ASSESSMENT OF FIRE SAFETY PREPAREDNESS AT JOMO KENYATTA INTERNATIONAL AIRPORT NAIROBI, KENYA.

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Assessment of Fire Safety Preparedness at Jomo Kenyatta International Airport Nairobi, Kenya.

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DECLARATION

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

Signature…….. Date……

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This thesis report has been submitted for examination with our approval as University supervisors

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DEDICATION

I dedicate this study to my husband Tom, daughter Tessy Kwamboka, and son Jackson Wambugu. Thanks for the patience and support during the study period.

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ABSTRACT

Recently, Kenyans have witnessed an increase in incidences of fire where fire has gutted down homes, buildings and factories with loss of lives and property. Lack of disaster preparedness has remained one of Kenya's enduring development challenges for decades. There is lack of recognition of the inter-relationship between disaster preparedness, unsustainable production and consumption patterns. Most of the fire disaster response initiatives in Kenya tend to be ad hoc, uncoordinated and short term measures, mainly in the form of emergency relief services to the worst affected areas Fire outbreaks are not only a health risk; they adversely affect the social, economic and environmental conditions of an organization. Consequently, they also become a deterrent in the organization ability to attract investment. Fire safety is an important component in airport operations. Fire safety is also equally important in implementing the engineering design for airports. Fire safety equipment in airports buildings should be defined and stated clearly in order to provide safe, cost-effective, and sustainable buildings.The purpose of this study was to assess fire safety preparedness measures in place at Jomo Kenyatta International Airport based on International Civil Aviation Organizational standards (ICAO). The study evaluated the preparedness measures that have been put in place to minimize the potential effects of fire disaster. Questionnaires were administered to 340 respondents using proportional random sampling technique. A checklist developed from the rules was also used to conduct workplace inspections. Secondary data was obtained from JKIA emergency plan, and compared with obtained data. The data was analyzed using appropriate analytical software and descriptive statistic carried out.The study has established that most of the respondents (89.7%) were aware of the locations of fire emergency exits in their work place. Similarly, 90.7% of the

respondents were aware of fire fighting appliances in their workplace for use in case of fire and 91.2% could locate them. Male respondent (93.3%) were more likely to be aware of locations of fire emergency exits as compared to the female respondents (84.3%) and this association was statistically significant (χ^2 = 5.559; p=.018, df =1). More than a quarter (26%) of the respondents reported that the exit doors could not be opened and 16.4% admitted that the exit doors are not clearly marked. Three quarters of the respondents reported that there were fire detectors at their workplace with most of them reporting smoke detectors (86%), heat detectors (14%) and flame detectors (15%).Most of the respondents (87.7%) were aware of emergency assembly point in their workplace. The study has also found that more than a quarter of the respondents (25.8%) had not been trained on what actions to take in case of a fire outbreak while close to a half (42.5%) reported that their workplace does not carry out emergency evacuation drills. The results showed that male respondents (77.8%) were more likely to have trained on how to use a fire extinguisher as compared to the female respondents (57.1%) and this was statistically significant (χ^2=13.172; since p<.001,df=1) Almost a third of the respondents (29.8%) had not been trained on how to use a fire extinguisher and a quarter (23.3%) reported lack of procedures in place for emergency evacuation in case of fire outbreak at their workplace. The overall level of compliance to the requirements of the fire risk reduction rules and ICAO standards stands at below 60% in terms of fire protection, fire suppression, fire prevention and management control which poses a serious risk to safety issues in case of a fire emergency. The study has also found that there is lack of mechanism to integrate the safety standards and practices of the different stakeholders in and around the airport. This study recommends an integrated fire disaster management system involving all organizations operating at the airport and a provision for more and bigger emergency exits and a public address system that can be relied upon in case of a fire disaster. The finding of this study has also found some gaps on fire safety preparedness at JKIA which can be investigated in other airports.

CHAPTER ONE

INTRODUCTION

1.1 Background information

Disasters are a serious disruption of a society progress, causing widespread human, material and environmental losses, which exceeds the ability of the affected society to cope with from its own resources.Disasters may arise from many causes ranging from mechanical problems to even human related factors such as terrorism with the later having the greatest frequency. Not only do disasters occur frequently around the world, but it would seem that their incidence and intensity have been increasing in recent years (UN/ISDR, 2008).

The word fire refers to the natural phenomenon that occurs whenever a combustible fuel comes into contact with oxygen from the air and gives out light, heat and smoke. Fire is the byproduct of a chemical reaction in which heat stored in a combustible fuel is converted to a heat and accompanied by light. A fire's flame refers to the visual indication of light that occurs once the gas is heated, and is evidence that a fire has taken place (Tonui, 2009).Fire has been identified as the greatest challenge to the safety of not only the industrial plants but in all workplaces in Kenya (Kelvin, 2009).

A fire can result in extensive damage and destruction of property as well as injuries and death to occupants of a given premise (DiGuiseppi et al., 2012). Even when fires don't injure workers, they can because disrupt activities quite significantly and bring most operations to a standstill. Fires can lead to the destruction of property and loss of important records and information hence the need for clear fire safety rules to minimize outbreaks and the loss that can result from such hazards (Schifiliti, 2009).

Fire safety measures include those that are planned during the construction of a building or implemented in structures that are already standing, and those that are taught to occupants of the building. Fire safety system need to be considered as an inherent part of the building design and not as supplementary to others matters such as ergonomics, services or finishes (Schifiliti, 2009).Fire Safety Service is an important

element of any development as people's lives, properties and investments are put at risk in the event of fire outbreak.The main objective of fire safety efforts is to protect occupant from injury and to prevent loss of life or injuries during fire incidences and the second goal of fire safety is to prevent property destruction. By preventing fires and limiting damage we can assure that work operations will continue uninterrupted. Any fire must have three elements to ignite and maintain combustion: fuel, heat and oxygen. The strategy of fire prevention is to control or isolate sources of fuel and heat in order to prevent combustion (Kelvin, 2009).

Recent disaster profiles in Kenya indicate many incidents of fires, which have occasioned great loss of resources and human suffering. It is envisaged that in future, fire disasters may increase in terms of frequency, complexity, scope and destructive capacity. Fire disasters may arise from natural causes, negligence, civil disorder, accidents and enemy action (Gitau, 2006). The fire fighting service provision in Kenya today is grossly inadequate. It operates within a system of meager resource and inadequate training, which does not equip it to sufficiently respond effectively and efficiently to the needs of communities in the event of fire outbreaks.

Airports differ in complexity, but each has unique features. Some are small with uncomplicated facilities serving a more rural environment, while others represent a good sized community complete with residential, industrial, and commercial installations serving major metropolitan areas. Airports are operated by the local government such as a city or county; or by an Authority representing multiple local governments; and some are operated by the State. However, one thing they all have in common is that they are all subject to emergencies and incidences. Jomo Kenyatta International Airport, formerly called Embakasi Airport and Nairobi International Airport, is Kenya's largest aviation facility, and the busiest airports in east and central Africa, handling over four million passengers yearly. It is served by Runway 06/24. Runway 06 is Instrument Landing System (ILS) equipped, 4 117m long by 45 m wide and is used for take-offs and landings (Kenya Advisor, 2010).

Kenya Airport Authority which manages and provides a coordinated system of airports in the country establishes emergency plans for different airports including

JKIA to conform to Kenya Civil Aviation (aerodrome regulations) of 2008 and the Kenya Civil Aviation manual of aerodromes standards and incorporates the Kenya National State Safety programme. The objective of airport emergency plan is to minimize the effects of any emergency occurring within the aerodromes (8km radius – full response area), by providing a framework that shall direct and unify actions of all responding agencies to achieve effectiveness and efficiency in respect to saving lives, reducing damage to property and facilities and retuning airports to normal operations (Kenya Advisor, 2010). It is in the view of such mandate and maintenance of standards that this study has been carried out to evaluate fire safety preparedness at JKIA.

1.2 Statement of the research problem

In the recent years incidences of fire have increased tremendously and have become a national concern in Kenyan Airports (Obwaya, 2010).The result of this has led to loss of lives, life threatening injuries, loss of business and investment opportunities which has serious consequences in Kenyan Airports. Increase in the number of flights in Kenyan airports and the increasing growth in passenger numbers in these facilities is posing new challenges to airports management and operations in terms of fire safety preparedness.

The fact that Airport fires do not only affect the occupier and employees but the general public, who include the vulnerable groups such as the elderly, children contractors, tenants and the disabled means that it is essential to prepare for emergencies that face an airport in order to be able to respond quickly, efficiently and effectively (Ayres, 2009).Owing to the nature of airport operations, airport terminal buildings are generally atrium designed. As such buildings are large and spacious; any fire outbreak can spread rapidly. This, coupled with the high number of passengers commuting through the airport daily, places airport buildings in the high fire load category. This study therefore aimed at assessing the level of fire safety preparedness at Jomo Kenyatta International Airport.

1.3 Hypothesis

1.3.1 Null Hypothesis

Jomo Kenyatta International Airport has no adequate preventive and preparedness measures in place to minimize the potential effects of any fire disaster occurrence.

1.4 Justification of the study

In recent years, the potential for fire disaster has increased significantly. Though with minimal adoption of modern facilities, equipment and taking up disaster preparedness, mitigation and recovery policies, Jomo Kenyatta International Airport (JKIA) is still relying on facilities which were designed when fewer travelers were flying in smaller aircrafts. Consequently, the airport is more susceptible to fire disaster than was the case when it handled far less traffic.

The recent fire incident at Jomo Kenyatta International Airport which resulted in gutting down the whole of international arrivals and immigration area in August 7th 2013 demonstrated the vulnerability of Kenyan airports and the ill preparedness of the facility in handling fire emergencies. Thus the need for the study of fire safety preparedness in Kenya's main airports.

1.5 Research Questions

In order to assess the issues on fire safety preparedness, research questions formulated to capture the salient issues on fire safety at JKIA. These questions included among others the following:

1.6 Objective

1.6.1 Main objective

The main objective of this study was to assess the fire safety preparedness at Jomo Kenyatta International Airport.

1.6.2 Specific Objectives of the study:

- To establish the fire safety awareness of the airport workers.
- To assess the fire safety measures that has been put in place to minimize the potential effects of fire tragedy at JKIA.
- To determine the compliance with provision of fire risk reduction rules and International Civil Aviation Organization (ICAO) standards.

1.7 Scope of the Study

Airport consists of two distinct areas; - airside and landside. Airside is the restricted area of the airport that is not accessible to the public whereas landside is the non-restricted area of the airport that is accessible to the public. This study focused on the landside. This study commenced in April 2013. However, since fire destroyed the whole of international arrivals and some of the immigration areas in August 2013, the study did not cover the above said areas as it was declared a security zone.

1.8 Conceptual framework

This is a set of concepts, definitions, and propositions that explain or predict these events or situations by illustrating the relationships between variables (Croyle, 2005).Conceptualization is all about developing or coming up with a concept and visualizing it mentally. It is the process of creating new ideas that aim at tackling situations. It is a simplified view of the world that a researcher wishes to represent (Kisilu and Tromp, 2006). This study adopted its own conceptual framework that helped in understanding the objectives of the study.

Independent variables **Intermediate variables** **Dependent variable**

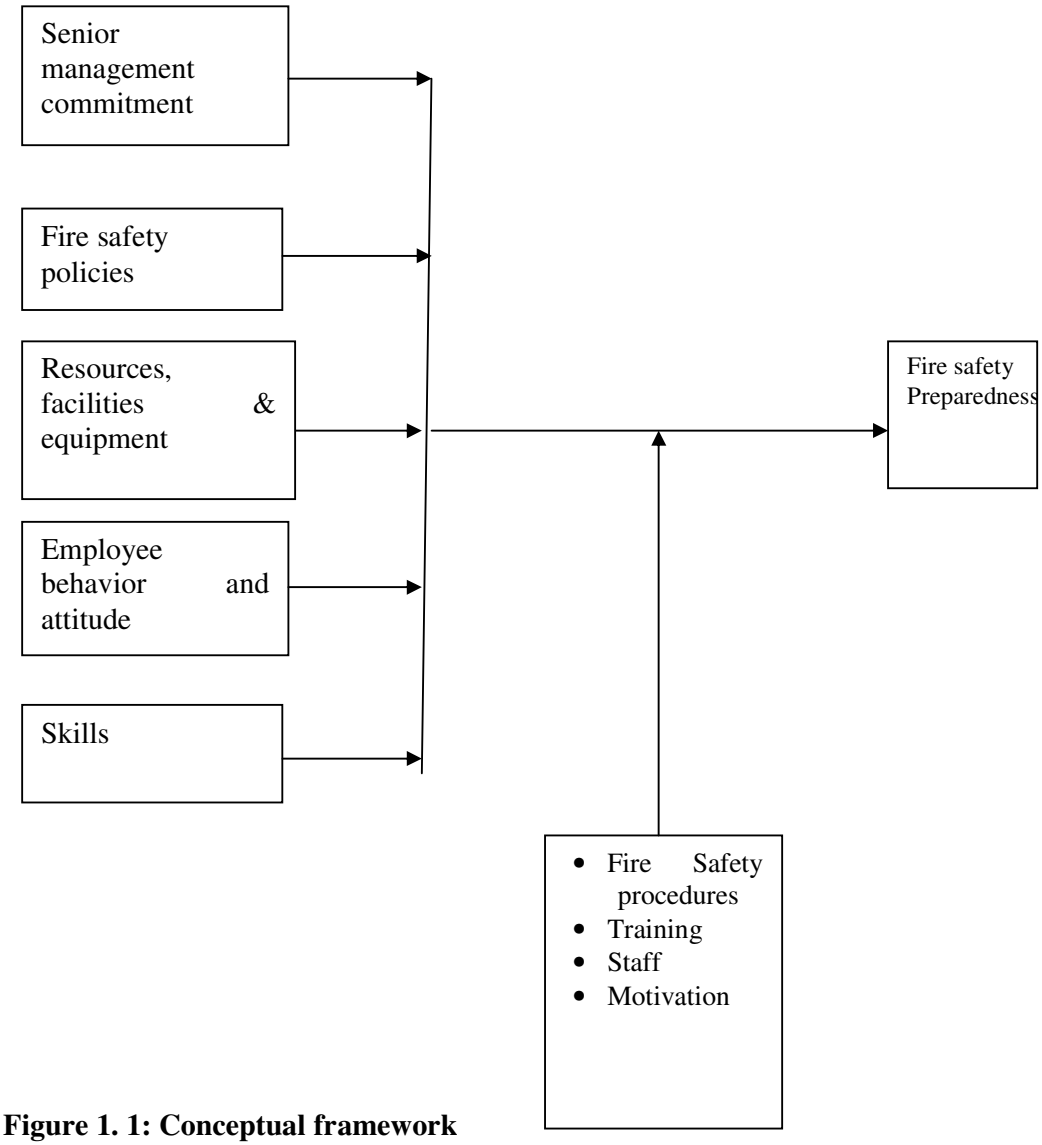

Figure 1. 1: Conceptual framework

As shown in the figure 1.1 above various independent variables need to be well coordinated in order to have adequate fire safety preparedness. Fire safety policies and procedures need to be well documented, updated and made available to all employees. Senior management must be committed to the policies and should provide adequate

training and skills to all the staff. Resources should be made available and facilities and equipment in place maintained all the time.

