results revealed that fire safety awareness among employees was directly related to performance of fire safety management.

Correlation analysis indicated that fire safety awareness among employees correlated well with performance of fire safety management ($r = 0.65$). Further, the results indicated a regression coefficient, β_1 equal to 0.69. This meant that a unit change in fire safety awareness among employees resulted in a change of 0.69 units of performance of fire safety management. Standardized coefficients showed that an increase in one standard deviation of fire safety awareness among employees resulted in a 0.7814 standard deviation increase in performance of fire safety management.

Correlation analysis indicated that fire safety awareness among management correlated well with performance of fire safety management ($r = 0.66$). Additionally, the results indicated a regression coefficient, β_2 equal to 0.30. This meant that a unit change in fire safety awareness among management resulted in a change of 0.30 units of performance of fire safety management. Standardized coefficients showed that an increase in one standard deviation of fire safety awareness among management resulted in a 0.3386 standard deviation increase in performance of fire safety management. Compliance with relevant sections of BOWEC, FRRR and ICAO SARPS was the most prominent of the variables. It correlated well with performance of fire safety management in a positive sense (r = 0.68). The results indicated a regression coefficient β_3 for Compliance with relevant sections of BOWEC, FRRR and ICAO SARPS as 0.67 and a standardized coefficient of 0.8385. Therefore, a unit change in Compliance with relevant sections of BOWEC, FRRR and ICAO SARPS predicted a change of 0.67 units of performance of fire safety management. A change in one standard deviation of Compliance with relevant sections of BOWEC, FRRR and ICAO SARPS resulted in 0.8385 standard deviation increase in performance of fire safety management. Therefore, Compliance with relevant sections of BOWEC, FRRR and ICAO SARPS was an important predictor of performance of fire safety management. The coefficients of determination (R^2) which, is the amount of variation explained by the independent variables were 0.4225, 0.4356 and 0.4624 for employees' fire safety awareness, management fire safety awareness and compliance with relevant sections of BOWEC, FRRR and ICAO SARPS respectively. As a result, fire safety awareness among employees and Management explained 42.3% and 43.6% respectively and compliance with relevant sections of BOWEC, FRRR and ICAO SARPS explained 46.2%, of variance in performance of fire safety management.

4.8 Hypothesis Testing

The null hypothesis (H_o) which was fire safety management performance at international airports in Kenya is not affected by fire safety awareness among the management team and employees, compliance with fire safety standards, and adequacy of fire protection systems was tested using t-test in order to either accept or fail to accept it (null hypothesis). It is a predictive statement that can be scientifically tested as it relates independence to dependent variables (Kothari & Garg, 2019).

T-statistic was computed for each of the variables by using the formula:

$$t = (\mu - M)/[s / (\sqrt{n})]$$

Where:

t = computed statistic for each variable

M = sample mean for each variable,

μ = assumed population mean = 2.5,

N = the sample size, and

s = standard deviation (SD) for each independent variable

The computed *t*-statistics and their corresponding table critical values are shown in Table 4.46.

Table 4.46: Computed t-Statistics at α = 0.05

Variable	*N*	*M*	*S*	*μ*	Computed *t*-statistic	Critical Values
FS awareness -Employees	270	2.41	0.883	2.5	1.667	1.645
FS awareness - Management	120	2.34	0.866	2.5	2.025	1.645
Compliance with Fire Standards	270	2.33	0.799	2.5	3.498	1.645

