EVALUATION OF FIRE SAFETY STATUS OF SELECTED PUBLIC AND PRIVATE UNIVERSITIES IN KENYA WITH REFERENCE TO FIRE RISK REDUCTION RULES, 2007

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Evaluation of fire safety status of selected public and private universities in Kenya with reference to fire risk reduction rules, 2007

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DECLARATION

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

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DEDICATION

I dedicate this study to my wife Nancy, daughter, Lucy and son Michael Andrew. Thanks for the patience and support during the study period.

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I would like to thank my supervisors Prof. E. Gatebe and Mr. P. Makhonge for their guidance and support. Their technical and academic guidance made this study possible. I would also like to thank the management and staff of the Universities that allowed to be used for this study for their generous and kind support in providing information for the study. Many thanks also go to my fellow students for their constructive comments and support. Finally Jomo Kenyatta University of Agriculture and Technology offered a good environment for study and research of which I am truly grateful.

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LIST OF ABBREVIATIONS

ACF	Arson control forum
APB	Arson prevention bureau
BOMA	Building Owners and Managers Association International
CFOA	Chief fire officers association
CHE	Commission for higher education
DCLG	Department for communities and local government
DOSHS	Directorate of Occupational Safety and Health services
FPA	Fire protection association
FPAA	Fire Protection Association Australia
HSE	Health Safety Executive
LEL	Lower explosive limit
MFLP	Merseyside fire liaison panel
MOC	Marine operation Centre
NFPA	National fire protection association
UEL	Upper explosive limit
OSHA	Occupational safety and health Act

ABSTRACT

Fire-related incidents often result in property destruction, injuries and sometimes fatalities. One way to prevent fire incidents and also minimize loses in the event of an outbreak is by institutions complying with current laws and regulations. This study had set to establish fire safety measures in place in local universities in Kenya based on the stipulations of the Fire risk reduction Rules, LN 59 of 2007. Data was collected using questionnaires from a total of seven (three public and four private) universities representing the 27 universities in Kenya as at March 2010. These were selected through stratified random sampling technique with the two categories (public and private) classified as separate strata. Questionnaires were administered to 481 respondents using proportional (purposive) random sampling technique. A checklist developed from the rules was also used to conduct workplace inspections. The study has established that more than 74% (n=481) of employees were not aware on any fire training programmes in place with no significant difference in both categories of universities ($\chi^2 = 3.72$; $p > 0.05$, $df = 2$). Failure to conduct regular fire evacuation drills was common to both categories ($\chi^2 = 3.16$; $p > 0.05$, $df = 2$). The study has found that the workplaces were adequately equipped with Fire exits signs (98%), Fire extinguishers (99%), Hose reels (82%) and had Fire action procedures posted (88%). There is low compliance with the requirement to provide Emergency lighting, Automatic Fire suppression systems and Fire Hydrants in both categories of universities. Private universities with an average score of 21% complied marginally better than public universities (19%) on the installation of these essential equipment. Lack of information on the existence of the Fire risk reduction rules (mean index

4.45 out of maximum 5.00) and lack of Enterprise level Fire policies (mean index 4.27) compounded by lack of funds (Mean index 4.15) allocated for emergency preparedness were determined as the main factors affecting compliance to the rules. The overall level of compliance to the requirements of the rules stands at below 60% in both categories of universities. The study recommends the development of comprehensive fire safety policies and programs that will cover prevention, protection and emergency response backed by University executives' endorsement and support. The DOSHS should also make the public aware of these rules through regular outreach programs and enforcement.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

A fire can result in extensive damage and destruction of property as well as injuries to occupants of a given premises. Even when fires don't injure workers, they can 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, 2003).

According to Thomson (2004) the causes of many fires especially in the workplace may be accidental or as a result of a deliberate act on the part of employees. Several fires have been brought about by the acts or omissions of staffers in organizations. Being careless at work or failure to comply with regulations as laid down has been a cause of catastrophic fires that have led to destruction of property and loss of life. The failure to take concrete remedial actions when hazardous situations are identified has been a cause of infernos in the work places hence the need for fast action to prevent fires when hazardous situations are discovered (Thomson, 2004). Regardless of how a fire might start, it could lead to destruction of property and loss of life making it imperative for compliance with safety guidelines. It is vital for fire cause to be pointed out in order to avoid future recurrence of the same. These conditions include: the device or equipment involved, the presence of an ignition source, the type of the material initially ignited, and the circumstances or actions that brought all the factors together (Hurley and Bukowski, 2008).

A report by the Marine Operation Centre, points out that on a daily basis in countries such as the USA, 200 fires are experienced at the workplace. This is an indication of how serious the hazard is and a threat it can be. The fires result in 200 deaths annually and injure many others making them incapacitated and unable to work again. The financial cost of fires is estimated to run into billions of dollars hence the need to manage fires at work (Schifiliti, 2003). The human and financial effects make fire at the work place a hazard that needs to be paid close attention. Fires at the work place can be started severally by: chemicals, electricity, flammable liquids, combustible materials, compressed gases, smoking, even poor housekeeping. Protective measures against these hazards should be taken to avoid being a part of the statistics on the human toll of work place fires (Roberts, 2003). .

The main objective of fire safety efforts is to protect occupants from injury and to prevent loss of life or injuries. The second goal of fire safety is to prevent property damage. 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 (Drysdale, 1985). If all three elements are not present in adequate proportions, a fire won't ignite or a fire will not be able to sustain combustion. Combustible materials are all around us. Given the appropriate circumstances, they can be made to burn by subjecting them to an ignition source which is capable of initiating a self-sustaining reaction. In this process, the "fuel" reacts with oxygen from the air to release energy (heat), while being converted to products of combustion, some of which may be harmful

(Drysdale, 1985). 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. It helps draw attention to risks that could materialize.

1.2 Statement of the problem

A university set up is usually a beehive of activity. There are students, members of staff engaged in teaching and research as well as other support staff members providing auxiliary services for the smooth operation of institutions. The population concentration in the campuses and residential quarters is also characteristically high. The presence of Laboratories, workshops and stores holding flammable substances provide potential sources of ignition and big Fire loads that are sources of Fuel. Universities hold a rich collection of priceless research data and materials and potentially the future individual contributors to new knowledge in Kenya. Fire safety is a major pillar in any Health and safety management system. Kenya's workplaces have for a long time been characterized by lack of basic foundations of managing workplace health and safety. This status can be attributed to various internal and external factors that include:

- Lack of comprehensive enterprise policies to manage Health and safety;
- Failure to maximize the use of appropriate technology to prevent fire outbreaks and/or minimize Fire spread
- Weak or non-existent enforcement of statutory stipulations by authorities with the given mandate to enforce safety legislation.

The result of this is Fire related injuries and loss of property that continue to have serious consequences in Kenyan industry. This study sought to identify the level of preparedness by institutions of higher learning to prevent as well as combat a fire outbreak and identify existing weaknesses in the fire safety measures while exploring possible remedial measures using the Fire risk reduction Rules, 2007 as the point of reference.

1.3 Justification and Significance of the study

Universities are key employers in Kenya with the sector of higher learning currently demonstrating fast growth. It is prudent that lives and property in the university premises are protected and Fire outbreaks can compromise this. There are currently no studies done specifically on the implementation of the fire risk reduction rules, 2007 in our institutions of higher learning meaning that there is a knowledge gap. According to data obtained from the records at the Directorate of occupational safety and health (DOSH) none of the universities in Kenya are registered under the Occupational safety and health Act, 2007 and there has been no independent evaluation of their safety status periodically as required by law. This study sought to assess the risk of fire at Kenyan Universities and determine how safe Kenyan universities are to the members of staff and learners. The findings will aid in the identification of weaknesses in fire safety policies in universities where identified and enable administrators take remedial measures for the safety of learners and teachers. The study shall also provide reference to researchers seeking information on fire risk status in Kenyan Universities. The results of this study will be of use to safety and security officers in Kenyan universities as they will show how well the

fire reduction rules have been applied and areas that need to be improved to make our institutions of higher learning safer. Government agencies will also use the findings on implementation of the rules to formulate policies on their enforcement.

1.4 Research Questions

The study sought to find out;

1. What are the essential fire safety measures in place at Private and Public universities in Kenya?
2. What are the factors affecting the implementation of the Fire risk reduction rules?
3. What are the compliance levels of Private and Public Universities in Kenya with the provisions of the Fire risk reduction rules?

1.5 Research objectives

1.5.1 Main objective

To evaluate the risk of fire at Kenyan Universities with reference to the factories and other places of work (fire risk reduction) rules, 2007.

1.5.2 Specific objectives

The study had the following specific objectives:

1. To establish the essential fire safety measures in place at Private and Public universities in Kenya.

2. To establish the factors affecting the implementation of the Fire risk reduction rules.

3. To determine the compliance levels of Private and Public Universities in Kenya with the provisions of the Fire risk reduction rules.

1.6 Scope of the study

The study was conducted at public and private universities that were recognized by the Commission for Higher Education (CHE) by March 2010 and focused on the main campuses.

1.7 Conceptual framework

According to Kisilu and Tromp (2006), 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. They add that a conceptual framework is a tool in research that aids a researcher to better comprehend the phenomenon that is under study. Where it is well comprehended, it eases the process of interpreting the findings made by the researcher.

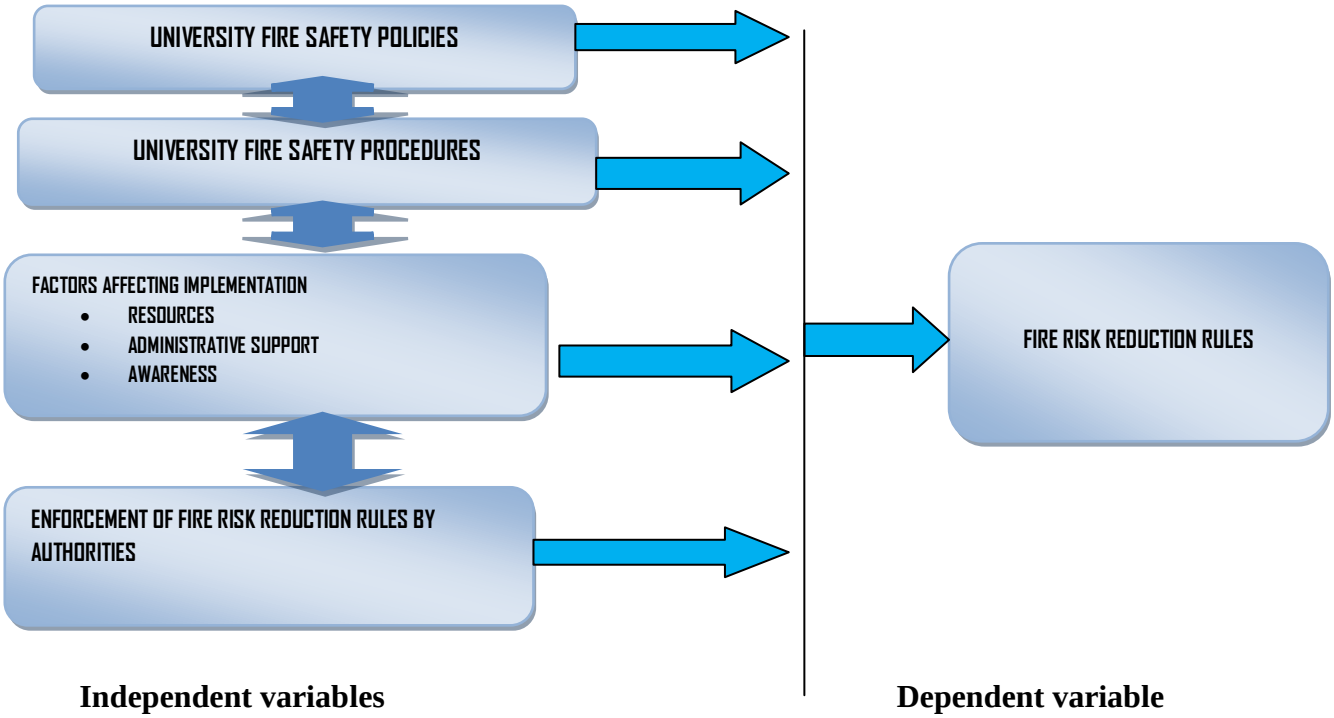


Figure 1: Conceptual framework

1.7.1 Operational Definition of terms

The following operational definitions are pertinent to this study:

1. **Fire-** a state of combustion that comes about due to a reaction between a fuel source, oxygen and an ignition source in the right proportions

2. **Hazard-**this is a precarious incident or scenario that could create an emergency situation or disaster

3. **Private university-** this is a university that is privately owned and funded through private means

4. **Public university-** this is a university that is government owned and usually funded by the public through taxes.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Campus Fire Safety

There is little University campus fire safety research that has been published in peer reviewed journals (De Bard, 2004). One of the few studies explored whether college student self-perception of knowledge about fire and life safety was related to the students' actual knowledge (Cote *et al*., 2008). The researchers conducted a telephone survey of 467 college students and inquired how well informed students felt they were about fire safety (dependent variable) compared to their actual knowledge, past fire experience, level of fear of fire, fire education, gender, and knowledge prior to arriving on campus. General study findings indicated that college students perceived higher levels of fire safety knowledge than they actually possessed and that this may lead to more risk taking, as they believed risk levels to be low. For instance, students' lack of actual knowledge was evident, as "only 23 percent know the correct telephone number to dial in the event of a fire emergency". So, whereas many indicated they knew what to do in a fire (perceived knowledge), in fact they did not even know the emergency phone number to dial in the event of a fire. As an implication of the study, Cote *et al*. (2008) argue that "stricter measures should be taken to both educate, and ultimately protect, the student population", although the researchers offered no suggestions for accomplishing this task.