CHAPTER TWO

LITERATURE REVIEW

2.1 Airport fire safety

Airports handle many passengers and visitors. When there is a fire, it is characterized by a large number of people at risk. Frequent users e.g. staffs are expected to recognize the nearest escape route easily and evacuate. However, the infrequent users such as passengers and visitors might have difficulties in locating the escape routes as they are unfamiliar with the building (British standards Institution, 2007).

The effects of fire on aircraft as well as the types of injuries and the level of fatalities associated with aircraft accidents are well documented. Much research has gone into evacuation of passengers from burning aircraft and realistic response times that are required in order to minimize the level of harm to passengers and crew in addition to the number of fatalities. However, little work has been done on fire safety preparedness in airports.

Braithwaite (2011) noted that to reduce the level of ARFF (Airport Rescue and Fire Fighting) coverage at airports in Australia was a step in the wrong direction, given that the aims of the industry in terms of safety was to reduce accident rates. Braithwaite presents a case for the need to ensure that passengers, regardless of their airport of choice, are provided with an optimum level of ARFF (Airport Rescue and Fire Fighting) coverage in the event of an accident.

Cooke (2009) also examined the issue of rescue and fire coverage at airports particularly in the UK and the USA. In his thesis, He presented arguments for raising the standards of fire and rescue services, particularly at the larger and busiest airports in the aforementioned countries. Obwaya (2010) in his thesis on disaster preparedness at Jomo Kenyatta International Airport focused on Aircraft Fires and terrorist attacks. He noted that the airport has inadequate fire/emergency escapes routes and few trained personnel in firefighting. Some safety equipments are under serviced, for example fire extinguishers and the equipments are inadequate compared to the number of people.

Obwaya also noted the lack of a mechanism to integrate the safety standards and practices of the different stakeholders in and around the airport which has a detrimental effect on safety. Obwaya recommended a need to have an integrated disaster management system involving all organizations operating at the airport and a provision for more and bigger emergency exits and a public address system that can be relied upon in case of a disaster.

Weir (2009) also looked at the issue of fire in aircraft accidents and advocates the need to ensure that safety precautions and safety research are constantly carried out. Much of his writing in 'The Tombstone Imperative – the Truth about Air Safety' focuses on the roles that airlines and the regulators can play in the provision of a relatively safe air transport industry.

From the literature search that has been conducted it has revealed that many authors recognized the need for an adequate level of rescue and fire coverage. Some authors also recognized that cost was a factor in an airport's ability to provide a certain level of standards. However, there is little detail about fire safety in airports, particularly the smaller airports where traffic levels and profitability are not as high as the larger well known airports such as Heathrow in the UK and Sydney in Australia (Cooke, 2009).

2.2 History of Fire

Fire has been with mankind since the beginning of time. People have always known about fire, because fires happened naturally when there were lightning strikes or15 sparks from two rocks hitting together. Early man invention of on-purpose cooking fires is estimated at about one million years ago. Perhaps the last Ice Age, which ended about 10,000 BC, made people invent the idea of fires inside, to keep their caves warm. To make their wood supply last longer, they started to use ovens (Brown *et al*, 2009).

Greek mythology dating around 1000 BC has it that fire was stolen from the gods by a witty and sly Prometheus as a revenge mission on god Zeus (Semmelroth, 2009).With the acquisition of fire came the problem of preserving it and to keep it from spreading or theft. A screen to protect it from the wind, in the form of a rock shelter or cave was

used and a fire-keeper delegated to the work, thus starting a social organization (Brown *et al*, 2009)

2.3 Fire

The rapid oxidation at elevated temperatures accompanied by the evolution of heated gaseous products of combustion, and the emission of visible and invisible radiation is known as Fire (Abdullah, 2011). According to Kelvin (2009), the concept of fire can be symbolized by the Triangle of Fire, which is represented by fuel, heat, and oxygen as in Figure 2.1 (Dowd, 2012). The removal of any one of these factors usually will result in the fire being extinguished.

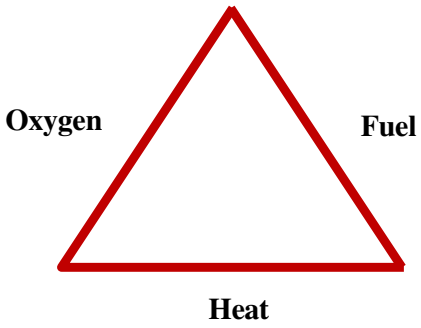

Figure 2.1: Triangle of Fire (Dowd, 2012)

2.3.1 Stages of Fire Development

There are four main stages of fire development. These stages are incipient, growth, fully developed, and decay (Hartin, 2005). This first stage, the Incipient or ignition Stage begins when heat, oxygen and a fuel source combine and a chemical reaction occurs resulting in fire (Proulx, 2013). It is usually represented by a very small fire which often (and hopefully) goes out on its own, without moving to the consequent stages.

Recognizing a fire in this stage provides us with best chance at suppression or escape (Kelvin, 2009). The second stage is the Growth Stage where the building structures' fire load and oxygen are used as fuel for the fire and as long as air is available (in well

ventilated buildings), the fire grows very quickly. Factors such as location of in the room, types of combustibles, ceiling height and the potential for thermal layering affect the growth stage (DiGuiseppi et al., 2012). It is during this shortest of the four stages when the surfaces of everything within a compartment or room seem to burst into flame simultaneously; a condition called flashover occurs (Kennedy & Kennedy, 2013). Flashovers are well known of their potential of trapping, injuring or killing persons within the building.

The third stage is when the growth stage has reached its maximum and all combustible materials have been ignited, a fire is considered fully developed and is therefore called the fully developed stage. This is the hottest phase of a fire and the most dangerous for anybody trapped within (Mowrer, 2012). The last stage is the Decay Stage, usually the longest stage of a fire and is characterized by a significant decrease in oxygen or fuel, putting an end to the fire. Two common dangers during this stage are the existence of non-flaming combustibles, which can start a new fire if not fully extinguished. Secondly, there is the danger of a back draft when oxygen is reintroduced to a volatile, confined space.

2.4 Classes of Fire

According to the OSHA subsidiary legislation on fire risk reduction, Kenya classifies fire in four main classes. These are Classes A, B, C and D (GoK, 2007).Class A involves fires that occur in materials such as wood, paper, and rubbish. Extinguishing agent is large quantity of water while Class B involves fires that occur in vapour mixture of flammable liquids. Examples include petrol, oil, grease, paints and thinners. Extinguishing agents to class B fires is the dry powder, carbon dioxide (CO2) and foam. Class C fires involve fires caused by energized electrical equipment. Extinguishing agents here are dry powder and CO2 and lastly class D involves burning of metals e.g. potassium, titanium, Zirconium, Lithium, Potassium and Sodium. Dry powder is the most preferred extinguishing agent for this class of fire.

2.5 Fire Extinguishing Agents

The portable fire extinguishers for the four types are colour coded for ease of identification. It is important for fire fighters to have full knowledge of the types of fire extinguishers that can be used for the different classes of fire. Inaccuracy choice of the type of extinguisher could easily lead to exaggeration of the fire, injuries and death (Tonui, 2009).

2.6 Fire Prevention

Loss from a fire can be measured in terms of physical injury to employees, visitors and anyone near the premises; in damage to the premises and its contents and financially through loss of business, reputation and through court action. But statistics show that the majority of fires could be prevented from happening or at least reduce the consequences (Naito, 2006).

Many building fires are arson-initiated where in certain cases; purported victims were eventually proven to be the culprits themselves with fraudulent intentions in seeking redress (Mostue, 2011).

To reduce the risk of fire occurring in the workplace proper housekeeping should be maintained. Poor housekeeping creates the right environment for a fire to take place, providing both a place where ignition can occur together with a ready source of fuel. It may also create obstructions to the escape routes (Cote, 2011).The majority of fires in workplaces are caused by faulty electrical appliances and leads (Gold & Koigi, 2009). Steps that can be taken to reduce the risk of fire will include ensuring all electrical equipment are not damaged and working correctly. Fraying cables, exposed electrical connections and cracked and sooty marking on casings should be checked. Likewise, multi-point extension leads can also become overloaded and catch fire.

Gases and flammable liquids in workplaces should be used and stored in small quantities for day to day activities. Leaks and spillages of flammables should be cleaned up immediately and no naked flames should be allowed in the vicinity of stored flammable substances or where they are being used. Poorly maintained or

inoperative fire safety equipment, such as fire detection and alarm systems together with emergency lighting installations could put employees in danger if a fire were to occur. They are designed to both detect a fire in its early stages and provide adequate warning to all occupants so that safe escape can be achieved (U.S. Department of Labor, 2001). Portable fire extinguishers should be maintained. Maintenance activities can also be the cause of a fire in workplaces. Many maintenance activities create heat, spark or use naked flames. Activities may also impact the fire safety systems or obstruct escape routes. Permits to work such as for hot working, isolation of fire systems and interruption to sprinkler supplies should be availed (U.S. Department of Labor, 2006).

2.7 Fire Protection

In the event of a fire, it is the escape routes that will get everyone in the workplace out of the building in the shortest possible time. For this reason they must remain usable at all times. It should be ensured that escape doors are working correctly i.e. the automatic closer operates, double doors align with each other when closed and smoke seals are not damaged. Escape signage should be clearly visible formal locations in the workplace and the sign on the fire exit door prominently displayed (HMSO, 1999).

The Health and Safety Executive HSE (2006) states that Fire risk assessment is a critical activity that helps in the protection of workers as well as bringing an institution to be in compliance with the law of the land.

A well trained fire fighting team with well-defined responsibilities in case of fire should be established and on hearing the fire alarm sound, the team should assist fellow workers, visitors and customers by leading them through the fire exits. They should not allow people to come back to the building or even collect personal belongings unless clear escape is obvious and they should also make sure that all proceed to the assembly point for roll-call (Gold and Koigi, 2009).

All the above fire prevention and protection activities can easily be implemented by establishment of a Fire Safety Program me that includes inspection, fire drills,

training, management procedures and communication. Fire drill is an important exercise for instilling skills on evacuation procedures and consequences of fire are completely avoidable if safety requirements are observed. Training must meet the goal of reducing the number of fires and thus reduce death and injury among workers, and the financial loss on organizations (Cote, 2011).

2.8 Possible causes of fire in Airports building.

Airports have a wide range of occupancies such as restaurants, duty-free shops, lounges, etc, and also a large overall volume of combustibles such as alcohol, furniture and carpets which can result in major fire outbreak in addition jet fuel is highly flammable, and whenever there is air disaster, it is almost inevitable that a fire will break out (Coulles & Eskell, 2010).

An airport terminal is a large multi-purpose construction; hence, the cause, type and location of fire are highly varied.

In Taiwan's previous cases of terminal fire (Schultz et al., 2006; Xiang, 2008), most are caused by construction failure (4 out of 11); other causes include electrical short circuit (2 out of 11), fire in the trash can (2 out of 11) and fire in a restaurant (1 out of 11); none of the aforementioned fire caused casualty. As for cases of fire in airport terminals overseas (Lu, 2009), the case of Airport Orly of Paris, France, in 1973, was caused by electrical short circuit in Transformer Room B2, which fortunately did not result in any casualty.

The case in Düsseldorf, Germany in 1996 was much less fortunate: the fire was due to a construction failure at a flower shop in the arrival area between the first and second floors; the smoke spread to all parts of the arrival hall through air ducts, and the accident caused 16 deaths and 62 injuries.

In Kenya at Jomo Kenyatta International Airport this happened in August 2013 whereby fire destroyed the whole of International arrivals and Immigration area. The cause of fire was due to electrical faults.

In Kenya Section 16 of the Fire risk reduction rules prescribes to the occupier to maintain the following: Ensure that all electrical machines equipment and hand tools in a workplace are properly earthed or double insulated. Ensure that all electrical motors, fittings, attachment and switches shall be spark proof in workplaces where flammable liquids, vapors, dust and gases are likely to be present.

Ensure that all electrical equipment and the related attachments are inspected in every period of six months by a competent person and a record of the inspection kept.

Airports keep huge reserves of jet fuel. This makes them highly vulnerable to fire disasters, even from a cigarette butt disposed of carelessly (Owen, 2011). Structural fires and medical emergencies can occur anywhere near airport property. Fast foodservice and restaurant with cooking facilities is another concern, Very high thermal power stoves operated by either town gas or diesel oil are equipped in the kitchen of those various restaurants. The risk of starting a small accident fire in kitchen would be high (Chow, 2012)

Fires can also be caused by individuals who smoke in restricted area. Placing of trash bins along corridors and lobbies might result in smokers discarding lighted cigarette butts into them resulting in the burning of combustible materials inside (McKenzie, 2008).

Poor housekeeping can be a potential source of ignition and can support the spread of fire in case of an outbreak. Sections13-15oftheKenyaFireriskreductionrulesset up required standards of housekeeping, removal of wastes and layout of machinery in the workplace. It is required that dirt and refuse are removed at least once a day; the dirt and refuse removed are kept in a receptacle; every store shall have a marked gangway of at least one meter wide for the movement of persons; and where mobile equipment for transportation of material is in a store, a marked gangway shall be provided to accommodate the size of the equipment and for the use of persons working therein and a distance of at least one meter between any two machines or from any machine and a fixed structure is provided, so as to ensure easy movement and access of persons. In addition the rules stipulate that every occupier shall ensure that finished

products, by-products and any waste products are removed immediately they are produced so as to avoid accumulation of products or waste products (McKenzie, 2008).Most of these accidents happen within the precincts of the airport.

2.9 Possible causes of aircraft fire disasters

Travel by air is, by and large, perceived as a very safe mode of transport. Because of the nature of flying and the sheer volume of air travel today, though, there are a rising number of accidents. Aircraft disasters have a multiplicity of causes and by extension effects. Planes are flying at such high speeds and are so massive that any accident is almost sure to cause serious injury or death to the passengers. They also tend to fly over dangerous areas, like oceans or mountains, which make the chances of surviving an accident very slim. There are various causes of aircraft accidents, and unfortunately, some of them, including weather, cannot be controlled. However, many of them are a result of human error that can be avoided. According to Devine (2009), some of the causes of aircraft accidents include structural defects, tower error and bad weather as discussed below.

2.9.1 Pilot error

Approximately 80% of all aircraft accidents occur shortly before or during take-off and landing. These are usually said to have been caused by ‘human error'. Pilots are responsible for the well-being of the aircraft and of every passenger. Human error is certainly one of the easiest factors to consider when looking at causes of airplane crashes.

Humans, by their very nature, make mistakes; therefore, it should come as no surprise that human error has been implicated in a variety of occupational accidents, including 70% to 80% of those in civil and military aviation. While the number of accidents attributable solely to mechanical failure has decreased markedly over the past 40 years, those attributable to human error have declined at a very slow rate (Krasner, 2009).

2.9.2 Structural defects

Structural defects can lead to dramatic and unpredictable aviation accidents. Defects can range from faulty or aging wires to corrosion and fuselage loss. In 1988, a Boeing 737 flown by Aloha Airlines experienced a ruptured fuselage, tearing part of the cabin apart and blowing a flight attendant off the plane and to her death. The accident was caused by problems with the adhesive bonding process (Devine, 2009). Structural problems in aircraft are usually related to corrosion, surface cracks, fatigue cracks and skin disbands. Aging aircraft may experience structural defects from general use and lack of maintenance. When these problems go undetected, the lives of passengers and flight crew are endangered. This is especially important because of the very precise calculations that go into the physics of flying. It is a complicated science, and a bad design can be a huge problem. Equipment must be maintained and checked regularly to ensure the least possible chance of mechanical failure (Devine, 2009).Engine failure is a mechanical problem that can easily lead to aviation accidents. There are many reasons engine failure may occur, including an insufficient fuel supply and the breaking of engine parts. Pilots and crew are specially trained to manage engine failure as best they can by gliding the plane to a safe landing, but sometimes the aviation accidents resulting from this mechanical problem can be horrific (Devine, 2009).

