A STUDY OF FIRE SAFETY WITHIN KARIOBANGI LIGHT INDUSTRIES

VALENTINE NYAWIRA WAGURA

MASTER OF SCIENCE

(Occupational Safety and Health)

JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

2019

A Study of Fire Safety within Kariobangi Light Industries

Valentine Nyawira Wagura

A thesis submitted in partial fulfilment for the degree of Master in Occupational Safety and Health in the Jomo Kenyatta University of Agriculture and Technology

2019

DECLARATION

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

Signature…….. Date……

Valentine Nyawira Wagura

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

Signature…….. Date……

Dr. Charles Mburu, PhD
JKUAT, Kenya

Signature…….. Date……

Prof. Peter K. Karanja, PhD
JKUAT, Kenya

DEDICATION

I am dedicating this thesis to my husband and parents for their patience, support, understanding and encouragement.

ACKNOWLEDGEMENT

I am particularly indebted to my supervisors, Dr Charles Mburu and Prof. Peter Karanja for their counsel and intellectual guidance and for accepting to supervise this research.

I wish to thank the Nairobi City County Government for providing me with the necessary information which has been valuable in this research. I am appreciative to the business owners of Kariobangi Light Industries who participated in this research and for their support during my study.

Special thanks go to the staff of the Institute of Energy and Environmental Technology (IEET) at Jomo Kenyatta University of Agriculture and Technology for providing a conducive learning environment during my study and to Jomo Kenyatta University of Agriculture and Technology; as a whole, for the opportunity to complete my studies.

I am thankful to my classmates, family and friends for their support during this academic journey. I thank Jehovah for provision and His grace upon my life.

TABLE OF CONTENTS

DECLARATION ..... **ii**

DEDICATION ..... **iii**

ACKNOWLEDGEMENT ..... **iv**

TABLE OF CONTENTS ..... **v**

LIST OF TABLES ..... **viii**

LIST OF FIGURES ..... **ix**

LIST OF PLATES ..... **x**

LIST OF APPENDICES ..... **xi**

LIST OF NOMENCLATURE AND ABBREVIATIONS ..... **xii**

OPERATIONAL DEFINITION OF TERMS ..... **xiii**

ABSTRACT ..... **xiv**

CHAPTER ONE **1**

INTRODUCTION **1**

1.1 Background to the study 1

1.2 Statement of the problem 2

1.3 Justification of the study 2

1.4 Objectives 3

1.4.1 Main objective 3

1.4.2 Specific objective 3

1.5 Research question 3

1.6 Conceptual framework 3

CHAPTER TWO **5**

LITERATURE REVIEW 5

2.1 Theoretical principles 5

2.1.1 Kariobangi Light industries 5

2.1.2 Fire and fire safety 7

2.1.3 Fire fuel sources 8

2.1.4 Fire ignition sources 13

2.1.5 Fire safety awareness 14

2.1.6 Fire hazard control measures 17

2.1.7 Legal Requirement 19

2.2 Previous Work Relevant to the Study 26

CHAPTER THREE 29

MATERIALS AND METHODS 29

3.1 Study design 29

3.2 Study area and population 29

3.3 Sampling method 30

3.4 Sample size determination 31

3.5 Research instruments 31

3.6 Data processing and analysis 32

CHAPTER FOUR 33

RESULTS AND DISCUSSIONS 33

4.1 Social-demographic characteristics 34

4.1.1 Distribution by gender 34

4.1.2 Distribution by years of operation 34

4.1.3 Distribution by level of education 35
4.2 Implementation of fire safety 36
4.2.1 Pearson correlation analysis between years of operation and implementation of fire safety 37
4.3 Fire fuel and ignition sources within Kariobangi Light industries 39
4.3.1 Fuel sources 39
4.3.2 Ignition Sources 41
4.3.3 Pearson correlation analysis between the level of education and fuel and ignition sources 44
4.4 Fire safety awareness 45
4.4.1 Fire safety policy 45
4.4.2 Fire safety audits 45
4.5 Fire hazard control measures 50
4.5.1 Pearson correlation between fire safety awareness and fire hazard control measures 59
4.6 Regression analysis between the dependent and independent variables 60
CHAPTER FIVE 62
CONCLUSIONS AND RECOMMENDATIONS 62
5.1 Conclusions 62
5.2 Recommendations 64
5.3 Recommendations for further study 64
REFERENCES 65
APPENDICES 75

LIST OF TABLES

Table 2.1: Licensed industries within Kariobangi Light industries. 6

Table 4.1: Pearson correlation between years of operation at Kariobangi Light industries and implementation of fire safety 38

Table 4.2: Pearson correlation between the level of education of respondents and fuel and ignition sources present in the sampled enterprises 44

Table 4.3: Availability of fire safety policy's in the sampled enterprises 45

Table 4.4: Respondents undertaking annual fire safety audits..... 46

Table 4.5: Fire safety awareness of respondents within the sampled enterprises..... 47

Table 4.6: Fire hazard control measures executed in the sampled enterprises 50

Table 4.7: Pearson correlation between fire safety awareness and fire hazard control measures executed by the business owners..... 59

Table 4.8: Variables used in the linear regression analysis 60

Table 4.9: Linear regression coefficients..... 60

LIST OF FIGURES

Figure 1.1: Conceptual framework 4

Figure 3.1: Map of study area Enclosed: map of Kenya displaying location of study area. Source: Google maps 30

Figure 4.1: Occurrence of sampled enterprises by their business description 33

Figure 4.2: Distribution of respondents by their gender 34

Figure 4.3: Distribution of enterprises by their years of operation 35

Figure 4.4: Distribution of respondents by their level of education 36

Figure 4.5: Respondents perception on their implementation of fire safety 37

Figure 4.6: Occurrence of flammable and highly flammable materials within the sampled enterprises 39

Figure 4.7: Occurrence of combustible materials within the sampled enterprises 41

Figure 4.8: Occurrence of fire ignition sources within the sampled enterprises 42

Figure 4.9: Fire safety awareness of respondents within the sampled enterprises 48

Figure 4.10: Fire hazard control measures executed in the sampled enterprises 51

Figure 4.11: Fire hazard control measures executed by the sampled enterprises 54

LIST OF PLATES

Plate 4.1: Exposed live electric wires 43

Plate 4.2: Trader attending to a fire lit to burn company waste 43

Plate 4.3: Fire extinguisher fastened by the discharge.....52

Plate 4.4: Wrongly placed fire extinguisher.....53

Plate 4.5: Fire extinguishers not mounted at the workplace 53

Plate 4.6: Emergency exit access with a height of 76 centimeters.....55

Plate 4.7: Emergency key box without a break glass hammer.....56

Plate 4.8: Normal route of entry obstructed with flammable and combustible material 57

Plate 4.9: Poor housekeeping practices at the sampled enterprises 58

Plate 4.10: Accumulation of product, raw materials and waste in one of the enterprises ..58

LIST OF APPENDICES

Appendix I: Non-Disclosure Agreement 75

Appendix II: Research Questionnaire 78

Appendix III: Research Checklist 82

Appendix IV: Fire Safety Management Plan 85

LIST OF NOMENCLATURE AND ABBREVIATIONS

DOSHS Directorate of Occupational Safety and Health Services

FSDU Financial Sector Deepening Uganda

GoK Government of Kenya

IPA Isopropyl Alcohol

KLI Kariobangi Light Industries

LEV Local Exhaust Ventilation

LPG Liquid Petroleum Gas

MSMEs Micro, Small and ,Medium Enterprises

ND Not Dated

NFPA National Fire Protection Agency

OCHA Office for the Coordination of Humanitarian Affairs

OSHA Occupational Safety and Health Act

SAP Structural Adjustment Program

UFL Upper Flammable Limit

UN United Nations

OPERATIONAL DEFINITION OF TERMS

Fire Hazard Control	These are measures taken to manage fire risks. They include fire prevention strategies, protecting the workplace from the threat of arson and suppressing of fires so as to extinguish and prevent their spread (Hughes & Ferret, 2013).
Fire Safety	It is the set of practices intended to ensure that fires do not occur and if they do occur, they are controlled or contained quickly, effectively and safely; or that if an uncontrolled fire does occur, everyone in the premises is able to escape to a place of total safety easily and quickly (Department for Communities and Local Government, 2006).
Fire Safety Awareness	It is basic knowledge of the available resources for fire safety at a workplace/premises (Della-Giustina, 2014).
Fire Safety Management Plan	It is a plan that details the proactive measures taken to manage fire safety so as to prevent fire from occurring and, in the event of fire, to protect people and property (Ferguson & Janicak, 2005).
Fuel	It is anything that burns during a fire or explosion (Ferguson & Janicak, 2005).
Ignition	It is any source of heat; hot enough to ignite the fuel's flammable vapour in air (Ferguson & Janicak, 2005).

ABSTRACT

Kariobangi Light Industries is an industrial cluster characterized by high population densities, poor infrastructure and, numerous concrete buildings. The buildings house semi-organized, unregulated and small scale enterprises in industrial units on the ground floor and low-income inhabited dwellings on the floors above. These conditions and uncharacteristic aspects make Kariobangi Light Industries of special interest with regard to fire safety due to the magnitude of destruction and loss that would result from an immense fire. The main objective of this research was to study fire safety within Kariobangi Light Industries within Nairobi County, Kenya with the Occupational Safety and Health Act, 2007 and its subsidiary legislation the Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007 as a standard on the fire safety requirements at all workplaces in Kenya. Specifically, the research aimed at identifying and profiling potential fire ignition and fuel sources within the industrial cluster, evaluation of measures executed by the business community to control fire hazards as well as assessing fire safety awareness among the business community operating within the industrial cluster. A descriptive survey research design was employed to describe the condition of fire safety within the industrial cluster as it subsists. The target population was all industries operating in Kariobangi Light Industries. Purposive sampling was employed thus thirty industries sampled which constituted 100% of the licensed industries within Kariobangi Light Industries during the year 2014. Interviewees in the research consisted of the business owners or their appointed representatives. Statistical Package for Social Sciences (SPSS) version 20 was employed in computing of inferential statistics while qualitative data were summarized into notes for each of the specific objectives. The findings of the study showed that there is a significant positive correlation between fire safety awareness among the business community and their implementation of measures to control fire hazards (P value < 0.05. r (27) = .597**, p = .001). The linear regression analysis established that fire safety awareness of the business community (p = 0.001) greatly influences their implementation of fire safety. The study concludes that increased fire safety awareness among the business community is vital and hence recommends that the Nairobi Fire Services and (or) the Directorate of Occupational Safety and Health Services should implement fire safety awareness programs to benefit the business community operating within the industrial cluster.

CHAPTER ONE
INTRODUCTION

1.1 Background to the study

Fire disasters are amongst man's earliest causes of distress and they, therefore, need to be studied closely and thoroughly to develop effective mitigation strategies. Understanding the nature and magnitude of the fire is essential when providing a basis for reducing; and better still, preventing fire losses. In a typical workplace, fires result in human losses which are death and injury of people, direct losses which comprise of burnt equipment, goods/materials and buildings and indirect losses which are mainly lost production time and business interruption. Workplaces/industrial areas are of special risk either because of the presence of a particularly dangerous quantity of flammable or toxic material or because of characteristically dangerous processes being carried out. Between January and February 2011, 71 fires were reported in Nairobi, Kenya. These fires resulted in the loss of 2,016 jobs, 376 houses, 113 shops, 2 deaths, 11 casualties (5 hospitalized) and asset loss in excess of KS 80 million (over USD 1 million) (OCHA,2011).

It is everyone's interest to avert aggressive fires, prevent loss of lives in fires, reduce fire-related injuries and eliminate property losses. The government normally works towards promoting the welfare of the community and in the event of a major fire loss, the community may be inclined-; in fact, may be enthusiastic - to allow improved government inquiry into their activities. The concerns of the business community in fire prevention fundamentally are protecting property and saving lives, which have greatly evolved from the efforts of businesses protecting their financial interests (Diamantes D., 2016).

Fire disasters are very common in Kenyan informal settlements that are home to the majority of urban residents in the major cities and towns. Informal settlements and slums are usually because of the tenacious need for shelter by the urban poor who; due to their social and economic status, cannot get better formal housing (Shaluf, Hamden & Said, 2003). The residents living here no longer find their homes safe due to fires, which regularly interrupt their lives. Majority of these fires can be predicted and the required

control measures put in place to prevent their occurrence or reduce their adverse impacts on the community.

Kariobangi Light Industries is an informal manufacturing hub characterized by high population densities, poor road networks and accessibility, disgraceful living conditions and numerous concrete structures with little to medium commercial ventures in godowns on the ground floors and low-wage private flats on the floors above. These characteristic features make Kariobangi Light Industries a cluster of immense concern when it comes to fire hazards and safety. There is a need for active and pre-emptive intervention from all stakeholders in reducing fire risks, which can be very effective in improving the quality of life for its occupants. Strict enforcement of the Occupational Safety and Health Act, 2007 and the Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007 and other relevant rules and legislation within the industrial cluster will ensure gains in fire safety made will benefit current and future generations.

1.2 Statement of the problem

When a fire occurs within Kariobangi Light Industries, it causes great concern to all the stakeholders involved. They include business owners, local residents, government and non-governmental agencies, potential investors, financial institutions and insurance providers. The most probable consequences of these fires are, and not limited to, loss of lives, extensive bodily harm, destruction of property, displacement of residents, loss of livelihoods, emission of toxic fumes and mists into the environment and subsequent legal implications. This research was influenced by the need to obtain baseline information on fire safety within Kariobangi Light Industries as well as raise awareness on fire safety amongst the business community.

1.3 Justification of the study

Fire disasters remain a major menace to the safety, health, dignity, livelihood, and security for those living and working within Kariobangi Light Industries. The state of fire safety within Kariobangi Light Industries is distinct in that industries are housed within the same

building as is residential apartments. The study developed an exhaustive report containing findings on fire safety awareness of the business community operating within Kariobangi Light Industries with the aim of providing baseline information to be used by the relevant stakeholders in improving the quality of life of the business community and residents at the industrial cluster.

1.4 Objectives

1.4.1 Main objective

The main objective was to study fire safety within Kariobangi Light Industries in Nairobi County, Kenya.

1.4.2 Specific objective

1. To identify and profile the potential fire ignition and fuel sources within Kariobangi Light Industries.
2. To assess the fire safety awareness among the business community operating within Kariobangi Light Industries.
3. To evaluate the fire hazard control measures executed by the business community operating within Kariobangi Light Industries.

1.5 Research question

1. What are the fuel and ignition sources for fires within Kariobangi Light Industries?
2. Is the business community operating within Kariobangi Light Industries aware of fire safety?
3. What fire hazard control measures have been executed by the business community residing within Kariobangi Light Industries?

1.6 Conceptual framework

Figure 1.1 below is a conceptual framework elucidating the relationship of the dependent and independent variables in this study. It shows the relationship between the independent variables (fire fuel and ignition sources, fire safety awareness and fire hazard control

measures) and the dependent variable (implementation of fire safety). Fire prevention, fire protection and fire suppression characterize fire hazard control methods.

In this study, the Kenyan laws and regulations at the County and National level weighed heavily in providing a framework for fire safety implementation. At the County level is the Nairobi City Fire Brigade Bylaws and at the National level, the Occupational Safety and Health Act, 2007 and its subsidiary legislation, the Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007.

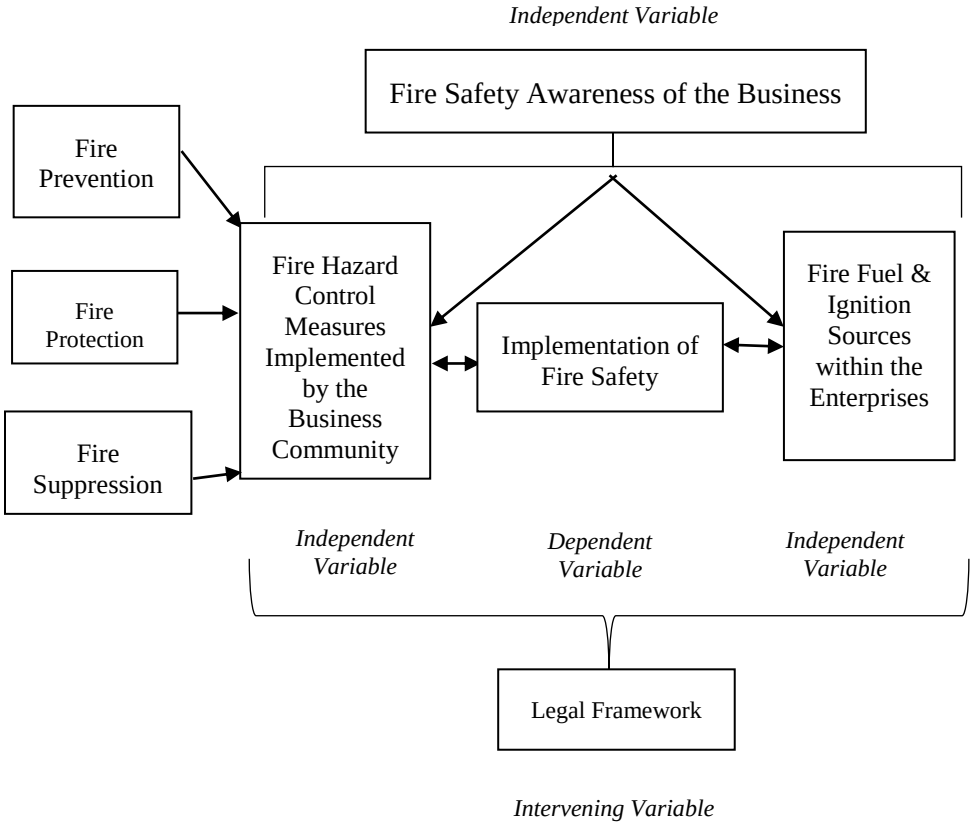


Figure 1.1: Conceptual framework

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical principles

2.1.1 Kariobangi Light industries

Kariobangi Light Industries is a conglomeration of manufacturing industries located in the North Eastern suburbs of Kariobangi North estate in the capital of Kenya, Nairobi. The high population in the area has led to the creation of uncontrolled developments and expansions by private developers. Consequently, it is characterized by high levels of insecurity and poor infrastructures such as pitiable roads encroached by numerous concrete buildings. The buildings comprise of micro, small and medium enterprise industries on the ground floors and inhabited dwellings on the floors above (Gisesa, 2011).