A ten year review of the American College and University Housing Officer-International (ACUHO-I) library yielded only three relevant presentations from

ACUHO-I conferences and three articles from "non-academic". The three presentations entitled, *New Approaches to Fire Safety Training* (Longcore and Rossiter, 2008), *Life Safety Networks—A Parallel Network Approach*, (Matthew, 2007) and *General Safety in Residence Hall Buildings.* (Shervington, 2008) did not contain references to literature and appeared to have been more anecdotal. Longcore and Rossiter (2008) provide an overview of the New York State Fire Safety Act, showing that fires do occur from common behaviors, such as decorating halls with combustible materials, improperly disposing of smoking materials, and having candles in sleeping areas.

They also provided the Fire Safety Template for Floor Meetings used at Syracuse University which provides insight into the fire safety education contents at a large university (Shervington, 2008). It includes a description of the fire protection systems in the residence halls, including how they operate and how to avoid tampering with them. However, most of the content consists of a review of fire prevention activities that the university pursued, as well as the prevention activities expected of the residents, including rules. Expected fire response behaviors were addressed at the conclusion of the template. Again, a major shortcoming is that the template did not include any information about how to effectively deliver the information (Longcore and Rossiter, 2008).

Matthew's (2007) presentation focused on the installation of security services into the network communication system used to connect a building fire alarm (life safety) system to the police or fire department. Specifically, it focused experiences at the University of Washington in St. Louis and described the technical aspects of making

the various systems work together. Shervington's (2008) presentation to the 2008 ACUHO-I annual meeting included prohibitive rules in support of fire prevention and detailed information about flammable decorative materials. It also briefly presented the fire response information that Appalachian State University presented to it residential students. Similar to the aforementioned works, it only addressed the content, not the presentation style or delivery techniques used. Two of only three articles found were from the trade publication *College Planning and Management*. This is not a peer-reviewed journal.

In the first, Milshtein (2008) interviewed Michael Halligan, Associate Director of Environmental Health and Safety at the University of Utah and Peter Babigian, a principal at WB Engineers. The article offered their insights and personal experiences concerning fire safety education on college campuses. Both provided wide reaching suggestions that included awareness campaigns and "smarter" alarms systems that can connect to personal communication devices. One suggestion from Halligan was that face-to-face education should be conducted by younger firefighters as this "turns a lecture into a peer to peer discussion that students may be more open to". The second article, "How to Prevent On- and Off- Campus Fires" (2005) restated the contents of the American Society of Safety Engineers (ASSE) Fire Protection Practice Specialty (PS) online pamphlet "How to Prevent On/Off-Campus Fires, ASSE Fact Sheet 2" (2009).

The third article found was from a trade publication *American School and University*; in it Kennedy (2007) summarized recommendations from the U.S. Fire Administration electronic one-page pamphlet entitled "Fire Safety 101: A factsheet

for colleges and universities" (2006). This included prevention information such as not to overload electrical outlets, use cooking equipment properly, and understand and obey fire alarm warnings. The pamphlet also noted, "There is a strong link between alcohol and fire deaths", but did not cite a source for this information. Although each of these articles offers information about fire safety for college campuses, the information is anecdotal and based on personal experience and recommendations from committees or groups, and moreover, has not been validated by empirical measures or consistently collected and analyzed using research methodologies.

Additional information at ACUHO-I meetings has been presented since Glenn's review in the summer of 2009. *Only You Can Prevent Campus Fires: Interactive Fire Safety Training for RAs and Residents* (Francis *et al*. 2009) and *Life Safety for On and Off Campus Housing Can You Afford It? How Can You Not?* (Monikowski and Gray, 2009) also appear largely anecdotal. Francis *et al.* (2009) gave a review of recent fire safety training efforts at George Mason University that included details about their Resident Assistant (RA) Fire Academy developed with the Fairfax County Fire Department. It reviewed their residential student fire safety programming effort, which focused on an interactive Life Safety Fair. This event promoted fire safety by exposing participating students to a variety of fire safety related exhibits. These exhibits included fire extinguisher training, a smoke filled trailer walkthrough, access to fire department equipment, and a controlled room burn, in effort to raise awareness of the residential population. However, no information about how many of the 4,800 residential students participated or if the

event had a positive effect was presented. It must also be noted there could be a potential conflict of interest.

Monikowski and Gray (2009) presented information about the efficiency of the fire protection systems manufactured and installed by Simplex-Grinell, a leading fire alarm manufacturer. They are both employees of this company and this presentation appeared to be a sales-pitch for adding fire protection systems to residence halls. Neither presentation contained any references or citations giving the appearance that their recommendations were based primarily on personal experiences.

Furthermore, Ta *et al.* (2006) conducted a literature review of all fire safety interventions published between 1998 and 2004 and of the 15, did not find any related to campus or university fire safety. In their conclusions, they note that fire department personnel were involved in successful programs, but admit that this was not tested as part of any of the experimental designs. It is also important that this review reiterates criticisms of much older reviews that called for "evaluations that will inform fire injury prevention efforts, and ideally such evaluations will utilize randomized, controlled studies".

Finally, review of the professional publications and program books of professional development conferences presentations reveals little evidence of empirical research or peer review articles and presentations related to campus fire safety or related educational experiences. Many campus fire safety professionals seem largely informed by past practices and fire safety information developed for delivery to the larger community or specifically to young children.

2.2 Fire safety learning experience

Fire safety content or information being delivered to residential college students is not covered specifically in any publication. Mowrer (1999) discussed two broad areas for content about fire safety education fire prevention topics and fire response topics. Fire prevention topics focus on behaviors or information that students can use to prevent fires from occurring. This might include information such as ‘do not use frayed extension cords’, ‘do not smoke in bed’, or ‘always watch food cooking on the stove’. Topics related to response are those that involve planning for and acting during a fire. This information could offer suggestions such as ‘always know two ways out of your building’, ‘do not open doors before checking for heat’, or ‘know how to activate the fire alarm’.

Mowrer’s (1999) research was informed by an examination and analysis of selected college fires (included as an appendix to the report) by John L. Bryan, professor emeritus of Fire Protection Engineering at the University of Maryland and a leading international authority on fire safety. To develop content for a fire safety learning experience Bryan’s work on fatal campus fires, including occupant behaviors during a fire, facility fire safety protections systems, and college fire causes, is a primary source. Campus Firewatch’s (2011) list of fatal campus fires indicates that 81% of fatal fires occur in off-campus housing. This is not often a common discussion item either in on-campus housing orientation or fire safety meetings, but might be included in future efforts.

2.3 Definition of 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, 2001). According to Drysdale (1985), the concept of fire can be symbolized by the Triangle of Fire, which is represented by fuel, heat, and oxygen as in Figure 2 (Dowd, 2002). The removal of any one of these factors usually will result in the fire being extinguished.

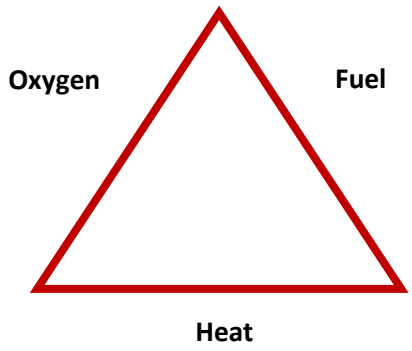


Figure 2: Triangle of Fire (Dowd, 2002)

2.4 Common elements in the Fire Triangle

Fuel materials include wood and wood-based products (Satyen *et al.*, 2003; Istre *et al.*, 2002; Halpern and Hakel, 2003; Diquiseppi *et al*., 2002), Plastics (Curmi *et al*., 2003). Textiles (Proulx, 2003; Tan and Hiew, 2004), Liquids (Arson Control Forum, 2006) and Gases. The sources of oxidants include; oxygen in Air (Kennedy, 2003), chemically bound oxygen (Davis, 2008). Sources of heat energy include electrical heat energy (Proulx, 2003), Chemical heat energy (DCSF, 2007) and mechanical heat energy (FPA (Fire protection association), 2007).

2.5 Causes of Fire in universities

In the history of university fires, the established causes of fire outbreak have been found to be due to faulty electricity, smoking, arson, cooking or during renovations (Abdullah, 2001). Faulty electrical installations can be a significant potential source of fires (Fraser *et al*., 2007). It is thus imperative that occupiers maintain the highest standards of electrical safety (Stokes, 2007).

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, attachments and switches shall be spark proof in workplaces where flammable liquids, vapors, dusts 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. Take adequate measures to ensure that electrostatic charges do not build up where flammable substances are present.

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. Sections 13 – 15 of the Kenya Fire risk reduction rules set 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 metre 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 metre 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).

2.6 Building Designs

A Fire Safety Strategy is an essential component of the design for a building. It ensures that in the event of a fire, building occupants can be evacuated safely. The main consideration in these strategies is time. The engineer must show that all occupants can evacuate the building without being exposed to the fire. This is particularly difficult in the case of tall buildings where occupants must travel long distances downward before they can exit the building. A rule of thumb to estimate total building evacuation time is one minute per floor. The escape routes must remain structurally intact and smoke free to allow safe passage of occupants from the building. (Torero *et al*, 2012)

The focus on access into premises to enable disabled people to fully use a building needs to be matched with arrangements for their safe egress in the event of fire. The

safe egress and evacuation of disabled people requires careful consideration and attention. (Department of Health, Social Service and Public safety – UK, 2011)

Building designs can contribute to fire outbreaks and fire spread in a number of ways. For example construction using Timber can be a potential hazard if not done properly. Timber is classified as a combustible material; however, if a timber structure is properly designed it can perform very well in a fire. There are mainly two ways of delaying the ignition of timber elements; by encapsulation of the building elements by noncombustible lining materials like gypsum or by impregnation or coating with fireproof agents. These measures require expert knowledge and must be carried out carefully. The long term behavior of impregnating and coating systems is still under investigation and development. (Östman, *et al*., 2010) Light timber construction is normally protected with cladding while heavy timber construction has good inherent fire resistance because a char layer is formed which retards the heat penetration.

Therefore the properties of wood surfaces in the early stages of fire may cause a risk of flashover. But traditional wooden structures like wood frame and laminated structures generally have good fire resistance in the fully developed fire. Solid wood constructions are more robust than timber frame structures under fire. Solid wood constructions are less vulnerable to collapse because of more load bearing reserves. But single puncture holes or bad fits in joints between two elements can cause fast burning in the lower part of the fire room and jeopardize the integrity. Contrary to timber frame structures, solid wood structures can contribute to fire duration and large quantities of flammable gases may be formed. This may increase risk of fire

spread via windows or openings. These elements need to be taken into account when selecting appropriate active and/or passive fire protection measures (Östman *et al*., 2010).

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, 2001).

Renovations whether minor or major (remodeling) have to be closely supervised and monitored as there have been numerous cases of outbreak of fire in high-rise buildings not only during renovations, but also due to illegal haphazard renovations (Kennedy, 2003). In view of safety, comfort and wellbeing of building occupants, renovations should not be carried out during occupancy time.

Poor storage of highly flammable substance can cause fire outbreaks. In Kenya Sections 4 to 12 of the Fire risk reduction rules cover location, storage, marking and labeling and handling of flammable substances. According to Kennedy (2003) the purpose of stringent standards for storage of highly flammable standards is to prevent the spread of fire either to the material or from the material during an outbreak (Kennedy, 2003).

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.

Sections 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 section 10 requires the occupier to continuously monitor a workplace with flammable substances with a view to mitigate against any possible fire risks.

The rules provides for the need to have suitable ventilation that allows for free flow of fresh air that includes windows, doors vents, louvers or any other ventilation facility to prevent accumulation of flammable vapors, dust, gases or fumes under section 11. Local exhaust ventilation systems or mechanical ventilation facilities should be provided in enclosed rooms (Naoum, 2007).

In order to prevent ignition sources presence in areas prone to flammable fumes, vapors, gases or dust the occupier is required under section 12 to take necessary steps to remove these hazardous substances (Nugent, 2006). The rules stipulate that a person wishing to set up or operate a facility for the use of or storage of highly flammable substance shall ensure that such facility is located in the designated area.

Poor storage of highly flammable substances can encourage fire spread in case of ignition.

2.7 Effects of Fire and Fire Products

2.8 Effects of Fire on People

According to Nugent (2006), recent fire statistics for 12 countries reveal that on average the number of fire deaths per 100 000 of population varies between 0.54 (for Switzerland) and 2.50 (for US) (Nugent, 2006). The chances of being killed by fire have been estimated to be 1:60 000 per year (Nicholsson, 2008a). The lowest fire death rate is in the 15-35 age groups, as this group is able to evacuate more rapidly in the event of fire (Dowd, 2002). Younger people (children up to five) and older people (over 65) are the most likely victims, as fire deaths of these groups are disproportionably higher, since they spend most of their time at home.

