# EVALUATION OF FIRE SAFETY COMPLIANCE IN PAINT INDUSTRY IN NAIROBI COUNTY

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**AGRICULTURE AND TECHNOLOGY**

**2020**

# Evaluation of Fire Safety Compliance in Paint Industry in Nairobi County

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**A Thesis submitted in partial fulfillment for the Degree of Masters of Science in Occupational Safety and Health in the Jomo Kenyatta University of Agriculture And Technology**

**2020**

## DECLARATION

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

Signature…….. Date……..

**Valentina Ngenyi Mutuku**

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

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## DEDICATION

I would like to dedicate this work to my father Benjamin Mutuku Kaleli, my dear husband James Kimutai Koech and my children Bill Kiprono, Claire Cheptoo, Benjamin Kipruto and Elizabeth Cherotich for encouragement and their continued support morally, socially and financially during my entire studies.

**ACKNOWLEGMENT**

I would like to convey my gratitude to the following for providing me with inspiration and constant motivation to embark and complete this research thesis. My deepest thanks go to my first supervisor, Professor Erastus Gatebe who vigorously but kindly gave me the motivation to perform to my maximum ability. Special gratitude goes to my second supervisor, Dr Leonard Gitu for his constant help and precious advice. Their detailed and constructive comments were vital to the formulation, development and subsequent research on this thesis. I would also thank the management and staff of paint industries within Nairobi area who were generous and kind in providing information for the study. To my research assistants, Gerald Kamau and Kiplimo Rono thank you for going out of your way to make data collection and validation successful. I am indebted to my colleagues at JKUAT and at work (Infinity Plastics and Megablow Plastics Industries limited) for being a great source of support in encouragement and sharing literature. To all of the above, I say much thanks and God bless.

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## LIST OF ABBREVIATIONS AND ACRYONMS

| | |
|---|---|
| **AKI** | Association of Kenya Insurance |
| **CBD** | Central business district |
| **CFOA** | Chief fire officer association |
| **CO2** | Carbon Dioxide |
| **DOSHS** | Directorate of Occupational Safety and Health Services |
| **FRRR** | Fire Risk Reduction Rules |
| **GNP** | Gross Net Profit |
| **GOK** | Government of Kenya |
| **HSE** | Health Safety Executive |
| **KLR** | Kenya Law Reforms |
| **LN** | Legal Notice |
| **LPG** | Liquefied Petroleum Gas |
| **NCC** | Nairobi City Council |
| **OSHA** | Occupational Safety and Health Act |

## ABSTRACT

Workplace fires is one of the greatest challenge to occupational safety of most industries worldwide. Manufacturing industries in the recent past have experienced several fire incidences which have led to loss of life, life threatening injuries, loss of business and investment opportunities. Fire safety disaster management systems are not well established in Kenya thus greatly affecting fire safety preparedness especially in manufacturing industries. This study has evaluated fire safety compliance in paint industries in Nairobi county focusing on fire risks, fire safety measures in place, fire safety awareness, fire safety preparedness as well as the gaps in observing fire risk reduction rules in the selected Paint industries. Secondary data was obtained from Nairobi fire brigade (2015, 2016), DOSHS Kenya and private security companies. Data was collected using checklists and questionnaires for both workforce and management. Data was analyzed using appropriate analytical software and descriptive statistics carried out. The study targeted 6936 workers in registered paint industries represented by a sample size of 364 giving a response rate of 93.4 %. This study has revealed that paint industry is male dominated (70.9%) and only 29.1% are females. Female workforce had higher turnover than male at 80.8% and 50.3% respectively and this association was statistically significant ($P \leq 0.05$); $\chi^2$=20.87, df=3, p-value=0.000. The study has also found that most of the workers were educated with high school and college education and have worked for less than 4 years and this relationship was statistically significant at ($P \leq 0.05$ level of significance for both management (($\chi^2$=36.084, df=6, p-value=0.000) and workforce $\chi^2$=50.008, df=3, p-value=0.000) and this was found to be statistically reliable based on Cronbach's alpha value of 0.765 for management and 0.629 for workforce. The study revealed 23.3% paint industries had poor handling of flammables which is a high risk factor, with 85.7% in Industrial area and 14.3% from Kariobangi light industries. It's worth to note that 23.28% of the industries were above satisfactory level in compliance on handling of flammables and all were from Industrial area. The research has found that 72.1% of the industries had experienced fire incidences with only 32.8% recording the incidences and this relationship was statistically significant at $P \leq 0.05$ level of significance ($\chi^2$=33.408, df=4, p-value=0.000) with a moderate reliability value of 0.457 due to low level of recording .The work has found that a greater number of workplaces have fire safety measures in place; Measures to prevent electrical fires (90%), removal of flammable vapor from ignition (91.7%), no smoking Notices (100%) as well as proper labelling and storage of flammables (100%). In safe handling and transportation of flammables, 81.2% of the facilities were compliant with 81.4% from Industrial area and 18.6% from Kariobangi light industries and this was statistically significant at 95% confidence level with $\chi^2$ (df=2) =12.901 since p<.002.The relationship was also found to be significant and reliable (Cronbach's alpha 0.67). On fire safety awareness, the results revealed that 72.9% of the workers were sufficiently trained on fire safety while 96.8% of workers were aware of fire safety procedures. On the other hand, 59.0% of the industries had no fire safety awareness procedures to visitors and only 27.1% had those facilities and all were from Industrial area and this association was statistically significant with $\chi^2$ (df=2) =11.736 since p<.003.The reliability test has revealed that there is a serious gap in terms of awareness in these facilities with Cronbach's alpha of 0.496 and 0.541 for workforce and management respectively. On fire safety policy, this