From the Table 4.46, the calculated t-statistics for Fire Safety Awareness among employees, management team and Compliance with relevant sections of BOWEC, FRRR and ICAO SARPS (compliance with fire standards) were 1.667, 2.025 and 3.498 compared to t-table critical values of 1.645 respectively. These results showed that the computed *t*-statistic for each of the null hypotheses (H_0: $\mu - 2.5 = 0$) was more than right-tailed critical value of the *t*-distribution. The null hypotheses were, therefore, rejected in favour of the respective alternative hypotheses (HA: $\mu - 2.5 \neq 0$). This is an indicator that performance of fire safety management was affected by Fire Safety awareness among employees and management and Compliance with relevant section of BOWEC, FRRR and ICAO SARPS at International Airports in Kenya.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study concluded that all the independent variables in the study, that is, fire safety awareness among employees and management, compliance with relevant sections of BOWEC, FRRR and ICAO SARPS, and adequacy of fire protection system significantly influenced the performance of fire safety management (dependent variable) at international airports in Kenya. This relationship was confirmed through correlation and regression analysis, which revealed a positive and statistically significant linear relationship between the independent variables and dependent variable. Regression analysis results showed that an increase of one unit in Fire Safety awareness among Employees, Fire Safety awareness among Management and Compliance with relevant sections of BOWEC, FRRR and ICAO SARPS predicted an increase of 0.69 units; 0.30 units and 0.67 units in performance of Fire Safety Management respectively.

5.1.1 Fire Safety Awareness among Management Team and Employees

The findings showed significant disparities between management and employees. Majority of management personnel had not received basic fire safety training, including instructions on the types and use of fire extinguishers. No documented records of re-current training existed for management and their knowledge of fire hazards and evacuation procedures was below average. Conversely, employees had moderate exposure to fire safety training and recurrent training that included instructions on types and use of fire extinguishers. Statistical analysis confirmed that awareness significantly influenced fire safety management performance.

The regression analysis showed that a unit change in fire safety awareness among employees and Management predicted a change of 0.69 and 0.30 units in performance of fire safety management respectively. The null hypothesis that fire safety awareness among employees and management does not affect performance of fire safety management was rejected in favor of the alternative hypothesis, as the computed t-statistics were 1.667 and 2.025 compared to table critical value of 1.645 and 1.645 respectively exceeded the critical value of 1.645 (Table 4.46). These results demonstrated that fire safety awareness is a critical determinant to effective fire safety management in Kenyan international airports

5.1.2 Compliance with Relevant Sections of BOWEC, FRRR and ICAO SARPS

Findings revealed low levels of compliance with fire safety regulation and international standards. Critical fire protection systems were either missing or non-functional in most airports, fire hydrants were dry, sprinkler and alarm systems were not installed at most of the airports, the Airport Emergency Plan was not regularly tested. Furthermore, ARFFS was inadequate and not commensurate with published airport category and ARFFS personnel had not participated in live fire drills particularly those involving pressure fed-fuel fires. These deficiencies reflect systemic non-compliance with mandatory fire safety regulations and standards. Statistical analysis further demonstrated that compliance had a significant influence on the performance of fire safety management. Results of the regression analysis results showed that a unit change in compliance with relevant sections of BOWEC, FRRR and ICAO SARPS predicted a change of 0.67 units in performance of fire safety management. The null hypothesis “performance of fire safety management is not affected by compliance with relevant sections of BOWEC, FRRR and ICAO SARPS” failed in the t-test. The computed t-statistics was 3.498 exceeded to the table critical value of 1.645 (Table 4.46). These findings confirm that effective fire safety management in Kenyan international airports is heavily dependent on consistent compliance with BOWEC, FRRR, and ICAO SARPs.

5.1.3 Adequacy of fire protection systems

The study revealed that most fire protection systems and means of escape at Kenyan international airports were inadequate and poorly maintained. Among the assessed portable fire extinguishers, 33.1% lacked safety pins, 62.6% were uninspected or were overdue for inspection, 57.8% were obstructed, 18.4% had their gauge on red zone, 56.1% were mounted more than 60cm on the walls, 19.6% were exposed to adverse weather and none had undergone hydrostatic testing.

Of the hose reels assessed, 78.9% and 64.5%were dry and lacked opening knobs respectively, while 60.7% of them were obstructed. Fire hydrants were also deficient, with 85.9% of them having inadequate pressure, 62.1% lacked hydrant covers, 82.9% were dry while 67.4% were obstructed. Escape routes were equally compromised. Approximately 62.3% of the emergency exits were obstructed, 30.0% opened inwards, 64.9% of them had width greater or equal to 90m and of the assessed workplace, 77.7% lacked alternative means of escape. About 76.5% and 53.3% of the assessed workplace lacked sprinkler systems and fire alarms respectively.