2.7.2 Effects of Fire on Property

According to Nicholsson (2008a) fires lead to a high destruction of property thus causing loses amounting to millions of shillings (Nicholsson, 2008b). Indirect losses from fires are hard to assess. They often cannot be measured in monetary terms, such as loss of credit standing, loss of trained personnel, and loss of customer confidence among others. The World Fire Statistics Centre lists seven key parameters which indicate fire losses, and calls for a uniform reporting of fire losses using these parameters as a base (Bishop, 2005).

2.7.3 Effects of Smoke

According to Bryant (2008) and British (2009), the physical conditions of combustion, such as the combustion rate, the combustion mode and the temperature,

have more influence on the smoke composition than does the kind of burning material (Bryant, 2008). The characteristics of smoke that are most dangerous to people are its toxicity, colour and density.

2.9 Fire Safety Management in Buildings

According to Kidd (2008), it is the synergistic effect of all building systems and features working together harmoniously that ensure the safety in the building (Kidd, 2008). Therefore, it is essential that the security and fire life safety systems be well planned, managed and executed. Hence, the human interface has become the complementary factor that supplements these sophisticated systems (Nugent, 2006). Preventive management is defined as an agent or device intended to prevent conception. Preventive management includes education and training, electrical inspection, renovation inspection, pest control programme and good housekeeping practice, signage, operation and maintenance of fire equipment and fire drill procedures (Nugent, 2006).

2.8.1 Fire safety training

Residential fires, workplace fires, and environmental fires such as bushfires result in severe and fatal burn injuries (Kennedy, 2003). Fires also lead to property loss, psychological distress, and sometimes loss of life (DiGuiseppi *et al*., 2002; Halpern and Hakel, 2003; Kennedy, 2003; National Fire Protection Association [NFPA], 2000; Proulx, 2003) have identified fire safety training as 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.

In Kenya it is stipulated under section 21 (1) of the Fire risk reduction rules, 2007(GOK, 2007) that ‘every occupier shall ensure that all workers are instructed in the safe use of firefighting appliances. Section 21(2) further prescribes basic training course on fire safety to be undertaken by every member of the firefighting team. This training must be done within three months of appointment to the team and a refresher taken at least once in every two years (Fire risk reduction rules, 2007) (GOK, 2007). Fire drills are carried out to check that staff understands the emergency fire action plan, to ensure that staff are familiar with operation of the emergency fire action plan, to evaluate effectiveness of the plan and to identify any weakness in the evacuation strategy (Jackman and Morgan, 2004). 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, 2003). These findings warrant the need to investigate the extent to which fire safety training is provided and the level of fire safety knowledge within the community.

2.8.2 Legal requirements for Fire safety provisions in buildings

In Kenya sections 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 least 15 cm in height.

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.

Section 17 of the rules prescribe that every workroom is fitted with an emergency exit of at least 90cm wide, situated as far away as possible from the ordinary exit, and located in a manner that the exit will not lead any person to a trap in the event of a fire breaking out. In addition the rules stipulate that an external staircase or ramp affording a means of escape in case of a fire is adequately aerated, well lit and of at least one metre width, provided that a spiral staircase shall not be considered as a suitable emergency exit. Section 17 of the rules prescribe that every workroom is fitted with an emergency exit of at least 90cm wide, situated as far away as possible from the ordinary exit, and located in a manner that the exit will not lead any person to a trap in the event of a fire breaking out. In addition the rules stipulate that an external staircase or ramp affording a means of escape in case of a fire is adequately aerated, well lit and of at least one metre width, provided that a spiral staircase shall not be considered as a suitable emergency exit. 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 work place 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.

The rules have prescribed standards for color coding of pipes and Containers of extinguishing agents. Pipes carrying water for firefighting shall be painted in red while firefighting appliances should be coded in the following manner;

Extinguishing Agent	**Color code**
Water	Red
Foam	Cream
Powder	Blue
Carbon dioxide	Black

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.

In the event of a fire there should be adequate water to assist in extinguishing it. It is thus imperative that sites have storage facilities for this emergency water. Section 33 of the rules has prescribed that every site should have at least access to water and water storage facility capable of storing at least 10000 litres of water.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

This chapter outlines and describes the methodology that has been adopted in the study. To undertake the study conclusively, data was collected from the targeted population, organized, collated, analyzed and interpreted and the interpreted data presented. The activities that were involved in this are discussed in this chapter.

3.1 Research design

The study applied a descriptive research design. This type of research shows the characteristics of a given individual or groups in this case the group was local universities. Both Qualitative and Quantitative data was collected and used. Both primary and secondary information was used to collect data on the implementation of the provisions of the fire safety regulations in private and public universities in Kenya.

3.2 Study area and Target population

Total population target included 27 public and private universities registered by the Commission for Higher Education by March 2010. The physical facilities were observed and questionnaires administered to randomly sampled staff in sections of the institution.

3.3 Area of study

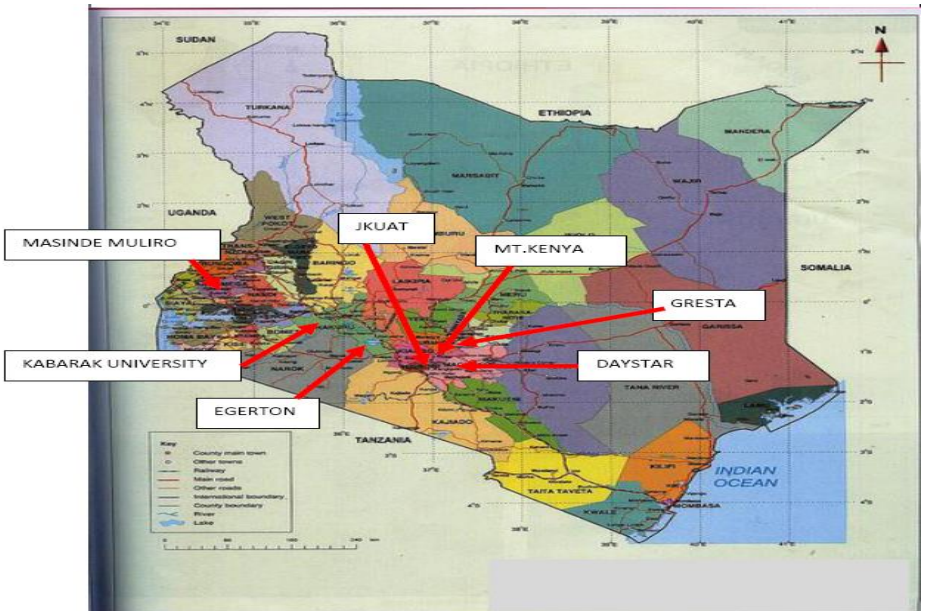


Figure 3: Map of Kenya showing location of sampled university main campuses

The study covered 7 public and 20 private universities. A list of all universities is presented in Appendices II and III. The universities have various campuses and constituent colleges. This study was however conducted at the main campuses of the selected universities as shown in figure 3.

3.3 Sampling Procedure

This study was interested in establishing the implementation of the fire safety provisions in public and private Universities in Kenya with reference made to the Fire risk reduction rules, 2007. Mutai (2000) contends that the sample size must be determined during the planning phase of the research. The target population comprised the 27 public and private universities including their constituent colleges and campuses. A select sample was used using stratified random sampling technique to distinguish private and public universities as separate strata. Mutai (2000)

suggests that for descriptive studies, ten percent of the accessible population is enough. Mugenda and Mugenda (1999) contends that where time and resources allow, a researcher should take as big a sample as possible .The study took 25% of the total targeted institutions thus 7 of the targeted 27 universities were sampled.

In this study 3 public and 4 private universities were purposefully selected. The proportionate number for public universities selected was higher than for private universities as they hold a proportionately higher population of both staff and students. The Universities have been randomly coded as A01 to A07 for confidentiality.

3.4 Sample size for questionnaire administration

For determination of the sample size for questionnaire administration, the researcher has applied the following formula (Bartlett, Kotrlik and Higgins (2001)):

$$N = \frac{Z^2 * (P) * (1-P)}{C^2}$$

Where:

Z = Z value (1.96 for value of selected alpha level of 0.025 in each tail (95% confidence interval thus acceptable error of 5%). p = percentage picking a choice, expressed as decimal (.5 used for sample size needed as maximum possible proportion). c = acceptable margin of error for proportion being estimated, expressed as decimal.

Therefore:

$$N = \frac{1.96^2 * (0.5) * (1-0.5)}{0.05^2} = 384$$

A sample size of 384 is the minimum ideal target sample for questionnaire administration for this study. However with an anticipated return estimated at 75%, 481 persons have been sampled for this study to further enhance data accuracy.

3.5 Sample size distribution

The selected samples were in two distinct categories during questionnaire administration and structured observation:

a. Members of staff: This targeted all members of staff (academic and non-academic) within the confines of the selected main campuses. The selection covered staff randomly selected from wide range of facilities and locations within the main campuses of the sampled institutions.

   The results from questionnaire administration were obtained from respondents of 4 private universities and 3 public universities using proportional (purposive) random sampling technique.

   $n_o = \frac{N_h}{N} \times n$

   Where, N_h = employees population per university, N = Total employees population for the seven universities, n= the sample size.

Using the formula equitable numbers of staff were interviewed using proportional (purposive) random sampling (Table 1) as follows:

Table 1: Sample size distribution

University Code	Total Population	% of the Total Population	Sample size
A01	180	3.2	15
A02	1851	32.6	156
A03	790	13.9	67
A04	92	1.6	8
A05	467	8.2	39
A06	434	7.6	37
A07	1864	32.8	158
Total	**5678**	**100**	**481**

b. Facility managers: This targeted officers with direct responsibility in managing the facilities in terms of security, safety, maintenance and administration. This was applicable for part D of the questionnaires only.

3.6 Data collection instrument

This study employed questionnaires, and structured participatory observations using a prepared checklist (part D) in the collection of information. The questionnaire was designed in four main Parts. Part A relates to the general information of the respondents capturing the university and duration worked. Part B aims to obtain the opinion of the respondents about the essential fire safety measures that are available in their institution and also captures their awareness levels on Fire safety. Part C requires the respondent to indicate how the listed factors affect the implementation of the fire risk reduction rules in their institution whereas Part D was a Participatory

observation check on compliance with provisions of the fire risk reduction rules (2007) with the observer ranking compliance of the institution with the provisions of the fire reduction rules (2007) through conducting a facilities tour with the officer in charge of safety, security or facility maintenance.

The questions asked in parts B and C and ranking method in part D was in the form of multiple choice questions. The options in the questions in Part B and C have been formulated with consideration given to a whole range of possible answers to aid the respondents make a decision closest to their views whilst for part D the observer has options to place the institution to the closest percentage level of compliance based on an inspection of various parts of the facility. A sample of the questionnaire that was used is represented in Appendix 1.

3.6 Data analysis and reporting

The data generated from structured questions were coded, numbered and classified under different variables for easy identification and then summarized in answer summary sheet. The questionnaires measurements were based on rating scales as follows. For part B the questionnaire is measured based on a scale of 3 ordinal measures from one to three rated as follows: Yes (3), Not sure (2) and No (1). For Part C the questionnaire is based on Likert's scale of five ordinal measures of agreement towards each statement from one (1) to (5) rated as follows:

1= Strongly disagree
2= Disagree
3= Not sure
4= Agree
5= Strongly agree

The rating scale is given below as,

1= strongly disagree (1.00≤Mean index<1.50)
2= disagree (1.50≤Mean index<2.50)
3= not sure (2.50≤Mean index<3.50)
4= agree (3.50≤Mean index<4.50)
5= strongly agree (4.50≤Mean index<5.00)

For Part D the questionnaire was measured based on a scale of 4 ordinal measures rated as follows

1= poor (1.00≤Mean index<1.50)
2= average (1.50≤Mean index<2.50)
3= satisfactory (2.50≤Mean index<3.50)
4= good (3.50≤Mean index<4.00)

The mean index formula for all cases above is given as follows:

Mean index =∑ (μ*n)/N

Where: **μ** is the weighting of each factor given by the respondents

n is the frequency of respondents

N is the total number of respondents

The results of the analysis is organized, summarized and presented using tables, pie charts, bar graphs, and bar charts clearly showing the frequency and percentages involved where applicable. SPSS statistical software is the data management tool used for the inferential statistics.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents the results of the study and discussions. The raw data is transformed into a form to make it easy to understand and interpret. Conclusions are derived from results of the analysis. These results are presented in various systems to make it possible to interpret population characteristics, comparisons and associations of data.

4.1 Population characteristics

4.2 Duration of service of respondents

Analysis shows that 53% of staff in the public universities had worked over 8years as compared to 30% in the private universities. This is expected outcome considering that the average time in existence of the Private universities as presented in the tables 2 and 3 below.

Table 2: Public universities

University	Year established	Year of attaining university status	Total years of existence
A02	1939	1988	72
A07	1981	1994	30
A03	1972	2009	39

The mean of the years of existence (up to 2011) of the selected public universities is 47 years.