2.9.3 Non-compliance with regulations

The International Civil Aviation Organizational (ICAO) and member states including Kenya under Kenya Civil Aviation Authority (KCAA) has very specific rules that cover almost all parts of air travel, from the equipment to ground personnel to passengers, luggage security, pilots and airports. They are designed for the utmost safety of everyone involved, and breaking these rules can create extremely dangerous situations (ICAO, 2004)

2.9.4 Tower error

Air traffic controllers have the largest responsibility of making sure that the various planes and pilots are not going to endanger each other. Pilots are dependent on them to

give timely, accurate information about everything from weather to landing patterns and runway positions.

Collisions can occur if this information is not accurate and prompt (Kumar & Malik, 2003).Recent reports of air traffic controllers acting dangerously only bring more attention to the potential consequences of their actions. In 2005 it was reported that by August, 200 human-related errors had been made by New York air traffic controllers, compared to 24 for all of 2004. Air traffic controllers have responsibilities just as pilots do. Mistakes and lapses in vigilance can result in aviation accidents and losses of life (Krasner, 2009).

2.9.5 Bad weather

Weather is the cause of almost a third of aircraft accidents. While it is blamed for causing most of air traffic delays, costing world airlines four billion dollars, and thunderstorms present some of the biggest hazards to aircraft in general. In fact, a single thunderstorm contains multiple threats to aircraft including heavy precipitation, hail, lightning, very severe turbulence, low level wind shear, microburst and icing conditions. Wind, mist and fog, particularly with regard to light aircraft, that impair visibility and air pressure have been noted to lead to air crashes. According to Baum (2010), failing to heed up-to-date weather forecasts is unwise especially where the elements are particularly changeable and intense due to the mountainous terrain and the prevalence of strong winds and turbulence.

2.10 Airports and fire disaster vulnerability

An aircraft is mechanically fabricated, and bearing in mind that human knowledge is limited to a certain degree, it is clear that air disasters are inevitable even with advancement in technology. All we can perhaps do is to put measures in place so as to minimize the impact should a disaster occur. Suffice to mention that jet fuel is highly flammable, and whenever there is an air disaster, it is almost inevitable that a fire will break out (Coulles & Eskell, 2010).

In most accidents, crash survivors immediately face the dangers of fire and smoke inhalation; those who cannot exit quickly are killed by toxic smoke. The smoke contains deadly compounds, such as hydrogen chloride, hydrogen fluoride, cyanide and carbon monoxide that can cause unconsciousness in only one or two breaths (Coulles & Eskell, 2010).This suggests that airports and aircrafts are highly vulnerable to fire disasters. It is to be borne in mind that aircraft fuel at the airports, meaning that airports keep huge reserves of jet fuel. This makes them highly vulnerable to fire disasters, even from a cigarette butt disposed of carelessly (Owen, 2011). Structural fires and medical emergencies can occur anywhere on airport property. Airports involve several square miles of concourses, terminals with shops, restaurants and parking structures. Similarly, a heart attack experienced by a passenger or visitor to an airport may not be fatal if emergency medical personnel provide timely medical attention. Fires or terrorist attacks can occur in a busy airport terminal causing mass casualties if not quickly contained. Lacking regulations and response policies, some airports employ *ad hoc* emergency response measures leading to disparities in the delivery of emergency services; while some airports have excellent response plans to save lives, others have very poor plans (Coote, 2010).

Manchester and New York airport authorities have their fire fighting and emergency medical personnel ready 24 hours a day. The two airports are the only ones in the world known to conduct Airport Emergency preparedness exercise with on-airport and off-airport fire departments every six months. Other airports of the world conduct their drills after every three years. The two airports are also known to follow FAA regulations to suspend air operations when fire protection falls below minimum levels, in extinguishing agents, staffing levels and medical emergency staff (ICAO, 2003).

2.11 Airport fire disasters

The availability of preparedness measures in most of the Airports in developed countries has tremendously reduced the impact of fire incidences (U.S. Fire Administration, National Fire Data Centre, 2007). In developing countries, however, the contrary is the case, for the lack of or inadequate preparedness measures in most Airports, and the increase in fire incidents are raising alarm. In rapidly developing

countries, the number of fires is increasing at a rate of at least as high as the growth rate of economy (Matti, 2006).The magnitude and severity of the fire varies depending on the level of preparedness. In this regard, most of the Airports fire incidents in developing countries had severe impact on human being due to the poor level of preparedness.

2.11.1 Air related fire disasters by continent

The Interior Aircraft Fires from 1950 to 2002 with the point of origin in the baggage compartment caused 1849 death out of 2015 passengers on board (South Africa. to, 2010). In 1998, the Federal Aviation Administration (FAA) mandated airlines registered in the United States to install fire protection systems in the baggage holds of passenger aircraft.

2.11.2 Air disasters in Africa

Although only about 4% of the world's air traffic passes over Africa, one in four plane crashes happens in Africa. It is certain that less than 1 in 10 plane crashes have occurred in Africa since 1945. Examining the period from 2001 to 20 May 2007, there were 349 fatal accidents in the world, of which 60 have occurred in Africa. While opening the summit of African Union of ministers responsible for aviation in 2005 in South Africa, South African president Thabo Mbeki noted: “It is alarming that, although the continent accounts for 3% of world aircraft departures, Africa witnesses 27 per cent of all fatal accidents on its soil" (Phillips, 2002).

This statement by president Mbeki captured the essence of aviation security in the entire continent of Africa. The same concern has been raised in many more analyses concerning the air safety issues (Phillips, 2002). These experiences have portrayed the continent as a dangerous place to fly and as the most vulnerable place in the world to air-related disasters. Other factors that have been blamed for the airport-related accidents in the continent are air safety, navigation, ground transportation, network immaturity, security, geographical conditions, governmental mismanagement most of which have often been presented as insurmountable (Kwiatkowski, 2007).

2.11.3 Air disasters in Kenya

In the case of air-related disasters, every time that one happens it leads to issues being raised on the country's state of airports and airstrips in particular and fire disaster preparedness in general. At the level of fire disaster preparedness, issues have been raised on the efficiency of equipment as well as availability of effective facilities at the airports. Other aspects like appropriate training have also been raised (Okungu, 2006). Air-related accidents and incidences in Kenya have therefore not been left out, and have been quite prominent.

Table 2.1: Air accidents in Kenya

Date	Type	Registration	Operator	Fatality	Location
2 July 2014	Fokker 50	5Y-CET	Skyward International Aviation	4	Near Nairobi -JKIA
22-AUG-2012	Let L-410UVP-E9	5Y-UVP	Mombasa Air Safari	4	Ngerende Air
10 June 2012	Euro copter AS350	5Y-CDT	Kenya Police Air Wing	6	Nairobi-Wilson
12-JAN-2012	Let L-410UVP-E9	5Y-BSA	Blue Sky Aviation	0	Kichwa Tembo
09 Nov 2009	Beech craft 1900D	5Y-VVQ	Bluebird Aviation	1	Nairobi-Wilson
29th Sep 2008	DHC-5D Buffalo	5Y-OPL	Trident Aviation	0	Lokichoggio
29th April2008	Fokker 540	5Y-VVL	Bluebird Aviation	0	Wajir
27th April2008	Airbus A340-313	G-VAIR	Virgin Atlantic	0	Nairobi-Jomo
12th Dec 2007	DHC-5D Buffalo	5Y-MEG	Trident Aviation	0	Nairobi-Wilson
12th Dec 2007	Cessna 208B Grand Caravan	5Y-SLA	Safari Link	0	Nairobi-Wilson
8th July 2007	ATR-72-212	5H-PAR	Precision Air	0	Nairobi-Jomo
6th July 2007	Beech craft 1900C	5Y-BTT	Aero Kenya	0	Nairobi-Wilson
30th Dec 2006	DHC-5 Buffalo	5Y-SRK	Sky Relief Services of Red Cross	0	Near Nairobi -JKIA

(Source: ASN, 2010)

2.12 Legal requirements for Fire safety provisions in buildings

In Kenya there are a number of statutes that provide for fire safety management at workplaces. These include amongst others, the Factories and Other Places of Work (Fire Risk Reduction) Rules Legal notice LN 59 of 2007 (GoK, 2007).Sections 6,9-12,17 -19, 26, 28, 29, 30, 32 and 33 of the Fire risk reduction rules LN 59, 2007 have been set to provide for physical facilities present to manage fire emergencies at the workplace. It is upon the occupants to ensure that the fire exit door, gangway and exit staircases are free of obstruction and that every emergency exit is distinctively and conspicuously marked in green letters of at least15cminheight. The emergency exit route should be clearly marked in writing or by signs indicating the direction of exit and that a drawing or map showing evacuation routes is posted in prominent positions in the work place.

It is stated under Section 6 of the Fire rules that every occupier shall ensure that highly flammable substances are stored in suitable fixed storage tanks in safe positions, or in suitable closed vessels kept in a safe positions in the open air, and where necessary, protected against direct sunlight; or in a suitable closed vessel kept in a storeroom which is either in a safe position or in a fire resisting structure; or in the case of a workroom where the aggregate quantity of highly flammable substances does not exceed 50 litres, in suitable closed vessels kept in a suitably placed cupboard or bin which is a fire resisting structure.

Section 9 to 12 of the fire risk reduction rules have been created to prevent spontaneous combustion caused by accumulation of high concentrations of vapors from highly flammable substances which can lead to explosions. Section 9 specifically states that 'Every occupier shall ensure that no means likely to ignite vapors from any highly flammable substances are present where a dangerous concentration of vapors from flammable substances may reasonably be expected to be present'. In support of this the rules under section10 requires the occupier to continuously monitor a workplace with flammable substances with a view to mitigate against any possible fire risks.

The legislation further in section 17 provides for exit doors which should be at least 90

cm wide, on the opposite of the entrance and clearly marked as fire exit doors. It also provides that Fire fighting appliances should be maintained and inspected. Testing of cylinders to be carried out every 12 months and should be selected for the correct class of fire depending on the type of combustible materials in the workplace.

Section 18 requires every occupier to ensure that any door of any store where flammable substances are stored are constructed in a manner that the door shall be self-closing, opening outwards or sliding and capable of containing smoke from within the work room, in event of a fire. Section 19 stipulates that where a workplace is a storeyed building, every occupier shall ensure that a work place is constructed in such a manner as to enable workers have access to other suitable outlet or exit for evacuation other than the emergency exits. It is also a requirement stipulated under section 26 that there should be suitable means of alerting persons in the event of a fire and that such means are made known to all.

Section 28 of the rules stipulates the requirement for installation of suitable means of detecting fire in the workplace. It prescribes the following: Every occupier shall ensure that fire detection appliances are located in the appropriate places for immediate activation of an alarm or automatic fire extinguishing systems. Every occupier shall ensure that fire detection appliances are connected to audible and visual flashing devices to provide a warning to the workers for emergency response; and fire detection appliances are regularly maintained and that they are inspected at least once every twelve months by a competent person.

It is a legal requirement under section 29 of the rules that every occupier provides means of extinguishing fire at the workplace and ensures that they are placed at distinctively and conspicuously marked locations. Portable fire extinguishers should be mounted at an easily accessible height of not less than 60 centimeters from the floor. Where fire hose reels are provided, every occupier shall ensure that there is at least one fire hose reel within a radius of 30 meters.

Section 32 of the rules stipulates every occupier shall ensure that all pipes conveying various substances shall be colour-coded for the purposes of identification. Every

occupier shall ensure that pipes carrying water for firefighting shall be painted in red and the occupier ensure that fire fighting appliances are coded in the following manner:

Extinguishing agent	Extinguishing body colour
Water	Red
Foam	Cream
Powder (all types)	Blue
Carbon dioxide	Black

Every occupier as stipulated in section 33 shall ensure that the work place has access to water and water storage facility capable of storing at least 10,000 litres of water; the water storage facility is kept full at all times, for use in event of fire and the water pressure in the fire fighting system is capable of raising water to the highest point of the workplace in the event of a fire.

2.13 International Civil Aviation Organization (ICAO) standards on fire safety

The main objectives of the International Civil Aviation Organization (ICAO) are to 'develop the principles and techniques of international air navigation and to foster the planning and development of international air transport.' (Brown *et al*, 2009). The ICAO has thus developed guidelines relating to a variety of areas such as airports, accident investigation, and safety and security.

Section 9.2 of annex 14 states that 'All rescue and fire fighting personnel shall be properly trained to perform their duties in an efficient manner and shall participate in live fire drills commensurate with the types of aircraft and type of rescue and firefighting equipment in use at the aerodrome. According to this Annex, the main objective of rescue and fire fighting services is to save lives. The Annex also recognizes that the provision of rescue and fire fighting services is particularly

important for accidents occurring at or in the immediate vicinity of an airport as this is where the opportunity for saving lives is greatest.

ICAO also provides guidelines for the number and deployment of personnel. These guidelines are as follows: Vehicles should be staffed in such a way that they can be deployed immediately with enough staff to have them fully operated. Vehicles should be staffed so as to ensure that they discharge principle and complementary agent at maximum capability.

Section 9.4 of ICAO standards recommends a response time of two minutes, but not more than three minutes for reaching the end of the runway as well as for reaching any other part of the movement area. Response time is defined in Annex 14 as the time between the initial call to the rescue and fire fighting service and the time when the first responding vehicle(s) is (are) in place to extinguish the fire. Section 9.6 of ICAO standards recommends that a system of preventive maintenance of rescue and fire fighting vehicles should be employed to ensure effectiveness of the equipment and compliance with the specified response time throughout the life of the vehicle.

Section 9.7 of the standards recommends that Emergency access roads should be capable of supporting the heaviest vehicles and should be usable in all weather conditions. The fire stations as recommended in Section 9.7 of the standards should be located so that the access for rescue and fire fighting vehicles into the runway area or terminal building is direct and clear requiring a minimum number of turns.

Communication system as recommended in section 9.9 should be provided linking a fire station with the control tower and any other fire stations on the aerodrome and the rescue and fire fighting vehicles. Airport emergency exercises/drills in accordance with the requirements stipulated in ICAO section 9.12 should be conducted at intervals not exceeding two (2) years. The purpose of a full-scale exercise is to ensure the adequacy of the plan to cope with different types of emergencies. Drills are considered as educational experience and are a valuable source of information and ideas. They (drills) help eliminate mistakes that would otherwise occur during a real emergency.

2.14 Fire disaster preparedness and recovery

Once a disaster has occurred, a set of activities has to be put in motion, aimed at firstly satisfying the immediate needs of the victims, their rehabilitation and the reconstruction of any infrastructure that may have been damaged or destroyed. According to Kapoor (2009), the recovery measures, both short and long term, will include returning vital life-support systems to minimum operating standards ;public information and health and safety education; economic impact studies; and counseling programmes.