The industrial cluster was set-up for workers retrenched during the implementation of the Structural Adjustment Program (SAP) by the local government in the early 1980s. The artisans set up workshops and garages along the main road (Sonobe, Akoten & Otsuka, 2006). They formed a cluster of industries, which Altenburg and Meyer-Stamer (1999), referred to as a "continued existence cluster of micro and small scale enterprises." Most of the products from the industries require a more advanced level of skills. For this reason, there is a progressive technological advancement in Kariobangi Light Industries than in other industrial clusters in Kenya.

The table below gives a brief description of the nature of businesses within Kariobangi Light Industries as per the Nairobi City County Licensing Department, 2014.

Table 2.1 Licensed industries within Kariobangi Light industries. Source: Nairobi City County Reports 2014

Business Activity Description	Number of licensed Industries in the Year 2014
Manufacture of mattresses	2
Carton manufacturing	1
General engineering and repair	2
Manufacture and sale of paints, thinners and adhesives	13
Manufacture of plastic products	3
Bakery	1
Shoe cream, polishes and leather dye manufacturers	2
Mixing and repackaging of cosmetics/beauty products	4
Processing of popcorn, crisps and peanut butter	1
Storage depot, warehouse, godown, fuel filling station	1

Employers constantly seek to avoid the cost associated with state-regulated labor markets. The informal sector offers manufacturers an avenue of reducing operational costs and costs of employing a large and skilled workforce. Informal labor is characterized by the lack of government regulation in the implementation of contracts between workers and employers. This means that workers in informal sector industries do not benefit from social security, retirement, or health benefits or even safety and health provisions enforceable by the government (Benton, 1990).

Since Kenya attained her independence in 1963, she has experienced an urban growth rate of about 6% per annum due to guaranteed freedom of movement of its citizens with increasing rates of rural-urban migration (Obudho, 1997). The migration has led to the deterioration in physical and institutional infrastructure hence Kenyan town centers are

characteristic of extensive informal settlements, poor sanitation, and water services and decrepit infrastructure (Obudho, 1997). Informal settlements take up a vague legal situation, existing in principle illegally, but inhabitants protected by statute, which grants them; whether by right or not, tenancy privileges by virtue of occupancy on the land. They are also largely characterised by lack of proper housing and amenity provisions (Robyn, 2009).

Because governments may be unwilling to distinguish unlawful settlements and encourage their stable establishment, they do not implement guidelines that would typically administer the growth of a lawfully established or partitioned area. Most amenities typically accessible to lawfully established and occupied areas are not lawfully available in informal settlements. Lack of/limited water makes it difficult to put out fires in informal settlements in Nairobi; a situation which is compounded by drought and dry conditions (OCHA, 2011).

Studies by Satterthwaite (2006) have reported that in developing countries, such as those in Africa, a great percentage of the populace works in the informal economy and resides in dilapidated and congested houses in off-the-record residential areas with high fire risks. Risk-levels are increased by the lack of infrastructure and services in many areas. Local governments do not seem to take any measures that can reduce the hazards. Both unemployment and informal sector employment have increased while the formal sector or modern wage employment has declined. The increasing rate of in-formalization has magnified the incidence of poverty, as the earnings in the informal sector are much lower than in formal employment (Mwabu G., 2004).

2.1.2 Fire and fire safety

Fire poses a significant risk in the workplace. It is an oxidation reaction that discharges light, heat, sound, and energy and results in smoke, the lethal unwanted residue of fire. For a fire to happen and be sustained, three constituents must exist; fuel (something that produces flammable vapors), heat (enough to make the fuel burn) and oxygen (which makes up 21% of the air); these are commonly referred to as the fire triangle (NFPA,

2016). This infers that fire prevention aims at ensuring the three elements of the fire triangle do not come together while extinguishing of a fire aims at breaking the elements forming the fire triangle.

The fire reaction is instigated when a material releases vapor; this vapor signifies the fuel. When it combines with oxygen in the air in appropriate quantities a flammable mixture is attained and all that is left is an ignition source to complete the fire triangle. In principle then; it is the air-fuel mixture that burns and not the material itself.

The mantle of fire safety carried by a variety of organizations has varying aims. Some notably are interested in the public welfare others are profit driven and are looking to reduce insurance premiums. Regardless of the incentive, we all benefit when the chance of occurrence of a hostile fire decreases (Diamantes D, 2016). Fire safety is each individual's responsibility but at the workplace, it is the duty of the employer to ensure that his/her employees and any other persons present are free from fire risks.

2.1.3 Fire fuel sources

Commercial chemicals are potentially hazardous and call for suitable and safe handling practices that will ensure the safety of workers and the public who may be are at risk from a hazard materials incident (Dikshith, 2013). The chemicals are categorized as either liquids, solids or gases. For purposes of industrial fire safety; chemical liquids are further categorized into flammable liquids and combustible liquids. Both liquids will produce flammable vapors; however, it is into which of these two categories a liquid falls that determines its comparative fire hazard. Flammable liquids have a flash point below 38.78 degrees Celsius (100 degrees Fahrenheit) and are thus considered to be more hazardous primarily because they discharge ignitable vapors at low temperatures. Combustible liquids are those liquids whose flash point is above 38.78 degrees Celsius (100 degrees Fahrenheit). These materials pose a less fire hazard than flammable liquids and under certain circumstances are as perilous as flammables. Statistics point out that above 21 percent of manufacturing fires start with the ignition of a flammable or combustible liquid

(Stauffer, 2007). The flash point of a volatile substance is the lowest temperature at which its vapors will kindle. (Wray,1992).

Hydrocarbons and their compounds are common industrial chemicals. Acetone (dimethyl ketone) is a colorless volatile liquid with a sweet odor. It has a flash point of 15 degrees Celsius. It is broadly used in the manufacture of a diverse range of chemicals and is predominantly prevalent as a solvent (Cheremisinoff, 2000). In the manufacture of nail polish remover; acetone is used as a solvent and since acetone contact with the skin may cause irritation and dermal damage; nail polish removers having acetone also have emollients such as mineral oils, lanolin or castor oil. The nail polish removers may also contain constituents like vitamins, fragrance and coloring dyes (Toedt et al., 2005).

Isopropyl alcohol (2-propanol) is a colorless liquid. It is an isomer of propyl alcohol with a flash point of 11.67 degrees Celsius. It is used in the manufacture of many different chemicals and it is widely used as a solvent in the manufacture of household cleaning products especially to dissolve oils. Ethanol is a colorless liquid with a slightly sweeter odor than other alcohols. It has a flash point of 12.78 degrees Celsius. It is an excellent solvent and dissolves many substances. Due to its highly volatile nature, it is used in the manufacture of paints, varnishes, and perfumes (Lees & Payne, 2001).

Ethyl acetate is an organic colorless solvent with a distinctive sweet smell and a flash point of -4 degrees Celsius. It is used in the manufacture of glues, nail polish removers, paints (as a hardener) and perfumes. It is a flammable liquid that produces a vapor that forms explosive mixtures with air at normal temperatures (Stellman, 1998). White spirit also referred to as mineral turpentine or Stoddard solvent is another hydrocarbon solvent generally used in the industrial sector commonly in the paint and decorating industry. It is a crystal clear liquid with a flash point of 38 degrees Celsius. Its main uses are as a solvent in the paint industry, degreasing agents, polishes, varnishes and wood preservatives (Gupta, 2016). Odorless paint thinner is a solvent used to thin oil-based paints and is mainly traded at industrial levels in bulk. Commercially, solvents labeled "paint thinner" are usually mineral spirits having a flash point of about 40 degrees Celsius. They are used

to adjust the viscosity of paint depending on the application method and the paint used as well as control and regulate the drying time and evaporation time of paint thus preventing functional and aesthetic problems (NIIR, 2017).

Toluene is an aromatic hydrocarbon. It is a colorless liquid with a scented odor and a dangerous fire risk with a flash point of 6 degrees Celsius. It is a significant component in the manufacture of adhesives (glue); as it is an excellent solvent (Burke, 2003). In addition to flammability, toluene is toxic by ingestion, inhalation and skin absorption. It is one of the most frequently abused volatile substances and is sniffed in glues. It is also a key ingredient in the manufacture of polyurethane foam (Barceloux, 2012).

Polymers are also commonly used in industries and undergo combustion to yield varying amounts of heat, smoke and (or) additional toxicological agents such as hydrogen chloride, sulfur dioxide, hydrogen cyanide, and nitrogen oxides. Epoxy resin is a clear, viscous liquid polymer with a mild odor and a flash point greater than 93 degrees Celsius. The epoxy resin polymer undergoes pyrolysis (polymer decomposition into shorter length chains by application of heat) to liberate volatile products and solid residues. The decomposition starts at 240^{o} C and continues upwards to 450^{o}C (Visakh & Arao, 2015). Closed containers containing the product may rupture when exposed to extreme heat. In industries, epoxy resin polymer is mixed with solvents and solid pigments in the manufacture of paints. This resin is the film forming part of paints that allows them to adhere to surfaces once the solvents evaporate (Visakh & Arao, 2015).

Gases are fluids stored under high pressure; and on release from their containing vessels, will expand numerous hundred times to occupy the entire space. Gases can be categorized as flammable, combustible or oxidizing agents. Industrial gases pose a significant fire hazard in the workplace. This is because many gases and vapors are heavier than air and can travel considerable distances from the point of discharge to the ignition sources or source of heat. Moreover, gas clouds can sink into basements, drains, vents or ducts thereby posing a risk of an explosion which can traverse to the point of gas discharge (Thomson, 2002). Acetylene is a common gas in the industrial sector, especially in metal

engineering and repair works. It is a colorless, odorless, tasteless gas which is slightly lighter than air in its pure state; however, a foul-smelling chemical is added to the gas during storage so that accidental release can be detected by the sense of smell. It has a flash point of -18 degrees Celsius and is dangerously explosive when mixed with oxygen in appropriate amounts. Acetylene is especially used for welding of ferrous metals because the oxy/acetylene flame burns hotter than any other gas mixture. It is also used for brazing, cutting and heating (Bridigum, 2008).

Chemical solids common in the industrial sector are categorized as either flammable solids or combustible solids. Flammable solids that are solid in state; other than explosives, ignite quite easily and burn vigorously. Some flammable solids are air reactive (self-igniting) others are water reactive and some react spontaneously by combustion (can decompose and ignite either in the presence or absence of air) (Finger, & Holvad, 2013). In a fire scenario, a solid must have its exterior surface heated to high enough temperatures that pyrolysis gases are produced rapidly enough to exceed their lower flammability limit in the space above the surface.

Plastic is a material made of any of a wide range of synthetic or semi-synthetic organic complexes that are flexible and so can be shaped into solid items. Nearly all plastic materials are combustible and will contribute fuel to any fire in which they are involved. Common plastics in the industrial sector are polyethylene which is used in the manufacture of polythene bags, high-density polyethylene which is commonly used in the manufacture of jugs, plates as well as other household plastic products and polyurethane which is used in the manufacture of cushioning foams and mattresses (Peacock, 2000). The fire behavior of plastic materials is dependent on the chemical composition of the basic plastic, the kind of additives used, materials sizes and shapes (Brydson, 1995).

Industrialists cannot afford to disregard the importance of packaging of goods and hence cartons play a very significant role in every day manufacturing in the industrial set up.

They are combustible materials made from paper (interlocked cellulose fiber) and board (NIIR, 2010). Greases are combustible semi-solid lubricants. In the industrial sector, they are expected to combine high-temperature performance with extreme pressure properties, good water resistance, excellent oxidation stability, rust protection and resistance to chemical breakdown (Bloch, 2009).

2.1.3.1 Effects of smoke

Fires produce huge quantities of smoke which results from incomplete combustion of fuels, thereby producing a variety of by-products which are released into the atmosphere. Collectively, these by-products are called smoke; which has three major components; particles, and gases. (NFPA, 2008).

The composition of the toxic products in smoke is dependent on the burning fuel and conditions of combustion. The appearance of smoke mirrors its constituents and will differ from a very light color to a deep sooty black. The density of smoke is subject to the amount of the unburnt particles carried in the air; and the denser is the smoke, the more dangerous it is because of reduced visibility. Smoke particles consist of unburned, partially burned or completely burned substances. These particles are usually very visible and are lifted in the thermal column produced by the fire. Many smoke particles are so small that they can pass through the natural protective mechanism of the respiratory system and enter the lungs. They can also be extremely irritating to the eyes and digestive system. Smoke vapors are droplets of liquids suspended in air; if inhaled they affect the respiratory system (Stollard & Abrahams, 2002).

Smoke gases are dependent on the amount of oxygen in the workplace and the type of burning fuel. Carbon monoxide, hydrogen cyanide, and phosgene are the common gases present in smoke. Carbon monoxide is a colorless, odorless, and tasteless gas, therefore, making it more lethal. Effects of carbon monoxide poisoning on the body manifest at concentrations of as low as 35 ppm. When inhaled, it quickly replaces the oxygen in the bloodstream because it combines with the hemoglobin in the blood more readily than oxygen. Hydrogen cyanide is formed when wool, paper, wood, foam, plastics, and

polyurethane are burnt. It is a poisonous gas that is quickly absorbed by the blood and interfere with cellular respiration. Phosgene causes itchy eyes, sore throat and pulmonary edema (Stollard & Abrahams, 2002).

2.1.4 Fire ignition sources

Electrical safety in an industry is an employees' concern and is principal when planning for employee safety. In addition to fire, other common electrical hazards are shock, arc flash, and arc blast; arcing can be caused by opening up a circuit and occurs because somebody or somewhat shorted two conductors together (Babrauskas, 2003), intense heat and intense noise. Injuries resulting from electrical hazards comprise electrocution (which always means death) from electric shock, burns, impact injuries such as falls caused by electric contact, and injuries from flying parts and pieces in an electrical explosion. Arc flash causes injury to the ears and eyes (Jones & Jones, 2000).

Fires triggered by electric equipment can be categorized into four groups. Those caused by worn-out or defective equipment, those caused by wrong use of approved and rated equipment, those caused by defective connections and, those caused by other incidents. In the industrial setup worn-out/ defective electric equipment is characterized by deteriorating wire circuits, switches, appliances and extension cords. The temperature to which a wire or cable will elevate due to the flow of current depends on several factors, largely on the construction of the wire/cable, the current flow and the normal convection cooling available. Continued overheating, however, will cause advanced dilapidation of insulation, so smaller overloads may serve to cause ignition (Goodson, Perryman & Colwell, 2002).

Improper use of machinery and equipment is characterized by placing combustible materials like cloth or paper on light fixtures, lamps and light bulbs. Defective installations are characterized by the use of light-duty extension cords to connect a heavy duty appliance to a wall outlet. A fire caused by an electrical overload or short circuit can start whenever electricity is present, such as in the electric panel, fuses, fuse boxes, circuit breakers, wiring, and appliances. Natural events can also cause accidental electric fires; such as when a tree falls on high voltage live electrical wires (NFPA, 2008).

Incendiary fires are the main cause of industrial fires. They are committed by persons who; have a disagreement against the establishment or persons working therein or owning it, impostors who intend on destroying evidence of a previous wrongdoing, workers covering financial fraud, campaigners against particular products or practices of the establishment, opportunistic vandals and arsonists who relish the spectacle of fire (Channing, 2014). With arson, it is principally significant to rule out possible accidental causes; thus proving beyond doubt, that the fire was started intentionally (NFPA, 2008).

Cigarettes are the primary source of ignition in smoking-material fires due to the negligent or inconsiderate behaviors of smokers in the handling and disposal of smoking materials. Improperly discarded smoking material may fall onto combustible materials where they smolder for hours. This extended smoldering eventually results in an immense fire if not extinguished at its early stages.

Hot work is a process that can be a source of ignition when flammable and combustible materials are present in the workplace. Common hot work processes include welding, soldering, cutting, brazing burning and the use of electrically powered tools or similar fire generating processes outside of designated hot work areas. Good housekeeping is essential for hot work. The works should be well supervised and the work area should be inspected well hours after work (Sadgrove, 2015).

2.1.5 Fire safety awareness

Fire safety management is a critical aspect of every organization. Fire safety awareness is a key component in fire safety management and it entails staff involvement in planning and managing fire safety, thereby reducing fire risks associated with the businesses undertakings.

A fire safety policy sets out an organization’s aims for fire safety. Ideally, it will establish the commitment to fire safety from senior management by aligning fire safety with business plans and objectives and will give every employee responsibility for fire safety (Fire Protection Association, 2015).

Fire safety audits are the periodic (characteristically yearly), methodical and detailed evaluation of the execution, appropriateness, and efficiency of the fire safety management system. It is an organizations' means for hands-on monitoring of fire safety performance. They involve a comprehensive and autonomous execution of inspection of all aspects of the organizations fire safety performance against stated objectives (Furness & Muckett, 2007). The fire safety audits assess the effectiveness of the company's fire safety policy, arrangements in place for staff training and the existence and implementation of adequate risk control systems that have been implemented by the company.

Every workplace should have an emergency plan. The plan should consist of the actions to be taken by workplace occupants in the event of a fire, the evacuation procedures and the arrangements commended for alerting the fire and rescue services. For small workplaces, this can be a simple fire action sign posted conspicuously at positions where workers and any other persons present can familiarize themselves with it (Hughes & Ferrett, 2016).

In "Building in-house capability [part 1]," Lindtveit (2011a) states that to have a practical emergency plan, it is paramount to change the culture of workers at the workplace. Education and training are critical for any worker in charge of safety and first aid at the workplace. After training, the group of workers can evaluate the existing safety program to confirm that it covers the conceivable hazards at the workplace. The hazards investigated and the proposed control measures should all be documented. The more employees know and are ready for, the easier the emergency responder's work becomes (Lindtveit, 2011a, p. 37). It is vital that building occupants know what to do in case of a fire or other emergency as this reduces the time required to evacuate the premises.

In the follow-up article, Lindtveit (2011b) endorses preparation to deal with emergencies should be appropriate for each organization. Preparation and practicing along with the frequent re-evaluation of the emergency procedures will allow workers to propose new ways to improve them and their reaction competences to particular circumstances at the workplace. Undertaking drills will make adhering to the procedures easier in the event of an actual emergency. Boosting cooperation among workplace employees and always

culminating drills on an optimistic note can improve employee involvement, employees will feel the need to evaluate the activity and propose improvements (Lindtveit, 2011b).