Table 3: Private universities

University	Year established	Year of attaining university status	Total years of existence
A01	1996	2006	15
A04	2006	2006	5
A05	1984	1992	27
A06	2001	2001	10

The mean number of the years of existence (up to 2011) of the selected private universities is 14.25 years. The various staff service age categories and their percentage response are shown in figure 4.

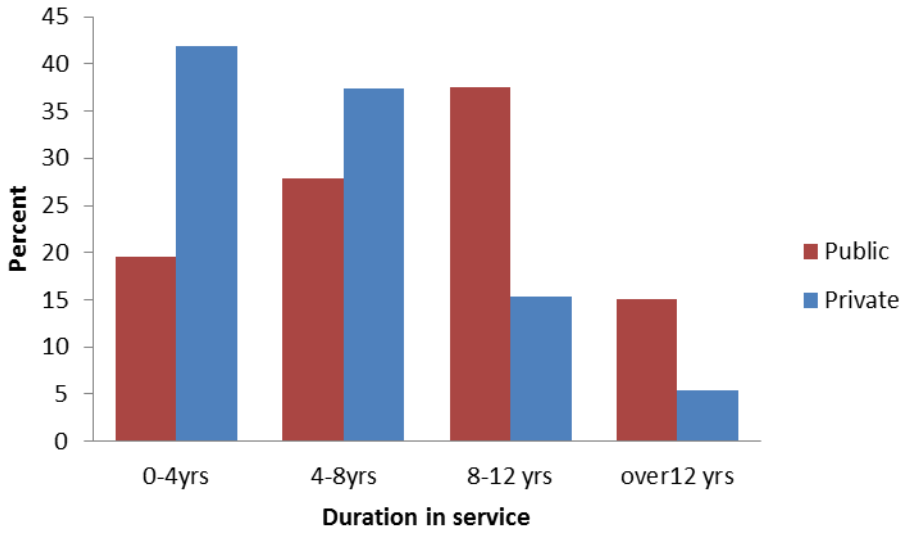


Figure 4: Kenyan universities staff duration of service

This findings concur with those of FPA (2009) who stated that public schools have existed for a longer period of time compared to private schools and hence staff in public schools have worked for a longer time compared to their counter parts in the private sector (FPA, 2007).

4.3 Essential fire safety measures in place in local universities in Kenya

The first objective of this study was to establish the essential fire safety measures put in place at the Private and Public universities in Kenya. The responses by sampled members of staff are represented in a frequency analysis table using a Likert scale for comparison in Table 4.

Table 4: Essentials fire safety measures in private and public universities

	Frequency					
	No	**Not sure**	**Yes**	**Mean index**	**Category of rating scale**	**Rank**
Fire extinguishers	3	0	478	2.99	3	1
Fire Exit signs	8	0	473	2.97	3	2
Fire safety procedures posted	44	12	425	2.79	3	3
Fire hose reels	68	17	396	2.68	3	4
Automatic fire detection and alarm systems	209	63	209	2	2	5
Fire doors	159	251	71	1.82	2	6
Fire hydrants	347	88	46	1.37	1	7
Fire safety Training programmes	356	79	46	1.36	1	8
Emergency lighting	354	90	37	1.34	1	9
Conduct of Fire Drills	386	76	19	1.24	1	10
Automatic fire suppression (sprinklers)	465	9	7	1.05	1	11

The results show that the facilities were adequately equipped with Fire exit signs (98% mean index 2.97), Fire extinguishers (99% mean index 2.99), Hose reels (82%, mean index 2.68) and had Fire action procedures posted (88%, average index 2.79) within the workplace. It was however clear that the campuses did not conduct regular fire drills (average index 1.24). In addition there is low compliance with the requirement to provide emergency lighting, automatic Fire suppression systems and Fire Hydrants as well as provision of formal training programs on Fire safety (all

having an average index of below 1.50). Respondents were not sure of the presence of fire doors within their premises. In most cases the respondents confused Fire doors with Fire exits.

According to CFOA (2006) fire safety equipment are essential in fighting fire in institutions. Lack of these facilities would lead to major disasters in most cases resulting to severe damage and even loss of lives (CFOA, 2006). The findings of this study also agree with Bryant (2008) that fire drills are quite essential to educate the members of staff and even the population at large on fire safety management (Bryant, 2008). Regular fire evacuation drills put into practice the existing emergency plans within institutions.

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.* (2002), and the NFPA (2000, 2002) reports that also indicated that fire safety training enables individuals to take more precautions to prevent a fire spread.

4.2.1 Private and public universities compared on fire safety measures

The study compared the essential fire safety measures in place between local and public universities to determine a correlation between a specific provision and category of university.

4.2.1.1 Presence of Automatic fire suppression

Automatic fire suppression equipment were not present according to the population sampled in both public and private universities. From the results, 94% of the

respondents agreed that there were no automatic fire suppression equipment in private universities compared to 99% in public universities. However private universities have marginally more areas equipped with automatic suppression systems than the public universities as shown in figure 5**.** The Pearson Chi- square (P) value of 0.009 indicates that the presence of automatic fire suppression systems is dependent on the university category (χ^2 = 9.377; df = 2, p < 0.05). According to Plackett (1983) for the test of independence, also known as the test of homogeneity, a chi-squared probability of less than or equal to 0.05 (or the chi-squared statistic being at or larger than the 0.05 critical point) is commonly interpreted by applied workers as justification for rejecting the null hypothesis that the row variable (in this case the university categories) is independent of the column variable.

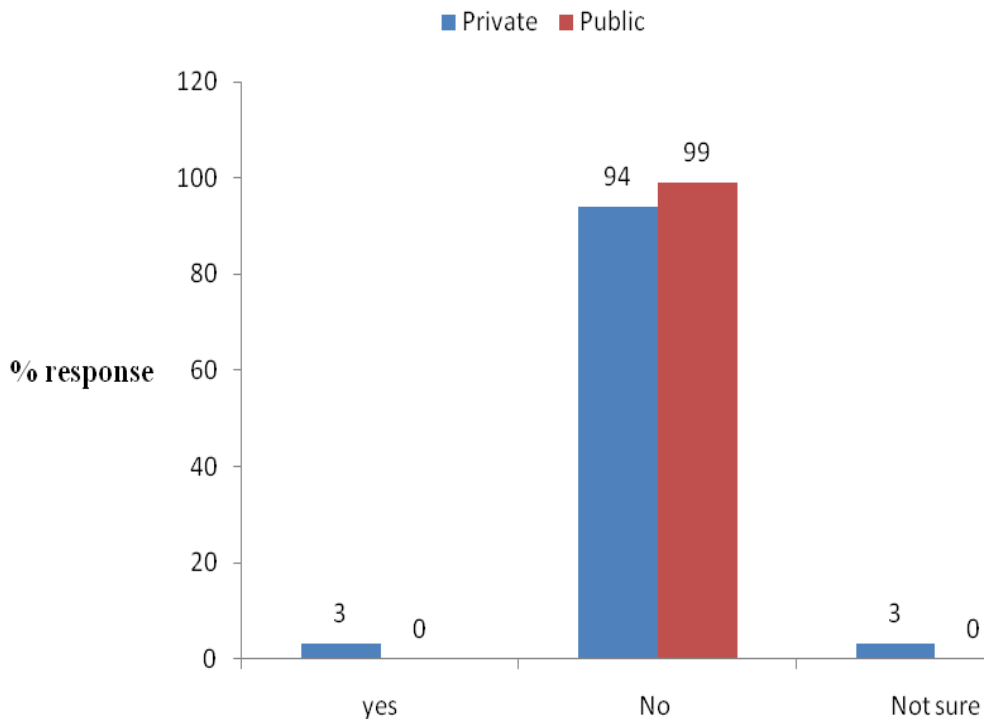


Figure 5: Presence of Automatic fire suppression in the premises

A report by Kennet (2008) states that an automatic fire suppression system control can extinguish fires without human intervention. To do so it must possess a means of detection, actuation and delivery. In many systems, detection is accomplished by mechanical or electrical means. Mechanical detection uses fusible-link or thermo-bulb detectors. These detectors are designed to separate at a specific temperature and release tension on a release mechanism. Electrical detection uses heat detectors equipped with self-restoring, normally-open contacts which close when a predetermined temperature is reached. Remote and local manual operation is also possible (Kennet, 2008). The buildings in the private universities are on average 14.25 years old as compared to 47 years for the public university buildings. Fire suppression systems are more likely to be found in modern building designs as this is relatively new technology. It was however observed that some older buildings have undergone upgrading renovations over time and had installed fire suppression systems. They are mostly installed in computer server rooms to protect data in case of fire outbreak.

4.2.1.2 Presence of fire hose reels

The study shows that the presence of fire hose reels is dependent on university category as the Pearson chi square value determined is $p = 0.0001$ ($\chi^2 = 46.94$; $df = 2$, $p < 0.05$)**.** Although both categories of universities are well equipped with fire hose reels, it is clear that the prevalence is significantly higher in private universities as shown in figure 6. Later buildings constructed tend to have safety provisions inherent in the designs.

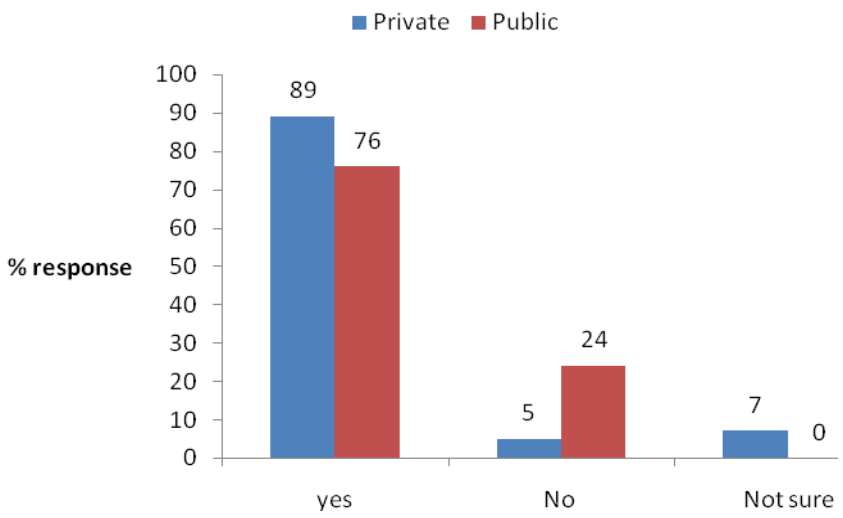


Figure 6: Presence of fire hose reels on sites per university category

4.2.1.3 Installation of Fire hydrants

With an average response index of 1.37 (Rating scale category of 1 representing a response of No) the respondents confirmed that they did not have fire hydrants installed in most of the sites.

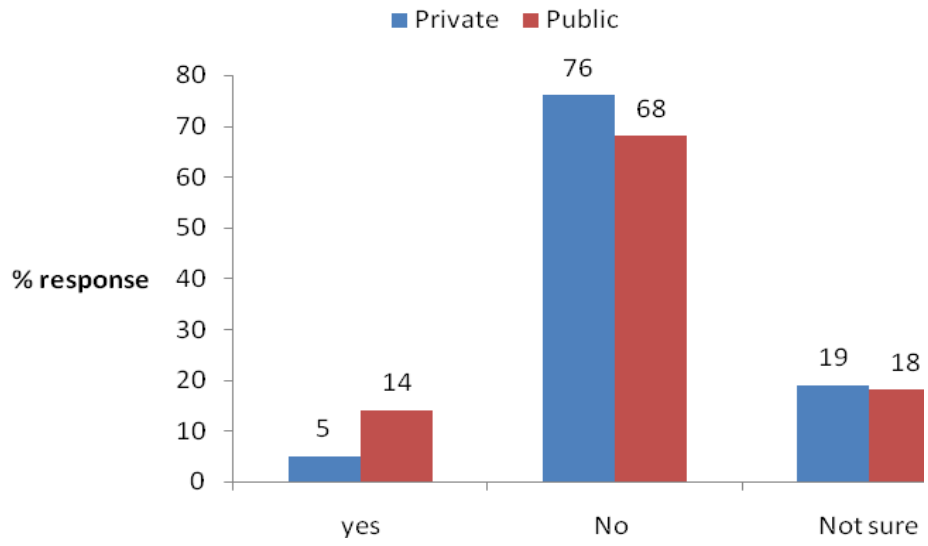


Figure 7: Presence of fire hydrants on sites per university category

Further analysis also show that presence of fire hydrants is dependent on university category (χ^2 = 11.74; df = 2, p < 0.05 with p = 0.003)**.** There is a significant difference between the category of university and installation of fire hydrants. The public universities have significantly more areas installed with fire Hydrants.

4.2.1.4 Installation of automatic fire detection and alarm systems

Respondents were asked whether their workstations had automatic fire detection systems. This is represented in Figure 8.