Coordination is an essential ingredient in a disaster preparedness plan. This means arrangements and preparations put in place not only to prevent a disaster, but also to be implemented once a disaster occurs (Salvano, 2002).For effective response to be achieved, however, a structure for decision-making and coordination of the action plan, and the actual response must be put in place. Throughout all the activities that are meant to promote disaster preparedness, the ultimate objective should be to have plans in place that are not only agreed upon by stakeholders, but also implementable given the available resources both material and manpower. Over-ambitious plans, especially with inadequate resources, are bound to fail and lower the credibility of the organization in the eyes of the public. Indeed, any disaster preparedness plan must have adequate resources that have been committed and readily available (Salvano, 2002).For fire disaster response and recovery plans to be effective and hence successful, it is important for the responders to know what to do and how to do it in case of a disaster, what is described as empowering the community to participate in disaster recovery (ISDR, 2003). For this reason, an essential part of fire disaster preparedness and recovery plan is the creating awareness among those who may be threatened by disaster such as fire outbreak at JKIA.

CHAPTER THREE

MATERIALS AND METHODS

This chapter outlines and describes methodology that was adopted for the study. Data was collected from a targeted population, organized, collated, analyzed, interpreted and presented.

3.1 Study Design

The study utilized descriptive research design. Descriptive research is suitable when one studies things as they are in the field without manipulating variables and also gives views and feelings from the respondent regarding issues like where, how and whom (Babbie, 2002.)

3.2 Study area and target Population

3.2.1 Location of JKIA

JKIA is the largest Airport in East and Central Africa, and is the focal point for major aviation activity in the region. Its importance as an aviation hub makes it the pacesetter for other airports in the region. JKIA is located approximately 20 km to the southeast of the CBD within the geographical coordinates 1° 18' 0" South, 36° 55' 0" East. It is located a short distance from the main Mombasa – Nairobi Highway in Embakasi Constituency. The closest towns to JKIA include Mavoko to the south while Nairobi Industrial areas are to the west. Residential areas (Syokimau, Mlolongo, Njiru, Ruai, Umoja and Kayole) are found to the South, East and North East. Jomo Kenyatta international airport handles over four million passengers yearly. Figure 3.1 and 3.2below illustrate the Republic of Kenya showing Kenyan Airports and location map of JKIA respectively.

Figure 3. 1: Map of the Republic of Kenya showing JKIA (Source AEO, 2006)

3.2.2 Area of study

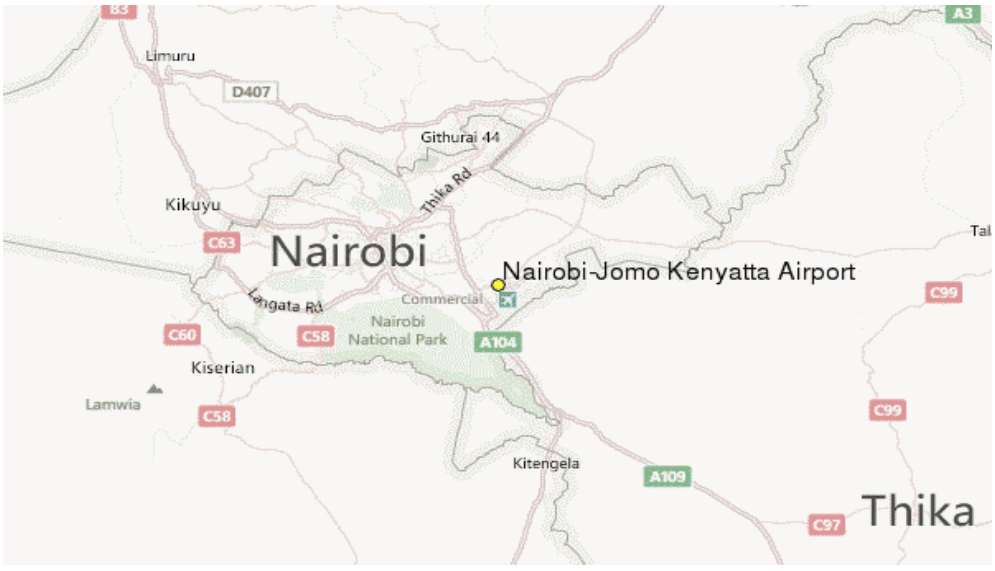

Figure 3. 2: Location map of JKIA, (Source KAA, 2010)

The population of the study comprised of Government Agencies and Cleaning Contractors within JKIA which included employees from Kenya Airport Authority,

Immigration, Kenya Airport Police, Kenya Civil Aviation Authority, Port Health and Cleaning Contractors among others. The exposed population was 1850.

3.3 Sample size determination

For determination of the sample size for questionnaire administration, the researcher applied the following formula (Bartlett *et al*, 2011):-

$$n_0 = \frac{t^2 * (p) * (1-p)}{d^2}$$

Where

no= Sample size

t = the standard variate value at 1.96 for 95% confidence level

p = the half-half chance of picking a choice, expressed as decimal of 0.5

d is the margin of error at 95% level of confidence, expressed as decimal of 0.05and then correcting for this finite population with the following equation

$$new\ n_1 = \frac{}{1 + \frac{n_0}{pop}}$$

Where:

Pop = population of 1850

From the equations, the sample size for study was 318, giving 340 with 5% allowed for attrition

3.4 Sample size distribution

The selected sample was from Employees from various Government Agencies and Cleaning Contractors.

Table 3.1: Sample size distribution

Organization	Employee category	Total population	% of th total population	Sample size With 5% allowed for attrition
KAA(Kenya Airport Authority)	KAA Employees	780	42	141
Department o Immigration	Immigration Employees	160	9	29
Kenya Airport Police	Airport police	250	14	45
Kenya Civil Aviation Authority	Air Navigation Services Employees	160	9	29
Port Health	Port Health Employees	80	4	15
Cleaning Contractors	Steward/Stewardess	420	22	77
Total population		1850	100	340

3.5 Sampling frame

A sample frame is a list of all organizations operating at JKIA. This list might not be exhaustive but included the government agencies directly involved in airport operations like the Police, KAA, KCAA, Immigration, Port Health and Cleaning Contractors among others. The size of the sample was based on the fact that the period of the research only allowed for a minimum number of workers to be interviewed through the questionnaire. To effectively represent JKIA fire safety status, Stratified random sampling was used where the population was classified into groups according to various organizations.

3.6 Research instrument

The study employed questionnaires and structured participatory observations using a prepared checklist in the collection of information. The questionnaire was designed in three main parts. Part A relate to the general information capturing the organization and duration worked. Part B aimed at obtaining the opinion of the respondents about the essential fire safety measures that are available and also captured their awareness level on fire safety at various Government Agencies within JKIA, part C was a participatory observatory check on compliance with provision of fire risk reduction rules 2007 and ICAO standards with the researcher ranking compliance of JKIA. This was done through conducting a tour to verify the facilities and equipment in place for fire protection at JKIA.Secondary data was obtained from JKIA emergency plan, records and airport fire safety manuals which were compared with the obtained data.

3.7 Data collection procedures

Primary data was gathered using questionnaires which were self-administered and observation checklist. Bartlett, *et al*(2011) state that self-administered interviews help to reach a large number of potential respondents in different locations. The questionnaires also helped to collect data from a large population of respondents at a short period of time.

The questionnaire was used to obtain both qualitative and quantitative data from the targeted respondents. Primary data collection was conducted by the researcher over a period of six weeks. Secondary data was obtained from literature review including JKIA emergency plan, records and airport fire safety manuals.

Data collection was done in two phases with the first phase involving administering questionnaires to the respondents in the selected organizations and filling in the observation checklist in the study area.

3.8 Data Processing and Analysis

After the fieldwork the obtained data was coded and classified for easy identification and then summarized for ease in interpretation. The result of the analysis wasorganized

summarized and presented using tables, pie charts, bar graphs among others.SPSS and Excel was used for data analysis.

3.9 Pilot testing

A pilot study was conducted at Wilson Airport to measure the validity and reliability of the research instrument as this has some of the highest incidences of fire disasters in Kenya. The pilot study targeted a sample size of 20 respondents in which all of them filled the questionnaires making a response rate of 100%.

3.10 Authorization

Authorization was sought from Kenya Airport Authority which is the major Government Agency within JKIA. The confidentiality of the respondents was protected in that no names or personal information was required in the questionnaire and measures were taken to ensure no coercion or undue influence was exercised. This ensured that the respondents gave fair responses.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

The study targeted a sample size of 340 respondents in which 299 completely filled the questionnaires making a response rate of 87.9%. Babbie (2002) argues that in descriptive survey research, response rate above 50 percent is adequate for data analysis. Mugenda (2003) also argues that a rate of 50 percent or higher is adequate for data analysis. This implies that 87.9 percent response rate was very appropriate for data analysis. The characteristics of the respondents sampled are presented in the first part of this chapter. The second part involved analysis of fire safety preparedness at Jomo Kenyatta International Airport.

4.1 Respondents' Characteristics

4.1.1 Respondents' Demographics

In order to establish the various issues in fire safety preparedness at JKIA, demographic data such as education, age, and gender was determined as shown in Table 4. 1. In total there were more male respondents who formed 61.5% than female who were 38.5% of the respondent. According to OSH (2007) more men than women work in jobs that expose them to high risks.

The age of the respondents show that in general most of the respondents (38.1%) were between 18-29 years of age with minority (9.7%) being above 49 years. According to Owen (2011), age of the respondents has a significant influence in responses given in descriptive studies. In spite of fire safety training programs currently available, it is unclear why reports indicate a lack of fire safety knowledge, delayed threat recognition, and delayed evacuation among the general community, especially among younger and older persons (Proulx, 2013).

The level of education for the respondents was also sought in the questionnaires. Overall results showed that almost a half (42.8%) of the study participants had secondary education with 39.8% having a university degree. This variation in education level ensured varied responses which richly contributed to getting very

valuable information for a study (Schultz et al., 2006).

Table 4. 1: Respondents' Demographics

Variable	Category	Frequency	Percent
Gender	Female	115	38.5
	Male	184	61.5
Age	18-29 yrs	114	38.1
	30-39 yrs	100	33.4
	40-49 yrs	56	18.7
	50-59 yrs	29	9.7
Level of Education	Secondary	128	42.8
	College	5	1.7
	Graduate	119	39.8
	Post graduate	47	15.7

4.1.2 Distribution per Agency

In view of the multi-organizational nature of risks in the operation of JKIA and mechanism to integrate the safety standards and practices to different stakeholders in and around the airport the study also wanted to establish the coordination and response in case of a fire emergency and to achieve this respondents' government agency they work for was sort as indicated in Figure 4. 1.

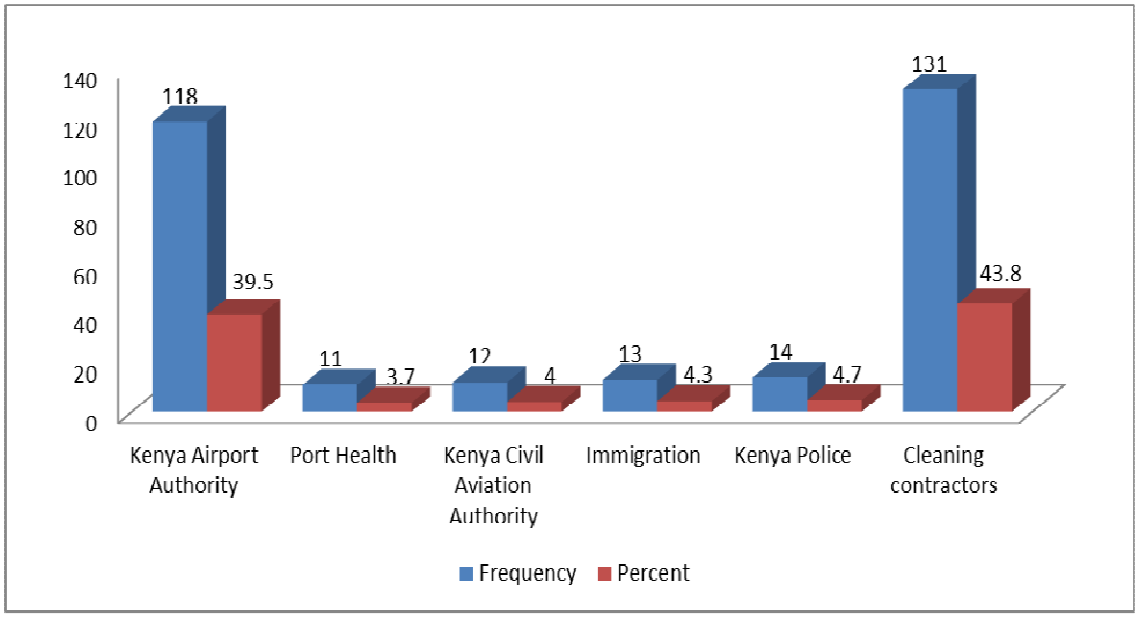

Figure 4. 1**: Respondents' Agency Employer**

The study indicated that most of the respondents (43.8%) were working as cleaning contractors followed by those working for Kenya Airport Authority (39.5%) and 16.7% for other respondents' agency employer providing support in the event of an emergency to Kenya Airport Authority. According to OSH (2007), lack of coordination in emergency response has been found to be a major contributor of accidents and injuries and even deaths.

4.1.3 Work Experience

Fire emergency preparedness is a factor of experience and training, According to Proulx (2013), fire safety training is a way of increasing public fire safety knowledge and improving their response to a fire with the aim of reducing the number of fire-related casualties.At JKIA, this was sought in order to understand how prepared the workers are in case of an emergency as shown in Figure 4. 2.

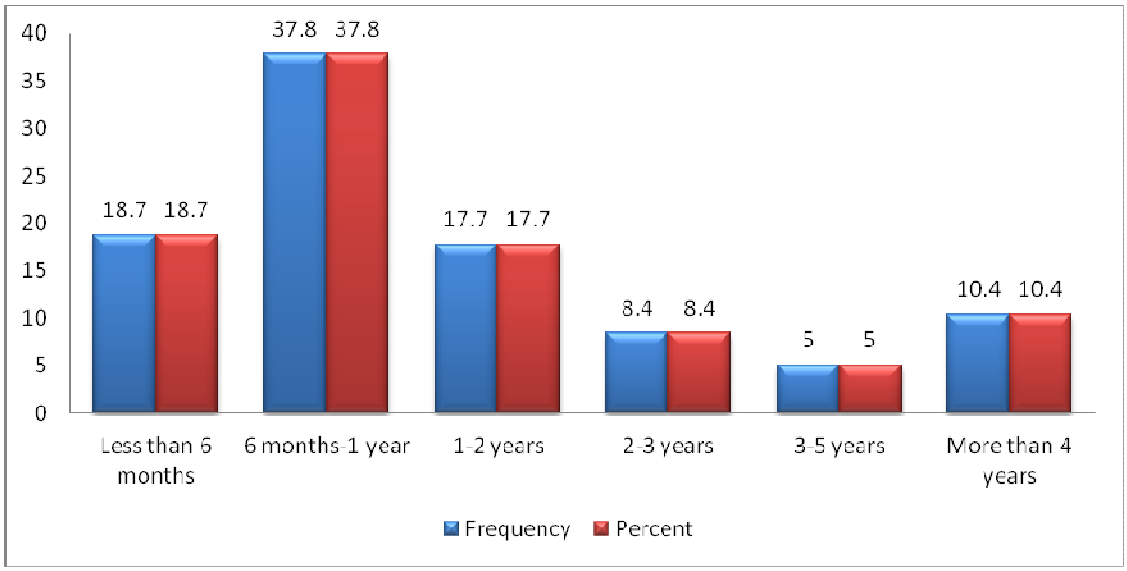

Figure 4. 2: **Length of work at the Airport**

Majority of the respondents (39.8%) had worked with the airport for 1-5 years while a good number (23.8%) reported to have worked with the airport for over 10 years. These results show that most of the respondents were familiar with the airport and could thus give reliable information. Under the management of Health and Safety at work Regulations (1999), an employer has a responsibility of ensuring that young and new people employed by them are not exposed to risk due to lack of experience or been unaware of exiting or potential risk and or lack of maturity.