The study further identified regulatory limitations, as the Fire Risk Reduction Rules (2007) which is a subsidiary legislature of the Kenya OSH Act, 2007 and ICAO SARPS do not define measurable standards for some critical firefighting equipment – such as minimum hydrant pressure or cylinder testing pressure requirements. These gaps in legislation and international standards further exacerbate inadequacies in system design, maintenance, and enforcement. Collectively, the findings demonstrate that fire protection systems in Kenyan international airports are technically deficient and further undermined by insufficient regulatory framework, thereby limiting their reliability during fire emergencies.

5.2 Recommendations

i. Implement mandatory and comprehensive fire safety induction for all management and employees, including practical sessions on use and operations of fire protection systems, fire hazard identification and evacuation procedures
ii. Establish regular refresher training programs for all management and employees and maintain documented records to ensure continuous competency and awareness.
iii. The agency and Ministry responsible for aviation safety oversight and occupational safety and health; for this case KCAA and DOSHS respectively should enforce regular, risk- based inspection at the airports to ensure compliance with the Civil Aviation Regulations, ICAO SARPS and Fire Risk

Reduction Rules (FRRR);

iv. Conduct routine inspection, maintenance and functional testing of all fire protection systems, emergency exits and alternative escape routes to ensure readiness during emergencies and compliance with standards.

v. Invest in firefighting infrastructure and equipment commensurate with published airport category and ensure that ARFFS personnel participate in live fire drills including pressure fed-fuel fires.

vi. Provide and ensure constant supply of sufficient and reliable emergency water within fire protection systems for use

vii. periodic testing of Airport Emergency Plan (AEP) should be done in accordance with regulatory requirements

viii. All weather emergency access roads should be constructed and maintained around airports, where terrain conditions permit, to ensure unobstructed access for rescue and firefighting operations.

ix. All occupied floors at the airport should be fitted with adequate fire protection systems, including sprinklers, hydrants, fire alarms, and portable fire extinguishers.

x. The Fire Risk Reduction Rules (2007) and ICAO SARPS should be reviewed and updated to incorporate measurable standards- such as required hydrant pressure and testing requirements for fire cylinders;

xi. Future studies should assess the role of aviation safety Regulators in enhancing Fire Safety Performance at International airports in Kenya.

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APPENDICES

Appendix I: Participants Consent Form

My name is Philip Otieno, a Master of Science Degree in Occupational Safety and Health (OSH) student from Jomo Kenyatta University of Agriculture and Technology. I am conducting a research study on "**Factors Affecting Fire Safety Management Performance at International Airports in Kenya".**

Supervisor Name:

1) Dr. Charles M. Mburu
2) Dr. Benson Karanja

The purpose of this study is to collect and analyze data about performance of fire safety management at international airports in Kenya in order to assess the achievement of fire safety as stipulated by relevant sections of Building Operations and Works of Engineering Constructions (BOWEC), Fire Risk Reduction Rules (FRRR) and International Civil Aviation Organization (ICAO) Standard and Recommended Practices (SARPS).

By signing this consent form, I declare that:

1) I voluntarily agree to participate in this research study.
2) I understand that even if I agree to participate now, I can withdraw at any time /stage without giving a reason for my decision or refuse to answer any question without any consequences of any kind and information given destroyed and that my withdrawal will not affect my legal rights.
3) I have had the purpose and nature of the study explained to me in writing and I have had an opportunity to ask questions about the study; which have been fully answered to my satisfaction.
4) I understand that all information I provide for this study will be treated confidentially and used exclusively for academic purposes and not given/shared to any third party.
5) I understand that in any report on the results of this research my identity will remain anonymous. This will be done by changing my name and disguising any details of my interview which may reveal my identity or the identity of people I speak about.
6) I understand that I am free to contact the Principal Investigator for further clarification and information on the research study on Telephone number: 0734925731 and Email: phlpotieno.otieno@gmail.com and Secretary JKUAT Institutional Review Committee on Telephone number (067) 58700001-4; Email: ethics@jkuat.ac.ke on concerns about my rights as a research participant.