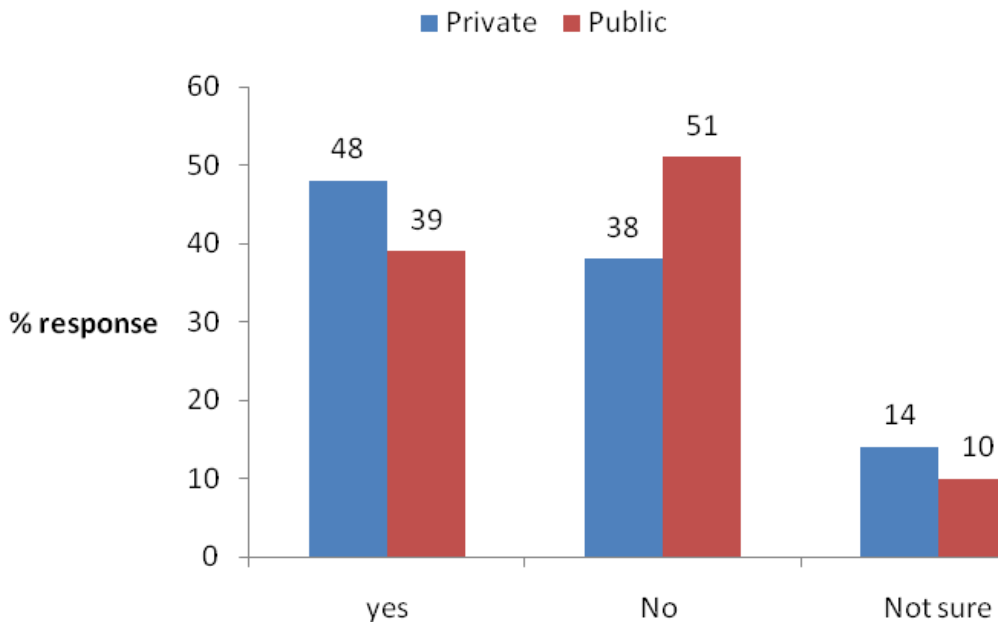


Figure 8: Presence of fire detection on university premises

The Fire detection and alarm systems are installed in some locations within the universities as indicated in the results presented above, The difference between the two categories of universities is however not significant. (χ^2 = 4.78; df = 2, p >0.05 with P = 0.092)**.** Thus it is concluded that the presence of automatic fire detection &

Alarm systems is statistically not dependent on the university category. Section 28 (1) of the Fire risk reduction rules states that every occupier shall provide and maintain fire detection appliances. Holland (2002) stated several ways on how to save our schools from deadly fires. He mentioned the importance of firefighting equipment including Fire detection systems in fire safety management. Smoke and heat detectors are the common types of fire detection systems.

4.2.1.5 Installation of fire doors

The respondents were mostly unsure (average index 1.82) about the installation of Fire Doors. There was no association between the presence of fire doors and category of university ($\chi^2 = 3.838$; df = 2, $p > 0.05$ with $p = 0.147$). During interview most respondents initially confused the fire exit doors with fire doors described above. Fire doors are designed to prevent the spread of Fire and Smoke as they are made of fire resistant material. Lack of fire doors would accelerate the spread of fire during an outbreak.

4.2.1.6 Presence of emergency lighting

University employees were asked whether emergency lighting is installed in their work areas and the findings are represented in figure 9.

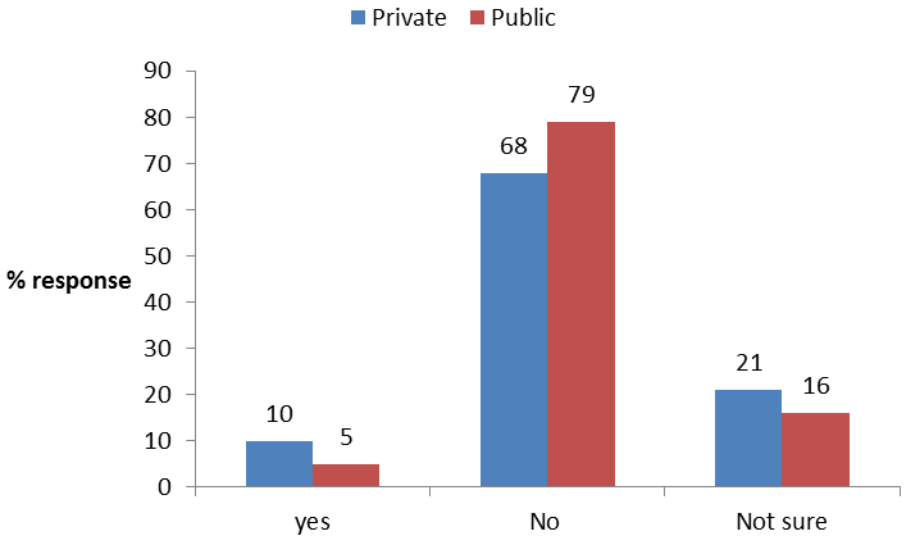


Figure 9: Presence of emergency lighting within the premises

Further analysis also show that presence of emergency lighting is dependent on university category (χ^2 = 7.79; df = 2, p > 0.05 with p = 0.02)**.** There is significant association between the category of university and installation of emergency lighting. The Private universities have more premises installed with emergency lighting albeit the percentage is still small. Once again the fact that the some of the buildings are of old design in the public universities and are more likely to lack emergency lighting is an indicator that this provision was less considered at design stage in earlier years as compared to now.

4.2.1.7 Fire drills

The study sought to establish whether the institutions conducted fire evacuation drills. The results for both categories of universities are represented in figure 10.

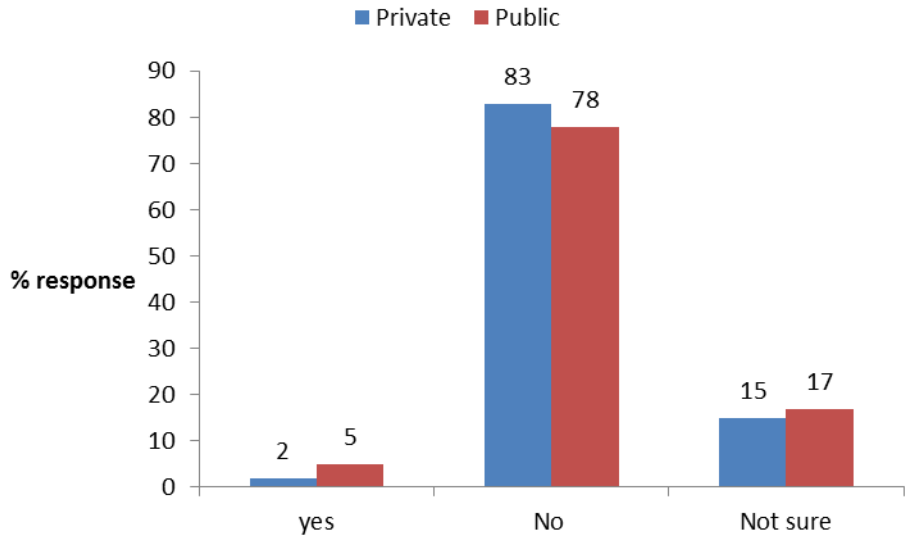


Figure 10: Conduct of Fire drills at the universities

The respondents in both categories of universities stated overwhelmingly that drills were not practiced regularly. The results show that 78% of the Public university respondents indicated that these were not done relative to 82.6 % of the Private counterparts**.** The average index of 1.37 falls in the rating category of 1 thus confirming that these drills are not conducted in all the universities. There was no significant statistical association between the university categories as regards the regular practice of Fire drills (χ^2 = 3.16; df = 2, p> 0.05, with p = 0.206).

It is critical that regular evacuation drills are conducted to enhance emergency response and preparedness.

4.2.1.8 Fire training programs

The study results found that there is lack of fire training programs targeting staff members of the local universities (average index in table of 1.36 which lies in scale category of 1 (No)). In both categories 74% (n=481) of respondents were not aware

of any fire safety training programs in their institutions and have not attended any as shown in figure 11.

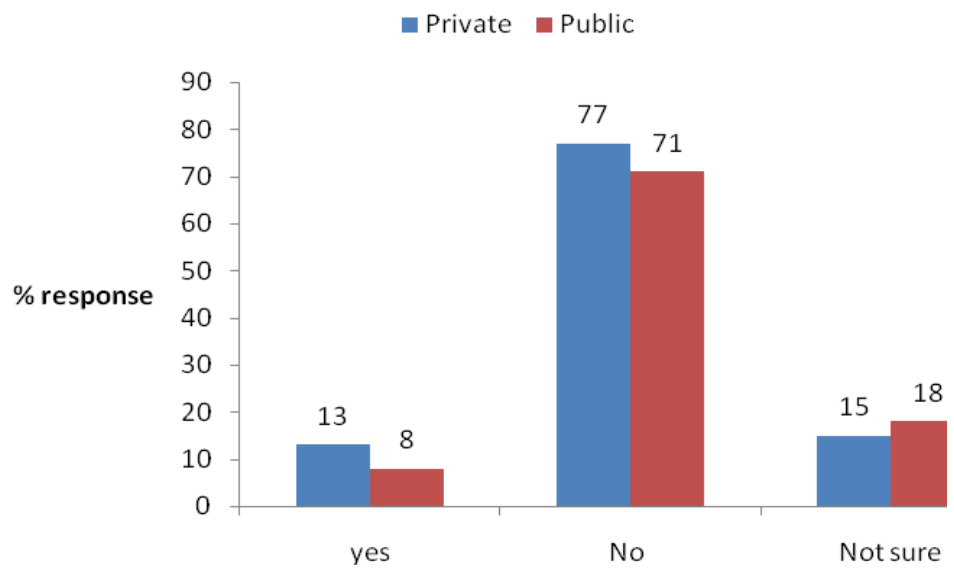


Figure 11: Proportion of staff aware of Fire training programs in universities

Provision of fire safety training variable is independent of university category (χ^2 = 3.72; df = 2, p> 0.05, with p = 0.156) as there is no significant difference among the categories of universities.

This finding directly relates to the fact that both categories of universities have no comprehensive fire policies that would require provision of training as illustrated in later parts of this study report.

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.

4.2.1.9 Provision of Basic Fire safety requirements

A total of 49 locations representing 7 locations per university campus were inspected. The locations were diverse and comprised of Office blocks, Laboratories, Workshops, Lecture halls, Clinics, Kitchens. Figure 12 illustrates the findings.

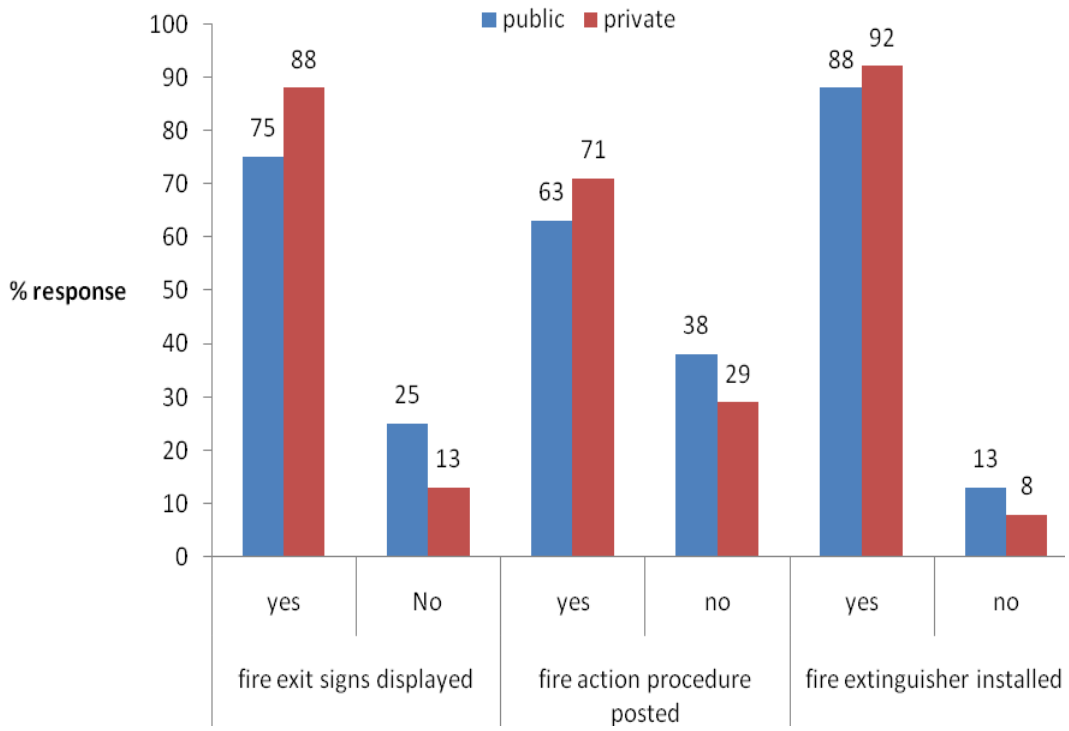


Figure 12: Provision of basic Fire safety items at the universities

It is clear from the results that there is no significant difference between both categories of universities. Provision of these basic fire safety measures was generally good in both categories with above 75% average compliance. These are requirements that are mandatory for insurance cover and licensing by the local authorities.

4.2.1.10 Establishment of in-house firefighting teams

Only 4% of the respondents said that their sites have established in-house firefighting teams. The results show that 96% said that they were either not aware or unsure of

the existence of such a team in their workplaces for both categories of universities as shown in figure 13.