4.1.4 Reliability test Results

The most common internal consistency measure known as Cronbach's alpha (α) was used to ascertain reliability of data used. It indicates the extent to which a set of test item can be treated as measuring a single latent variable (Sekaran, 2009); Cronbach's alpha reliability coefficient that ranges between 0 and 1. 0 implies that there is no internal reliability while 1 indicated perfect internal reliability. Cronbach's alpha reliability coefficient value of 0.7 or higher is considered sufficient (Sekaran, 2009). The recommended value of 0.7 was therefore used as a cut-off of reliability (Sekaran, 2009). Reliability results for all the set of variables in the questionnaires gave a Cronbach's alpha statistics of more than 0.7, thus the threshold value of 0.7 were

met.

Table 4.2: Summary of Reliability Test

Variable	Cronbach's Alpha	Number of Items
Fire safety awareness	.871	**6- questions**
Fire safety measures	.836	**12- questions**

4.2 Fire safety awareness of the airport workers

The first objective of this study was to establish the fire safety awareness of the airport workers and in order to determine the awareness levels of Airport workers; respondents were presented with several yes/no questions as shown in Figure 4. 3.

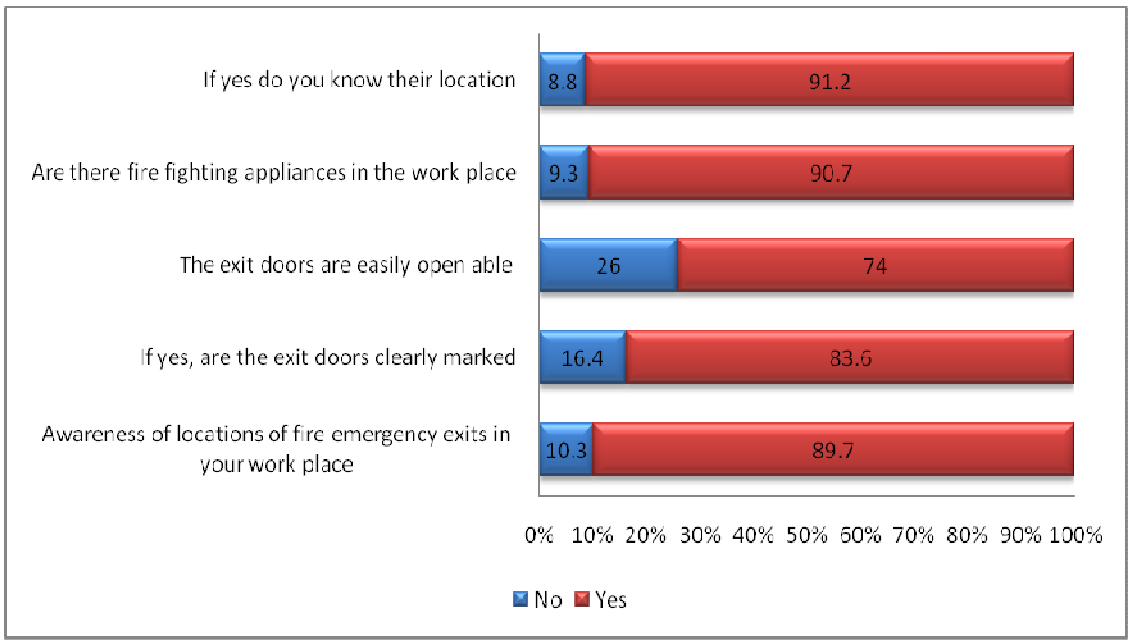

Figure 4. 3**: Fire safety Awareness**

Most of the respondents (89.7%) were aware of the locations of fire emergency exits in their work place whereas (90.7%) of the respondents were aware of fire fighting appliances in their workplace for use in case of fire and (91.2%) could locate them. These findings are in consistent with Mostue (2011) who documented that awareness level of the fire safety management will help reduce the losses and damages suffered during fire outbreaks.

More than a quarter (26%) of the respondents reported that the exit doors are not easily open able and 16.4% reported that the exit doors are not clearly marked, these findings do not conform to those of HMSO (1999) that documented that escape signage should be clearly visible formal locations in the workplace and the sign on the fire exit door prominently displayed. Obwaya (2010) also observed that Jomo Kenyatta International Airport has inadequate fire/emergency escapes routes and few trained personnel in fire fighting.

A spot check conducted by the researcher of the facility however revealed that fire exit doors are permanently closed, this is due to heightened security measures which is in contrast with Fire Risk Reduction Rules section 17 which states that every occupier shall ensure that the fire exit door, gangway and exit staircases are free from obstruction and are easily openable. The escape route should lead to a place of safety normally outside and away from the building.

4.2.1 Awareness of locations of fire emergency exits by respondents' demographics

Association between respondents' demographics (Gender, age, level of education and length of work at the Airport) and awareness of locations of fire emergency exits was sought and results displayed in

Table 4. 3.

Table 4. 3: Awareness of locations of fire emergency exits by Respondents' Demographics

Variable	Category	Aware of locations of fire emergency exits in work place		
		No	Yes	Chi-Square
Gender	Female	15.7%	84.3%	χ^2=5.559, df=1,
	Male	6.7%	93.3%	p=.018
Age	18-29 yrs	8.7%	91.3%	χ^2=2.750, df=3,
	30-39 yrs	8.2%	91.8%	p=.432
	40-49 yrs	16.0%	84.0%	
	50-59 yrs	14.3%	85.7%	
Highest level of education	Secondary	5.4%	94.6%	χ^2=6.215, df=2,
	Graduate	15.7%	84.3%	p=.045
	Post graduate	13.9%	86.1%	
Length of work at the Airport	Below 1 yr	17.3%	82.7%	χ^2=6.849, df=5,
	1-5 yrs	14.2%	85.8%	p=.232
	5-10 yrs	13.7%	86.3%	
	10-15 yrs	10.0%	90.0%	
	15-20 yrs	13.3%	86.7%	
	Above 20 yrs	6.7%	93.3%	

In terms of gender, fire safety awareness was sort and the results indicated that male respondent (93.3%) were more aware of locations of fire emergency exits as compared to the Female respondent (84.3%).This association of locations of fire emergency exits and gender of the respondents was statistically significant at 95% confidence level with $\varkappa^2$ (df=1) =5.559 since p=.018 was less than the conventional 5% level of significance. Younger respondents (18-39 years) were more aware of locations of fire emergency exits as compared to the older ones. This association of awareness of locations of fire emergency exits and age of the respondents was not statistically significant at 95% confidence level with $\varkappa^2$ (df=3) =2.750 since p=.432. Most of the respondents that had secondary education were more aware of locations of fire emergency exits as compared to the other higher levels of education. This can be attributed to their support and technical nature of working.

This association of awareness of locations of fire emergency exits and level of education of the respondents was statistically significant at 95% confidence level with $\varkappa^2$ (df=2) =6.215 since p=.045. Respondents with over 20 years working at the

airport were aware of locations of fire emergency exits as compared to the newer respondents. This would be due to experience and training which is a way of increasing public fire safety knowledge and improving their response to fire emergencies. The association of awareness of locations of fire emergency exits and length of time working at the Airport of the respondents was not statistically significant with $\varkappa^2$ (df=5) =6.849 since p=.232.

The results of this study were in agreement with those of HMSO (1999) who associated awareness of locations of fire emergency exits in work place with both gender and level of education of the respondents. It documented that male respondents and respondents with secondary education were more likely to be aware of the location of fire fighting equipment and emergency exits compared to female respondents and those with higher education. This could be attributed to the technical nature of work for most men (Owen, 2011). However, the results were not consistent with those of Coulles&Eskell (2010) who associated awareness of locations of fire emergency exits in work place with respondents' experience.

4.2.2 Type of fire fighting appliances provided

When asked to indicate the type of fire fighting appliances provided, most of the respondents mentioned Portable fire extinguishers (41%), Hose reels (35%) and Fire hydrants (19%). The findings are in line with fire rules that every occupier shall ensure that highly flammable substances are stored in suitable fixed storage tanks in safe positions, or in suitable closed vessels kept in a safe positions in the open air (GoK, 2007).

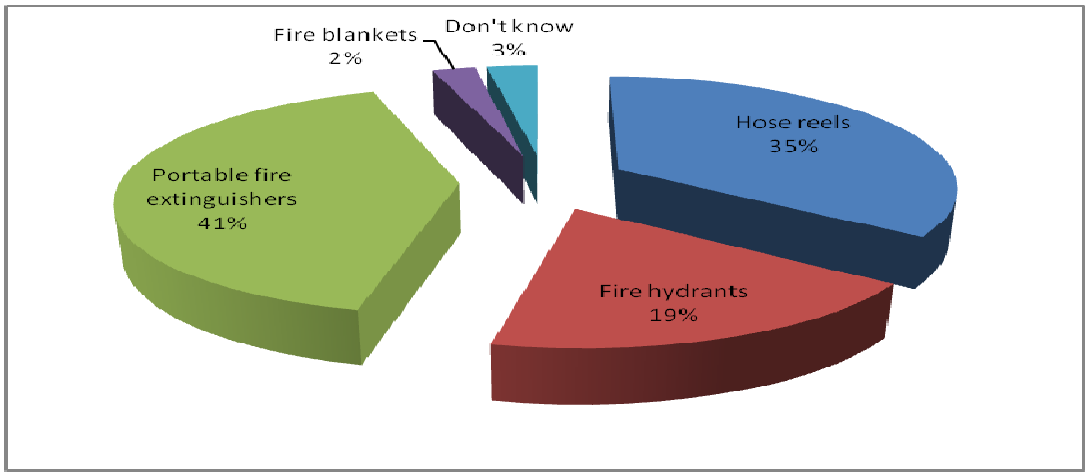

Figure 4. 4: Fire fighting appliances provided

4.2.3 Awareness of fire fighting appliances by respondents' demographics

On awareness of fire fighting appliances (Portable fire extinguishers, Hose reels, Fire hydrants, fire blankets etc) in terms of Gender, age, level of education and length of work at the Airport the results are as shown in Table 4.4.

Table 4.4: Awareness of fire fighting appliances in the work place by Respondents' Demographics

Variable	Category	Awareness of fire fighting appliances in the work place		
		No	Yes	Chi-Square
Gender	Female	13.6%	86.4%	χ^2=3.177, df=1,
	Male	7.1%	92.9%	p=.075
Age	18-29 yrs	7.9%	92.1%	χ^2=4.019, df=3,
	30-39 yrs	16.7%	83.3%	p=.259
	40-49 yrs	4.2%	95.8%	
	50-59 yrs	7.9%	92.1%	
Highest level of education	Secondary	4.5%	95.5%	χ^2=7.215, df=2,
	Graduate	12.6%	87.4%	p=.027
	Post graduate	17.5%	82.5%	
Length or work at the Airport	Below 1 yr	13.7%	86.3%	χ^2=8.719, df=5,
	1-5 yrs	14.5%	85.5%	p=.121
	5-10 yrs	12.0%	88.0%	
	10-15 yrs	8.0%	92.0%	
	15-20 yrs	6.7%	93.3%	
	Above 20 yrs	6.5%	93.5%	

In terms of gender, fire safety awareness was sort and the results indicated that male respondents (92.9%) were more aware of fire fighting appliances in the work place as compared to the female respondents (86.4%). The association of awareness of fire fighting appliances in the work place and gender of the respondents was not statistically significant at 95% confidence level since p=0.075 Between (30-39 years) respondents were least aware (16.7%) of fire fighting appliances in the work place as compared to the other age groups. The association of awareness of fire fighting appliances in the work place and age of the respondents was not statistically significant at 95% confidence level with $\varkappa^2$ (df=3) =4.019 since p=0.259.

Most of the respondents that had secondary education (95.5%) were more aware of fire fighting appliances in the work place as compared to the other higher levels of education. This association of awareness of fire fighting appliances in the work place and level of education at secondary school level of the respondents was statistically significant at 95% confidence level with $\varkappa^2$ (df=2) = 7.215 since p=.027.

The current results were consistent with those of Kwiatkowski (2007) who associated awareness of fire fighting appliances in the work place to level of education of the workers arguing that employees with lower level of education were likely to be the technical personnel working on the ground and thus more aware of the location of fire fighting appliances. However, society expects that the higher the level of education a person has, the more aware he/she is in all aspects of life.

Respondents with over 15 years working at the airport were more aware of the location of fire fighting appliances in the work place as compared to those who had worked between (1-5 years).This association of awareness of fire fighting appliances in the work place and length of time working at the Airport of the respondents was not statistically significant with $\varkappa^2$ (df=5) =8.719 since p=0.121.

Fire fighting equipment must be in place for employees to use without exposing them to danger, to extinguish a fire in its early stages. The equipment must be suitable to the risks and appropriate staff will need training and instruction in its proper use. In larger and more complex premises, a greater number of portable extinguishers,

strategically sited throughout the premises are likely to be the minimum required (OSH, 2007).

4.2.4 Likely causes of fire at workplace

Respondents in an open ended question were asked to state the likely causes of fire in their workplace and their responses were presented in Figure 4. 5. A total of 18 likely causes of fire were detected, of this majority stated causes of fire in workplace included electrical fault and exposed cables (87%), smoking (28%) and flammable chemicals (27.6%).