Signature of participant Date

I believe the participant is giving informed consent to participate in this study

Signature of researcher Date

Appendix II: Questionnaires for International Airports' Employees

This questionnaire is designed to collect data on Factors Affecting Fire Safety Management Performance at International Airports in Kenya. Kindly complete the following questionnaire using the instructions provided for each set of questions. The information collected will be confidential and used exclusively for academic purposes. Participation in the study is voluntary and therefore you have a right to participate or not to and to withdraw from the study at will at any stage without suffering any harm to your decision.

Instructions: Please tick (√) as appropriate. Do not write your name on this questionnaire.

PART A: Demographic Data

1. Your gender?

(a) Male [ ] (b) Female [ ]

2. In which of the following age brackets does your age fall?

(a) 20-30 years [ ] (b) 31-40 years [ ] (c) 41-50 years [ ] (d) 50 and above [ ]

3. Your highest education level

(a) Secondary school [ ] (b) Certificate [ ] (c) Diploma [ ]

(d) Undergraduate [ ] (e) Post Graduate [ ] (f) Other ____________

4. Please identify your station/ airport:

(a) Malindi [ ] (b) JKIA [ ] (c) Kisumu [ ] (d) Eldoret [ ] (e) Moi [ ]

(f)Wilson Airport [ ] (g) Wajir [ ] (h) Lokichoggio [ ]

5. Please identify your department:

(a) Engineering [ ] (b) Security [ ] (c) Safety [ ]

(d) Rescue & Firefighting [ ] (e) HRD [ ] (f) Customer Care [ ]

(g) Any other? Specify ____________

6. Number of years you worked with Kenya Airports Authority?

(a) Less than 1year [ ] (b) 1-3 years [ ] (c) 4-6 years [ ]

(d) 7-10 years [ ] (e) More than 10 years [ ]

PART B: Fire Safety awareness

7. Please indicate the extent to which you agree with the following statements about fire safety. (5-Strongly agree; 4- Agree; 3-Neutral; 2- Disagree; 1- Strongly Disagree). Indicate your response using a tick (√) to mark the applicable box.

Statements	**5**	**4**	**3**	**2**	**1**
a. You have received training on basic fire safety training including type and use of fire extinguishers					
b. Information on fire safety are adequately communicated to all at the airport					
c. You are aware of actions to take during fire emergency at the airport					
d. Regular recurrent fire safety training are conducted to all employees					
e. Every staff has access to fire safety policy					
f. You are aware of the emergency number to call in the event of fire outbreak at the airport					
g. You clearly understand fire hazards at the airport					
h. You are aware of the evacuation procedure at the airport					

8.Using the scale in brackets, please indicate with a tick [√] the number of times each of the listed practices has occurred to you or in your airport. (5-At least four, 4- three, 3- two, 2- one, 1-zero)

S/No	Practices	5	4	3	2	1
a.	Number of Fire safety trainings you have attended					
	List Fire safety trainings attended by titles …………………………………………………………………… ……………………………………………………………………					
b.	Fire safety Refresher training held					
	List Fire safety refresher trainings attended by titles …………………………………………………………………… ……………………………………………………………………					
c.	Number of work tasks with Fire safety guidelines					
d.	Number of Communications of Fire Safety Information at the airport					
e.	List at least 5 Fire safety hazards at the airport you know ……………………………………………………………………. …………………………………………………………………					
f. No of Communications of Fire Safety Information at the airport	Number of evacuation drills conducted at the airport					
g.	List at least 3 emergency numbers you know and functional to call during fire emergency at the airport ……………………………………………………………………..................... …………………………………………………………………………….........					
h.	Frequency of access to Fire safety policy					

PART C: Compliance with relevant sections of BOWEC, FRRR and ICAO SARPS

9. Using the scale below, indicate the extent to which you agree with the following statements.

(5-Strongly agree; 4- Agree; 3-Neutral; 2- Disagree; 1- Strongly Disagree). Indicate your response using a tick (√) to mark the applicable box.