Emergency services should be called be as soon as possible after the start of a fire emergency as it gives the fire and rescue team time to contain the fire and save lives. It is important that an organization has a well-defined policy to call for emergency services in good time and a person(s) designated to make the call. Emergency telephone numbers are a key element of the policy and the person(s) nominated to make the call should be trained on how to make it. Key information is the identification of the caller and the company, exact location of the fire incident, type of work undertaken at the company, size of fire and nature of burning materials (Hughes & Ferret, 2016).

An assembly point should be established for use in the event of an evacuation. Muindi (2014) indicates that it is appropriate or recommended for a factory to have proper guidance on a fire assembly point of the correct size so as to accommodate all persons at the workplace and an adequate number; where there are to be several. The location of the assembly point must be in such a way as to avoid the incident completely and it should be known to all employees. In the case of a small workplace, a comprehensive list of the names of all staff present should always be available so that a roll- call can be made if evacuation becomes necessary. In workplaces where the number of staff would make a single roll- call difficult, each fire marshal should maintain a list of the names of employees and contractors in their respective sections at the workplace (Hughes & Ferret, 2016).

Portable firefighting equipment are key fire safety items at the workplace. Where portable fire extinguishers and fire blankets have been provided; it is essential that employees be instructed on their safe use. It is plausible that an individual should use the nearby fire extinguisher to put out a small fire at the workplace. Therefore; it would be not correct if an employer did not provide basic training on the safe use of fire extinguishers. Workers should be edified on the operation of the various types of portable fire extinguishers

including fire blankets, the different types of fire extinguishers and their uses and the limitations of portable fire extinguishers (Thomson, 2002).

Businesses are appreciating the significance of having a well-trained team of fire marshals/ fire wardens as a critical component of their fire emergency evacuation plan (Thomson, 2002). Among other functions, fire wardens are responsible for undertaking fire risk assessments at the workplace and making recommendations for corrective action. They are also responsible for evacuating staff from the workplace and moreover, assist staff members who suffer disability so as to ensure they are not injured during the evacuation. The fire marshals should, therefore, undergo training to enable them to execute their duties efficiently (Burtles, 2013).

Smoking cigarettes at the workplace is a potential for fire at the workplace. Improperly discarded smoking material may ignite flammable and combustible materials and with the latter, the materials can smolder for hours. The health risks associated with cigarette smoking are detrimental to both the smoker and other immediate persons/second-hand smokers. Policies that restrict smoking at the workplace aim at preventing fires and providing clean indoor air to non-smokers (Osinubi et al. 2005). A restrictive smoking policy at the workplace aims at prohibition smoking in areas where safety and health hazards exist, making certain all shared areas are non- smoking zones, designating smoking zones with ashtrays for smokers and provision of signage communicating the policy to workers and other building occupants of the policy (Tones & Tilford, 2001).

2.1.6 Fire hazard control measures

Fire hazard control measures focus on fire prevention, fire protection, and fire suppression. Fire protection demands that employers and self- employed persons should introduce preventive measures to control fire risk. As far as it is practicable, fire risks should be eliminated completely at the workplace (Thomson, 2002). Fire prevention depends on avoiding the three elements of the fire triangle; fuel, oxygen, and ignition source, from coming together (Hughes & Ferrett, 2016).

In the event of a fire it is critical that everybody in the workplace is alerted as soon as possible. The faster the fire is discovered, the more likely it is that building occupants will be able to escape before the fire takes hold and before it blocks escape routes or makes escape difficult. Every workstation should have detection and warning provisions. They aim at ensuring that people on site are alerted of a fire situation and consequently make their escape before it becomes life-threatening. The fire alarm system should be unique, clearly audible above any other noise and is known to all employees (Hughes & Ferret, 2016).

An exit route is an uninterrupted and unhindered pathway of egress from whichever location an individual is within a workplace to a place of complete safety. It is also commonly defined as whichever means of an outlet from a building that is utilized in the event of a fire (Andre' Elizabeth, 2006). The standard on which a means of egress requirements are founded is that the time interval between the starting of the fire and it making the means of escape from the workplace precarious is greater than the interval between the discovering of a fire and raising alarm and everyone within the facility evacuating to a place of total safety (Health and Safety Authority, 2016).

An exit route comprises of three distinctive parts: exit access; it is the part of an exit route that leads building occupants to an exit. Exit; it is the part of an exit route that is typically parted from other workplace zones to offer a secure way of access to the exit discharge. Exit discharge; it is the part of the exit route that leads building occupants right outdoor or to a road, path, safe area, communal area or open space with access to the outside (OSH Administration, 2003).

In cases where the exit discharge does not lead to a place of total safety; it may not be feasible to use these building exits. The outsides of obstructed emergency exits that temporarily lead building occupants into a construction job site; with deep excavations and at other sites hindering the use of the exit, it should be obvious that the populace's safety is best attended by provisionally terminating one or more of these emergency exits. This can be achieved by casing the illuminating EXIT signs at those exits, posting impermanent

signs guiding building occupants to alternative exits and by an oral announcement, and more importantly, to execute a fire or evacuation drill at the time when the exits are impassable (Havel G., 2015).

Security should never override safety. Emergency push pads or panic bar devices should be used in workplaces where security is an issue of great concern and depending on the risk. Where roller shutters or security grills have been fitted on an escape route, they should be provided for in a method in which they can be opened by persons within the premises (Health and Safety Authority, 2016).

Fire-fighting equipment should be provided at the workplace for employees to use, without exposing themselves to peril, to douse a fire in its early stages. Use of a portable fire extinguisher to a developing fire can be an actual initial response if they are fitted and used correctly. To avoid exposing the building occupants to peril, firefighting appliances should be provided throughout the workplace and be readily accessible in the event of a fire (OSH Administration, 2003). It is critical that all fire equipment are fit for their purpose and are properly maintained and tested. All equipment provided to assist with suppressing fire should be regularly checked and maintained by a competent person in line with the manufacturers' recommendations. Equipment provided to assist persons within the workplace to evacuate the premises; such as fire detection and alarm systems, should be maintained as well (Hughes & Ferret, 2016).

Machinery should be frequently serviced and maintained well lubricated. Vents ought to be kept free of obstruction to avoid overheating, oil leaks and drips should be absorbed with mineral absorbents; not sawdust, drip trays ought to be used where needed and should be regularly emptied (Sadgrove, 2015).

2.1.7 Legal Requirement

There are several legislations by both the National and the Nairobi City County Government to enhance fire safety in both industrial and residential areas.

2.1.7.1 Nairobi City County by-laws

The Nairobi City County Government provides the Fire Services under the Governor's Office with the Nairobi Fire Service along Tom Mboya Street as the headquarters.

The Nairobi City County has by-laws on the Fire Brigade. The by-laws declare it an offence to enter a premises, which is on fire without approval from the senior officer, clouding or meddling with any individual from the fire department when on obligation, giving false distress calls to the fire department, deliberately starting a fire, denying or hindering an officer from assessing or getting any data from any premises or utilizing water from a premises without a fire to extinguish a fire.

The by-laws give the obligations of the Chief Fire Officer present at the scene of a fire to control every one of the operations. The Chief Fire Officer may enter or break into any premises inside of the city where there is an impression of there being a fire without having to obtain permission from any individual and might incidentally close any road/section or through-route in or close to a fire. The Chief Fire Officer additionally has the ability to utilize any supply of water whether on private or open property amid a fire.

2.1.7.2 Occupational Safety and Health Act, 2007

At a national level, the Occupational Safety and Health Act, 2007 provides for fire safety in the work environment. It is an Act of Parliament to promote the safety, health and welfare of workers and all persons legally present at the workplace. It also gives provision for the formation of the National Council for Occupational Safety and Health and for associated purposes. The overall responsibility for fire safety at the workplace is with the employer.

2.1.7.2.1 Storage of materials at the workplace

Section 74 of the Occupational Safety and Health Act, 2007 on storage of goods, objects and materials at the workplace states that storage should be in such a manner as not to obstruct the passageways, gangways or traffic lanes or the effective functioning of

smoke/heat detectors, sprinkler systems and access to other fire extinguishing equipment within the workplace.

2.1.7.2.2 Fire prevention

Section 78 on fire prevention requires that all highly flammable substances should be kept either in a fire-resisting structure or in a safe location outdoors away from of any occupied building and no person should smoke, light or carry matches, lighters or other fire igniting objects anywhere dangerous, extremely combustible or very flammable substances are manufactured or stored. An occupier is also required to mount; as close as could reasonably be expected, at each spot in which there are extremely combustible or very flammable substances a distinctive notice signifying that smoking is prohibited at that workplace.

2.1.7.2.3 Safety provisions in case of fire

Section 81 on safety provisions in case of fire requires that in every workplace there should be provided and regularly maintained fire extinguishing equipment. All means of extinguishing fire should be conspicuously displayed, not obstructed - thereby readily accessible, adequate and suitable for the class of fire. There should also be trained persons on the safe use of firefighting equipment present during all work shifts.

The provisions require that every workplace shall have a suitable means of escape, in case of fire, for the persons working there. All the means of escape shall be appropriately maintained and kept free of obstacles hence all emergency exits should direct occupants' to a place of total safety. Materials at the workplace should also be arranged such that there is maintained a free passage to all means of exit. All doors acting as a means of exit from the workplace shall; excluding in the case of sliding doors, be constructed to open outwards. All exits shall not be locked or fastened in such way that they cannot be effortlessly and straightaway opened from the inside. Every, window, door or other exit acting as a means of escape; other than the means of exit in ordinary use, shall be characteristically and noticeably marked by a notice printed in red letters of an adequate size. It is the duty of

every occupier of a workplace to take effective measures to make certain that all employees are acquainted with the means of escape/exit in case of fire and with the actions to be followed in case of fire.

Furthermore, the provisions also require that there shall be marked on the floor of every workroom gangways to facilitate proper organization of the materials at the workplace with an aim of keeping all fire extinguisher points and fire exits free from obstructions and for ensuring proper housekeeping.

2.1.7.2.4 Evacuation procedures

Section 82 on evacuation procedures requires that every occupier of a workplace shall come up with evacuation procedures to be followed during any emergency and have the procedures tried at regular intervals. The occupier shall also take actual measures to ensure that all employees are familiar with the means of escape in case of fire and with the plan to be followed in case of fire or any other emergency.

2.1.7.3 The Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007

The Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007 are a subsidiary legislation of the Occupational Safety and Health Act, 2007. This rules are applicable to every factory, operations and process to which the requirements of the Act apply. The provisions on the location, storage, handling and clear marking/labeling when dealing with highly flammable substances require that fire resistant construction material should be used where flammable substances are manufactured, used, or handled.

The rules give the duties of the occupier with regard to fire safety. It is the duty of the occupier to constantly inspect the workplace and make an evaluation of any probable fire risks and mitigate against them. Every workroom shall be maintained clean, free of accumulation of waste products and provided with adequate ventilation. Every occupier shall also take all necessary measures to remove gases or vapours in a workplace or reduce them to be non-flammable where applications involve the use of heat. The occupier also

has to provide fire escape exits and a means of evacuation to be used in times of a fire at the workplace.

2.1.7.3.1 Fire Safety Policy

Section (34) of Rules requires the formation and execution of a fire safety policy in every workplace. The purpose of the policy is to uphold fire safety within the workplace, prevent damage to organization property and to comply with the Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007. The occupier is also mandated to ensure that all workers are informed on the contents of the policy. This can be done during induction of new employees, posting the policy conspicuously within the workplace, publications and newsletters and any other means of communication.

2.1.7.3.2 Firefighting team

All workplaces are required by law to have a sufficient number of fire marshals to deal with fire emergencies fast and effectively. Section 20 requires workplaces to establish a firefighting team. Section 21 requires all members of the firefighting team to take on the prescribed basic fire safety training course within three months from the date of appointment. Members of the firefighting team are required to undergo a refresher training course at least once in every two years.

2.1.7.3.3 Firefighting equipment

Firefighting equipment are active fire protection appliances used to extinguish or control small fires. They can reduce the risk of a small fire developing into a large uncontainable fire. Section (29) requires the occupier to provide a means of extinguishing fire at the workplace, mark the position of the firefighting equipment with a conspicuous fire point sign and ensure all portable fire extinguishers are mounted at an easily reachable height of not less than sixty centimetres from the floor. Where fire hose reels are provided, every occupier shall make certain that there is at least one fire hose reel within a radius of 30 meters.

2.1.7.3.4 Fire detection and alarm systems

Fire detection and alarm systems are designed to warn building occupants of a fire situation. These alarms can be either mechanical bells or wall mountable sounders/horns with the latter been activated from smoke detectors and heat detectors or via manual fire alarm activation devices such as manual call points or pull stations. Section (28) requires the occupier to install and maintain fire detection appliances at the workplace and their positioning should be at strategic locations for immediate activation of an alarm or automatic fire extinguishing system.

The occupier is also required to ensure fire detection appliances are linked to audible and visual flashing devices to provide a warning to the workers for emergency response. Moreover, the fire detection appliances should be regularly maintained and be inspected at least once every twelve months by a competent person.

2.1.7.3.5 Smoking at the workplace

Smoking is a leading cause of workplace fires in many countries. Section 27 requires that a 'No Smoking' sign is displayed at the entrance to a workplace in such a way to make staff and visitors aware that they must comply; except in workplace where smoking is permitted.

2.1.7.3.6 Fire drills

A fire drill is a method of practicing how a building would be evacuated in the event of a fire or other emergency. Usually, the building's existing fire alarm system is activated and the building is evacuated as if the emergency had occurred. Generally, the time it takes to evacuate is measured to ensure that it occurs within a reasonable length of time, and problems with the emergency system or evacuation procedures are identified to be remedied. Section (23) requires that the occupier makes certain a fire drill is conducted at least once in every period of twelve months at the workplace. A record of such drills should always be kept available for inspection.

2.1.7.3.7 Fire assembly point

In the event of a fire or other emergency; where it is necessary to evacuate the building, all persons must leave the building promptly and make their way to the appropriate assembly point. Section (24) requires the occupier to identify a location in the workplace where every worker shall assemble in the event of a fire.

2.1.7.3.8 First aid

First aid is the assistance given to any person suffering a sudden illness or injury with aim to preserve life, prevent the condition from worsening, and/or promote recovery. It includes initial intervention in a serious condition prior to professional medical help being available, such as performing CPR while awaiting an ambulance, as well as the complete treatment of minor conditions, such as applying a plaster to a cut. The employer has a legal requirement to prepare an emergency plan that outlines how fire emergencies will be dealt with in the event of a fire outbreak. Section (25) requires the employer to make necessary arrangements to provide first aid to any person injured in a fire incident as well as arrange for the transportation of the injured person to the nearest health facility.

2.1.7.3.9 Electrical equipment and electrical installation

Electrical equipment used at the workplace are potentially hazardous and can cause fires, electric shock and burn injuries if improperly used or maintained. Section (16) requires the occupier to ensure all electrical machines, equipment and hand tools at the workplace are properly earthed or double insulated. All electrical equipment and installations are also required to be inspected in every period of six months by a competent person and a record of the inspection kept.

2.1.7.3.10 Housekeeping

Rubbish and temporary storage of materials at the workplace presents a fire hazard and if in or near walkways, a tripping hazard as well. Section (13) requires every occupier to

ensure that the workplace is kept in a clean state and ensure dirt and refuse is removed at least once a day; the dirt and refuse collected should be contained in a receptacle.

2.1.7.3.11 Fire escape exits

Escape routes are designed to ensure, as far as possible, that any persons confronted by fire anywhere at the workplace are able to turn away from it and escape to a place of reasonable safety e.g. a protected stairway. From there they will be able to go directly to a place of total safety away from the threat of harm. Section (17) requires the occupier to provide fire escape exits of at least ninety centimeters wide and should be distinctively and conspicuously marked in green letters of at least fifteen centimeters in height. The fire exit door and exit staircases should always be maintained free of obstruction.

Every emergency exit route should be clearly marked with signs indicating the direction of exit and a drawing or map showing evacuation routes should be posted in prominent positions at the workplace.

2.1.7.3.12 Water storage for fire fighting

Water is a critical resource in firefighting both for suppressing structural fires and for defending structures from fires. When firefighters arrive at a workplace, they need a dependable and ready supply of water. Section 33 requires every occupier to provide water and water storage facility capable of storing at least 10,000 liters of water; the water storage facility should be kept full at all times for use in event of fire.

The water pressure in the firefighting system should be capable of raising water to the highest point of the workplace in the event of a fire and where hose reels are used, and the storage water reservoir is at ground level or underground, an isolated water pump should be provided.

2.2 Previous Work Relevant to the Study

An assessment by Makachia (2013) on the state of fire safety in particular public and private universities in Kenya with reference to the Factories and Other Places of Work

(Fire Risk Reduction) Rules, 2007 sought to establish fire safety measures executed in local universities in Kenya.

The study applied a descriptive research design. The target population was 27 public and private universities listed by the commission for higher education by March 2010. Stratified random sampling was applied in coming up with public and private universities as distinct strata while 3 public and 4 private universities were purposefully selected by the researcher from the strata.

The study recognized that providing of basic fire safety articles that include fire extinguishers and fire exits was normally good with a mean score of 2.87 out of a maximum score of 4.0. Prescribed training courses were normally deficient at the universities with 74% of the workforce not cognizant of such curriculums. It also established that absence of information, non-existence of policies and insufficient resources are top contributing factors affecting compliance to the FRRR, 2007. The compliance level to the FRRR was found to be below 60% with an average score of 1.96 out of a maximum score of 4.0. The study concluded that the lack of information on the existence of the legal requirements of the FRRR has contributed meaningfully to the low safety standards in Kenya's universities.

A study by Olekina (2013) on challenges of handling fire outbursts in informal settlements; the case of the 12th September 2011 Sinai fire in Nairobi County sought to scrutinise the level of awareness to the risks attributable to fire hazards and reaction in the event of a fire among the populaces of the Sinai informal settlement. It also examined if Nairobi County government has issued standard operating procedures that detail the sequence of events to be followed when responding to a fire tragedy in informal settlements, how the Sinai calamity was responded to and any challenges faced.

The methodology employed a case study research design. The researcher purposively selected 341 households from a population of those who were affected by the Sinai fire catastrophe to represent a population of 44,881 Sinai slum residents according to the National Population census of 2009.