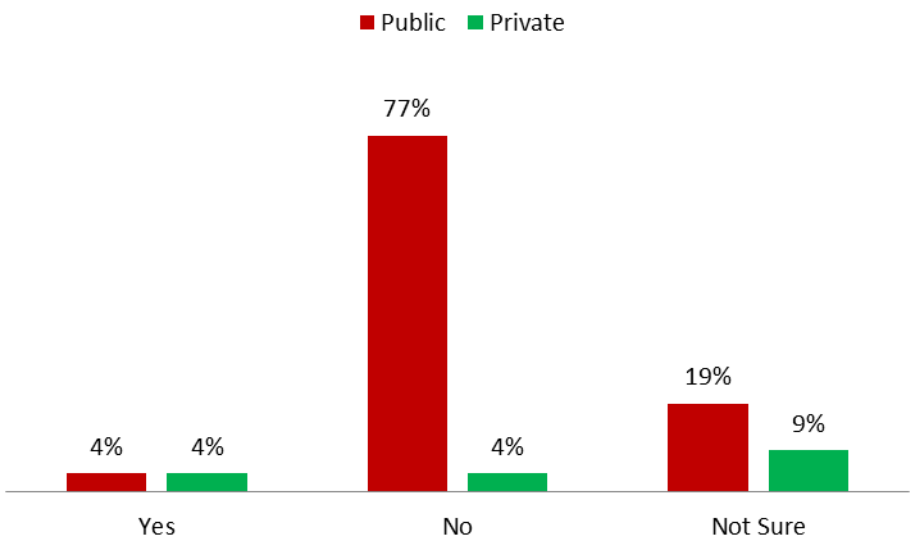


Figure 13: Establishment of in-house firefighting teams

Structured observation survey confirmed that none of the sampled locations had trained and active in house firefighting teams comprising of regular staff. There is also marginal difference between the two categories of universities (χ^2 = 8.606; df = 2, p> 0.05, with p = 0.021) with public university staff having a significantly greater number of staff not sure of the presence of these teams.

According to Kidd (2008) Firefighting teams help in fighting fire outbreaks in institutions and firms so as to contain the fires and hence reducing damage of properties and loss of lives (Kidd, 2008).

4.2.2 Fires safety awareness levels

In order to determine the awareness levels of staff in local universities on basic Fire safety and the Fire risk reduction rules, 2007, the respondents were asked questions relating to this objective.The responses are represented in a frequency analysis table with mean indices determined. The results are represented in Table 5.

Table 5: Employees Fire safety awareness

	Aspects of Fire safety awareness	**Frequency analysis**		**Mean index**	**Remarks**
		1 (N)	**2 (Y)**		
		No of respondents			
1.	Awareness of the Factories (Fire risk reduction) rules	363	89	1.20	Poor
2.	Know the escape routes and fire exits	159	320	1.67	Good
3.	Know the assembly point location	132	339	1.69	Good
4.	Aware of action to take on discovering a fire	132	339	1.72	Good
5.	Know the location of the nearest firefighting equipment	136	278	1.67	Good
6.	Aware of the need that Lifts should not be used in case of fire	30	442	1.94	Good
7.	Aware of the need to turn off electrical equipment and machinery when not in use	52	396	1.88	Good
8.	Aware that you should keep corridors and exits clear of obstruction	45	421	1.90	Good
9.	Aware to keep Fire equipment points clear of obstruction	84	351	1.81	Good
10.	Aware to keep workplace free from combustible waste	125	278	1.69	Good
11.	Aware of fire warning system and evacuation procedure	257	219	1.46	Poor
12.	Aware of the storage areas for flammables	362	41	1.10	Poor
13.	Aware of the need to close doors and windows in event of fire	117	170	1.49	Poor
14.	Aware of the institutions smoking policy	114	321	1.74	Good
15.	Aware of institution's fire safety policy and procedures	346	128	1.27	Poor

The χ^2 Test results are presented in Table 6. The Pearson chi square (p) values are greater than 0.05 with the all aspects tested except five namely; Awareness of the fire risk reduction rules (χ^2 =29.02), the need to turn off electrical equipment and machinery when not in use (χ^2 =24.979), keeping Fire equipment points clear of obstruction (χ^2 =16.795), awareness of the smoking policy (χ^2 =25.866) and awareness of the institutions' Fire safety policy and procedures (χ^2 =7.318). The calculated χ^2 value greater than the table value of 5.99 at 95% level of significance, df = 2.

Therefore it is concluded that in most of the aspects there is no significant difference between the public and private universities. The high chi square values indicate a low probability that the observed deviations are due to random chance alone.

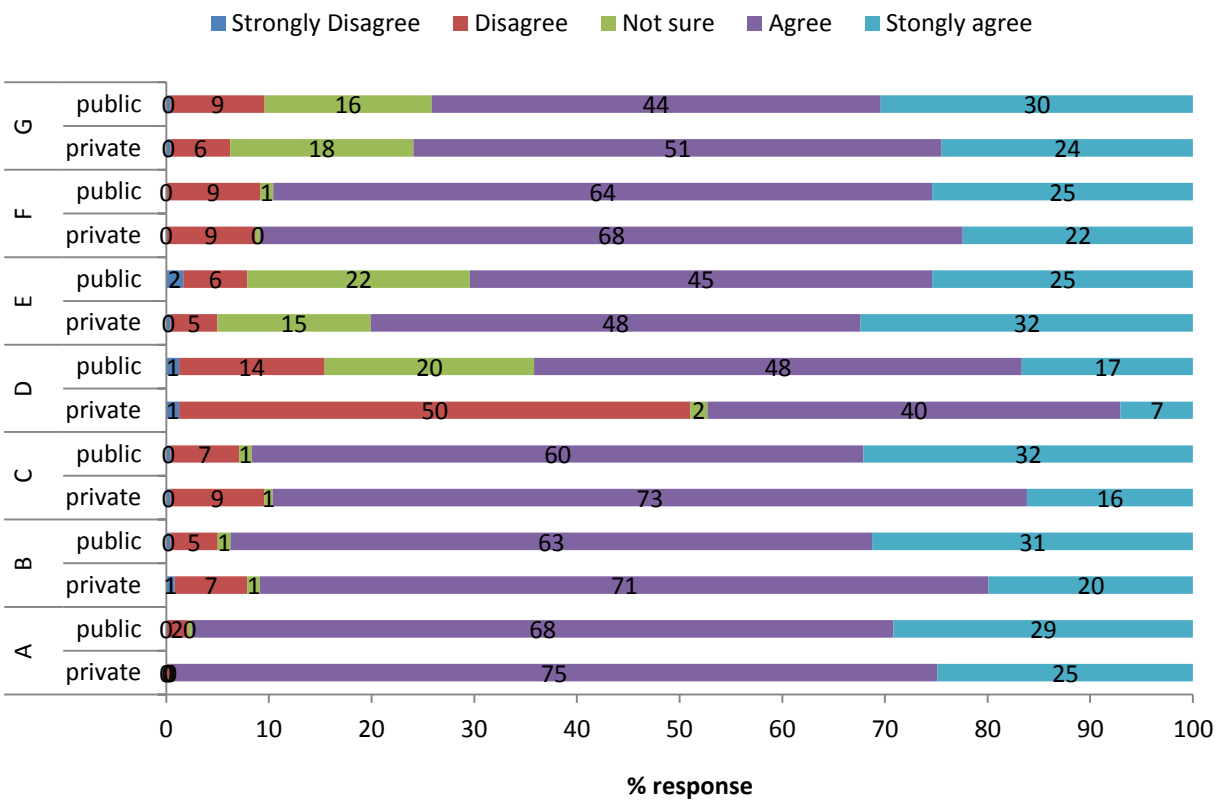
Table 6: χ^2 Test analysis for the key safety awareness aspects (N=481)

	Aspect of fire safety awareness	**χ^2 Value**	**P Value**
1.	Awareness of the Factories (Fire risk reduction) rules	29.02	0.0001
2.	Know the escape routes and fire exits	2.779	0.702
3.	Know the assembly point location	1.456	0.842
4.	Aware of action to take on discovering a fire	5.908	0.009
5.	Know the location of the nearest firefighting equipment	3.391	0.116
6.	Aware of the need that Lifts should not be used in case of fire	4.487	0.073
7.	Aware of the need to turn off electrical equipment and machinery when not in use	24.979	0.0001
8.	Aware that you should keep corridors and exits clear of obstruction	3.092	0.0001
9.	Aware to keep Fire equipment points clear of obstruction	16.795	0.0001
10.	Aware to keep workplace free from combustible waste	3.812	0.159
11.	Aware of fire warning system and evacuation procedure	3.928	0.140
12.	Aware of the storage areas for flammables	2.196	0.334
13.	Aware of the need to close doors and windows in event of fire	1.596	0.450
14.	Aware of the institutions smoking policy	25.866	0.0001
15.	Aware of institution's fire safety policy and procedures	7.318	0.062

It is clear from the results that the awareness level of basic aspects of fire safety awareness is generally high amongst staff in the local universities as presented in table 5. This is despite the fact that they are low awareness levels of the Fire risk reduction rules, 2007 and lack of comprehensive institution fire policies. According to Mostue (2001), awareness levels of the fire safety management will help reduce the losses and damages suffered during fire outbreaks (Mostue, 2001). It is the responsibility of the management together with DOSHS to embark on awareness training of fire safety rules and regulations.

4.4 Factors affecting implementation of the Fire risk reduction rules

Members of Staff were asked to indicate what factors they felt most affected the implementation of the Fire risk reduction rules. This was the study's second objective. The results are summarized in Figure 14 that compares the two university categories.



KEY: A. The lack of information, B. Lack of adequate funds, C. Lack of a comprehensive fire policy, D. Lack of support from the management, E. The absence of government support, F. The absence of skilled personnel, G. Inappropriate technology

Figure 14: Factors affecting implementation of the Fire risk reduction rules

The Pearson Chi square (p) value is greater than 0.05 for all the aspects tested meaning that there is no significant difference between the two categories of universities in regard to factors influencing implementation of the fire rules.

The results from both categories of universities are combined to determine the overall perception of university staff in regard to the factors they felt had the most influence on the implementation of the Fire risk reduction rules. These are represented in table 7 below.

Table 7: Combined Ranking of factors affecting implementation of the Fire rules

	Frequency analysis					Mean index	Rank
	1	2	3	4	5		
	No. of Respondents						
The lack of information	0	6	1	244	230	4.45	1
Lack of a comprehensive fire policy	1	39	5	220	216	4.27	2
Lack of adequate funds	1	30	6	301	143	4.15	3
Inappropriate technology	4	39	4	311	123	4.06	4
The absence of skilled personnel	0	43	4	319	115	4.05	5
The absence of government support	35	59	26	250	111	3.71	6
Lack of support from the management	3	185	2	234	57	3.33	7

Respondents agreed that all the factors listed were important in influencing the implementation of the rules as the average index ranged between 3 .0 to 5.0.

The study has established that 99% (mean index 4.45) of employees in both categories of the universities felt that lack of information as relates to the rules as the main factor affecting the implementation of the rules. The rules were gazzzeted in the year 2007 and were only 6 years in existence at the period of this research. They can be thus classified as new legislation. In Kenya all new legislation and rules are published in the Kenya Gazzete. There have been no other programs by the Government to further increase awareness of the Fire risk reduction rules. The lack of knowledge of the rules combined with lack of Fire policies (92%, mean index 4.27) within the institutions contributed significantly to poor implementation of fire safety stipulations. Section 34 (1) of these subsidiary legislation requires every occupier to establish and implement a written fire safety policy, outlining the organization and arrangements for carrying out the policy (Fire reduction rules, 2007). A typical fire policy should have in place arrangements for training of

employees on fire safety, emergency response, and conducting risk assessments among other essential elements of fire safety. In a previous study, Proulx (2003) concurred that 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. He however could not establish why reports indicated a lack of fire safety knowledge, delayed threat recognition, and delayed evacuation among the general community, especially among younger and older persons (Proulx, 2003).

Lack of adequate funds to address fire safety related issues also ranked highly as a significant factor affecting the implementation of the rules. 92% (mean index 4.15) of the respondents felt that this was a significant factor affecting the implementation of the rules. This result concurs with the results obtained under the first objective of this study that was seeking to establish the essential fire safety measures in place within university facilities. Installation of Fire detection, alarm and suppression systems that are relatively expensive was lacking across both categories of universities (see section 4.2). Where we have in place fire prevention and fighting equipment 90% (mean index 4.06) of the respondents felt that the technology used was inappropriate. Without fire policies in place as confirmed under section 4.4, there is little chance that priority would be given to procurement and installation of expensive fire equipment during finance budgeting.

The study has established that lack of government support (mean index 3.71) and management support (mean index 3.33) had the least influence on the implementation of the fire risk reduction rules relative to the other factors discussed.

4.5 Evaluating compliance status to the Fire risk reduction rules 2007

The third objective was to evaluate the compliance status of the universities against the gazzzeted Fire rules. The fire risk reduction rules, LN 59 of 2007 can be classified into 5 distinct parts stipulating the management of fire in the workplace as follows:

I. Management of flammable substances
II. Housekeeping
III. Electrical safety
IV. Emergency preparedness
V. Management framework and DOSHS statutory reporting obligation

In this study the institutions compliance to these provisions of the fire rules was determined through conducting a facilities tour. The checklist used was developed from the pertinent sections of the rules (Appendix 1 Part D). A four level rating score as shown in Table 8 was used to place the level of compliance to the particular requirements of the rules.