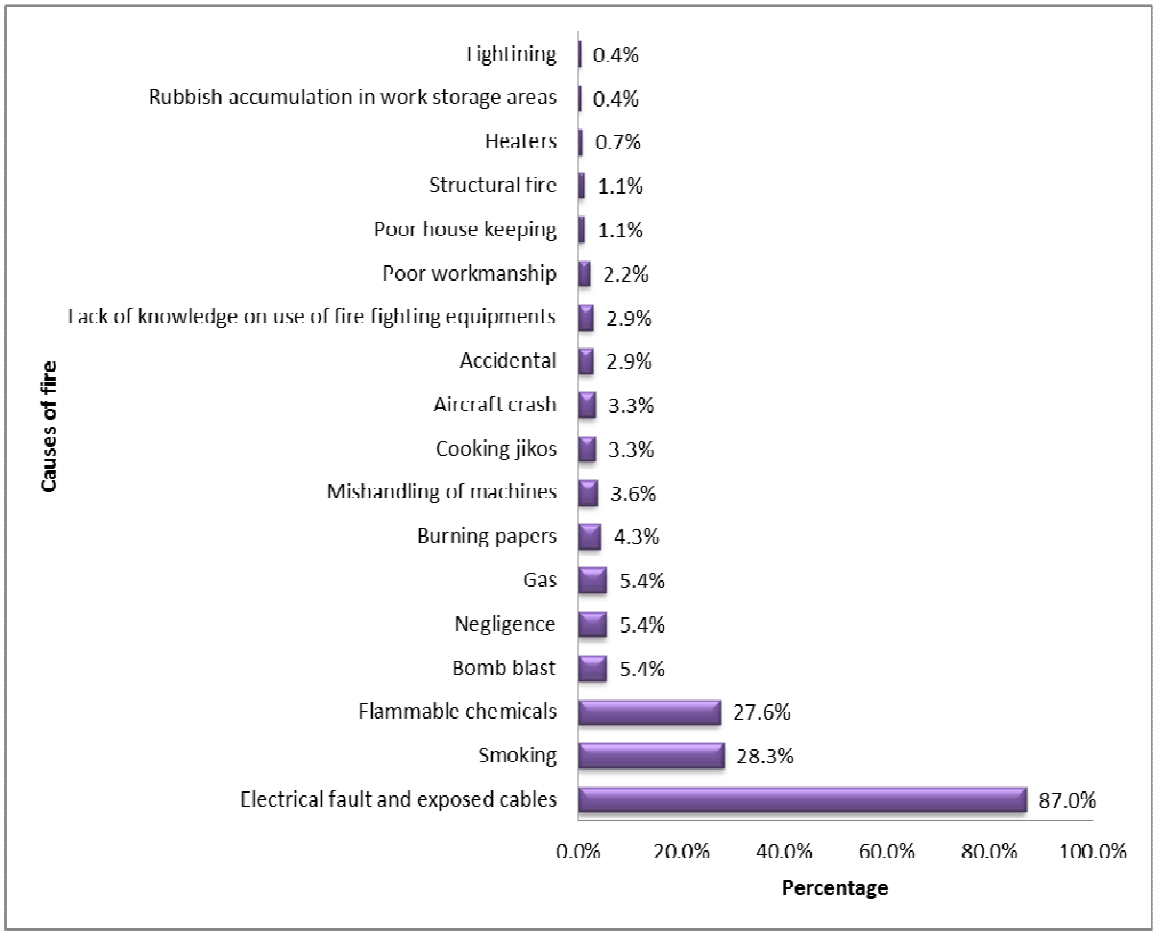

Figure 4. 5: Likely causes of fire in workplace

These findings agree with those of Gold and Koigi (2009) who reported that majority of fires in workplaces are caused by faulty electrical appliances and exposed cables,

for instance the recent fire incident at Jomo Kenyatta International Airport which destroyed the whole of international arrivals and immigration area in August 7th 2013 as shown in Figure 4. 6, Figure 4. 7 and Figure 4. 8. Faulty electrical installations can be a significant potential of fire ignition sources. It is that imperative that occupiers maintain the highest standards of electrical safety (Stokes, 2007).

Figure 4. 6: Jomo Kenyatta international arrivals before the fire

Figure 4. 7: Jomo Kenyatta international arrivals during the fire

Figure 4. 8: Jomo Kenyatta International arrivals after the fire

4.3 Fire safety measures in place to minimize the potential effects of fire tragedy at JKIA

The second objective of this study was to evaluate the fire safety measures that have been put in place to minimize the potential effects of fire tragedy at JKIA.As shown inFigure 4. 9. Most of the respondents (75%) reported that there were fire detectors at their workplace. When asked to state the types of fire detection systems provided, most of the respondents (86%) reported smoke detectors with a few reporting heat detectors (14%) and flame (15%). The findings were in line with fire safety provision that, every occupier shall ensure that fire detection appliances are located in the appropriate places for immediate activation of an alarm or automatic fire extinguishing systems GoK (2007).

Section 28 (1) of the Fire risk reduction rules states that every occupier shall provide and maintain fire detection appliances and ensure that fire detection appliances are connected to audible and visual flashing devices to provide a warning to the workers for emergency response. It mentions the importance of firefighting equipment including Fire detection systems in fire safety management.

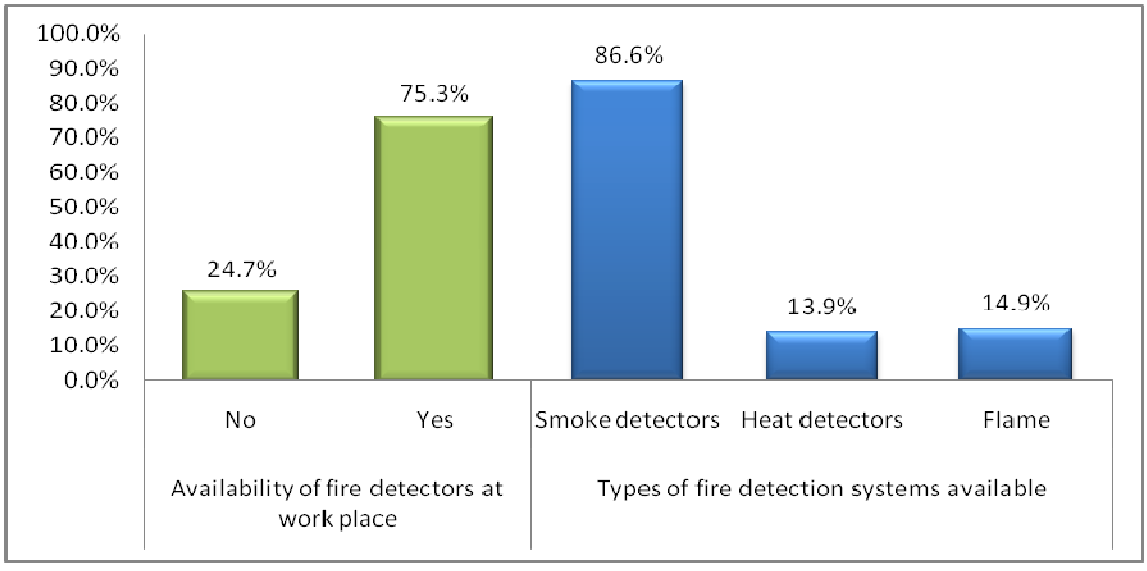

Figure 4. 9: Availability of fire detectors

4.3.1 Awareness of presence of fire detectors by respondents' demographics

Association between respondents' demographics (Gender, age, level of education and length of work at the Airport) and awareness of presence of fire detectors was sought and results displayed in

Table 4. 5.

Table 4. 5: **Fire detectors at your work place**

Variable	Category	Availability of fire detectors at work place		
		No	Yes	Chi-Square
Gender	Female	29.7%	70.3%	χ^2=2.02, df=1,
	Male	21.6%	78.4%	p=.155
Age	18-29 yrs	22.9%	77.1%	χ^2=11.048, df=3,
	30-39 yrs	15.3%	84.7%	p=.011
	40-49 yrs	37.0%	63.0%	
	50-59 yrs	40.9%	59.1%	
Highest level of education	Secondary	20.4%	79.6%	χ^2=2.772, df=2,
	Graduate	30.9%	69.1%	p=.250
	Post graduate	27.0%	73.0%	
Length or work at the Airport	Below 1 yr	19.5%	80.5%	χ^2=12.775, df=5,
	1-5 yrs	22.7%	77.3%	p=.026
	5-10 yrs	13.7%	86.3%	
	10-15 yrs	36.4%	63.6%	
	15-20 yrs	46.7%	53.3%	
	Above 20 yrs	39.3%	60.7%	

The results showed that male respondents (78.4%) report more on availability of fire detectors at work place as compared to the female respondents (70.3%). This association of availability of fire detectors at work place and gender of the respondents was not statistically significant at 95% confidence level with $\varkappa^2$ (df=1) =2.02 since p=.155.The findings of this study agrees with those of Okungu (2006) who associated awareness of fire detectors at work place with respondents gender indicating that male workers were more likely to be aware of fire detectors at work place.

Respondents (18-29 years) reported more on availability of fire detectors at work place as compared to the age bracket of (50-59 years). This association of availability of fire detectors at work place and age of the respondents was statistically significant at 95% confidence level with $\varkappa^2$ (df=3) =11.048 since p=.011. Most of the respondents that had secondary education were reported more on availability of fire detectors at work place as compared to the other higher levels of education; this is attributed to their support/technical nature of working. The association of availability of fire detectors at work place and level of education of the respondents was not

statistically significant at 95% confidence level with χ^2 (df=2) =2.772 since p=.250. Respondents with less than 10 years working at the airport were more likely to report availability of fire detectors at work place as compared to those with more than 10 years' experience. This association of availability of fire detectors at work place and length of time working at the airport of the respondents was statistically significant at 95% confidence level with χ^2 (df=5) =12.775 since p=.026.

The Health and Safety Authority (OSH, 2007) prescribes that all workplaces should have arrangements for detecting fire. Consideration must be given to any parts of the work place where a fire could start and spread undetected. This could be a storage area or a basement that is not visited on a regular basis.

4.3.2 Fire safety training programmes

On rating fire safety measures the respondents were asked to state whether they had been subjected to various training programmes as shown in Figure 4. 10. Almost a third of the respondents (29.8%) had not been trained on how to use a fire extinguisher while a quarter of the respondents (25.8%) had not been trained on what actions to take in case of a fire outbreak. The findings do not conform to those of Okungu (2006) who recommended appropriate training in fire disaster preparedness for all workers.

In terms of procedures in place a quarter of the respondents (23.3%) reported lack of procedures in place for emergency evacuation in case of fire at their workplace. Most of the respondents (87.7%) were aware of emergency assembly point at their workplace and close to a half of the respondents (42.5%) reported that their workplace does not carry out emergency evacuation drills.Lack of training on basic fire safety increases the risk of fire outbreaks as well as resulting in poor response in case of an emergency.

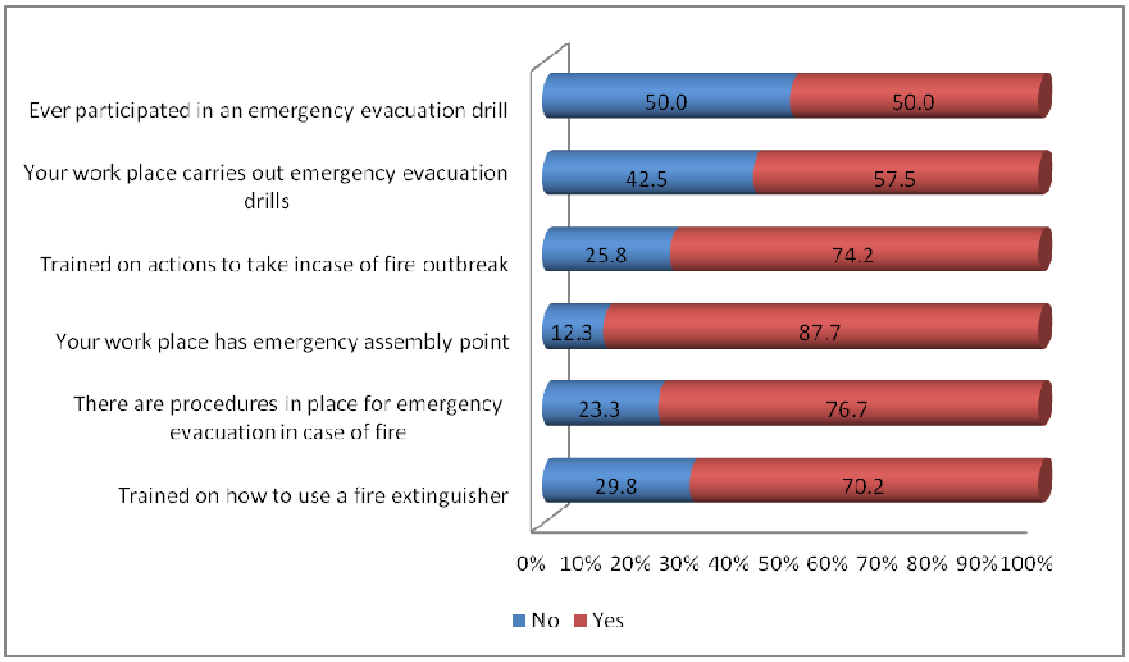

Figure 4. 10: **Rating of fire safety measures**

These results were not consistent with those of Cote (2011) who documented that fire drill is an important exercise for instilling skills on evacuation procedures and consequences of fire are completely avoidable if safety requirements are observed and that training must meet the goal of reducing the number of fires and thus reduce death and injury among workers, and the financial loss on organizations.

Lack of training programmes and Fire drills downgrade the usefulness of measures put in place to respond to fires as employees would still not know what to do in case of emergencies. This finding is similar to that of DiGuiseppi et al. (2012), and the NFPA (2000, 2002) reports that also indicated that fire safety training enables individuals to take more precautions to prevent a fire spread.

4.3.3 Training on use of fire extinguisher by respondents' demographics

The respondent's training on use of fire extinguisher at the Airport was subjected to chi statistics against demographic parameters as shown in

Table 4. 6.

Table 4. 6: Training on use of fire extinguisher by Respondents' Demographics

Variable	Category	Trained on how to use a fire extinguisher		
		No	Yes	Chi-Square
Gender	Female	42.9%	57.1%	χ^2=13.172, df=1,
	Male	22.2%	77.8%	p<.001
Age	18-29 yrs	35.6%	64.4%	χ^2=3.999, df=3,
	30-39 yrs	31.1%	68.9%	p=.262
	40-49 yrs	30.0%	70.0%	
	50-59 yrs	15.4%	84.6%	
Highest level of education	Secondary	30.9%	69.1%	χ^2=0.380, df=2,
	Graduate	28.3%	71.7%	p=.827
	Post graduate	26.2%	73.8%	
Length or work at the Airport	Below 1 yr	40.7%	59.3%	χ^2=15.856, df=5,
	1-5 yrs	33.3%	66.7%	p=.007
	5-10 yrs	30.8%	69.2%	
	10-15 yrs	28.0%	72.0%	
	15-20 yrs	13.3%	86.7%	
	Above 20 yrs	6.3%	93.7%	

The results showed that more male (77.8%) respondents were trained than female (57.1%). on how to use a fire extinguisher. This association of training on how to use a fire extinguisher and gender of the respondents was statistically significant at 95% confidence level with $\varkappa^2$ (df=1) =13.172 since p<.001. Older respondents (above 40 years) were more trained on how to use a fire extinguisher as compared to the younger ones. However, this association of training on how to use a fire extinguisher and age of the respondents was not statistically significant at 95% confidence level with $\varkappa^2$ (df=3) =3.999 since p=.262.

Most of the respondents that had secondary education were less trained on how to use a fire extinguisher as compared to the other higher levels of education. This association of training on how to use a fire extinguisher and level of education of the respondents was not statistically significant at 95% confidence level with $\varkappa^2$ (df=2) =.380 since p=.827. Respondents with over 10 years working at the airport were more trained on how to use a fire extinguisher as compared to those who had worked between (1-5) years. This association of training on how to use a fire extinguisher and length of time working at the airport of the respondents was statistically significant at 95% confidence level with $\varkappa^2$ (df=5) =15.856 with p=.007.

Results of the current study were not consistent with those of ISDR (2003) that recommended that for fire disaster response and recovery plans to be effective and hence successful, it is important for all people to know what to do and how to do it in case of a disaster, what is described as empowering the community to participate in disaster recovery.

4.3.4 Procedures in place for emergency evacuation by respondents' demographics

Association between respondent's awareness on procedures in place for emergency evacuation in case of fire at the Airport and trainings on how to use a fire extinguisher and action to take in case of fire outbreak was sought and the results were presented in Table 4. 7.