The study discovered that majority of the respondents (76%) were not aware of the standard operating procedures employed during firefighting. Respondents explained that poor planning with houses occupying spaces meant for roads and narrowed paths between houses makes the area inaccessible during a fire or other tragedy.

The results indicate that 49.6% of the respondents indicated that they were faced with various hurdles such as inadequate knowledge on firefighting, non-existence firefighting equipment and those obtainable are faulty as well as lack of information on firefighting policies and standard operating procedures.

The study concluded that the level of awareness on fire hazards among the populaces was inadequate. This was validated by the residents drawing off a highly flammable fuel and putting it away in their houses. The subsequent ignition of the flammable vapours and explosion led to the death and injury of many residents and destruction of property.

Ndegwa (2015) undertook a study on perceptual measures determining the implementation of OSH programmes in the manufacturing sector in Kenya. The studies independent variables were management support, employee training, legal framework and employee participation while implementation of OSH programs was the dependent variable.

The study adopted a cross sectional survey design and gathered both qualitative and quantitative data. The sample size consisted of 259 industries randomly selected from a list of 735 manufacturing industries registered with the Kenya Association of Manufacturers in 2013.

The study findings revealed that there is a significant positive linear relationship between employee training and implementation of OSH programmes meaning that improved employee training enhanced implementation of OSH programs.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study design

The study applied a descriptive survey employing a cross-sectional survey design. It purposed to acquire information regarding the existing condition of fire safety at Kariobangi Light Industries and other occurrences; and wherever conceivable, to draw an inference from the actualities deliberated. It was used to report on the condition of fire safety within Kariobangi Light Industries.

3.2 Study area and population

The study area was Kariobangi Light Industries which is an industrial cluster that lies in the North and Eastern parts of Kariobangi North estate, Nairobi, Kenya. Kariobangi Light Industries commonly known as 'Lighti' by the local slang, was designated by the local government in the early 1980s as an area for artisans who have in the years established small and medium manufacturing enterprises within the area. Land grabbing in the early to late 1990s has led to a change in the intended land use in the area and consequently the cluster comprises of low-income residential units and industrial establishments housed on the same building.

The study population comprised of the enterprises within Kariobangi Light Industries. The number of licensed enterprises to operate in the area in the year 2014 were 30 and are involved in the manufacture of mattresses, cartons, paints, plastic products, beauty products as well as a bakery (City County of Nairobi Licensing Department, 2014).

Figure 3.1: Map of study area Enclosed: map of Kenya displaying location of study area. Source: Google maps

3.3 Sampling method

Sampling means choosing an assumed figure of elements from a categorized populace as expressive of that populace. Any declarations made about the elements ought to be binding

for the populace. Thirty industries were purposively sampled which constituted 100% of the licensed industries within Kariobangi Light Industries during the year 2014.

3.4 Sample size determination

Purposive sampling was used in determining the sample size. Licensed enterprises as per the Nairobi City County Licensing Department records of 2014 were purposively selected as the sample in this research. All the licensed enterprises formed 100% of the sample. The enterprises were involved in various activities, as indicated in table 2.1. Interviews were also restricted the business owners or their appointed representatives in the 30 licensed enterprises.

3.5 Research instruments

Primary data was collected from the field by undertaking a walkthrough survey of the sampled industries making observations and taking photographs of characteristic findings, use of questionnaires, checklists and by conducting interviews. Secondary data was obtained from the review of existing literature on the study area.

3.5.1 Checklists

Well-structured lists of probable ignition sources, fuel sources and fire hazard control measures within the sampled enterprises were prepared as a research tool when undertaking the workplace inspections at the sampled enterprises. The checklists gave quantitative data on the occurrence of fuel and ignition sources as well as fire hazard control measures.

3.5.2 Questionnaires

Quantitative data was collected using a structured questionnaire. The questionnaires were used since they permit respondents to offer their feedback in an unrestricted situation. They obtained data on the socio-demographic characteristics of the respondents, fire safety awareness of the respondents and fire hazard control measures that have been implemented by the business community operating within the industrial cluster.

3.5.3 Interviews

Unstructured interviews were conducted with the respondents. The interviews provided valuable qualitative data on the respondents' point of view on certain aspects pertaining to fire safety awareness.

3.6 Data processing and analysis

The finished questionnaires were checked for mistakes and oversights and then coded and evaluated qualitatively and quantitatively. Qualitatively the data was put into topics in line with the specific objectives. This allowed the researcher to make overall declarations in terms of the witnessed characteristics hence conceptualization.

Quantitative data from the questionnaires and the checklists were summarized, coded, tabulated and analyzed. Editing was done to improve the validity of data for coding. Coded data was fed into the statistical package for social sciences (SPSS) version 20. This version of SPSS was selected for analysis since it offers a more user-friendly interface and can easily be linked with Microsoft office utility programs. Descriptive statistics such as cumulative percentages, mean and standard deviation were generated for each independent study variables. Bivariate Pearson's Correlation analysis of the study variables was used to determine the relationship between the independent variables while a linear regression analysis was used to determine the significant independent variables that greatly influence implementation of fire safety; the dependent variable.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

29 industries were visited out of 30 industries which constituted 96.66% of the sample population. All respondents in the 29 industries returned their questionnaires. Figure 4.1 shows the occurrence of the enterprises visited based on their description of their business activity. 44.8% of the sampled enterprises were involved in the manufacture and sale of paints, thinners, and adhesives.

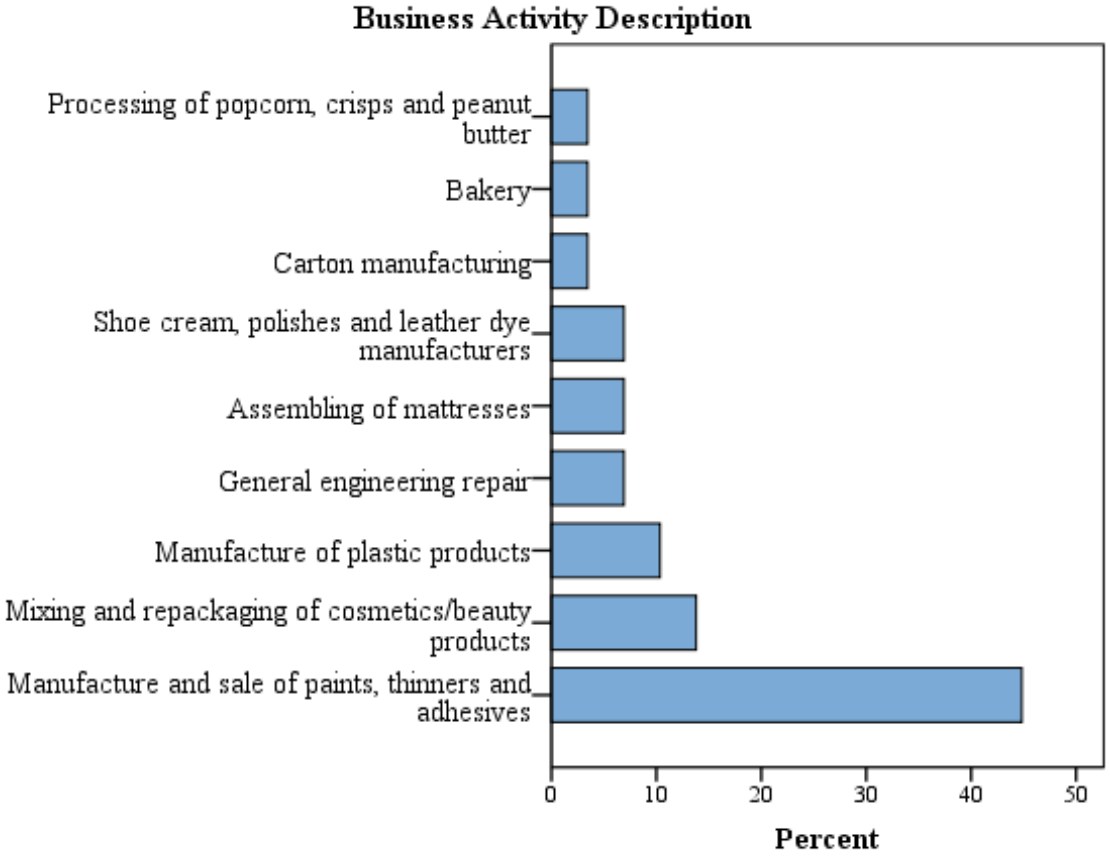


Figure 4.1: Occurrence of sampled enterprises by their business description

4.1 Social-demographic characteristics

4.1.1 Distribution by gender

The respondents were asked to indicate their gender. 68.97% of the respondents were males while 31.03% were females. These study findings agree with the outcomes of a study by Olabisi, Olagbemi & Atere (N.D) on a gender-based analysis of factors affecting small-scale commercial performance in the informal economy in Lagos-State Nigeria. The study sought to determine if there was a difference between factors prompting small scale business performance among the female- owned enterprise and male-owned enterprises in the informal economy in Lagos state, Nigeria. Male respondents (business owners) were 54% and female respondents (business owners) were 46% (Olabisi, Olagbemi & Atere, N.D).

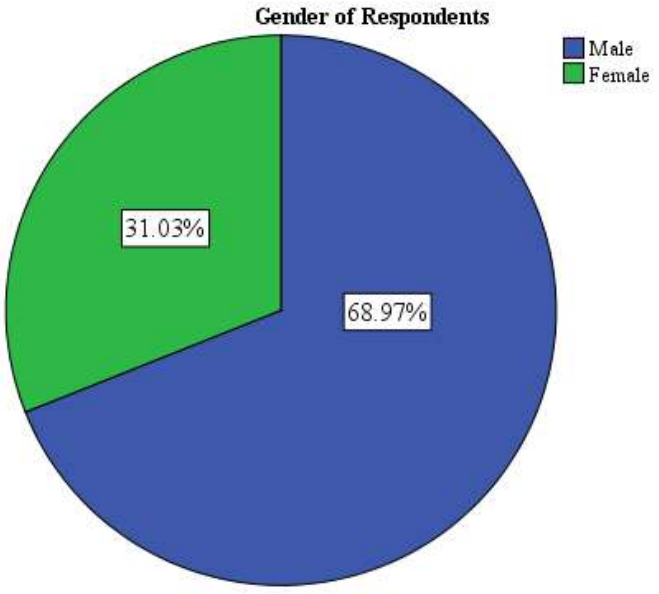


Figure 4.2: Distribution of respondents by their gender

4.1.2 Distribution by years of operation

The respondents were asked to specify the number of years they have been operating at Kariobangi Light Industries and the findings are presented in figure 4.3. Greater than 50%

of the sampled enterprises had been in operation for more than 10 years. The findings of this research are in line with the outcomes of a study be Fatoki (2013) on the determinants of the longevity of microenterprises in South Africa in which 43.80% of the sampled enterprises were 10 – 15 years in operation (Fatoki, 2013).

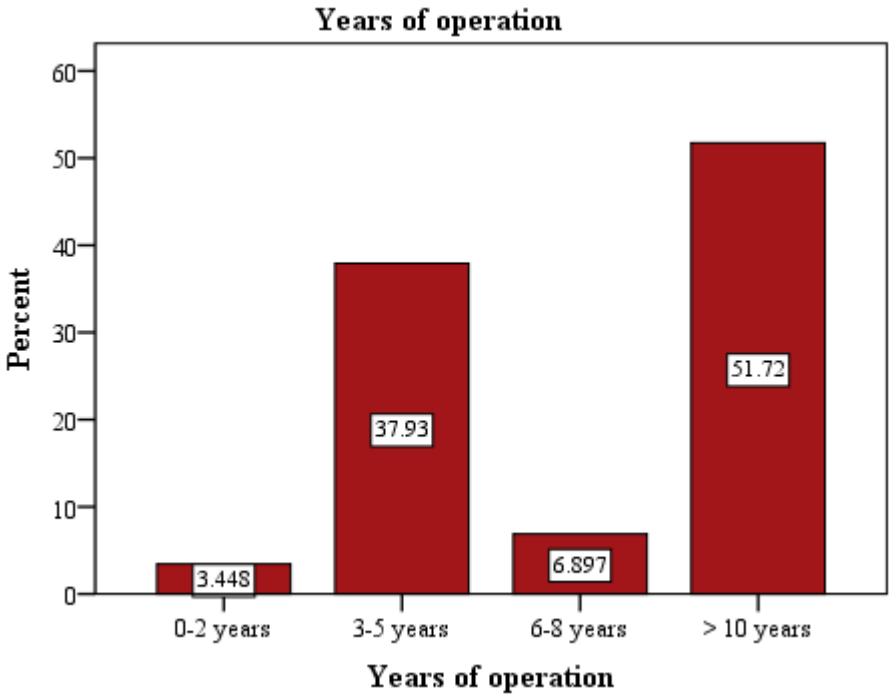


Figure 4.3: Distribution of enterprises by their years of operation

4.1.3 Distribution by level of education

The respondents were asked to indicate their level of education. The findings are presented in figure 4.4 below. Majority of the respondents (41.38%) had attained secondary education. These findings are in line with those of a study by Nathan Associates and TNS (2014) for Financial Sector Deepening Uganda (FSDU) which found that owners of micro, small and medium enterprises (MSMEs) in Uganda are fairly well- learned. Above half have secondary education or higher (Nathan Associates & TNS, 2015).

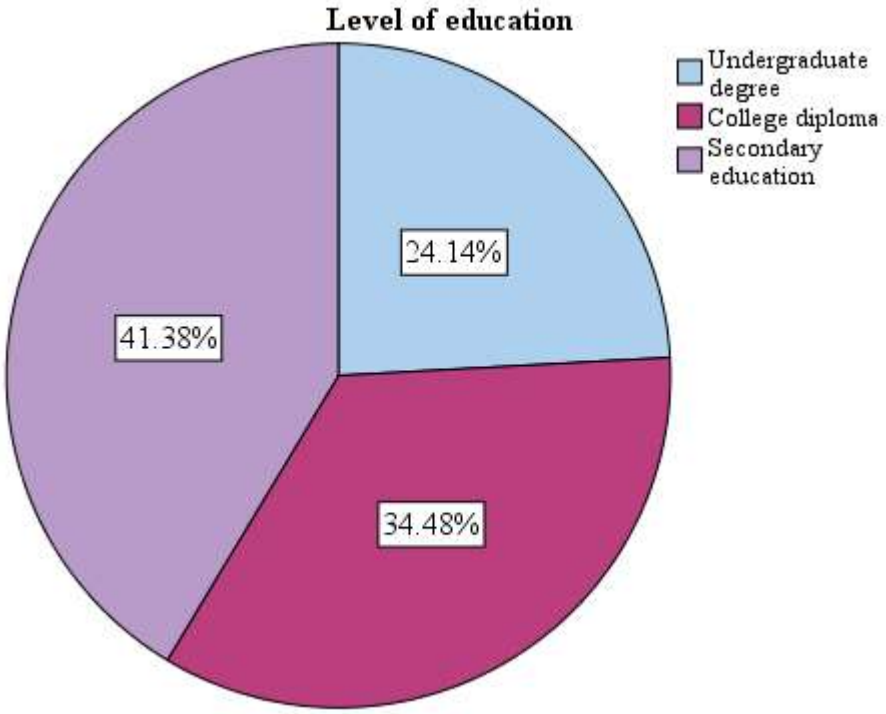


Figure 4.4: Distribution of respondents by their level of education

4.2 Implementation of fire safety

This section of the study sought to find out to what extent the respondents perceived they implement fire safety at their respective enterprises. A five-point Likert scale questionnaire was used and figure 4.5 is a presentation of the findings. The majority of respondents implied that they rarely implement fire safety (34.48%) in their respective enterprises. The respondents perceived that the provision of firefighting equipment was vital in the implementation of fire safety.

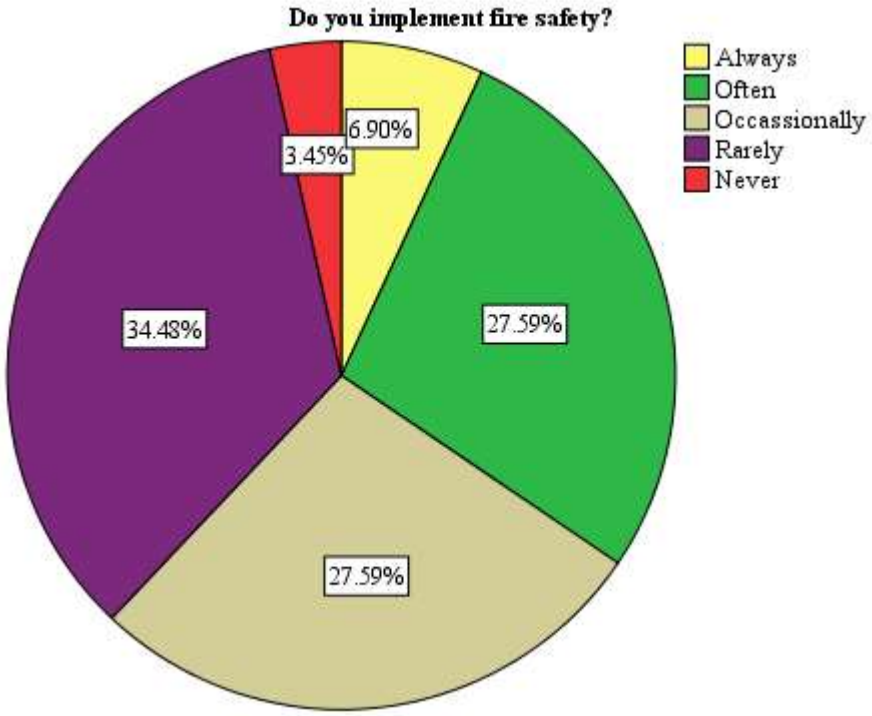


Figure 4.5: Respondents perception on their implementation of fire safety

4.2.1 Pearson correlation analysis between years of operation and implementation of fire safety

A Pearson correlation analysis between the years of operation at Kariobangi Light industries and implementation of fire safety by the respondents within the sampled enterprises was determined. A significant positive correlation interprets that as the years of operation within the industrial cluster increase, the respondents' implementation of fire safety will increase and that the findings of the sample are apparent in the entire population. P value < 0.05. r (27) = .401*, p = .031.