Statements	5	4	3	2	1
a. Fire protection systems (smoke, heat and sprinkler systems/extinguishers?) are installed at the airport					
b. Inspection of fire protection systems are done as stipulated by Fire risk reduction rules LN No. 59					
c. Fire hydrants installed in the airport					
d. Fire safety audits are conducted annually in the workplace by competent and qualified fire safety auditors					
e. Aerodrome Emergency Plan established at the airport					
f. Aerodrome Emergency Plan tested periodically					
g. Aerodrome Rescue and Firefighting Service established is commensurate with the airport category					
h. Emergency Access roads provided where terrain conditions permit					
i. Aerodrome Rescue and Firefighting Service personnel trained to perform their duties efficiently					
j. Aerodrome Rescue and Firefighting personnel participate in live fire drills including pressure-fed fuel fires					

10. Using the scale in brackets, please indicate with a tick [√] the number of times each of the listed practices has occurred to you or in your airport. (5-At least four, 4- three, 3- two, 2- one, 1-zero)

Practice	**5**	**4**	**3**	**2**	**1**
a. Availability of fire protection system at the airport					
b. Regular inspection of fire protection system					
c. Availability of charges / with water fire hydrants at the airport					
d. Approved persons carrying out fire safety audits at the airport					
e. Establishment of Aerodrome Emergency Plan at the airport					
f. Periodic testing of the Aerodrome Emergency Plan at the airport					
Indicate the type of emergency exercises conducted at the airport and when conducted ……………………………………………………………………………. …………………………………………………………………………… ……………………………………………………………………………..					
g. Provision of Aerodrome Rescue and Firefighting Service that is commensurate with the airport category					
h. Provision of all-weather emergency access road at the airport					
i. Number of Training Aerodrome Rescue and Firefighting Service personnel have attended					
List Aerodrome Rescue and Firefighting trainings attended by titles ……………………………………………………………………………………. …………………………………………………………………………………….					
j. Participation of Aerodrome Rescue and Firefighting Service personnel in live fire drills including pressure-fed fuel fires					

Thank You for your contribution, Time and Cooperation

Appendix III: Questionnaires for International Airports' Management

This questionnaire is designed to collect data on Factors Affecting Fire Safety Management Performance at International Airports in Kenya. Kindly complete the following questionnaire using the instructions provided for each set of questions. The information collected will be confidential and used exclusively for academic purposes. Participation in the study is voluntary and therefore you have a right to participate or not to and to withdraw from the study at will at any stage without suffering any harm to your decision.

Instructions: Please tick (√) as appropriate. Do not write your name on this questionnaire.

PART A: Demographic Data

1. Your gender?

(a) Male [ ] (b) Female [ ]

2. In which of the following age brackets does your age fall?

(a) 20-30 years [ ] (b) 31-40 years [ ] (c) 41-50 years [ ] (d) 50 and above [ ]

3. Your highest education level

(a) Secondary school [ ] (b) Certificate [ ] (c) Diploma [ ]

(d) Undergraduate [ ] (e) Post Graduate [ ] (f) Other ____________

4. Please identify your station/ airport:

(a) Malindi [ ] (b) JKIA [ ] (c) Kisumu [ ] (d) Eldoret [ ] (e) Moi [ ]

(f)Wilson Airport [ ] (g) Wajir [ ] (h) Lokichoggio [ ]

5. Please identify your department:

(a) Engineering [ ] (b) Security [ ] (c) Safety [ ]

(d) Rescue & Firefighting [ ] (e) HRD [ ] (f) Customer Care [ ]

(g) Any other? Specify ____________

6. Number of years you worked with Kenya Airports Authority?

(a) Less than 1year [ ] (b) 1-3 years [ ] (c) 4-6 years [ ]

(d) 7-10 years [ ] (e) More than 10 years [ ]

PART B: Fire Safety awareness

7. Please indicate the extent to which you agree with the following statements about fire safety. (5-Strongly agree; 4- Agree; 3-Neutral; 2- Disagree; 1- Strongly Disagree). Indicate your response using a tick (√) to mark the applicable box.