Table 8: Interpretation of Fire rules compliance rating

Mean Index	**Rating**	**Interpretation**
1.00 – 1.50	Poor	Compliance is below 60% of the requirements
1.51 - 2.50	Average	Complies with at least 60% of the requirements
2.51 - 3.50	Satisfactory	Complies to at least 75% of the requirements
3.51 - 4.00	Good	Complies to at least 90% of the requirements

The results are represented in tables indicating the mean indices derived from the observations.

4.4.1 Management of flammable substances

Sections 4 to 12 of the Fire risk reduction rules stipulate the minimum standards premises should have as regards to the management of flammable substances. The university premises were audited against these standards. The study's findings as are summarized in Table 9.

Table 9: Management of highly flammable substance

	Frequency analysis (Compliance level)				**Mean index**
	>60%	**<60%**	**<75%**	**<90%**	
	No. of locations				
Location of highly flammable substances- Section 4 &5	6	6	2	0	1.7
Storage of flammable substances - Section 6	2	10	2	0	2
Marking and labeling storage for flammables - Section 7	0	4	8	2	2.9
Handling of flammables - Section 8	0	6	8	0	2.6
Ventilation for flammables storage - Section 9	0	4	10	0	2.7
Removal of flammables where there is heat - Section 12	0	6	8	0	2.6
Overall Average rating					**2.41**

The average rating mean index is 2.41. This means that the overall compliance level as regards the management of flammable substances stands at an average of 60% in both private and public universities. The purpose of such stringent standards for storage of highly flammable standards is to prevent the spread of fire either to the material or from the material during an outbreak.

The observation results for specific sections presented in Table 9 are interpreted in the following sub-sections.

4.4.1.1 Location of Highly flammable substances (Section 4,5 of Fire rules)

The fire risk rules requires every occupier to ensure that any highly flammable substance capable of reacting and producing heat when mixed is identified and kept in separate storerooms or compartments and any highly flammable substance that is self-combustible, is kept in separate stores away from other substances or material.

The study found that Institutions had in most cases allocated areas for storage of flammables such as petrol, laboratory chemicals. The workrooms however failed to meet all the prescribed standards in the rules thus the low mean index of 1.7. This represents an overall compliance level of below 60%. Flammable substances when not stored properly are a major fire hazard as they provide potent fire load that would further propagate a fire once ignited.

4.4.1.2 Storage of flammable substances (Section 6 of Fire rules)

The rules stipulate that flammable substances are stored in purpose built storage areas. Observations made against this standard indicate overall compliance level of 60% (mean index 2.00). Flammable chemicals were mostly stored in suitable locations within the Laboratory. However flammable paints were in most cases not stored in purpose built storage areas thus increasing the fire loads in the premises.

4.4.1.3 Marking and labeling storage of flammable substances ((Section 7)

The requirements for marking and labeling storage of flammable substances are prescribed under Section 7 of the rules. The institutions were compliant to at least 60% (mean index of 2) on the requirement for storage and above 75% (mean index of 2.9) for the requirement for marking and labeling. This is an average score and

was boosted by the fact that flammable substances were mostly used in purpose designed Laboratories.

4.4.1.4 Handling of highly flammable material (Section 8 of Fire rules)

The handling of highly flammable material and requires every occupier to ensure that the quantity of any highly flammable substance present at any one time in a workplace, is as small as is reasonably practical, having regard to the processes or operations being carried on. This is prescribed under section 8 of the rules. Stock control and management of cost demand that wastage is minimized. Conveyance of highly flammable substances within the workplace should be done through totally enclosed systems incorporating pipelines and where this is not practical purpose designed vessels can be used to avoid spilling of substance. This provision addresses the concerns in manufacturing industry for example where Industrial Methylated spirit used for cooling of vessels has to be conveyed. It was thus not applicable at the sampled institutions

The facilities achieved a satisfactory rating mean score of 2.60 (at least 75% compliance) for manual handling flammable substances.

4.4.1.5 Ventilation of Flammable storage areas ((Section 9 -12 of Fire rules)

Compliance score measured against sections 9-12 of the rules was rated at satisfactory rating mean score of 2.7 (above 75% compliance average). The presence of fume cupboards, mechanical exhaust ventilation systems and low quantities of highly flammable material at the universities influenced this good score.

4.4.2 Housekeeping

The workshops and laboratories present at the main campuses were inspected and were rated against the provisions on housekeeping under sections 13 – 15 of the rules A satisfactory mean rating of 2.76 (above 75% on average) as shown in table 9 was deduced.

Table 10: Housekeeping practices

	Frequency analysis (Compliance level)				**Ave. index**
	>60%	**<60%**	**<75%**	**<90%**	
	No. of locations				
Housekeeping procedures - Section 13	0	4	10	0	2.71
Removal of waste - Section 14	0	2	12	0	2.86
Machinery layout - Section 15	0	4	10	0	2.71
Overall mean rating					**2.76**

4.4.3 Electrical safety

Faulty electrical installations can be a significant potential fire ignition sources. It is thus imperative that occupiers maintain the highest standards of electrical safety (Stokes, 2007).

The institutions registered a poor score averaging below 60% (mean index 1.7). In some areas unsafe electrical connections were observed with direct connection of bare wires to the live sockets. There were signs of overheating or scorching of plugs and in some instances taped joints on extension leads. Records of inspection of portable electrical equipment in every period of six months were lacking in majority of the sites.

Table 11: Handling of electrical equipment

	Frequency analysis (Compliance level)				Ave. index
	>60%	<60%	<75%	<90%	
	No. of locations				
Handling of electrical equipment - Section 16	5	8	1	0	1.7
Overall Average rating					**1.7**

4.4.4 Emergency preparedness

Compliance to the provisions on emergency exits was at least 60% average (mean 1.92) as shown in Table 12.

Table 12: Physical provisions for emergency preparedness

	Frequency analysis (Compliance level)				Ave. index
	>60%	<60%	<75%	<90%	
	No. of locations				
Fire escape exits - Section 17	0	10	2	2	2.42
Control of spread of smoke - Section 18	12	2	0	0	1.14
Means of evacuation - Section 19	2	10	2	0	2.00
Means of emergency communication - Section 26	12	2	0	0	1.14
Fire detection system - Section 28	4	10	0	0	1.71
Firefighting appliances - Section 29	0	0	0	14	4.00
Maintenance of fire extinguishers - Section 30	0	4	2	8	3.28
Color coding of pipes - Section 32	10	4	0	0	1.14
Water storage - Section 33	14	0	0	0	1.00
Overall Average rating					**1.92**

The results determined and presented in Table 12 are interpreted in the following sub-sections.

4.4.4.1 Fire escape exits

The institution scored a mean index of 2.42 (at least 60% compliance level) Failure to maintain the exits and exit routes clear of obstruction and lack of fire exits in some buildings considerably compromised this rating. Lack of alternative means of escape in a building seriously lowers the probability of survival of occupants in case of emergency.

4.4.4.2 Control of spread of smoke

Compliance to this factor was poor (below 60% (mean index 1.14)) as none of the doors observed were designed to be able to contain smoke. Majority of the doors were also not self-closing.

In a building fire it is often the spread of smoke into crucial areas that presents the greatest obstacle to escape. The problem is therefore to control this process, especially in 'compartmented', multi-occupation buildings (Majou,1999). It is generally accepted that the migration of smoke and toxic combustion products presents a greater hazard to life and more serious hindrance to firefighting efforts than the spread of the fire itself. (Zinn et al, 1974)

4.4.4.3 Means of evacuation

The sites were rated as average (at least 60% - mean index 2.00). It was common to have floors with only one staircase to access the floors. There was no alternative exit such as fire escape stair cases.

According to the Health and safety authority (HSA) (2013) 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). Regardless of the location of a fire, once people are aware of it, they should be able to proceed safely along a recognizable escape route, to a place of safety. Escape routes should be kept clear of all obstructions. The escape route should lead to a place of safety, normally outside and away from the building. Doors on escape routes must always be available for use without the use of a key.

4.4.4.4 Means of emergency communication

Few of the sampled work places had in place a fire alarm system with manual call points comprising of Break glass points. It was disappointing to note that in most cases the system had broken down thus a poor score of below 60% compliance average (mean index 1.14).

In most workplaces, the evacuation in case of fire will simply be by means of everyone reacting to the warning signal given when the fire is discovered and making their way, by the means of escape, to a place of safety away from the workplace. This is known as a 'simultaneous' evacuation and will normally be initiated by the sounding of the general alarm over the fire warning system. In almost all buildings, a suitable electrically operated fire warning system, with manual call points positioned both on exit routes and adjacent to final exits should be installed. This should have sufficient sounders for the warning to be clearly heard throughout the workplace. The sound used as a fire warning should be distinct from other sounds in the workplace and, where background noise levels are high or an employee has a hearing

impairment, it may also be necessary to install a visual alarm such as a distinctive flashing or rotating light (HSA, 2013).

4.4.4.5 Fire detection systems

The most common type of fire detection systems comprise of smoke and/or heat detectors connected to an audible alarm system.

The Health and safety authority (HSA, 2013) prescribes that all workplaces should have arrangements for detecting fire. Consideration must be given to any parts of the workplace 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 or a part of the workplace that has been temporarily vacated, for example at mealtimes. Fires that start and develop unnoticed can pose a serious danger to people in the workplace.

This study found that less than 60% (mean index 1.71) had fire detection systems installed. In some instances where this were available the system had broken down thus not of any use.

4.4.4.6 Fire fighting appliances

The section of the Fire rules with the best compliance was on the provision of Portable firefighting appliances. This consists in most cases of various types of Fire extinguishers in cylinders placed at strategic locations within the buildings. This provision is covered. The facilities averaged a score of at least 90% compliance to this provision. The law also requires that the equipment is properly maintained under section 30.

Fire-fighting equipment must be in place for employees to use, without exposing themselves 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 small premises, having one or two portable extinguishers may be all that is required. Signboards or a safety colour (or both) shall be used to mark permanently the location and identification of fire-fighting equipment. In larger or more complex premises, a greater number of portable extinguishers, strategically sited throughout the premises, are likely to be the minimum required. Other means of fighting fire may need to be considered. (HSA,2013)

4.4.4.7 Color coding

The study found that the fire extinguishers met the color coding standard. However where pipes for conveying fire water existed less than 60% (mean index 1.14) were color coded.

4.4.4.8 Water storage

In the event of a fire there should be adequate water to assist in extinguishing it. It is thus imperative that sites have storage facilities for of at least 10000 litres of this emergency water as prescribed under Section 33 of the rules. None of the site had provision for Fire emergency water in place thus scored poorly below 60% with the lowest mean index possible of 1.00.

4.4.5 Management framework and DOSHS statutory reporting obligation

Section 34 -36 of the Fire risk reduction rules cover the management framework required by an occupier as well as direct reporting obligations to the Directorate of occupational Safety and health services (DOSHS).

The institutions were rated very poorly overall with a lowly mean index of 1.00 or below 60% compliance as shown in Table 13.

Table 13: Management framework and DOSHS statutory reporting obligation

	Frequency analysis (Compliance level)				**Mean index**
	>60%	**<60%**	**<75%**	**<90%**	
	Number of locations				
Fire safety policy available - Section 34	7	0	0	0	1.00
Fire safety audit - Section 36	7	0	0	0	1.00
Notification of fire occurrence - Section 36	7	0	0	0	1.00
Overall Average rating					**1.00**

The specific findings presented in Table 13 are interpreted in the sub- sections below.

4.4.5.1 Fire safety policy

It is a requirement under Section 34 of the rules that institutions should establish and implement a written fire safety policy that outlines the organization structure and arrangements for implementing the policy. It stipulates that every occupier shall ensure that all workers are informed on the contents of the policy.

The study found that none of the 7 institutions had a Fire safety policy written as prescribed by the rules and submitted to the DOSHS thus scored poorly below 60% with the lowest mean index possible of 1.00.

4.4.5.2 Conduct of annual statutory Fire safety audit

The fire risk reduction rules stipulate under section 36 that the institutions being recognized as workplaces under the Occupational safety and health act, 2007 should undergo a fire safety audit taken at least once in every 12 months by an approved fire

safety auditor. A copy of the report should be submitted to the Director and a copy kept at the institution. The universities are within the scope of this requirement. There were no records of such an audit having been conducted for any of the sampled institutions at the DOSHS.

4.4.5.3 Notification of fire occurrences to the DOSHS

Section 35 of the rules prescribes the mandatory notification to the nearest occupational safety and health area office of any fire occurring in the workplace within 24 hours of occurrence. It also requires the occupier to provide a written report in a prescribed form within 7 days of occurrence. The study noted that though local authorities were notified of major fire occurrences the Directorate of occupational safety and health services was not notified as prescribed by this legislation.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The main objective of this study was to assess the fire risk potential at local universities in Kenya with the Fire risk reduction rules, 2007 as the reference standard.