Table 4.1: Pearson correlation between years of operation at Kariobangi Light industries and implementation of fire safety

Correlations			
		Do you implement fire safety?	Years of operation
Do you implement fire safety?	Pearson Correlation	1	.401*
	Sig. (2-tailed)		.031
	N	29	29
Years of operation	Pearson Correlation	.401*	1
	Sig. (2-tailed)	.031	
	N	29	29

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

Study findings by Gachago (2013) substantiate the significant positive correlation between the years of operation within the industrial cluster by the respondents and their implementation of fire safety. In her findings, there was a significant association between the respondents' duration of stay within Kiandutu slum; Thika and their perception of fire risk i.e. as the respondents' duration of stay increased, their perception to fire risk got stronger. For those who stayed for between 10 to 20 years, $p = 0.012$ and those who stayed between 21 to 30 years, $p = 0.002$. Perception of fire risk in the study was defined by; among other factors, the respondents having been affected by a fire, when the fire occurred, the origin of the fire, its effects, who notified the respondents of the fire, their immediate reaction and their awareness on how to suppress the fire (Gachago, 2013).

4.3 Fire fuel and ignition sources within Kariobangi Light industries

This section of the study sought to identify and document the potential fire ignition and fuel sources within Kariobangi Light Industries.

4.3.1 Fuel sources

Identification of fuel sources employed a checklist with the researcher noting down the specific materials in the enterprises. Flammable, highly flammable and combustible materials are the broad categories of the identified materials; based on their flash points.

4.3.1.1 Flammable materials

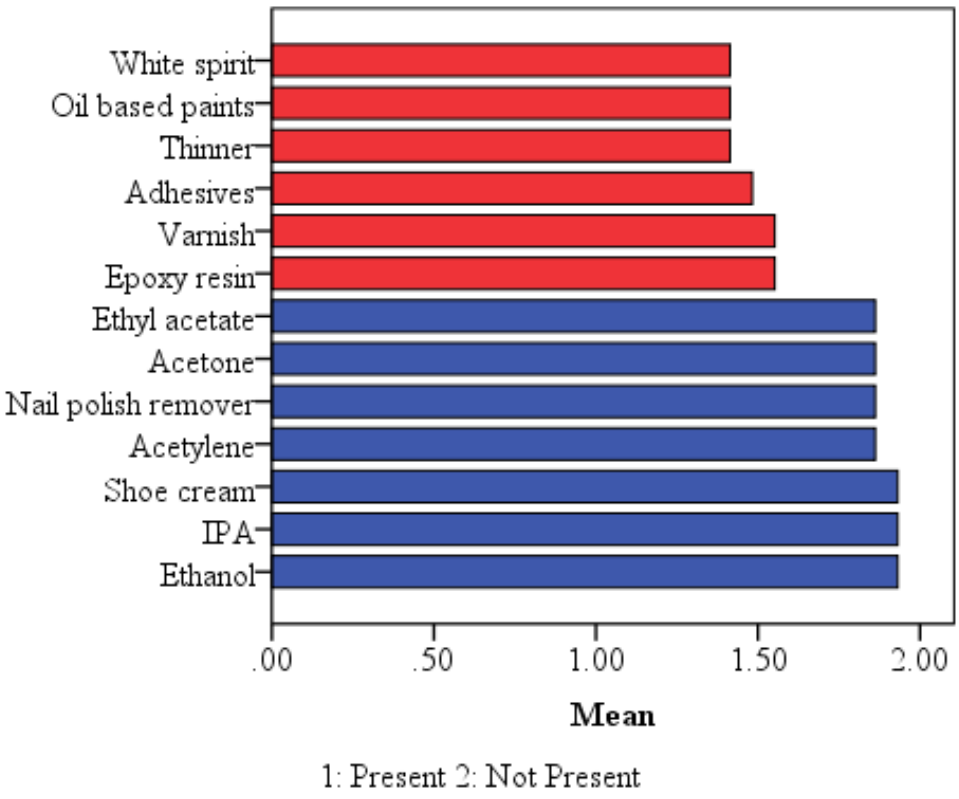


Figure 4.6: Occurrence of flammable and highly flammable materials within the sampled enterprises

Oil-based paints, white spirit, thinner and adhesives; which are or contain flammable industrial products are a significant fuel source within the sampled industries. They are manufactured and traded in paint and adhesives manufacturing enterprises; which constituted the majority of the sampled industries. Majority of the products have a flash point below 38.78 degrees Celsius meaning they discharge ignitable vapors at low temperatures.

Oil-based paints contain resins, solvents, and pigments. Despite the epoxy resins being combustible liquids, the solvents in the oil-based paints are highly volatile and have flash points of 38 degrees Celsius or lower. This infers that oil-based paints should be stored in tightly sealed vessels, in well-ventilated storerooms and their manufacture should be in closed process systems thereby reducing or better still eliminating the production of flammable vapors.

White spirit; is a very common solvent in the paint manufacturing industries. In the sampled industries, it is stored in bulk in 200 liters steel drums and repackaged in 500 milliliter and 1-liter polyethylene containers during trading. Due to its high volatility and flammability, the white spirit should be stored in tightly sealed vessels, in cool and well-ventilated rooms in volumes as low as is reasonably practical. This aspect was found lacking in the study area and exposes workers to a high degree of explosions and consequent fire disasters.

Paint thinner is also a common product in the paint manufacturing industries and is used to adjust the viscosity of paint. In the sampled industries, it is stored in bulk in 200 liters stainless steel drums and repackaged in 500 milliliter and 1-liter polyethylene containers during trading. This aspect was found lacking in the study area and exposes workers to a high degree of explosions and consequent fire disasters.

Adhesives (glues), also a common product manufactured in some of the paint industries contains toluene a flammable solvent with a flash point of 6 degrees Celsius. In the sampled industries it is stored in stainless steel and polyethylene drums. Due to its high

volatility and flammability, it should be stored in tightly sealed vessels, in cool and well-ventilated rooms in volumes as low as is reasonably practical.

4.3.1.2 Combustible materials

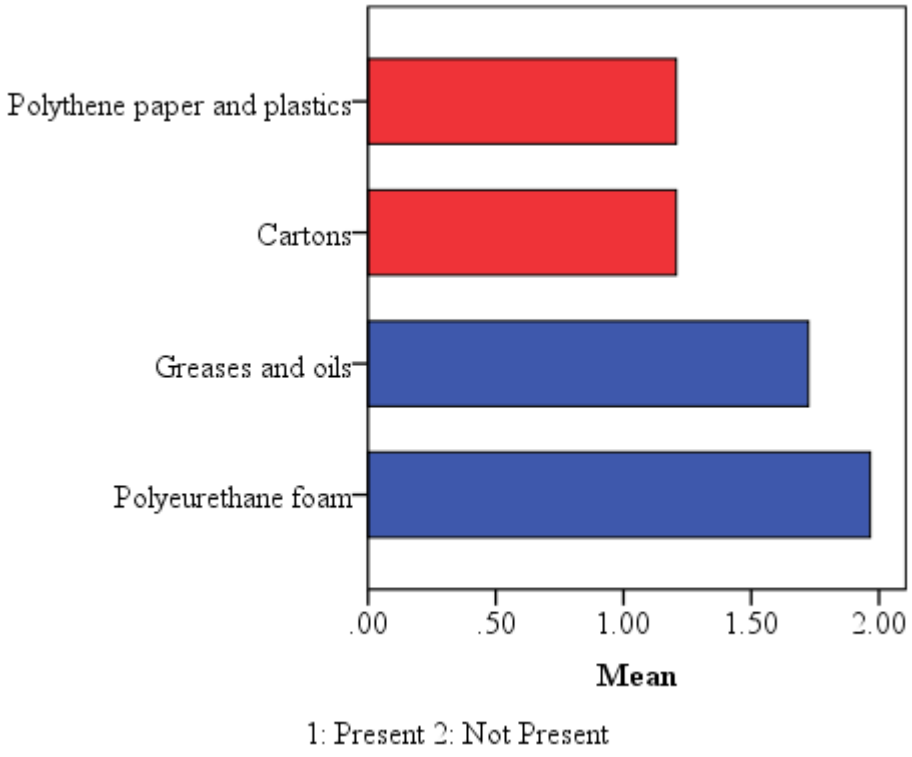


Figure 4.7: Occurrence of combustible materials within the sampled enterprises

Cartons, polyethylene materials; which are combustible materials, are significant fuels within the sampled industries. They are used as packaging materials for raw materials and finished products.

4.3.2 Ignition Sources

Ignition sources in the sampled industries were identified with the help of a checklist. Figure 4.8 gives a summarized representation of the identified ignition sources.

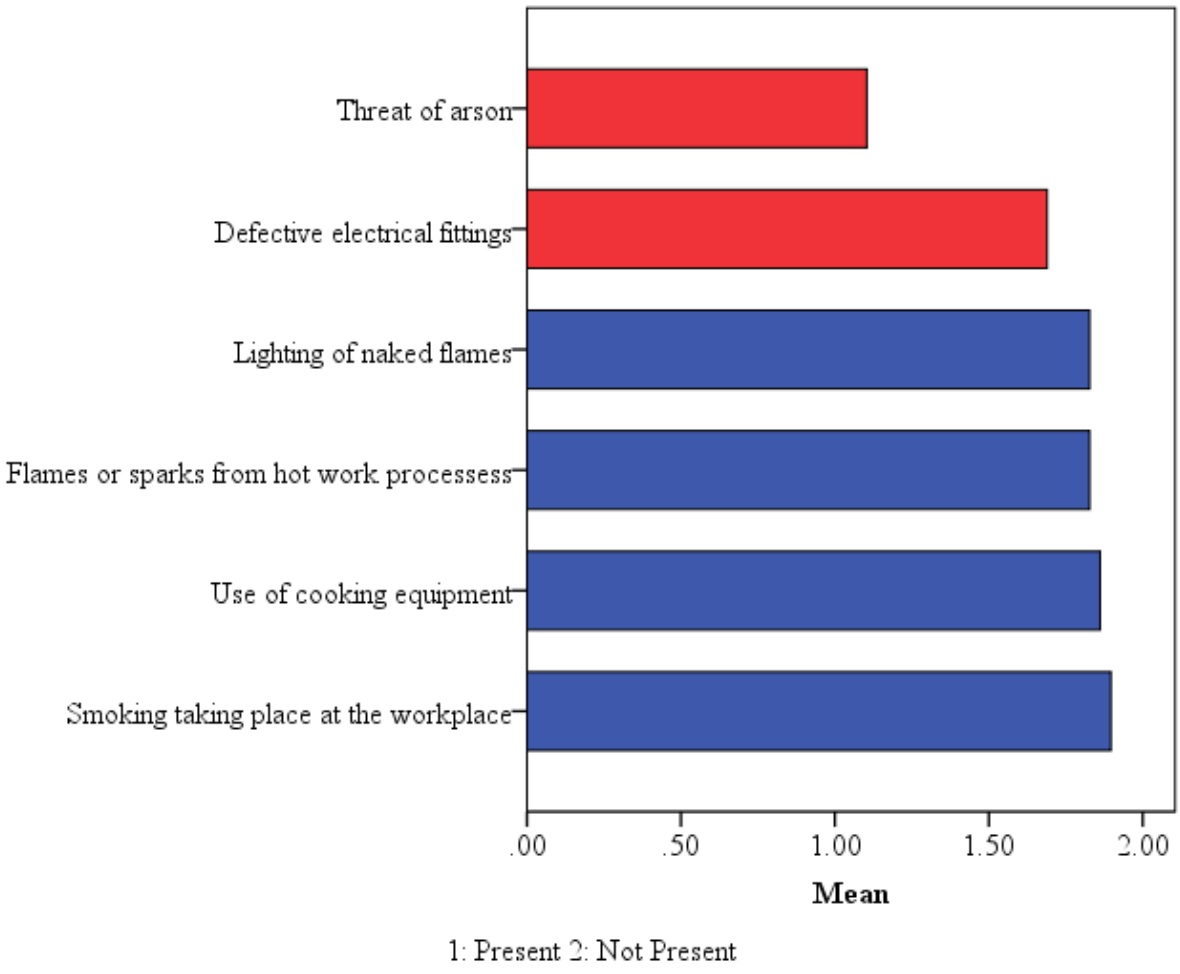


Figure 4.8: Occurrence of fire ignition sources within the sampled enterprises

Defective electrical fittings are a significant source of ignition for fire within the sampled enterprises. They were characterized by poking of naked electrical wires into sockets; the respondents explicated that replacing burnt fuses was not cost-effective. Exposed electrical wires were observed in the majority of the sampled enterprises. These were characterized by live electric wires protruding from open electric panels and missing sockets. The respondents were oblivious that exposed by electric live wires could cause fire and were more concerned with electrocution of persons within the enterprises.

Plate 4.1: Exposed live electric wires

Plate 4.2: Trader attending to a fire lit to burn company waste

Intentional lighting of fires with the purpose of burning waste was observed in one enterprise. The traders cited the lack of formal waste management services as the reason why they intentionally light fires to burn company waste. They, however, claimed that they

do not leave fires unattended. Arson is also a significant source of ignition for fire within the sampled enterprises. Control of access into the workplaces was observed to be very strict with all of the traders locking the entry/ exit doors to their enterprises at all times and a responsible person charged with the access key. Intruder alarm systems were not installed in the workplaces however; a closed – circuit television system was installed in one enterprise. All respondents explicated that they confronted the threat of arson which they attributed to business rivalry.

4.3.3 Pearson correlation analysis between the level of education and fuel and ignition sources

A Pearson correlation analysis between the level of education of respondents and fuel and ignition sources was determined. A negative correlation interprets that as the respondents level of education increases; in other words, they become more knowledgeable, fuel sources within their respective enterprises will be as low as is reasonably practical and ignition sources will reduce or better still be completely eliminated. The relationship was however, not significant. P value > 0.05. r (27) = -.219, p = .253.

Table 4.2: Pearson correlation between the level of education of respondents and fuel and ignition sources present in the sampled enterprises

Correlations			
		Level of education	Fuel and ignition sources
Level of education	Pearson Correlation	1	-.219
	Sig. (2-tailed)		.253
	N	29	29
Fuel and ignition sources	Pearson Correlation	-.219	1
	Sig. (2-tailed)	.253	
	N	29	29

4.4 Fire safety awareness

In this section, the study sought to assess fire safety awareness among the business community operating within Kariobangi Light Industries. Fire safety awareness was assessed by filling of a well-structured questionnaire.

4.4.1 Fire safety policy

The study sought to find out if the enterprises had a fire safety policy in line with the requirements of the Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007. 31.0% of the respondents indicated they had a fire safety policy but the policy was not availed on request and it was not posted within the workplace. 51.7% of the respondents were not aware of what a fire safety policy is nor its contents some of whom had the perception that having fire extinguishers at the workplace is the fire safety policy.

Table 4.3: Availability of fire safety policy's in the sampled enterprises

Fire safety policy available?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	31.0	31.0	31.0
	No	5	17.2	17.2	48.3
	Not aware	15	51.7	51.7	100.0
	Total	29	100.0	100.0	

4.4.2 Fire safety audits

The respondents were asked if they undertake annual fire safety audits as it is a requirement of the Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007. 31.0% of the respondents indicated they undertake annual fire safety audits but audit reports were not availed on request. 41.4% of the respondents were not aware of the requirement to carry out annual fire safety audits by a registered fire safety auditor.

Table 4.4: Respondents undertaking annual fire safety audits

Fire safety audits undertaken at the workplace?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	31.0	31.0	31.0
	No	8	27.6	27.6	58.6
	Not aware	12	41.4	41.4	100.0
	Total	29	100.0	100.0	

In the subsequent section on assessing fire safety awareness, the study used a five point Likert scale and the responses ranged from 5 = very great extent, 4 = great extent, 3 = moderate extent, 2 = little extent to 1 = no extent. Table 4.5 and figure 4.9 present the findings.