research has found that 72.9% of industries had developed fire safety policy though only 23.9% of the workers knew the content of the policy document and this were from Industrial area only. Statistically the association between having the policy document and knowing the content was significant with $\chi^2$= 22.464; df=2 and p at 0.000. This research has reported good fire safety preparedness with presence of escape routes and enough fire extinguishers at 100% as well as presence of assembly point and alarm system at 99%. On establishment of firefighting team, this study has found that 71.4% of managers had put the teams in place with 90.0% from Industrial area and 10.0% from Kariobangi light industries, this relationship had statistical significance of $\chi^2$ (df=2) =17.52 since p<.000 at 95% confidence level and the obtained data was found to be reliable (Cronbach's alpha of 0.842) On the other hand, there was poor preparedness in evacuation of disabled (18.8%), installation of fire suppression (23.9%), fire detection (37.6%) and emergency lighting (31.2%).The reliability test Cronbach's alpha of 0.648 has shown that the above factors had direct impact on the factories preparedness in case of fire incidence and non- adherence will result to a major catastrophe which the DOSHS should address immediately. The study also revealed that all workplaces (100%) had escape routes but 11.9% of the industries had obstructed the escape routes which is a fire risk factor during evacuation. On Compliance to DOSHS fire safety regulations, the study revealed that over 60% of industries had poor compliance but on fire audit slightly more than half (58.20%) carries out fire audits annually and inspects fire alarm system regularly (66.4%).This data was found to be reliable (Cronbach's alpha of 0.819) in terms of the data obtained from the factories on how the sector was run and the only challenges were found to be on enforcement. On factors affecting implementation of fire risk reduction rules, the respondent reported that there was lack of; Information on fire safety, comprehensive fire safety policy, support from management, appropriate technology as well as skilled workforce and this was found to be statistically reliable based on Cronbach's alpha value of 0.830. The overall level of compliance to fire risk reduction rules was found to be average on fire safety measures, awareness and preparedness. However, significant number of industries had low compliance levels hence regular inspection by the relevant agencies is recommended. Owing to high risks of fire from the flammables, it's recommended that daily fire risks assessments on job assigned be emphasized to help identify fire risks and control them.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the study

Workplace fires remains the single most threat to safety in majority of Workplaces worldwide. Statistics have revealed that in the industrial world, there are still typically 10 to 20 fire deaths per million population per year (Stellman, 2004). The direct fire losses are 0.1 to 0.2% of GNP and the total cost of fire prevention and consequences of fire are typically 10 times the cost of direct losses (Matti, 1996).

Fire has been identified as the greatest challenge to the safety of not only the industrial plants but in all workplaces in Kenya (Kelvin, 2009). The exposure to fire risk remains the single most threat to safety in majority of workplaces worldwide. In USA, 116,500 fires occurred in non- residential structures which include retail stores resulting to 105 deaths and 1350 injuries in 2007 (U.S. Fire Administration, 2008). In rapidly developing countries Kenya being one of them, the number of fires is increasing at a rate of at least as high as the growth rate of economy (Matti, 1996). According to Thomson (2004) the causes of many fires especially in the workplace may be accidental or as a result of a deliberate act on the part of employee. In addition to this, carelessness at work or failure to comply with the regulations on fire safety has been a cause of catastrophic fires that has led to destruction of properties and loss of life.