Table 4. 7: Procedures in place for emergency evacuation in case of fire

Variable	Category	Procedures in place for emergency evacuation in case of fire		
		No	Yes	Chi-Square
Trained on how to use a fire extinguisher	Yes	26.2%	73.8%	χ^2=9.237, df=1, p=0.031
	No	62.0%	38.0%	
Trained on what actions to take in case of a fire outbreak	Yes	26.9%	73.1%	χ^2=11.148, df=1, p=0.036
	No	58.8%	41.2%	

The results showed that respondents trained on how to use a fire extinguisher (73.8%) were more aware of procedures in place for emergency evacuation in case of fire as compared to those not trained (38.0%). This association of awareness of procedures in place for emergency evacuation in case of fire and training on how to use a fire extinguisher was statistically significant at 95% confidence level with $\varkappa^2$ (df=1) =9.237 since p=0.031. Respondents trained on what actions to take in case of a fire outbreak (73.1%) were more aware of procedures in place for emergency evacuation in case of fire as compared to those not trained (41.2%). This association of awareness of procedures in place for emergency evacuation in case of fire and training on what actions to take in case of a fire outbreak was statistically significant

at 95% confidence level with $\varkappa^2$ (df=1) =11.148 since p=.036.

Results showed that respondents who reported awareness of procedures in place for emergency evacuation in case of fire were likely to have been trained on how to use a fire extinguisher and on what actions to take in case of a fire outbreak. These results are in line with those of ISDR (2003) that documents that an essential part of disaster preparedness and recovery plan is creating awareness through comprehensive trainings among those who may be threatened by disaster.

4.3.5 Availability of emergency assembly point by respondents' demographics

The respondent's awareness on availability of emergency assembly point at the Airport was subjected to chi statistics against trainings on how to use a fire extinguisher and action to take in case of fire outbreak parameters as shown in **Table 4.** 8**.**

Table 4. 8: Your work place has emergency assembly point

Variable	Category	Availability of emergency assembly point		
		No	Yes	Chi-Square
Trained on how to use a fire extinguisher	Yes	8.5%	91.5%	χ^2=1.15, df=1, p=0.734
	No	16.7%	83.3%	
Trained on what actions to take in case of a fire outbreak	Yes	24.8%	75.2%	χ^2=2.542, df=1, p=0.468
	No	34.8%	65.2%	

The results showed that the association of awareness of availability of emergency assembly point and training on how to use a fire extinguisher was not statistically significant at 95% confidence level with $\varkappa^2$ (df=1) =1.15 since p=.734. The association of awareness of availability of emergency assembly point and training on what actions to take in case of a fire outbreak was also not statistically significant at 95% confidence level with $\varkappa^2$ (df=1) =2.542 since p=.468.

Results showed that most respondents were aware of availability of emergency assembly point irrespective of whether they had trained on how to use a fire extinguisher and on what actions to take in case of a fire outbreak or not. The results were consistent with those of OSH (2007) that recommends occupants to ensure that the fire exit door, gangway and exit staircases are free of obstruction and that every

emergency exit is distinctively and conspicuously marked in green letters and clear route to emergency assembly point provided.

The principle on which means of escape provisions are based is that the time available for escape, an assessment of the length of time between the fire starting and it making the means of escape from the workplace unsafe, is greater than the time needed for escape, the length of time it will take everyone to evacuate once a fire has been discovered and warning given (OSH, 2007).

4.3.6 Action to take in case of fire outbreak by respondents' demographics

The respondent's training on action to take in case of fire outbreak was subjected to chi statistics against demographics parameters as shown in **Error! Reference source not found.**.

Table 4. 9: Trained on actions to take in case of fire outbreak

Variable	Category	Trained on actions to take in case of fire outbreak		
		No	Yes	Chi-Square
Gender	Female	34.6%	65.4%	χ^2=5.050, df=1, p=.025
	Male	22.2%	77.8%	
Age	18-29 yrs	30.7%	69.3%	χ^2=4.210, df=3, p=.240
	30-39 yrs	20.2%	79.8%	
	40-49 yrs	34.0%	66.0%	
	50-59 yrs	23.1%	76.9%	
Highest level of education	Secondary	22.7%	77.3%	χ^2=1.807, df=2, p=.405
	Graduate	26.7%	73.3%	
	Post graduate	33.3%	66.7%	
Length or work at the Airport	Below 1 yr	26.4%	73.6%	χ^2=8.679, df=5, p=.123
	1-5 yrs	29.7%	70.3%	
	5-10 yrs	26.9%	73.1%	
	10-15 yrs	20.0%	80.0%	
	15-20 yrs	40.0%	60.0%	
	Above 20 yrs	6.7%	93.3%	

The results showed that male respondents (77.8%) were more trained on actions to take in case of fire outbreak as compared to the female respondents (65.4%). This association of training on actions to take in case of fire outbreak and gender of the respondents was statistically significant at 95% confidence level with $\varkappa^2$ (df=1) =5.050 since p=.018 was less than the conventional 5% level of significance. The likelihood of male workers having been trained on actions to take in case of fire outbreak more than their female counterparts contradicts with ISDR (2003) recommendation that comprehensive trainings among all those who may be threatened by disaster is essential part of disaster preparedness and recovery plan.

The association between training on actions to take in case of fire outbreak and age, level of education and length of work at the airport were not statistically significant at 95% confidence level. These results are in line with those of Kapoor (2009) that recommends public information and health and safety education for all occupants of high risk working areas.

4.3.7 Awareness of Emergency evacuation drills by respondents' demographics

The respondent's awareness on whether their workplace carries out Emergency evacuation drills at the Airport was subjected to chi statistics against trainings on how to use a fire extinguisher and action to take in case of fire outbreak parameters as shown in**Table 4. 10**.

Table 4. 10: Your work place carries out emergency evacuation drills

Variable	**Category**	Work place carries out emergency evacuation drills		
		No	Yes	Chi-Square
Trained on how to use a fire extinguisher	Yes	46.0%	54.0%	χ^2=0.812, df=1, p=0.733
	No	42.8%	57.2%	
Trained on what actions to take in case of a fire outbreak	Yes	39.0%	61.0%	χ^2=1.640, df=1, p=0.573
	No	41.8%	58.2%	

The results showed that the association of awareness of work place carrying out emergency evacuation drills and training on how to use a fire extinguisher was not statistically significant at 95% confidence level with($\varkappa^2$= 0.812df=1 p=0.733.) The association of awareness of work place carrying out emergency evacuation drills and training on what actions to take in case of a fire outbreak was also not statistically significant at 95% confidence level with ($\varkappa^2$ =1.64df=1 p=0.573.)

The study revealed that most respondents were not aware of work place carrying out emergency evacuation drills. These results do not confirm to provisions of ICAO (2004) that airport emergency exercises/drills in accordance with the requirements stipulated in ICAO section 9.12 should be conducted at intervals not exceeding two (2) years. It is critical that regular evacuation drills are conducted to enhance emergency response and preparedness.

4.3.8 Participation in Emergency evacuation drills by respondents' demographics

The respondent's participation in an emergency evacuation drill at the Airport was subjected to chi statistics against trainings on how to use a fire extinguisher and

action to take in case of fire outbreak parameters as shown in Table 4. 11.

Table 4. 11: Participation in an emergency evacuation drill

Variable	Category	Participation in an emergency evacuation drill		
		No	Yes	Chi-Square
Trained on how to use a fire extinguisher	Yes	38.5%	61.5%	χ^2=1.020, df=2, p=.221
	No	48.9%	51.1%	
Trained on what actions to take in case of a fire outbreak	Yes	31.4%	68.6%	χ^2=0.317, df=1, p=.378
	No	41.2%	58.8%	

The results showed that the association of participation in an emergency evacuation drill and training on how to use a fire extinguisher was not statistically significant at 95% confidence level with $\varkappa^2$ (df=1) =1.020 since p=0.221. The association of participation in an emergency evacuation drill and training on what actions to take in case of a fire outbreak was also not statistically significant at 95% confidence level with $\varkappa^2$ (df=1) =0.317 since p=0.378.

Results showed that a significant number of respondents do not participate in an emergency evacuation drill. These results were not in consistent with those of ICAO (2004) that considers drills as educational experience and a valuable source of information and ideas. They (drills) help eliminate mistakes that would otherwise occur during a real emergency.

4.3.9 Respondents actions in case of a fire outbreak

Respondents in an open ended question were asked to state in their own words, what they would do in case of a fire outbreak in their workplace as shown in figure 4.8 below; a total of 24 likely actions to take in case of a fire outbreak were detected and the most reported actions included; run shouting fire, fire and calling for help (37.2%), crawling towards fire exit doors (25.3%), using fire fighting equipment available to put off the fire (20.4%), alerting the fire brigade department (17.8%), switching on the alarm siren (16.0%), running towards fire assembly points (15.6%), following emergency evacuation procedures (12.6%) and walking out of the building (11.9%).

These results showed that most of the respondents knew of actions to take in case of fire outbreak thus in consistent withSalvano (2002) recommendation that coordination is

an essential ingredient in a disaster preparedness plan which means arrangements and preparations should be put in place not only to prevent a disaster, but also to be implemented once a disaster occurs.

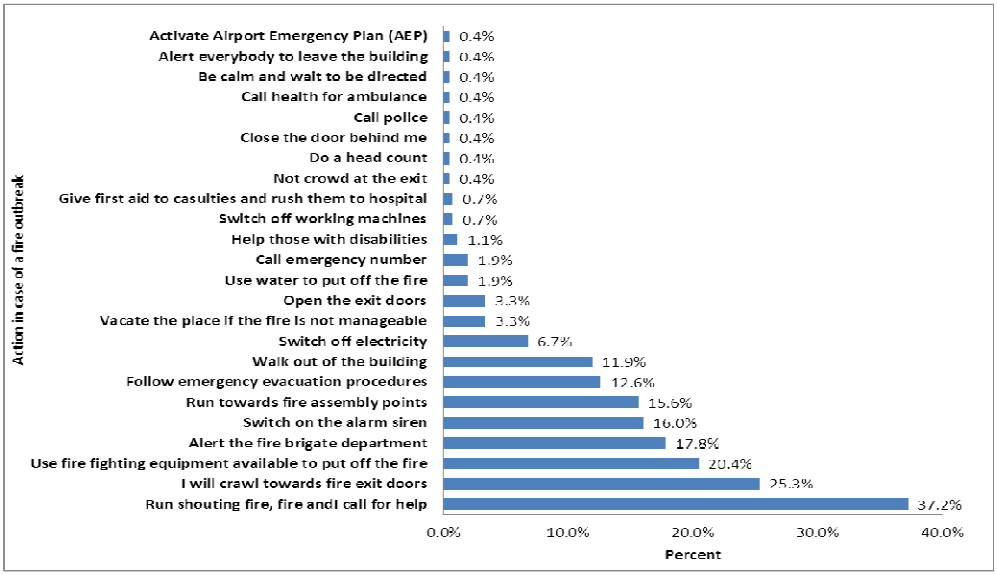

Figure 4. 11: Respondents' actions in case of fire

4.3.10 Fire Safety Policy

Most of the respondents (66%) reported that their workplace had fire safety policy while 17% had no idea of existence of such a policy. A spot check conducted by the researcher of the facility however revealed that there are no fire policies in place but only fire procedures which are not strategically placed. These results were not consistent with those of Salvano (2002) who recommended that any disaster preparedness plan must have adequate resources that have been committed and readily available and all vulnerable persons should be aware of workplace safety policy.

Lacking regulations and response policies, some airports employ *ad hoc* emergency response measures leading to disparities in the delivery of emergency services; while some airports have excellent response plans to save lives, others have very poor plans (Coote, 2010).

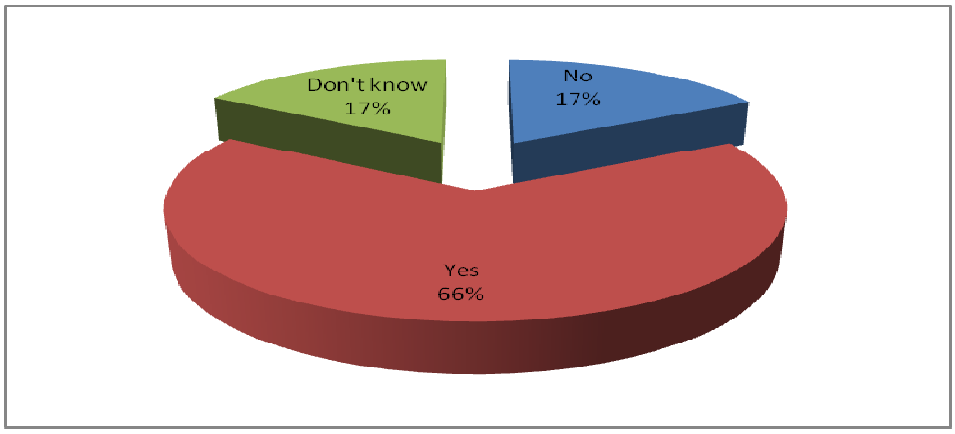

Figure 4. 12: Your work place has fire safety policy

4.3.11 Fire Disaster Preparedness

On five point likert scale respondents were asked to rate their workplace in terms of fire disaster preparedness. Most of the respondents (70.2%) agreed that their workplace has well trained manpower to handle fire emergencies. Slightly over a half of the respondents (55.8%) were well prepared to handle any fire related incidences at their workplace while (53.0%) of the respondents reported availability of good refresher courses and drills offered at their workplace to enable them handle any fire emergencies/disasters. Most of the respondent (72.4%) agreed that their workplace has facilities to handle any fire related incidences. The results were in consistent with those of ISDR (2003) which document that for fire disaster response and recovery plans to be effective and hence successful, it is important for those people who will respond to know what to do and how to do it in case of a disaster, what is described as empowering the community to participate in disaster recovery.

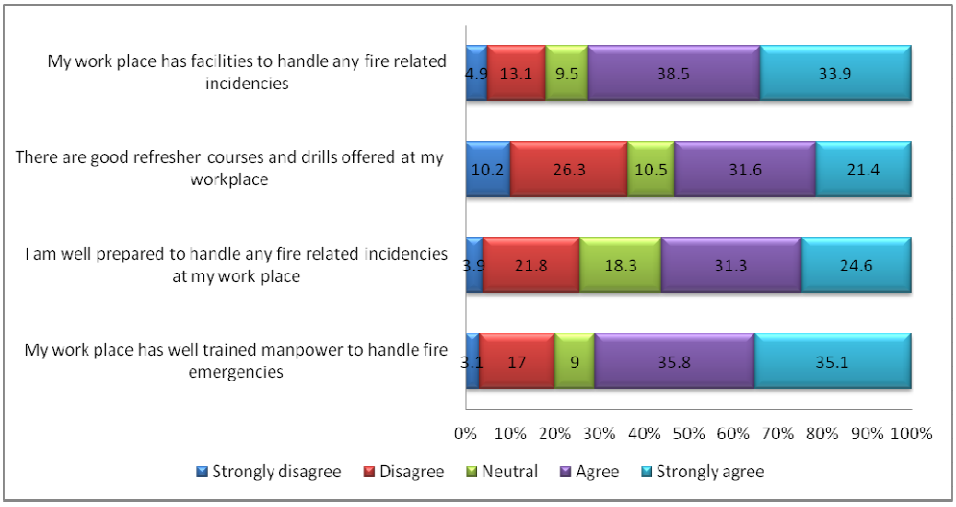

Figure 4. 13: Rating of workplace in terms of fire disaster preparedness

4.4 Compliance with provision of Fire Risk Reduction Rules and ICAO standards

The third objective of this study was to determine the compliance with provision of fire risk reduction rules and ICAO standards.The researcher used observational check list to rank compliance level of JKIA with the provisions of the fire reduction rules (FRR) 2007 and ICAO standards through conducting a facilities tour with the senior fire chief officer.