Table 4.5: Fire safety awareness of respondents within the sampled enterprises

	No extent	Little extent	Moderate extent	Great extent	Very great extent
There is an established firefighting team?	55.2%	17.2%	6.9%	10.3%	10.3%
The firefighting team is trained?	62.1%	10.3%	13.8%	3.4%	10.3%
All workers have been instructed on the safe use of fire extinguishers?	31.0%	31.0%	13.8%	10.3%	13.8%
There are fire action signs?	55.2%	31.0%	0.0%	3.4%	10.3%
You undertake annual fire drills?	86.2%	3.4%	3.4%	6.9%	0.0%
You have arrangements to call for emergency services in case of fire?	3.4%	17.2%	20.7%	44.8%	13.8%
Smoking is prohibited at the workplace?	3.4%	3.4%	3.4%	13.8%	75.9%
'No Smoking' signs have been put up?	44.8%	17.2%	0.0%	20.7%	17.2%
A smoking zone with an appropriate ashtray has been provided?	89.7%	0.0%	3.4%	6.9%	0.0%
First aid facilities are available?	0.0%	24.1%	27.6%	41.4%	6.9%
Transport for injured persons is available?	10.3%	0.0%	10.3%	48.3%	31.0%
Fire assembly point identified and marked?	86.2%	6.9%	0.0%	6.9%	0.0%

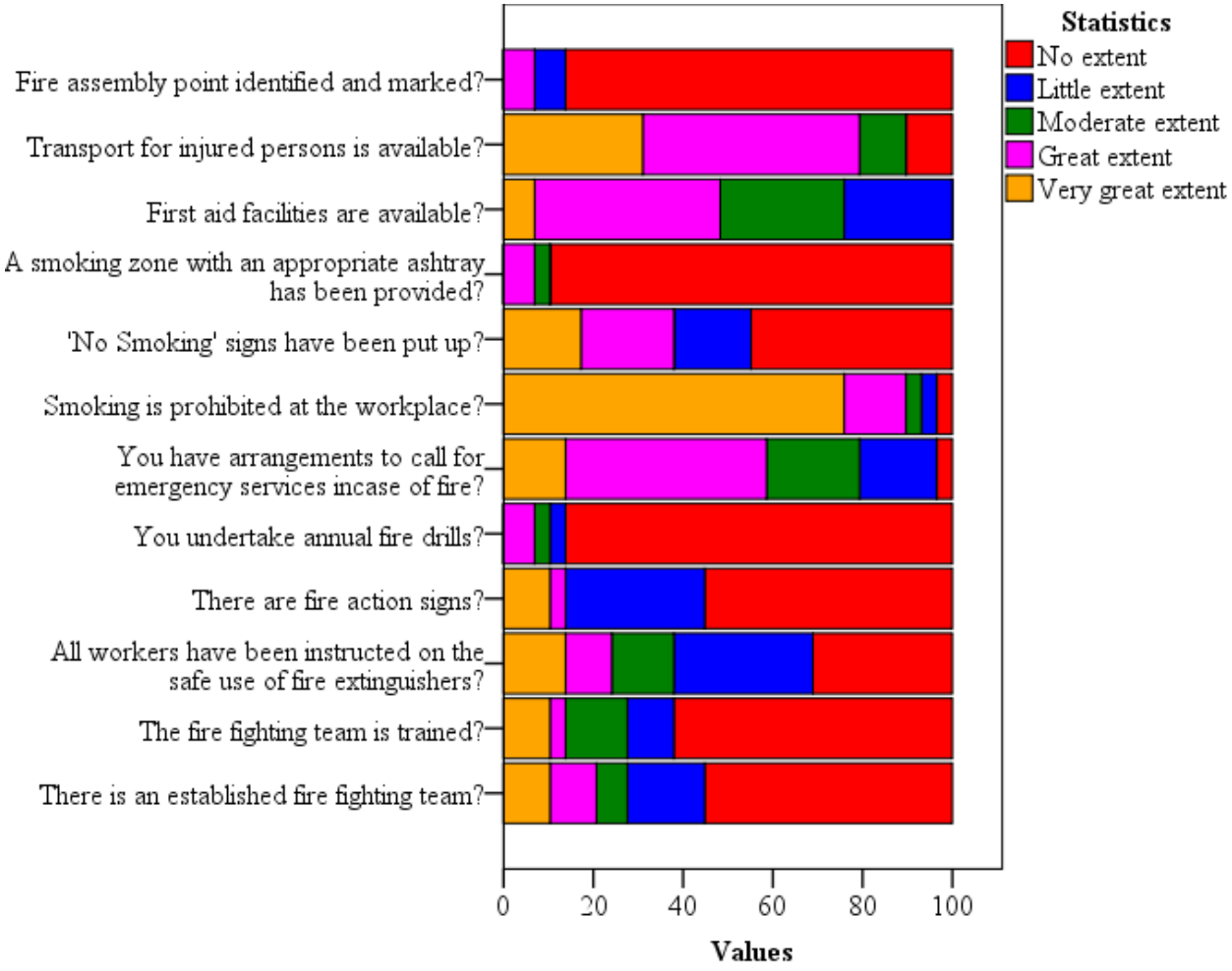


Figure 4.9: Fire safety awareness of respondents within the sampled enterprises

Most outstanding findings on fire safety awareness were that a substantial percentage of respondents indicated they had instructed/trained all workers on the safe use of firefighting equipment (13.8% to a moderate extent, 10.3% to a great extent and 13.8% to a very great extent) while a significant number indicated that there was a trained firefighting team available at the workplace (6.9% to a moderate extent, 10.3% to a great extent and 10.3% to a very great extent). However, observations made on the handling and condition of firefighting equipment in the sampled enterprises, deficiency in the selection and distribution of firefighting equipment in some of the enterprise i.e. water hose reel being provided as the sole firefighting equipment in an enterprise handling paints and provision

of a foam extinguisher at a generator are a clear indication that the respondents were not conversant with the basics of firefighting equipment.

Fire action signs to inform workers and other building occupants of what to do in case of fire were largely not available (55.2% to no extent). The respondents indicated that they do not undertake fire drills and the majority of them were not conversant with the term ‘fire drill’ or what it entails (86.2% to no extent). Fire assembly points were also not available in the sampled enterprises (86.2% to no extent). The respondents cited the lack of a suitable space where workers can assemble while other respondents cited having few employees as the reason why they do not comprehend the need for an emergency assembly point. This findings all relate significantly as fire action signs serve to advise the building occupants on what to do in case of a fire. The fire drills seek to practice the fire action instructions and a key feature in the fire action signs is the fire assembly point where the building occupants will assemble.

Smoking is a leading cause of workplace fires, the respondents indicated that smoking is greatly prohibited (75.9% to a great extent). However, ‘No Smoking' signs have considerably not been provided within the sampled enterprises (44.8% to no extent) and smoking employees or visitors to the sampled enterprises have not been provided with a smoking zone equipped with an appropriate ashtray (89.7% to no extent). Lack of suitable space to put up the smoking zones was cited by the majority of the respondents while some felt that it was the duty of the Nairobi City County to provide and maintain the smoking zones.

The respondents indicated they had provided first aid facilities at their workplaces (27.6% to a moderate extent, 41.4% to a great extent and 6.9% to a very great extent). However, it was observed that in some enterprises, first aid kits were not provided while in some the first aid kits had either expired provisions or they were empty. Certificates of trained first aiders were also not availed on request in the sampled enterprises. The respondent indicated that they had made arrangements to call for emergency services in case of a fire (20.7% to a moderate extent, 44.8% to a great extent and 13.8% to a very great extent); however, none of the respondents had contacts of the Nairobi Fire Services or a contracted

fire company. The respondents also explicated they were not aware of where to obtain the contacts.

4.5 Fire hazard control measures

This section highlights the fire hazard control measures that have been executed by the business community operating within Kariobangi Light Industries. Fire hazard control measures were assessed by filling of a well-structured questionnaire. The questionnaires used a five-point Likert scale and the questions ranged from 5=very great extent, 4=great extent, 3=moderate extent, 2=little extent to 1= no extent. The study also used a structured checklist in the identification of hazard control measures.

Table 4.6: Fire hazard control measures executed in the sampled enterprises

	No extent	Little extent	Moderate extent	Great extent	Very great extent
Maintenance of machinery and electrical equipment is undertaken regularly?	10.3%	13.8%	3.4%	34.5%	37.9%
Firefighting equipment have been provided at the workplace?	17.2%	6.9%	6.9%	17.2%	51.7%
The firefighting equipment are regularly serviced/maintained?	37.9%	27.6%	6.9%	24.1%	3.4%
There is a means of detecting fire / smoke/heat at the workplace?	93.1%	6.9%	0.0%	0.0%	0.0%
There is a means of alerting workers of a fire situation in the workplace?	41.4%	31.0%	13.8%	10.3%	3.4%

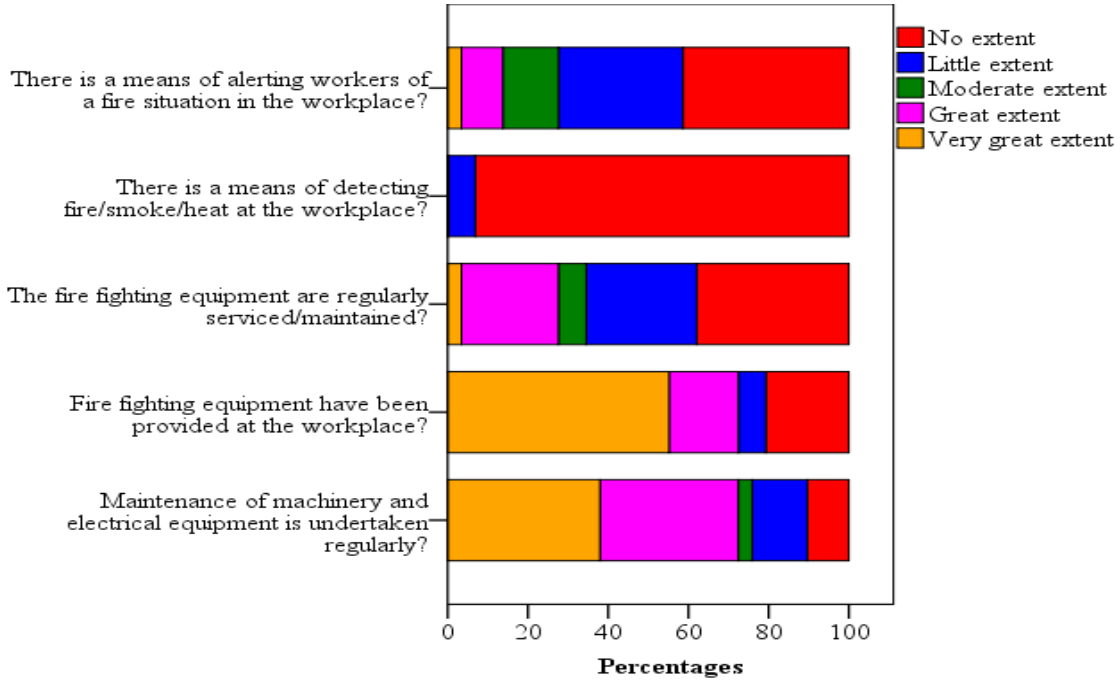


Figure 4.10: Fire hazard control measures executed in the sampled enterprises

The respondents indicated they had provided firefighting equipment (6.9% to a moderate extent, 17.2% to a great extent and 51.7% to a very great extent) and that they were regularly serviced/ maintained (6.9% to a moderate extent, 24.1% to a great extent and 3.4% to a very great extent). The most notable observations were that portable fire extinguishers constituted the majority of the firefighting equipment provided in the sampled enterprises. Two water fire hose reels were identified in one enterprise manufacturing paints. Flammable liquid fires (class B fires) are characteristic of paint manufacturing companies and hence water is not an appropriate extinguishing agent. The position of means to extinguish a fire in one of the enterprises was distinctively and conspicuously marked with fire point signs. However, some fire points were missing fire extinguishers. In the rest of the sampled industries, the points of fire extinguishers were not distinctively and conspicuously marked with a fire point sign and some of the extinguishers were not mounted at an easily accessible height of 60cm from the floor as required by law. Some improper practices concerning handling of fire extinguishers that

were observed were inconsistent with the respondents' responses on the servicing of firefighting equipment, were dangling of fire extinguishers by the discharge and mislaying of fire extinguishers, missing inspection stickers on fire extinguishers, old and obsolete fire extinguishers as well as fire extinguishers with cracked discharges. Records of examination of firefighting appliances; including hydraulic pressure tests, after every five years, were not availed on request and the respondents were not familiar with the requirement to examine the firefighting appliances.

It was also noted that there was an inadequacy in the selection and distribution of firefighting equipment at the workplace. Most evident inadequacies were the provision of a foam fire extinguisher at a generator room, provision of a dry powder fire extinguisher at a deep fat fryer, provision of water hose reels as the only firefighting appliance in an enterprise handling paints and provision of firefighting equipment at a distance from the hazard areas.

Plate 4.3: Fire extinguisher fastened by the discharge

Plate 4.4: Wrongly placed fire extinguisher

Plate 4.5: Fire extinguishers not mounted at the workplace

There were no means of detecting fire, heat or smoke at the workplace (93.0% to no extent) with the respondents not familiar with such systems. On means of alerting workers of a fire situation at the workplace, the majority of the respondents were not familiar with these systems (41.4% to no extent and 31.0% to little extent) with others clarifying they would shout ‘fire’ in the event one occurs.

The study also used a well-structured checklist in the identification of fire hazard control measures.

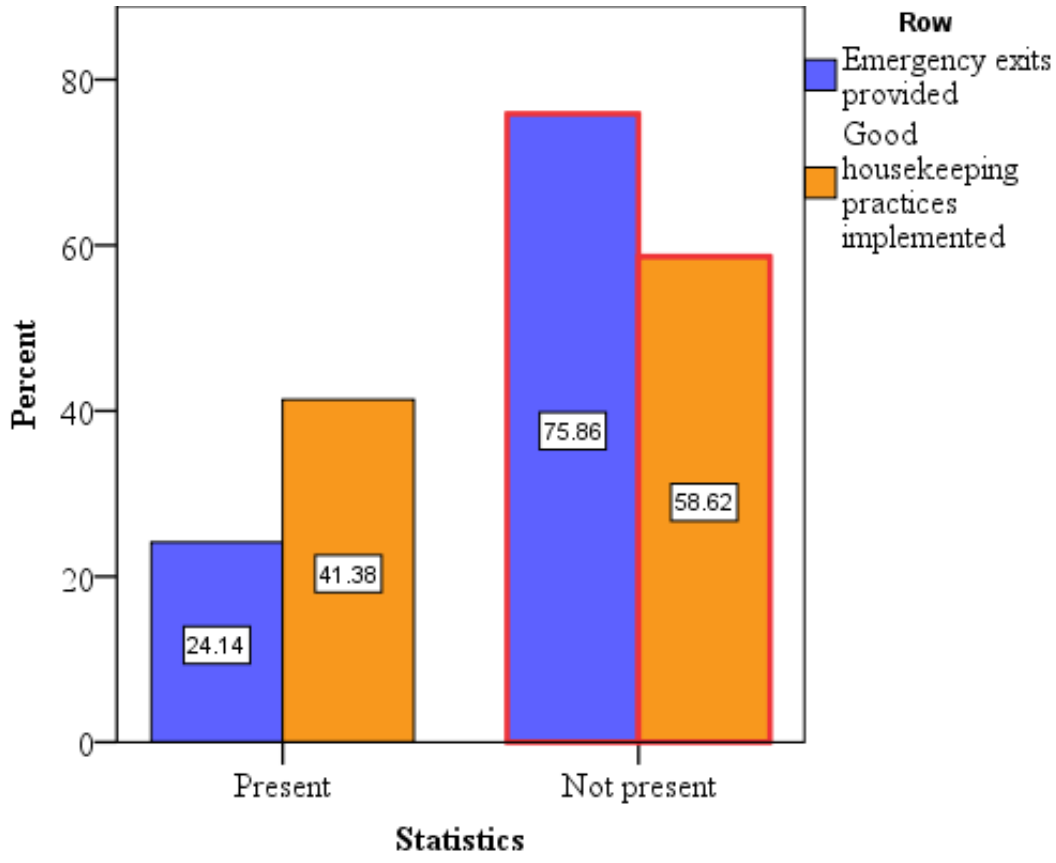


Figure 4.11: Fire hazard control measures executed by the sampled enterprises

Fire emergency exits were largely not present in 75.86% of the sampled enterprises. However, two enterprises have provided alternative exits to be used in case of a fire or other emergency in which case; there is blocking of the normal route of entry or exit. In one, the emergency exit route signs have been marked in yellow and the route signs in red. The emergency exit access was obstructed with bags of raw material as at the time of the visit. Part of the emergency exit access is a set of steep metallic stairs with a short and feeble guard rail that would not be safe for use in case of a fire or any emergency as workers would trip and fall and a stampede could occur. The exit access then leads to a short passageway (76 centimeters) which workers can crawl through leading them

downstairs terminating at the exit. The exit access is inadequately lit and workers would fall while coming down the stairs and cause a stampede. The exit is locked but a key has been provided in an emergency key box, an object to break the strong glass has not been provided. The exit discharge is adjacent to the generator; a high-risk area and no form of protection has been provided. The exit discharge will lead workers to a place of safety, which is a public road outside the company.

Plate 4.6: Emergency exit access with a height of 76 centimeters

Plate 4.7: Emergency key box without a break glass hammer

In the other enterprise, the emergency exit route signs are marked in green. The emergency exit from this facility is a spiral stairway landing on the rooftop of an adjacent building. From here, the building occupants can be rescued by firemen. The respondents justified the lack of emergency exits by explicating that they moved into preexisting godowns which were not provided with emergency exits as well as the fact that Kariobangi Light industries is congested with a company sharing three walls with neighboring companies.

It was noted that the normal route of entry/exit in a majority of the enterprises was always locked from within, with the key being retained by an authorized person. The respondents cited insecurity in the area as the reason why they have to always lock their normal route of entry/exit. The normal route of entry/exit was also obstructed with flammable and combustible materials of finished products, raw materials or empty chemical drums. Notably; in one of the enterprises, a deep fat fryer was positioned and used at the entry/exit to the enterprise.

Plate 4.8: Normal route of entry obstructed with flammable and combustible material

58.62% of the sampled enterprises were found to have poor housekeeping practices. These were observed to be characterized by accumulation of waste, products and raw materials due to lack of adequate working space, lack of marked gangways in all the enterprises visited, high stacking of goods in the workplace leading to insufficient lighting and ventilation as well as stacking of goods against the walls. In the company using the deep fat fryer, lack of adequate ventilation was causing the buildup of smoke and heat. Grease had also accumulated on the walls and tiled floor, thereby making it slippery and unsafe. A LEV system to extract fumes from the deep fat fryer should have been installed to mitigate these effects. These concerns demonstrate how most of these facilities were death-traps in case of a fire incident.

Plate 4.9: Poor housekeeping practices at the sampled enterprises

Plate 4.10: Accumulation of product, raw materials and waste in one of the enterprises

4.5.1 Pearson correlation between fire safety awareness and fire hazard control measures

A Pearson correlation analysis between the level of fire safety awareness of the respondents and the fire hazard control measures executed by the respondents was determined. A significant positive correlation interprets that as the respondents knowledge on fire safety increases; in other words, they become more knowledgeable on fire safety, there will be an increase in the implementation of fire hazard control measures characterized by fire protection, fire prevention and fire suppression measures. P value < 0.05. r (27) = .597**, p = .001.

Table 4.7: Pearson correlation between fire safety awareness and fire hazard control measures executed by the business owners

Correlations

		Fire safety awareness of respondents	Fire hazard control measures
Fire safety awareness of respondents	Pearson Correlation	1	.597**
	Sig. (2-tailed)		.001
	N	29	29
Fire hazard control measures	Pearson Correlation	.597**	1
	Sig. (2-tailed)	.001	
	N	29	29

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

4.6 Regression analysis between the dependent and independent variables

Table 4.8 shows the variables utilized in this study. The independent variables in the study are fuel and ignition sources, fire safety awareness and fire hazard control measures. The dependent variable is implementation of fire safety.

Table 4.8: Variables used in the linear regression analysis

Variables Entered/Removed[a]			
Model	Variables Entered	Variables Removed	Method
1	Fuel and ignition sources, Fire hazard control measures, Fire safety awareness of respondents[b]	.	Enter

a. Dependent Variable: Do you implement fire safety?

b. All requested variables entered.

Table 4.9: Linear regression coefficients

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.809	2.966		-.273	.787
	Fire safety awareness of respondents	1.979	.536	.625	3.694	.001
	Fire hazard control measures	.548	.521	.177	1.051	.303
	Fuel and ignition sources	-1.254	1.681	-.101	-.746	.463

a. Dependent Variable: Do you implement fire safety?