Statements	**5**	**4**	**3**	**2**	**1**
a. You have received basic fire safety training including type and use of fire extinguishers					
b. Information on fire safety are adequately communicated to all at the airport					
c. You are aware of actions to take during fire emergency at the airport					
d. Regular refresher fire safety training are conducted to all					
e. You are aware of the emergency number to call in the event of fire outbreak at the airport					
f. You clearly understand fire hazards at the airport					
g. You are aware of the evacuation procedure at the airport					

8. Using the scale in brackets below, please indicate with a tick [√] the frequency the listed items have occurred to you or at your airport. (5-At least four, 4- three, 3- two, 2- one, 1-zero)

S/No	Practices	5	4	3	2	1
a.	Fire safety trainings attended					
	List titles of Fire safety trainings attended: ……………………………………………………………………………… ………………………………………………………………………………					
b.	Fire safety Refresher training attended					
	List titles of Fire safety refresher trainings attended: ……………………………………………………………………………… ………………………………………………………………………………					
c.	Fire safety information adequately communicated at the airport					
	Indicate at least 3 means used to communicate fire safety information ……………………………………………………………………………… ……………………………………………………………………………… ………………………………………………………………………………					
d.	Emergency numbers to call are clearly and conspicuous displayed at the airport					
e.	List at least 5 fire related hazards you know: …………………………………………………………………………….. ………………………………………………………………………………					
f.	Fire action plans stating what to do and not to during emergency are clearly and conspicuously displayed at the airport					
g.	Number of evacuation drills conducted at the airport					

Appendix IV: Research Approval, JKUAT

JOMO KENYATTA UNIVERSITY
OF
AGRICULTURE AND TECHNOLOGY

OFFICE OF THE DIRECTOR, GRADUATE SCHOOL

P.O. BOX 62000, 00200 • NAIROBI •KENYA•TEL: (067)-5870001-4• Email: director@bps.jkuat.ac.ke

REF: **JKU/2/11/EET32-0316/2016**

1ST, FEBRUARY, 2023

PHILIP OTIENO
C/o IEET
JKUAT

Dear, Otieno

RE: APPROVAL OF RESEARCH PROPOSAL AND APPOINTMENT OF SUPERVISORS

Kindly note that your MSc. research proposal entitled: **"ASSESSMENT OF IMPLEMENTATION OF FIRE SAFETY MANAGEMENT AT INTERNATIONAL AIRPORTS IN KENYA "** has been approved. The following are your approved supervisors:-

1. Dr. Charles M. Mburu
2. Dr. Benson Karanja

Yours sincerely,

PROF. LOSENGE TUROOP
DIRECTOR, GRADUATE SCHOOL

Copy to: Director, IEET
/cao

JKUAT is ISO 9001:2015 and ISO 14001:2015 Certified
Setting Trends in Higher Education, Research, Innovation and Entrepreneurship

Appendix V: Introduction Letter JKUAT, IEET

JOMO KENYATTA UNIVERSITY
OF
AGRICULTURE AND TECHNOLOGY

INSTITUTE OF ENERGY AND ENVIRONMENTAL TECHNOLOGY

P.O. BOX 62000, NAIROBI, KENYA. Tel: (067) 52251/52711/52181-4, Fax: (067) 52164 Thika, Email director@ ieet.jkuat.ac.ke

20th February, 2023

TO WHOM IT MAY CONCERN

SUBJECT: PHILIP OTIENO – EET32-0316/2016

The above-named is a bonafide student of Jomo Kenyatta University of Agriculture & Technology pursuing a Master degree in Occupational Safety & Health (OSH) in this Institute. He has completed his course work and is currently involved in his research project entitled, ***"Assessment of Implementation of Fire Safety Management at International Airports in Kenya."***

This is therefore to request you to offer him any assistance that he may require in data collection.

Thank you.