Key to Rating; 4= Good: Complies to at least 90% of the requirements of the Rules; 3= Satisfactory: Complies to at least 75% of the requirements of the Rules; 2= Average: Complies to at least 60% of the requirements of the Rules and 1= Poor: Compliance is below 60% of the requirements of the Rules.

4.4.1 Fire Prevention

Compliance with provision of Fire Risk Reduction Rules and ICAO standards was checked using four components including; fire prevention, fire protection, fire suppression and management control. Scores were averaged for each component and results displayed in the tables below.

Fire prevention was composed of location of highly flammable substances; storage of flammable substances; marking and labelling storage for flammables; handling of

flammables; ventilation for flammables storage; removal of flammables where there is heat; removal of waste; machinery layout and handling of electrical equipment with an overall score of 3.0. This indicates that in terms of fire prevention, JKIA is satisfactory since it complies to at least 75% of the requirements of the Rules.

Table 4. 12: Fire Prevention

		FIRE PREVENTION	1	2	3	4
i.	FRR	Location of highly flammable substances				√
ii.	FRR	Storage of flammable substances				√
iii.	FRR	Marking and labelling storage for flammables				√
iv.	FRR	Handling of flammables				√
v.	FRR	Ventilation for flammables storage				√
vi.	FRR	Removal of flammables where there is heat				√
vii.	FRR/ICAO	Removal of waste	√			
viii.	FRR	Machinery layout	√			
ix.	FRR	Handling of electrical equipment	√			
Average Score			**3.0**			

4.4.2 Fire Protection

Fire protection was composed of fire escape routes; control of spread of smoke; means of evacuation; means of emergency communication; emergency lighting; fire alarm and detection system; fire evacuation drills and fire assembly points with an overall score of 1.1. This means that in terms of fire protection, JKIA is poor is compliance is below 60% of the requirements of the Rules.

Table 4. 13: Fire Protection

		FIRE PROTECTION	1	2	3	4
i.	FRR/ICAO	Fire escape routes	√			
ii.	FRR	Control of spread of smoke	√			
iii.	FRR/ICAO	Means of evacuation	√			
iv.	FRR/ICAO	Means of emergency communication	√			
v.	FRR/ICAO	Emergency lighting	√			
vi.	FRR/ICAO	Fire alarm and detection system	√			
vii.	ICAO	Fire evacuation drills	√			
viii.	ICAO	Fire assembly points		√		
Average Score			**1.1**			

4.4.3 Fire Suppression

Fire Suppression was assessed using; fire fighting appliances; maintenance and

testing of fire extinguishers; maintenance of fixed water systems; colour coding of pipes and water storage with an overall score of 2.2. This indicates in terms of fire suppression that JKIA is average since complies was at least 60% of the requirements of the Rules.

Table 4. 14: Fire Suppression

		FIRE SUPPRESSION	1	2	3	4
i.	FRR/ICAO	Fire fighting appliances		√		
ii.	FRR/ICAO	Maintenance and testing of fire extinguishers		√		
iii.	FRR/ICAO	Maintenance of fixed water systems		√		
iv.	FRR	Colour coding of pipes	√			
v.	FRR/ICAO	Water storage				√
Average Score			**2.2**			

4.4.4 Management Control

Management Control was measured using; fire safety policy available; fire safety audit; trained fire fighting team; fire evacuation procedures available; good housekeeping and notification of fire occurrence with an overall score of 1.0. Therefore, in terms of Management Control JKIA is poor since compliance is below 60% of the requirements of the Rules.

Table 4. 15: Management Control

		MANAGEMENT CONTROL	1	2	3	4
i.	FRR/ICAO	Fire safety policy available	√			
ii.	FRR/ICAO	Fire safety audit	√			
iii.	FRR/ICAO	Trained fire fighting team	√			
iv.	ICAO	Fire evacuation procedures available	√			
v.	FRR	Good housekeeping	√			
vi.	FRR	Notification of fire occurrence	√			
Average Score			**1.0**			

4.4.5 Summary

In summary the average of the four components of compliance with provision of Fire Risk Reduction Rules and ICAO standards is **1.9** which is close to average compliance with the rules.

Presently, modifications has been done to the upcoming buildings thus complies with the ICAO and FRR rules. Terminal 1A and Terminal 2 which by the time of the study were under construction and completed in the year 2014 complies with ICAO and fire risk reduction rules 2007. National youth service fire Engines have been brought on board and are permanently packed at the landside in case of any fire occurrence in the buildings unlike before whereby the Airport was only relying on the Kenya Airport Authority fire Engines.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

This chapter gives the conclusion and the recommendation of the research study based on the findings from the collected data.

5.1Conclusion

The general objective of this study was to assess the fire safety preparedness at Jomo Kenyatta international airport. The study was guided by three specific objectives including; establishing the fire safety awareness of the airport workers; to evaluate the fire safety measures that have been put in place to minimize and mitigate the potential effects of fire disaster at JKIA and to determine the compliance with provision of fire risk reduction rules and ICAO standards. Reliability results for all the set of variables in the questionnaires gave a Cronbach's alpha statistics of more than 0.7, thus the threshold value of 0.7 were met.

The first objective of the study established that most of the respondents were aware of the locations of fire emergency exits in their work place. It was however noted that some of those aware of fire emergency exits in their work place reported that the exit doors were not clearly marked while more than a quarter of the respondents reported that the exit doors are not easily open able. Most of the respondents were aware of fire fighting appliances in their workplace for use in case of fire and majority could locate them.

On the second objective, most of the respondents mentioned portable fire extinguishers, hose reels and fire hydrants as the type of fire fighting appliances provided. Most of the respondents reported that there were fire detectors at their workplace with majority mentioning smoke detection systems. Almost a third of the respondents had not been trained on how to use a fire extinguisher and a quarter of the respondents reported lack of procedures in place for emergency evacuation in case of fire at their workplace. Close to a half of the respondents reported that their workplace does not carry out emergency evacuation drills.

Under the third objectives the study established that JKIA compliance level currently stands at below 60% level (average index of 1.9 out of a maximum score of 4.0).

Based on the results of the study we reject the hypothesis that Jomo Kenyatta International Airport has adequate preventive and preparedness measures in place to minimize the potential effects of any fire disaster occurrence.

5.2 Recommendations

i. The study recommends an integrated fire disaster management system involving all organizations operating at the airport and a provision for more and bigger emergency exits and a public address system that can be relied upon in case of a fire disaster.
ii. Kenya Airport Authority should address the factors affecting implementation of the fire reduction rules and ICAO standards as determined by this study.
iii. Kenya Airport Authority fire safety trainers should develop a standard fire safety training programme in order to harmonize the information that is disseminated to the various workers in the Airport. They should also ensure the fire fighting appliances are properly calibrated and maintained.
iv. The study recommends that Airport emergency exercises/drills in accordance with the requirements stipulated in ICAO section 9.12 to be conducted at intervals not exceeding two (2) years
v. Kenya Airport Authority fire officers should be patrolling to ascertain to it that all fire emergency exits, gangway and exit staircases are free of obstruction and fire exit door are easily openable.
vi. Kenya Airport Authority management should have clear policy guidelines on fire safety in all airports and strict supervision of workplaces on adherence to the rules and regulation should be developed and implemented.

5.3 Areas of further research

The researcher recommends that further research be conducted on the following topics:

i. Examine the fire safety preparedness with a larger sample incorporating all airports in Kenya.

ii. Whereas this research has relied on quantitative approaches to examine the fire safety preparedness, an in-depth analysis of individual responses can generate useful inductive information and provide a richer understanding of the fire safety preparedness.

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APPENDICES

Appendix I: Questionnaire

FIRE SAFETY QUESTIONNAIRE TO JKIA EMPLOYEES

The information you provide will be treated in strict confidence and will not be shown to other individuals. Participation in this survey is voluntary and your views are important and welcome.

Section A: **General and Personal information**

1. Gender (please tick) [ ] Male [ ] Female
2. Age (please tick) [ ] Below 18 [ ] 18-29 [ ] 30- 39 [ ] 40-49 [ ] 50-59 [ ] 60 and above [ ] No response
3. Government agency (please tick)
    - Kenya Airport Authority
    - Port Health
    - Kenya Civil Aviation Authority
    - Immigration
    - Kenya Police
    - Cleaning contractors
4. Highest level of Education: (please tick)

    [ ] Primary [ ] Secondary [ ] Graduate [ ] Post Graduate [ ] Others

5. Length of work at the Airport: (please tick)

    [ ] Below 1 Year [ ] 1-5 Years [ ] 5-10 Years [ ] 10-15 Years [ ]15- 20 Years

[ ] Above 20 Years

Section B: JKIA Rating of Fire safety awareness.

Use the scales provided and tick where appropriate.

1. Are you aware of the locations of fire emergency exits in your work place?

[ ] YES [ ] NO [ ] NOT SURE

If the answer to number 1 is YES,

1.1 Are the exit doors clearly marked?

[ ] YES [ ] NO [ ] NOT SURE

1.2 Are the exit doors easily open able?

[ ] YES [ ] NO [ ] NOT SURE

2. Are there fire fighting appliances in your workplace for use in case of fire?

[ ] YES [ ] NO [ ] NOT SURE

If the answer to number 2 is YES,

2.1 Do you know where they are located?

[ ] YES [ ] NO [ ] NOT SURE

2.2 What type of fire fighting appliances are provided?

[ ] Hose reels [ ] Fire hydrants [ ] Portable fire extinguishers [ ] Fire blankets [ ] DON'T KNOW

3. What are the likely causes of fire in your workplace?

.....

.....

.....

JKIA Rating of Fire safety measures.

Use the scales provided and tick where appropriate.

1. Have you ever been trained on how to use a fire extinguisher?

[ ] YES [ ] NO

2. Are there fire detectors at your workplace?

[ ] YES [ ] NO [ ] DON'T KNOW

If the answer to number 2 is YES,

2.1. What types of fire detection systems are provided?

Smoke detectors [ ] heat detectors [ ] Flame [ ] others.....

3. Are there procedures in place for emergency evacuation in case of fire in your workplace?

[ ] YES [ ] NO [ ] DON'T KNOW

4. Does your workplace have emergency assembly point?

[ ] YES [ ] NO [ ] DON'T KNOW

5. Have you been trained on what actions to take in case of a fire outbreak?

[ ] YES [ ] NO

6. Does your workplace carry out emergency evacuation drills?

[ ] YES [ ] NO [ ] DON'T KNOW

If the answer to number 6 is YES,

6.1. Have you ever participated in an emergency evacuation drill?

[ ] YES [ ] NO If YES which year? ...

7. In your own words, what would you do in case of a fire outbreak in your workplace?

.....

.....

.....

8. Does your workplace have fire safety policy?

[ ] Yes [ ] No [ ] DON'T KNOW

9. How would you rate your workplace in terms of fire disaster preparedness?

Statement	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
My workplace has well trained manpower to handle fire emergencies					
I am well prepared to handle any fire related incidences at my workplace					
There are good refresher courses and drills offered at my workplace to enable me handle any fire emergencies/disasters					
My workplace has facilities to handle any fire related incidences					

End of Interview.

Many thanks for your participation and co-operation.

Section C: Participatory observation check on compliance with provisions of the fire risk reduction rules (2007) and ICAO standards.

The researcher shall rank compliance level of JKIA with the provisions of the fire reduction rules (FRR) 2007 and ICAO standards through conducting a facilities tour with the senior fire chief officer.

Key to Rating;

4= Good: Complies to at least 90% of the requirements of the Rules.

3= Satisfactory: Complies to at least 75% of the requirements of the Rules

2= Average: Complies to at least 60% of the requirements of the Rules

1= Poor: Compliance is below 60% of the requirements of the Rules.

The compliance with provisions on:

		FIRE PREVENTION				
i.	FRR	Location of highly flammable substances	**1**	**2**	**3**	**4**
ii.	FRR	Storage of flammable substances				
iii.	FRR	Marking and labeling storage for flammables				
iv.	FRR	Handling of flammables				
v.	FRR	Ventilation for flammables storage				
vi.	FRR	Removal of flammables where there is heat				
vii.	FRR/ICAO	Removal of waste				
viii.	FRR	Machinery layout				
ix.	FRR	Handling of electrical equipment				

		FIRE PROTECTION				
x.	FRR/ICAO	Fire escape routes				
xi.	FRR	Control of spread of smoke				
xii.	FRR/ICAO	Means of evacuation				
xiii.	FRR/ICAO	Means of emergency communication				
xiv.	FRR/ICAO	Emergency lighting				
xv.	FRR/ICAO	Fire alarm and detection system				
xvi.	ICAO	Fire evacuation drills				
xvii.	ICAO	Fire assembly points				
		FIRE SUPPRESSION				
xviii.	FRR/ICAO	Fire fighting appliances				
xix.	FRR/ICAO	Maintenance and testing of fire extinguishers				
xx.	FRR/ICAO	Maintenance of fixed water systems				
xxi.	FRR	Colour coding of pipes				
xxii.	FRR/ICAO	Water storage				
		MANAGEMENT CONTROL				
xxiii.	FRR/ICAO	Fire safety policy available				
xxiv.	FRR/ICAO	Fire safety audit				
xxv.	FRR/ICAO	Trained fire fighting team				
xxvi.	ICAO	Fire evacuation procedures available				
xxvii.	FRR	Good housekeeping				
xviii.	FRR	Notification of fire occurrence				

Appendix II: Publication

JKU/RPE/RES/JAGST/MS/17/15

ASSESSMENT OF FIRE SAFETY PREPAREDNESS AT JOMO KENYATTA INTERNATIONAL AIRPORT

1. Frachiah Wambugu, 1.Charles Mburu, 2. Erastus Gatebe

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ABSTRACT

Recently, Kenyans have witnessed an increase in incidences of fire where fire has gutted down homes, buildings and factories with loss of lives and property. Lack of disaster preparedness has remained one of Kenya's enduring development challenges for decades. There is lack of recognition of the interrelationship between disaster preparedness, unsustainable production and consumption patterns. Most of the fire disaster response initiatives in Kenya tend to be ad hoc, uncoordinated and short term measures, mainly in the form of emergency relief services to the worst affected areas. Fire outbreaks are not only a health risk; they adversely affect the social, economic and environmental conditions of an organization. The purpose of this study was to assess fire safety preparedness measures in place at Jomo Kenyatta International Airport based on International Civil Aviation Organization (ICAO) standards. The study employed descriptive research design targeting 340 respondents using proportional random sampling technique. A questionnaire was used in collecting data. Based on the results of the study, Jomo Kenyatta International Airport has inadequate preventive and preparedness measures in place to minimize the potential effects of any fire disaster occurrence. It lacks mechanism to integrate the safety standards and practices of the different stakeholders in and around the airport. This study recommends an integrated fire disaster management system involving all organizations operating at the airport and a provision for more and bigger emergency exits and a public address system that can be relied upon in case of a fire disaster.

Keywords: *Fire safety, preparedness, awareness, compliance, policies safety standards*