(y) = (-1.254 x fuel and ignition sources) + (1.979 x fire safety awareness) + (.548 x fire hazard control measures) -.809

The linear regression analysis was used to determine the relationship between the dependent variable (implementation of fire safety) and the independent variables (fuel and ignition sources, fire safety awareness and fire hazard control measures). An elucidation of the B value of the unstandardized coefficients interprets that as fire safety awareness of the respondents increases there will be an increase in the implementation of fire safety (1.979), as implementation of fire safety increases there will be an increase in the implementation of fire hazard control measures (.548) and as implementation of fire safety increases, fuel sources will reduce to as low as is reasonably practical while ignition sources will reduce and preferably, be eliminated (-1.254); holding all other factors constant. P-values for the t-test statistics were used to decide the significance of the independent variables in the regression model. Those variables with a p-value < 0.05 are significant in the equation. Fire safety awareness ($p = 0.001$) was found to impact significantly on implementation of fire safety at the sampled enterprises.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The main objective of this research was to study fire safety within Kariobangi Light Industries within Nairobi County, Kenya with the Occupational Safety and Health Act, 2007 and its subsidiary legislation the Factories and Other Places of Work (Fire Risk Reduction) Rules, 2007 as a standard guiding the study on the fire safety requirements at all workplaces in Kenya.

The first specific objective was to identify and document fire fuel and ignition sources for probable fire within Kariobangi Light Industries. It can be concluded that oil-based paints, white spirit, thinner and adhesives are the main flammable and highly flammable fuels within the industrial cluster. Cartons, polythene paper, and plastics are the main combustible fuels within the industrial cluster. Defective electrical fittings and arson were established to be a significant source of ignition for fire within the sampled enterprises.

The second specific objective sought to assess fire safety awareness among the business community operating at Kariobangi Light Industries. It can be concluded if a small fire was to start at the sampled workplaces, there would be barely any employees ready to do first-aid firefighting and that if a worker did use a fire extinguisher, there are high chances they would not do so safely given that there are different classes of fire and different types of fire extinguishers. It is also evident that the business community does not have documented fire safety policies nor undertake annual fire safety audits. The employers have also not constituted and trained a firefighting team who will; among other duties, instruct all workers on the safe use of firefighting equipment. Fire action signs are also not provided at the sampled workplaces to guide building occupants on what to do in the event of a fire and practicing the procedures by undertaking fire drills at least once in twelve months is also not being done. Critical elements not implemented as part of the overall fire safety program are the identification and marking of fire assembly points, mounting of ‘No

Smoking' notices, provision of smoking zones with appropriate ashtrays and provision of replenished first aid kits to be manned by trained first aiders.

The third specific objective sought to identify and document on the fire hazard control measures that have been executed by the business owners operating at Kariobangi Light Industries. It can be concluded that the business community operating within the industrial cluster has made effort to provide firefighting appliances within their respective enterprises; however, their selection and distribution was wanting. The findings of the research on the provision and maintenance of firefighting equipment indicate that the sampled industries are not prepared to tackle a fire emergency so as to ensure minimal or no property damage and preserve lives. Fire emergency exits were not available in the majority of the sampled enterprises with the normal route of entry and exit being obstructed with highly flammable and combustible materials. It can, therefore, be concluded that in case of an uncontrollable fire hindering access to the normal route of entry, workers would be trapped.

The inferential statistics findings in this research can be used to conclude that fire safety awareness is significant in the implementation of fire safety within Kariobangi Light industries. It can, therefore, be established that the business community should be edified on fire safety which will, in turn, lead to an enhancement in its implementation; consequently, there will be a proportional increase in the implementation of fire hazard control measures which comprise of fire prevention, fire protection, and fire suppression measures.

It is therefore concluded that lack of knowledge on fire safety has greatly contributed to the low fire safety standards within Kariobangi Light Industries. Baseline fire safety audits by Directorate of Occupational Safety and Health Services (DOSHS) approved fire safety auditors of the industrial cluster would form a good basis in advising the business owners.

5.2 Recommendations

The study recommends that business owners at Kariobangi Light Industries should enhance fire safety awareness programs which as per the study findings are vital in the implementation of fire safety. The fire safety awareness programs should include the establishment and training of a firefighting team in each of the workplaces as well instructing all workers on the safe use of portable fire extinguishers. In addition, the study recommends that the business owners should undertake annual fire drills which will seek to practice their fire emergency plans.

The study further recommends the adoption of the fire safety management plan developed in appendix IV which seeks to advise the business owners on the management of fire safety at the workplace. It applies a fire-loss-control principles which seek to reduce, and better still, eliminate losses experienced during and following fires.

It is also recommended that the Nairobi Fire Services and the Directorate of Occupational Safety and Health Services undertake fire safety awareness programs within the industrial cluster.

5.3 Recommendations for further study

The main motive of the research was to study fire safety at Kariobangi Light Industries. The study was limited to the industries operating at the industrial cluster which is a unique set-up as buildings house residential apartments and industrial enterprises. A similar study could be carried out focusing on another industrial cluster and compare the findings.

The study was limited to fire ignition and fuel sources for fires at Kariobangi Light Industries, fire safety awareness of the business community and fire hazard control measures implemented in the industrial cluster. There could be another study carried out on fire safety of buildings within the industrial cluster focusing on emergency egress of building occupants and inherent features of smoke management of buildings within the industrial cluster.

REFERENCES

Altenburg, T., & Meyer-Stamer, J. (1999). How to promote clusters: policy experiences from Latin America. *World development*, *27*(9), 1693-1713.

Amin, Altenburg, T., & Meyer-Stamer, J. (1999). *How to promote clusters: policy experiences* M., & Mattoo, A. (2005). *Does temporary migration have to be permanent?* Washington, D.C.: World Bank.

André, E. M. (2006). *Fire Escapes in Urban America: History and Preservation* (Doctoral dissertation, University of Vermont).

Babrauskas, V. (2003). *Ignition hand book. Society of fire protection engineers*: New York: Fire Science Publishers.

Barceloux, D.G. (2012). *Medical toxicology of drug abuse: synthesized chemicals and psychoactive plants.* New York. John Wiley & Sons.

Benton, L. (1990). Invisible Factories. *The Informal Economy and Industrial Development in Spain*. State University of New York Press.

Bloch, H. (2009). *Practical lubrication for industrial facilities*. New York: Fairmont Press.

Bridigum, T. (2008). *How to weld*: Motor books, United States of America.

Bromann, M. (2011). *Fire protection for commercial facilities*. New York: CRC Press.

Brydson, J.A. (1995). *Plastic materials*. Oxford, London: Butterworth – Heinemann Limited.

Burke, R. (2003). *Hazardous materials chemistry for emergency responders*; (2nd ed.). New York: Lewis Publishers.

Burtles, J. (2013). *Emergency evacuation planning for your workplace; from chaos to life saving solutions*. New York; Rothstein Publishing.

Channing, J. (2014). *Safety at work*. (8th ed.). New York; Routledge.

Cheremisinoff, N. (2000). *Handbook of hazardous chemical properties*. New York Butterworth-Heinemann Publications.

Chow, W. K. (2006). Design Fire in Performance based Fire Safety Design for Green and Sustainable Buildings. In *The 23rd Conference on Passive and Low Energy Architecture, Geneva, Switzerland*.

Nairobi city Council (n.d). *City Council of Nairobi By-Laws* Retrieved from http://www.nairobi.go.ke/home/common-city-laws-and-regulations/by-laws#h2_05.

City County Licensing Department. (2014). *Licensed Industries in Kariobangi*. Nairobi: Nairobi City County Government.

Cote, A & Bugbee, P. (1988). *Principles of Fire Protection.* New York; National Fire Protection Agency.

Darletshina, A. T & Cheremisinoff, P.N. (1998). *Fire and Explosion Hazards. Handbook of Industrial Chemicals*: New York. Noyes Publications.

Della-Giustina, D.E. (2014). *Fire Safety Management Handbook*. (3rd ed.). London: CRC Press.

Department for Communities and Local Government (2006). *Fire risk assessment*: New York: Department for Communities and Local Government.

DFID (2005). *Disaster risk reduction: A development concern*, London: DFID.

Diamantes, D. (2016). *Principles of fire prevention*. (3rd ed.). Burlington: Jones & Bartlett Learning.

Dikshith T.S.S. (2013). *Hazardous Chemicals:* CRC Press, London.

Factories and Other Places of Work (Fire Risk Reduction) Rules. L.N No. 59, GoK, 2007

Fatoki, O. (2013). The Determinants of Longevity of Micro Enterprises in South Africa. *Journal of Economics, 4, 133*-143.

Ferguson. H & Janicak, C (2005). *Fundamentals of fire protection for the safety professional.* Oxford, UK: Government Institutes.

Finger, M., & Holvad, T. (Eds.). (2013). *Regulating transport in Europe*. Edward Elgar Publishing.

Fire Protection Association. (2015). *Fire safety and risk management*: NEBOSH National Certificate in Fire Safety and Risk Management. New York: Routledge.

Furness, A. & Muckett, M. (2007). *Introduction to Fire Safety Management*. Oxford: Elsevier.

Gachago J. (2013) *An investigation of fire risk in Kiandutu slum in Thika Municipality, Kenya,* (Unpublished Msc Thesis Kenyatta University).

Gisesa N., (2011). *Inside Kenya's Death Factories.* Retrieved from http://ictfire.com/news/?p=258.

Goodson, M., Perryman, T., and Colwell, K., (2002). *Effects of polyurethane foam systems on wiring ampacity.* New York: Fire and Arson Investigator.

GoK (2005, May 4). *Factories and Other Places of Work (Fire Risk Reduction) Rules*. Nairobi: Government printers Retrieved from http://www.kenyalaw.org:8181/exist/kenyalex/sublegview.xql?subleg=CAP.%20514

Gupta, R.C (2016). *Fuels, furnaces and refractories*: New Delhi: PHI Learning Private Limited.

Hughes, P. & Ferrett, E. (2016). *Introduction to Health and Safety at Work* (6th Ed.). New York: Routledge

Hughes, P. & Ferrett, E. (2013). *Introduction to Health and Safety at Work* (2nd Ed.). New York: Routledge

Toedt, J, Koza, D & Kathleen, V. (2005). *Chemical Composition of Everyday Products*. Westport: Greenwood Press.

Hagimoto, V., Watanabe, N., and Okamoto, K., (2007). *A Short Circuit as an Ignition Source of Fire*. London: Interscience .

Havel, G (2015). *Construction Concerns: Blocked Emergency Exits*. New York: Fire Engineering.

Health and Safety Authority. (2016). *Emergency Escape and Fire Fighting.* London: Health and Safety Authority

ISDR (2002). *Living with risk: A review of global disaster risk reduction initiatives*. Geneva: ISDR.

Jacob Chege, Dianah Ngui & Peter Kimuyu. (N.D). *Scoping Paper on Kenyan Manufacturing: Learning to Compete, Kenya Institute for Public Policy Research and analysis, Kenyatta University & Nairobi University*. Nairobi: KIPPRA

Jaya Kumar, G.S. (2000). "Disaster management and social development. *International Journal of Sociology and Social Policy, 20* (7): 66-81.

Jones, A. R. & Jones, G. J. (2000). *Electrical safety in the workplace*: New York; National Fire Protection Agency.

Kenya, G. O., Ministry Of State for Special Programmes, & President, O. O. (2009). National Policy for Disaster Management in Kenya. *National Policy for Disaster Management in Kenya*. Retrieved from http://www.ifrc.org/docs/idrl/1058EN.pdf.

Kenya Red Cross. (2009). Kenya: Fires. International Federation of Red Cross and Red Crescent Societies.

Kothari, U. (2003). Introduction: Migration, staying put and livelihoods. *Journal of International Development J. Int. Dev., 15*(5), 607-609. doi:10.1002/jid.1018

Lees, D. & Payne, J. (2001). *Chemistry: For ORC A*, Oxford: Heinemann Educational Publishers.

Lindtveit, T. (2011a). Building in-house capability: Part 1. *Occupational Health & Safety, 80*(1), 36-37.

Lindtveit, T. (2011b). Building in-house capability: Part 2. *Occupational Health & Safety, 80*(2), 14-16.

Makachia G. (2013) *Evaluation of fire safety status of selected public and private universities in Kenya with reference to fire risk reduction rules*, (Unpublished Msc Thesis Jomo Kenyatta University of Agriculture And Technology).

Maps, G. (2015). Kariobangi Light Industries. Retrieved from https://www.google.co.ke/maps/@-1.2591197,36.8799306,17z?hl=en

Miles, M. B., & Huberman, A. M. (1999). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, Calif.:Sage.

Muindi, M. E (2014). *A Study in Kenya Medical Training College Campuses in Eastern Kenya Region.* (Unpubllished Msc thesis University of Nairobi).

Mwabu, G. (2004). Rural Development, Growth and Poverty in Africa. *Journal of African Economies*, *13*(Suppl_1), I16-I65. doi:10.1093/jae/ejh015.

Nairobi City County Reports (2014). Nairobi City County ICT Department.

Nathan Associates & TNS. (2015). *National Small Business Survey of Uganda*, Uganda: Financial Sector Deepening Uganda.

Ndegwa, P.W. (2015). Perceptual Measures of Determinants of Implementation of Occupational Safety and Health Programmes in the Manufacturing Sector in Kenya, Jomo Kenyatta University of Agriculture and Technology.

NFPA 101. (2000). Preventive Maintenance Manual: Life safety code, Ohio Department of Health

NFPA (2008). *Fundamentals of Fire Fighter Skills*: (2nd Ed.). New York: International Association of Fire Chiefs.

NFPA (2008). Industrial Fire Brigade. *Principles and Practice.* New York: Jones and Bartlett Publishers.

NFPA (2016). *What is fire? All about fire*. New York: National Fire Protection Agency.

NIIR Board. (2010). *Modern technology of synthetic resins & their applications*. New Delhi: Asia Pacific Business Press Inc.

NIIR Board. (2010). *Handbook on modern packaging industries*. (2nd ed.). New Delhi: Asia Pacific Business Press Inc.

NIIR Project Consultancy Services. (2017). *Manufacture of thinners & solvents*. India: NPCS Board of Consultant Engineers.

Obudho, R.A. (1997). *Nairobi: National capital and regional hub. The urban challenge in Africa: Growth and management of its large cities*, Tokyo: United Nations University Press.

Occupational Safety and Health Act (OSHA). *Kenya Gazette Supplement No. 111* Acts N0. 15. GoK, 2007 Rev.2010

Occupational Safety and Health Administration (OSHA) (2003). *Emergency Exit Routs*. New York: U.S Department of Labour

OCHA. (2011). *Kenya urban disasters*: *Fire* Geneva: United Nations.

Ogajo, N. J. (2013). *Influence of Fire Disasters on Mitigation and Preparedness In Commercial Premises in Kenya; A Survey Study Of Kisumu CBD* (Doctoral dissertation, University of Nairobi).

Olabisi S.Y, Olagbemi A.A & Atere A.A (N.D). *Factors Affecting Small- Scale Business Performance in Informal Economy in Lagos State- Nigeria: A gendered Based Analysis*, Lagos: Lagos State University.

Olekina, W. K. (2013). Challenges of Dealing with Fire Outbreaks in Informal Settlements: *The case of the 12th September 2011 Sinai Fire in Nairobi County, Kenyatta University*. Nairobi: KU

Olawale, F. (2013). *The determinants of Longevity of Micro Enterprises in South Africa*. University of Limpopo.

Osinubi, O.Y, Barbeu, E., Williams, J., & Sorensen, G. (2005). *Tobacco Control in the Workplace.* New Science Publishers Inc. New York.

Osorio, N. L., & Hurych, J. (2004). Literature of disasters from the human factors point of view: A descriptive analysis. *Collection Building, 23*(2), 64-72. doi:10.1108/01604950410530390

Othuman A. (2014) Human Factors in Fire Safety Management and Prevention. *International Journal of Mass Emergencies and Disasters: 10,* 91-114

Manwelo, P. (2007). Ethical Reflections on the Intervention of the UN and EUFOR in the DR Congo. *Sicherheit und Frieden (S+ F)/Security and Peace*, 127-132.

Peacock, J.A. (2000). *Handbook of Polyethylene. Structures, Properties, and Applications:* Marcel Dekker Inc. New York.

Pelling, M. (2003). Viewpoint: Disaster risk and development planning: The case for integration. *International Development Planning Review, 25*(4), I-Ix. doi:10.3828/idpr.25.4.1.

Robyn P. (2009). *Disaster Risk Reduction. Fire risk in informal settlements in Cape Town, South Africa*, London: Earth scan Publishers

Sadgrove, K. (2015). *The Complete Guide to Business Risk Management:* (3rd ed.). Routledge: Taylor & Francis Group, London & New York.

Satterthwaite D. (2006). Outside the Large Cities: The Demographic Importance of Small Urban Centres and Large Villages in Africa, Asia and Latin America. New York: IIED

Shaluf, I.M., Hamden, F. and Said, A.M. (2003). A review of disaster and crisis. *Disaster Prevention and Management, 12*(1), 24-32

Sonobe, T., Akoten, J.E., and Otsuka, K. (2006). The Development of the Footwear Industry in Ethiopia: How Different Is It from the East Asian Experience. *FASID Discussion paper 2006-09-003.*

State of the world's cities, 2008/2009: Harmonious cities UN Habitat. (2009): *Choice Reviews Online, 46*(08). doi:10.5860/choice.46-4749.

Stauffer, E. Dolan, J. & Newman, R. (2007). Fire Debris Analysis: New York: Academic Press.

Stelleman, M.J. (1998). Encyclopaedia of Occupational Health and Safety: (4th Ed.). Geneva: International Labour Office,.

Stollard, P. & Abrahams, J. (2002). Fire from First Principles: *A Design Guide to Building Fire Safety.* 3rd Edition. Taylor & Francis, United States of America.

Thomson, N. (2002). Fire Hazards in Industry, Butterworth- Heinemann. United Kingdom.

Tones, K. & Tilford, S. (2001). Health Promotion: *"Effectiveness, efficiency & equity"* (3rd ed.). Nelson Thornes Limited, Leeds, United Kingdom.