Prof. Joseph Ngugi Kamau, PhD
DIRECTOR, INSTITUTE OF ENERGY & ENVIRONMENTAL TECHNOLOGY
Jm

JKUAT is ISO 9001:2015 and ISO 14001:2015 Certified
Setting Trends in Higher Education, Research, Innovation and Entrepreneurship

Appendix VI: Approval by JKUAT ISERC

JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
P.O BOX 62000(00200) NAIROBI, Tel:(067) 58700001-4
(Office of the Deputy Vice Chancellor, Research Production and Extension Division)

JKUAT INSTITUTIONAL SCIENTIFIC AND ETHICS REVIEW COMMITTEE

REF: JKU/2/4/896B Date: 15th June, 2023

PHILIP OTIENO
INSTITUTE OF ENERGY AND ENVIRONMENTAL TECHNOLOGY, JKUAT

Dear Mr. Otieno,

RE: ASSESSMENT OF IMPLEMENTATION OF FIRE SAFETY MANAGEMENT AT INTERNATIONAL AIRPORTS IN KENYA

This is to inform you that JKUAT Institutional Scientific and Ethical Review Committee has reviewed and approved your above research proposal. Your application approval number is **JKU/ISERC/02316/0893.** The approval period is **15th June 2023 to 14th June 2024.**

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by JKUAT ISERC.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to JKUAT ISERC within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to JKUAT ISERC within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to JKUAT ISERC.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely

Dr Patrick Mburugu
CHAIR, JKUAT ISERC

INSTITUTIONAL ETHICS REVIEW COMMITTEE
15 JUN 2023
APPROVED
J K U A T

JKUAT is ISO 9001:2015 and ISO 14001:2015 certified
Setting Trends in Higher Education, Research, Innovation and Entrepreneurship

Appendix VII: Research Permit, NACOSTI

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **869576**

Date of Issue: **09/March/2023**

RESEARCH LICENSE

This is to Certify that Mr.. PHILIP OTIENO of Jomo Kenyatta University of Agriculture and Technology, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kilifi, Kisumu, Mombasa, Nairobi, Turkana, Uasin-Gishu, Wajir on the topic: ASSESSMENT OF IMPLEMENTATION OF FIRE SAFETY MANAGEMENT AT INTERNATIONAL AIRPORTS IN KENYA for the period ending : 09/March/2024.

License No: **NACOSTI/P/23/24328**

869576

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 VIII: Kenya Airports Authority Research Authorization

KAA Kenya Airports Authority

Head Office, Airport North Road
P.O Box 19001-00501 Nairobi, Kenya.
Tel:+254- 020- 822 111/ 6611000/6612000
Fax: +254-020- 822078, 827304.
Email: info@kaa.go.ke
www.kaa.go.ke

KAA/10/20/10 VOL. 1 (38)

17th July, 2023

Philip Otieno
P.O. Box 30163 – 00100
NAIROBI

Dear Philip

REQUEST TO COLLECT DATA FOR A RESEARCH AT KENYA AIRPORTS AUTHORITY

We refer to your letter dated **10th July, 2023** on the above subject matter.

We are pleased to inform you that you have been granted permission to collect data for your research **'Assessment of implementation of Fire Safety Management at International Airports in Kenya'** in the organization.

You will collect your data at the Jomo Kenyatta International Airport, Wilson Airport, Eldoret International Airport, Moi International Airport, Kisumu Airport, Malindi Airport, Lokichoggio Airport and Wajir Airport effective 1st August 2023 to 8th March 2024. You will be expected to abide by rules and regulations governing the organization during your research period in order to ensure normal work schedule is maintained without inconveniencing any office operations. Please be informed nay costs associated with the exercise will be met by yourself.

Kindly note that the information gathered will be purely for academic purposes and shall not be used for any other purpose. At the end of your research please facilitate us with a copy of your findings. We wish you the very best in your academic journey.

Yours faithfully,
For: KENYA AIRPORTS AUTHORITY

ANTHONY NJAGI
GENERAL MANAGER - HUMAN RESOURCE DEVELOPMENT

Appendix IX: Publication

Otieno, P., Mburu, C. M., & Karanja, B. (2024). Influence of Compliance with Fire Safety Standards and Regulations in Fire Safety Management Performance at International Airports in Kenya. *American Journal of Environment Studies*, *7*(5), 1-14. https://doi.org/10.47672/ajes.2470