The study has established that provision of the basic fire safety items that include portable fire extinguishers and Fire exits is generally good (Average index score of 2.87 out of a maximum score of 4.0). It is however notable that installation of complex firefighting and prevention systems that require relatively large capital expenditure was poor in the facilities (Average index score of 1.33 out of a maximum of 4.0). The good score in the provisions of basic fire equipment can be attributed to the need to comply with stringent building codes and insurance requirements and have not been influenced by the Fire risk reduction rules, 2007 stipulations. Formal Fire training programs were generally lacking at the universities with 74% of workers not aware of any such programs.

It has also been established that lack of information, lack of enterprise level policies and inadequate funds are the top contributing factors affecting compliance to the rules.

The compliance level against the Fire risk reduction rules currently stands at below 60% average index of 1.96 out of a maximum score of 4.0). Private universities had marginally better compliance levels than the public universities on average.

It is therefore concluded that the lack of knowledge on the existence and stipulations of the fire risk reduction rules has contributed significantly to the low fire safety standards in Kenya's Universities. The Directorate of Occupational safety and health services has the mandate to enforce safety legislation in Kenya but has not done so in the universities as the study found that none of them complied with the basic statutory requirements such as commissioning of annual Fire safety audits by DOSHS approved auditors. Baseline safety audits would serve as the starting point for improvement safety standards.

5.2 Recommendations from the study

The study recommends the following;

1) Local universities should develop comprehensive fire safety policies. These policies must be backed by specific programs to address the existing gaps found by this study. Focus of these programs should target prevention of fire occurrence, protection of people and property and minimizing fire spread and emergency response. These shall require funds and management should incorporate comprehensive budgetary provisions to implement the requirements.
2) Fire safety training should be incorporated as part of health and safety improvement programs targeting all staff and students.
3) A formal Fire safety audit as stipulated in the rules should be conducted for all institutions. This shall be conducted by a DOSHS approved Fire safety auditor.

4) University management should address the factors affecting implementation of the fire reduction rules as determined by this study.
5) Higher learning Institutions can transform the safety culture through demonstrated and visible leadership commitment by provision of both human and financial resources, recognizing and rewarding staff and departments who demonstrate their individual and collective contributions toward the safety improvement efforts among other culture change initiatives.

5.3 Recommendations for further study

The scope of this study covered only the university workplaces and targeted employees. It is thus recommended that a study on fire safety conditions at University student residential facilities should be conducted to provide an insight into the risk presented and explore ways to mitigate this risk so as to have a wholesome approach to safety within the university communities. An investigation looking into the design of buildings to cater for emergency evacuation of the disabled persons is also recommended.

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APPENDICES

Appendix 1: Questionnaire

Questions to Respondents

PART A: GENERAL AND PERSONAL INFORMATION

a. Name of respondent (optional)

……

b. Name of institution

……

c. How long have you worked in the institution?

i. 0-4 years

ii. 5-8 years

iii. 9-12 years

iv. Over 12 years

PART B: The essential fire safety measures in public and private universities

Respond to the following questions about the essential fire safety measures that are available in your institution and your awareness by ticking where appropriate.

	Yes	No	Not sure
1. Does your site have Automatic fire suppression (sprinklers)			
2. Does your site have Fire hose reels			

3. Does your site have Fire hydrants			
4. Does your site have Automatic fire detection and alarm systems			
5. Does your site have Fire doors			
6. Does your site have Fire extinguishers			
7. Does your site have Exit signs			
8. Does your site have Emergency lighting			
9. Does your site Conduct of Fire Drills			
10. Does your site have Emergency warning and interconnection system			
11. Does your site have fire fighting teams			
12. Does your site have Fire safety Training programmes			
13. Does your site have Fire safety procedures posted			
14. Are you aware of the Factories (Fire risk reduction) rules, 2007			
15. Have you read your institution's fire safety policy and procedures?			
16. Has the fire warning system and evacuation procedure been explained to you?			
17. Have you been shown the escape routes and fire exits?			
18. Do you know the assembly point in the event of a fire or fire drill?			
19. Do you know what action to take on discovering a fire?			

20. Do you know the location of the nearest fire fighting equipment?			
21. Do you know the storage areas for flammable materials?			
22. Are you aware of the need to close doors and windows in event of fire			
23. Are you aware of the institutions smoking policy?			
24. Are you aware of the need that Lifts should not be used in case of fire			
25. Are you aware of the need to turn off electrical equipment and machinery when not in use?			
26. Are you aware that you should only take from storage sufficient materials for the day's production/use?			
27. Are you aware that you should keep corridors and exits clear of obstruction?			
28. Are you aware that you should keep Fire equipment points clear of obstruction?			
29. Are you aware that you should keep workplace free from combustible waste?			

PART C: Factors affecting the implementation of the fire risk reduction rules.

Indicate how the following factors affect the implementation of the fire risk reduction rules.

Key

5= strongly agree

4= Agree

3= Not sure

2= Disagree

1= Strongly disagree

The implementation of the fire risk reduction rules has been affected by:

		1	**2**	**3**	**4**	**5**
i	The lack of information					
ii	Lack of adequate funds					
iii	Lack of a comprehensive fire policy					
iv	Lack of support from the management					
v	The absence of government support					
vi	The absence of skilled personnel					
vii	Inappropriate technology					

PART D: Participatory observation check on compliance with provisions of the fire risk reduction rules (2007)

The observer shall rank compliance of your institution with the provisions of the fire reduction rules (2007) through conducting a facilities tour with the officer in charge of safety, security or Facility maintenance.

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:

		1	**2**	**3**	**4**
i	Location of highly flammable substances				
ii	Storage of flammable substances				
iii	Marking and labeling storage for flammables				
iv	Handling of flammables				
v	Ventilation for flammables storage				
vi	Removal of flammables where there is heat				
vii	Housekeeping procedures				
viii	Removal of waste				
ix	Machinery layout				
x	Handling of electrical equipment				
xi	Fire escape exits				

		1	2	3	4
xii	Control of spread of smoke				
xiii	Means of evacuation				
xiv	Means of emergency communication				
xv	Fire detection system				
xvi	Fire fighting appliances				
xvii	Maintenance of fire extinguishers				
xviii	Colour coding of pipes				
xix	Water storage				
xx	Fire safety policy available				
xxi	Fire safety audit				
xxii	Notification of fire occurrence				

Appendix II**:** List of private universities in Kenya

List of Private Universities in Kenya as at March 2010

1. Adventist University of Africa (Private, Letter of Interim Authority)
2. Africa Nazarene University (Private, Letter of Interim Authority)
3. Aga Khan University (Private, Chartered)
4. Catholic University of Eastern Africa (Private, Chartered)
5. Daystar University (Private, Chartered)
6. Great Lakes University of Kisumu (Private, Letter of Interim Authority)
7. Gretsa University (Private, Letter of Interim Authority)
8. Kabarak University (Private, chartered)
9. KCA University (Private, Letter of Interim Authority)
10. Kenya Highlands Bible College (Private, Certificate of Registration)
11. Kenya Methodist University (Private, Chartered)
12. Kiriri Women's University of Science and Technology (Private, Letter of Interim Authority)
13. Mt Kenya University (Private, Letter of Interim Authority)
14. Scott Theological College (Private, Chartered)
15. St. Paul's United Theological College (Private, Certificate of Registration)
16. Strathmore University (Private, Chartered)
17. Pan African Christian University (Private, Chartered)
18. Presbyterian University of East Africa (Private, Letter of Interim Authority)
19. United States International University (Private, Chartered)
20. University of Eastern Africa, Baraton (Private, Chartered)

Appendix III**:** List of public universities

List of public Universities in Kenya as at March 2010

1. University of Nairobi
2. Kenyatta University
3. Jomo Kenyatta University of agriculture and technology
4. Egerton University
5. Moi University
6. Maseno University
7. Masinde Muliro University of science and technology

Appendix IV**:** Permission to conduct research

To whom it may concern

Dear Sir/ Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN YOUR ORGANISATION

I hereby request to conduct research in your institution as part of my thesis for the award of a Masters of Science Degree in Occupational safety and Health from Jomo Kenyattta University of Agriculture and Technology.

The research shall use a questionnaire – based survey entitled "***An evaluation of the Fire safety status of universities in Kenya with reference to the Fire Risk reduction Rules, LN No. 59, 2007"*** using both local and Private universities for sampling. Your institution is among those identified for sampling. The data collected shall be confidential and its findings will not be used for any other purpose other hat for academic purposes. The final report shall be availed to you for your record.

Please find attached an introduction letter from the institute and a copy of my questionnaire.

Kindly consider my request favorably.

Yours faithfully,

GILBERT L. MAKACHIA

Reg No. EET32-0174/2009

Appendix V**:** Recommendation letter

JOMO KENYATTA UNIVERSITY

OF

AGRICULTURE AND TECHNOLOGY

INSTITUTE FOR ENERGY AND ENVIRONMENTAL TECHNOLOGY

P.O BOX 62000, Nairobi, Kenya. Tel: (067) 52251/52711/52181-4, Fax : (067) 52164 Thika,

Email: director@ieet.jkuat.ac.ke

DATE: 01 MARCH, 2011

TO WHOM IT MAY CONCERN

SUBJECT: MAKACHIA, GILBERT – EET32-0174/2009

The above named person is a postgraduate student at this university from the Institute of Energy and Environmental Technology (IEET) pursuing a Masters of Science degree course in Occupational safety and Health. He is conducting research on ***"An Evaluation of Fire Safety Status of Universities in Kenya with Reference to the Fire Risk Reduction Rules, LN 59, 2007".*** He is currently at the stage of data collection.

Any assistance given to him shall be highly appreciated. The information collected thereof shall be confidential and its findings will not be used for any other purpose other than for Academic purposes. The student has undertaken to abide by the research ethics as stipulated by the institution.

Thank you for your assistance.

Yours Faithfully,

Dr. R. Kinyua

DIRECTOR, INSTITUTE FOR ENERGY AND ENVIRONMENTAL TECHNOLOGY

Appendix VI: NCST Research Authorization

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telegrams: "SCIENCETECH", Nairobi
Telephone: 254-020-241349, 2213102
254-020-310571, 2213123,
Fax: 254-020-2213215, 318245, 318249
When replying please quote

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RRI/12/1/SS011/1207**

Date: **18th August, 2011**

Gilbert L. Makachia
Jomo Kenyatta University of Agriculture
& Technology
P.O BOX 6200,
Nairobi

Dear Sir,

RE:RESEARCH AUTHORIZATION

Following your application for authority to carry out research on; **An evaluation of fire safety status of Universities in Kenya, with reference to fire risk reduction rules,2007, I** am pleased to inform you that you have been authorized to undertake research in **All Universities in Kenya,** Kenya for a period ending **30th April 2012**

You are advised to report to **The Vice Chancellors of Public and Private Universities,** before embarking on the research project.

On completion of your research project you are advised to submit **one hard copy and one soft copy** of your thesis/ project to this office.

P.N NYAKUNDI
FOR: SECRETARY/CEO
Copy to.

The Vice Chancellors
Public and Private Universities

Appendix VII: Journal Paper Abstract

EVALUATION OF FIRE SAFETY MEASURES AT LOCAL UNIVERSITIES IN KENYA WITH REFERENCE TO FIRE RISK REDUCTION RULES LN.59, 2007

G.L. Makachia[1], E. Gatebe[1] and P.Makhonge[2]

[1]Jomo Kenyatta University of Agriculture and Technology, P.O. Box 62000 Nairobi 00200, Kenya

[2]Directorate of occupational safety and health services (DOSHS), Ministry of Labour, and P.O. Box 34120 Nairobi 00100, Kenya

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Abstract

Fire-related accidents often result in injuries and sometimes death, which can be prevented through compliance to legislation and public awareness on fire safety. This study establishes fire safety measures in place in local universities in Kenya, and compared the compliance status between private and public universities on essential fire safety measures based on the stipulations of the fire risk reduction Rules, LN 59 of 2007. Data was collected using questionnaires from seven universities (three public and four private) targeting a sample size of 481 respondents. Site inspections were also conducted. The average duration worked by the respondents was significantly different with 53% of staff in the public universities having worked over 8 years at the universities as compared to 30% in the private universities. This had no significant effect on the levels of fire safety awareness amongst the staff as none of the institutions had formal policies and programmes on fire safety. More than 74% (n=481) of employees were not aware on any fire training programmes in place with no significant difference in both categories ($\chi^2 = 3.72$; $p > 0.05$, df = 2). Failure to conduct regular fire evacuation drills was common to both categories ($\chi^2 = 3.16$; $p > 0.05$, df = 2). The study found that the workplaces were adequately equipped with Fire exits signs (98%), fire extinguishers (99%), hose reels (82%) and had fire action procedures posted (88%). Despite the selected public and private universities having a mean existence of 47 years and 14.25 years respectively, there is equally low compliance with the requirement to provide emergency lighting, automatic fire suppression systems, fire detection and alarm systems and fire Hydrants. Private universities however complied marginally better than public universities on the installation of these essential equipment as they have relatively newer premises that have been constructed in compliance with current building codes. The study recommends the development of comprehensive fire safety policies and programs that will cover prevention, protection and emergency response backed by university management endorsement and support. The Directorate of occupational safety and health services should also make the public aware of these rules through regular training, outreach programs and enforcement.

Keywords: Fire safety, legislation, awareness, compliance, policies, universities