UN Office for the Coordination of Humanitarian Affairs. (2011). *Kenya Urban Disasters: Fire.* Nairobi: UNHR

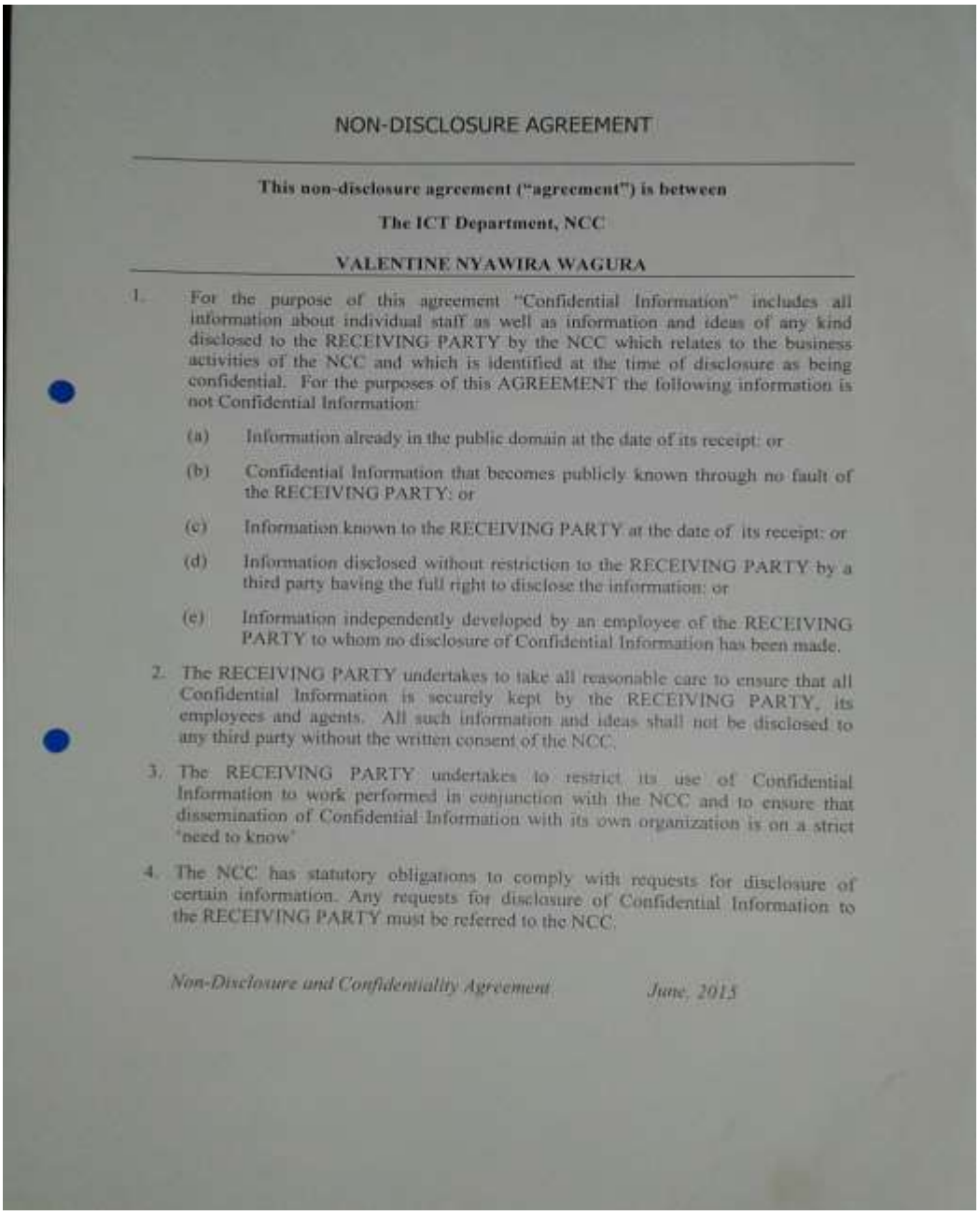
Visakh, P & Arao, Y. (2015). *Flame Retardants: Polymer Blends, Composites and Nanocomposites.* Basel: Springer International Publishing.

Weise R.D & Biging S. G. (1994). *Effects of Wind Velocity and Slope of Fire Behaviour*, Waterloo: International Association for Fire Safety Science.

Wray, H. (1992). *Manual on Flash Point Standards and their Use: Methods and Regulations*, Baltimore, USA: ASTM.

APPENDICES

Appendix I: Non-Disclosure Agreement



NON-DISCLOSURE AGREEMENT

This non-disclosure agreement ("agreement") is between

The ICT Department, NCC

VALENTINE NYAWIRA WAGURA

1. For the purpose of this agreement "Confidential Information" includes all information about individual staff as well as information and ideas of any kind disclosed to the RECEIVING PARTY by the NCC which relates to the business activities of the NCC and which is identified at the time of disclosure as being confidential. For the purposes of this AGREEMENT the following information is not Confidential Information:

   (a) Information already in the public domain at the date of its receipt: or

   (b) Confidential Information that becomes publicly known through no fault of the RECEIVING PARTY: or

   (c) Information known to the RECEIVING PARTY at the date of its receipt: or

   (d) Information disclosed without restriction to the RECEIVING PARTY by a third party having the full right to disclose the information: or

   (e) Information independently developed by an employee of the RECEIVING PARTY to whom no disclosure of Confidential Information has been made.

2. The RECEIVING PARTY undertakes to take all reasonable care to ensure that all Confidential Information is securely kept by the RECEIVING PARTY, its employees and agents. All such information and ideas shall not be disclosed to any third party without the written consent of the NCC.

3. The RECEIVING PARTY undertakes to restrict its use of Confidential Information to work performed in conjunction with the NCC and to ensure that dissemination of Confidential Information with its own organization is on a strict 'need to know'

4. The NCC has statutory obligations to comply with requests for disclosure of certain information. Any requests for disclosure of Confidential Information to the RECEIVING PARTY must be referred to the NCC.

Non-Disclosure and Confidentiality Agreement *June, 2015*

5. The RECEIVING PARTY acknowledges that Confidential Information contains valuable proprietary information of the NCC and that unauthorized disclosure could cause unnecessary commercial loss to the NCC.

6. Ideas, know-how, data and other intellectual property disclosed under this AGREEMENT shall remain the sole and exclusive property of the NCC.

7. The RECEIVING PARTY undertakes, within fifteen (15) days following request from the NCC, or in any event on completion of the work specified, to return to the NCC all documentation, copies, notes, diagrams, computer memory media and other materials containing any portion of the Confidential or secure destruction of such materials.

8. The obligations relating to confidentiality and use of information and ideas shall survive the termination of this AGREEMENT until such time as the parties agree otherwise in writing.

9. The RECEIVING PARTY shall not assign or transfer any of its rights or obligations contained in this AGREEMENT without the prior written consent of the NCC.

10. Nothing in this AGREEMENT shall be deemed to grant a license directly or by implication under any registered design, patent, copyright, trade secret or patent application.

11. Unless the parties agree otherwise, this AGREEMENT constitutes the entire understanding between the parties related to the protection of Confidential Information disclosed under the terms of this AGREEMENT and supersedes all prior and collateral communications, reports and understanding between the Parties relating to Confidential Information.

12. This AGREEMENT will be governed by and interpreted in accordance with Kenya Law and will be subject to the jurisdiction of the Kenya Courts.

13. The NCC warrants that the NCC is not aware of any patent, trade mark, copyright, registered design or other intellectual property right held by third parties which may be infringed by the RECEIVING PARTY's use of the Confidential Information under the terms of this agreement. If there are any such rights or alleged rights the NCC agrees to indemnify the RECEIVING PARTY against all liabilities for costs, damages, obligations and claims arising from such breach by the RECEIVING PARTY of those rights.

14. The RECEIVING PARTY agrees to indemnify the NCC against all reasonable costs, charges and expenses including lawyers' costs incurred by the NCC.

Arising from any breach of this AGREEMENT and Arising from the RECEIVING PARTY'S use of Confidential Information incurring or giving rise to liability, damages or costs.

Signed by the duly authorized delegates of the NCC and the RECEIVING PARTY to indicate their agreement to abide by the provisions set out above.

ICT, NCC:
By:.......................................

Name: [illegible] OGONDA..........

Title: Deputy Director ICT..........

Date: 27th May 2015..........

DEPUTY DIRECTOR ICT
NAIROBI CITY COUNTY

RECEIVING PARTY,
(Valentine Nyawira Wagura)

By:.......................................

Name: VALENTINE NYAWIRA WAGURA

Title: STUDENT..........

Date: 27/5/2015..........

Non-Disclosure and Confidentiality Agreement *June, 2015*

Appendix II: Research Questionnaire

This questionnaire is to collect data for purely academic purposes. The study seeks to study fire safety at Kariobangi Light Industries. All information will be treated with strict confidence. Answer all questions as indicated by either filling in the blank oy by ticking the option that applies.

SECTION A: GENERAL INFORMATION

1. Nature of Business Activity:.....
2. Gender of the respondents

   Male [ ] Female [ ]

3. What is your highest level of education?

   Master's degree [ ] Undergraduate degree [ ]

   College Diploma [ ] others (specify…….) [ ]

4. How many years has your business been in operation?

   0-2 years [ ] 3-5 years [ ]

   6-8 years [ ] More than 10 years [ ]

SECTION B: IMPLEMENTATION OF FIRE SAFETY

1. To what extent do you implement fire safety?

1 (Never)	2 (Rarely)	3 (Occasionally)	4 (Often)	5 (Always)

SECTION C: FIRE SAFETY AWARENESS

5. Do you have a written fire safety policy for this enterprise?

YES ( ) NO ( )

I am not aware of a fire safety policy nor its contents ( )

6. Do you undertake fire safety audits at the workplace at least once every twelve months by an approved Fire Auditor?

YES ( ) NO ( )

I am not aware of the requirement to undertake annual fire safety audits by a registered fire safety auditor ( )

7. Rate the level of application of the following factors at your workplace and their effect to fire safety awareness. Use a scale of 1-5 where 5-To a very great extent, 4-To a great extent, 3-To a moderate extent, 2-To a little extent, and 1-To no extent.

	Fire Safety Awareness	1	2	3	4	5
a)	There is an established fire fighting team at the workplace?					
b)	The fire fighting team at the workplace is trained?					
c)	All workers have been instructed on the safe use of fire extinguishers?					
d)	There are fire action signs indicating action to be taken by staff at the workplace during a fire?					
e)	You conduct fire drills at the workplace/ practice fire evacuation procedures?					
f)	You have made arrangements to call emergency services when a fire incident occurs?					

g)	Smoking is prohibited at this workplace?					
h)	Notices communicating that smoking is prohibited at the workplace have been put up?					
i)	A smoking zone with an ashtray has been provided for smoking employees?					
j)	Arrangements have been made to provide first aid to any person injured by a fire while at this workplace?					
k)	Arrangements have been made to transport injured persons to the nearest health facility during a fire at the workplace?					
l)	You have identified and marked a fire assembly point at the workplace where workers can assemble during a fire emergency?					

SECTION D: FIRE HAZARD CONTROL MEASURES

8. Rate the level of application of the following factors at your workplace and their effect to fire hazard control measures. Use a scale of 1-5 where 5-To a very great extent, 4-To a great extent, 3-To a moderate extent, 2-To a little extent, and 1-To no extent.

	Fire Hazard Control Measures	1	2	3	4	5
a)	Maintenance of machinery and electrical equipment is carried out?					
b)	There are firefighting equipment at the workplace					
c)	The firefighting equipment are regularly serviced,					

	maintained and or replaced					
d)	You have a means of detecting fire smoke or heat at the workplace					
e)	You have a means of alerting workers of a fire situation in the workplace					

Appendix III: Research Checklist

SECTION 1					
1. IGNITION SOURCES					
		YES	**NO**	**CHECKPOINT**	**REMARKS**
a)	Defective electrical fittings?			Exposed electrical wires on electrical fittings and equipment	
b)	Flames or sparks from hot work processes?			Welding or grinding operations generating sparks that can ignite flammable materials at the workplace	
c)	Lighting of naked flames?			Lighting of fires to burn rubbish or waste in and out of the workplace	
d)	Use of cooking equipment?			Cooking activities taking place at the workplace	
e)	Threat of arson?			Access control into the workplace and provision of intruder alarm systems or CCTV systems	
f)	Smoking taking place at the workplace?			Workers and (or) visitors/ customers smoking at the workplace with or without	

				the approval of the business proprietor	
SECTION 2					
2. FUEL SOURCES					
		YES	**NO**	**CHECK POINT**	**REMARKS**
a)	Use and (or) storage of flammable liquid products e.g. ethanol, petrol, white spirit, methylated spirit and paraffin?			Label of products within the workplace indicating the name of product and its flammability	
b)	Use and (or) storage of flammable gases			Presence of flammable gases at the workplace such as liquefied petroleum gas (LPG) and acetylene	
c)	Use and (or) storage of normal combustible materials?			Presence of considerably large quantities of paper, cardboards, clothes, foam such as polystyrene and polyurethane e.g. the foam used in upholstered furniture, plastics e.t.c	
SECTION 3					

3. HAZARD CONTROL MEASURES					
		YES	**NO**	**CHECK POINT**	**REMARKS**
a)	Fire emergency exits provided at the workplace?			Sliding door or a door that opens on the outwards that is opposite from the normal route of entry. It should be adequate in size, be well lit, not obstructed, accessible and if locked a key guard has been provided and leading to a place of relative safety	
b)	Good housekeeping practices undertaken at the workplace?			Marked gangways, accumulation of waste and poor machinery layout	

Appendix IV: Fire Safety Management Plan

Specific Purpose

The purpose of this plan is to provide guidance to the business owners of Kariobangi Light Industries on practices which if implemented at the workplace will ensure that fires do not occur and if they do occur, they will be controlled or contained at the incipient stage, effectively and safely; or that if an uncontrolled fire does occur, everyone in the premises is able to escape to a place of total safety easily and quickly.

Objectives of the Plan

1. Prevent fatalities and injuries.
2. Reduce damage to buildings, stock, and equipment.
3. Protect the community and environment.
4. Accelerate the resumption of normal operations.

Business Activity: Manufacture and sale of paints, thinners and adhesives

No.	Item	Aspect	Recommendations
1.	Fuel Sources	Storage and Handling	**Flammable Liquids:**
			Should not be stored near exits, electrical equipment or heating equipment.
			Where they are transferred from one container to another i.e. transferred form bulk tanks or drums, plastic containers should be used.
			Bulk storage rooms of flammable materials

			should be provided, separate of the production area.
			Provide facilities for free flow of fresh air, including windows, doors, vents, louvers or any other suitable ventilation facility to ensure that flammable vapours accumulate in the workroom.
			Signage indicating ‘Highly Flammable’ and ‘No Smoking’ shall be provided at the store.
			Flammable Gases:
			Do not allow uncontrolled mixing of acetylene and air or oxygen.
			Any leaks that occur during use of acetylene must be repaired immediately.

			Protect the hoses from damage, and replace them at appropriate intervals.
			Close acetylene cylinder valves during work breaks.
			Keep the amount of materials in storage as small as possible. It is good practice to keep no more than one day's supply of flammable gases in the immediate work area. Return any leftover material to the proper storeroom at the end of the day.
			Oxy acetylene cylinders should fixed and moved around the workplace on a trolley.
			Oxygen an acetylene cylinders should be stored separately in a safe positions in the open air, and where necessary, protected against direct sunlight.
			Combustible Materials:
			Shall be kept at a minimum distance of 90cm from electrical or heating equipment.
			Keep the amount of materials in storage as small as possible. It is good practice to keep no more than one day's supply of combustible materials in the immediate work area. Return any leftover material to the proper storeroom

			at the end of the day.
2	Ignition Sources	Smoking	Prohibit smoking in and around the workplace where flammable and combustible materials are stored or used.
		Flames from Hot Work Processes	Avoid hot works within the premises, however if this is not possible, relocate the object requiring hot work outdoors or to specially designated areas or schedule hot works during shut down and make use of a Permit System.
		Lighting of naked Flames	Prohibit lighting of naked flames at the workplace and burning of waste at close proximity the premises.
		Electrical Safety	Ensure ventilation points on machinery are not clogged with dust or other materials thereby causing overheating.
			Have electrical equipment serviced regularly by a competent person to prevent sparks and fires.
			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.
			Use a planned maintenance programme to

			properly maintain plant and equipment.
		Arson	Maintain security at the workplace
			Reduce the bulk of flammable and combustible materials to as little as is reasonably practical amounts.
			Maintain good housekeeping practise i.e. avoid accumulation of waste at the premises and around the perimeter wall.
3	Fire Safety Awareness	Fire Safety Policy	Document a Fire Safety Policy to provide for the implementation of this Fire Safety Management Plan and in compliance with the provisions of the Factories and Other Places of Work (Fire Risk Reduction) Rules of 2007.
		Fire Safety Audits	Engage DOSHS approved fire safety auditors in undertaking statutory fire safety audits in compliance with the provisions of the Factories and Other Places of Work (Fire Risk Reduction) Rules of 2007.
		Fire Fighting Team	Appoint a fire marshals team to who will be critical in spearheading the assessment and elimination of possible fire hazards at the workplace as well as managing fire and directing staff to safe areas in case of any fire emergencies.

		Fire Safety Training	Train the fire marshals team and instruct all workers on the safe use of portable fire extinguishers.
		Fire Drills	Conduct fire drills at least annually and maintain records for inspection.
		Fire Assembly Point	The industrial cluster should identify and mark an assembly point where building occupants should assemble in case of fire or other emergency
		Emergency Contacts	Maintain contacts of key resource organizations to assist during a fire emergency.
		First Aid Services	Provide and maintain first aid facilities and train first aiders to assist during a fire or other emergency.
3,	Fire Hazard Control Measures	Maintenance of Machinery and Equipment	Use a planned maintenance programme to properly maintain plant and equipment.
		Fire Detection and alarm systems	Install a manual and automatic fire detection and alarm systems.
		Firefighting equipment	Ensure there is always a means of extinguishing fire at the work place and that the position of the means is distinctively and conspicuously marked.

		Emergency Exits	Provide an unobstructed emergency exit which should not be locked when the workplace is occupied. If the number of employees, the size of the building, its occupancy, or the arrangement of the workplace allows all employees to evacuate safely during an emergency, one exit route is considered sufficient.
		Housekeeping	There should be no accumulation of finished products, by-products and any waste products at the workplace. These should be removed immediately they are produced so as to avoid accumulation of products or waste products.