In Kenya, there is very little information on fire incidents, most being highlighted in the media and are available in fire brigade centers, Kenya insurers and security firms especially when they are involved in putting off the fires and compensation of fire losses. According to the Association of Kenya Insurers annual report (2016), the net incurred claims for fire industrial class was at 1,145,470,394 shillings with technical loss ratio of 48.4%. The Fire industrial claims have been rising steadily in the past four years. In year 2012 - 2015 the net claims incurred for industrial fires was at 699,646,017 shillings, 798,299,859 shillings, 828,307,032 shillings and 1,145,470,394 respectively with technical loss ratio of 45.3%, 41.3 %, 42.1 % and

48.4% in that order. This shows yearly increment in industrial fire claims. (AKI, 2016). The financial cost of fires is estimated to run into billions of dollars hence the need to manage fires at work (Schifiliti, 2003).

The shrinking of public sector resources for the fire safety management almost everywhere means a decrease in firefighting resources and rescue personnel. Workplaces are then left to fend for themselves and the best way is to make sure that the fire prevention strategies are up to date and effective in the event of fire occurrence. (Karanja, 2012)

Out of the many fire occurrences experienced in most of manufacturing industries, paint industry is among the top according to Nairobi fire brigade database, 2016. This can be attributed to the flammability nature of the solvents used, the products being produced, storage of the products as well as lack of proper structured fire safety management systems in the industry.

This study is aimed at determining fire risks; fire preventive measures in place, fire safety awareness, and fire preparedness in paint industries and also identify fire safety technicalities that may be causing fire.

### 1.2 Problem statement

Paint industry in Kenya, has been growing rapidly in recent years because of massive construction and infrastructural development which requires paint as one of their material/products to be used; however, the growth has not been in tandem with growth of various aspects of safety standards. The growth has resulted to mushrooming of unregulated paint juakali industries to catch on the high demand of paints without following fire safety regulations. Also in the established paint industries, there is lack of proper fire safety disaster management systems in workplaces.

In the recent years, the Kenyan workplaces have experienced unprecedented cases of fire disasters. This has led to loss of lives, life threatening injuries, loss of business and investment opportunities (karanja, 2012).

Fire safety is a major pillar in any health and safety management system. Lack of proper management system can be attributed to various internal and external factors that include; lack of comprehensive legislation to manage safety and health, failure to maximize the use of appropriate technology to prevent fire outbreaks and or minimize fire spread. Most of the paint industries workers especially the informal industries lack basic fire safety awareness as well as have a weak or non-existent enforcement of statutory stipulations by authorities with the mandate to enforce fire safety legislation. The result of this is that fire related injuries and loss of properties continue to impact negatively to the operations of the industry.

In Kenya, the paint industry is not well regulated and as a result there are many informal industries which pose risks to the workers, owners as well as customers. Lack of proper safety regulation pose a risk to the standard of safety and quality. The issue of safety in workplaces is guaranteed by the constitution of Kenya (KLR, 2010) and as a result measures need to be put to guarantee safety to all persons. Paint industry is part of growth in industrialization and there is need to emphasis the creation of awareness in Occupational safety and health as stipulated in second medium term plan, 2013-2017 of vision 20-30.

With the rapid growth in industrialization, many fire accidents have been reported (NCC, 2016) as a result of paint manufacturing, processing or storage as well as the mushrooming of unregulated informal paint industries and it is for this reason this study was carried out to establish the extent to which the fire safety compliance is being implemented.

## 1.3 Hypothesis

### 1.3.1 Null Hypothesis

Fire safety compliance measures undertaken by paint industries in Nairobi have not led to reduction in fire incidences.

## 1.4 Justification and significance of the study

Fire has been identified as the greatest challenge to the safety of not only the industrial plants but in all workplaces in Kenya (Kelvin, 2009). Fire Safety is an important element of any development as people's lives, properties and investments are put at risk in the event of fire outbreaks.

Over 70% of paint industries in Kenya are found in Nairobi Industrial area and its surrounding (DOSHS Data base). There has been a rise in the number of fires in Kenya and this has resulted to damage to properties, injuries and loss of lives. Out of the fire occurrences in manufacturing industries, paint industry fires are among the highest (Nairobi fire brigade database) hence the need to minimize occupational fire hazards and prevent fire injuries in these industries. This justifies the study to help reduce the problem of fire occurrences especially in Nairobi.

A lot of research has been done on fire safety in schools, universities (Macharia, 2013), supermarkets (Karanja, 2012) among other areas, however there is no research done on fire safety in paint industry and as a result there is little information known in this field hence the importance of this research.

## 1.5 Research questions

In research, the research questions are normally used to guide in generating specific questions and answers for a particular area where open ended questions are used to generate data.

Since paint industry is very broad and involves both formal and informal sectors, research questions were used to find out what fire safety risks, measures and preparedness are in place and determine the compliance level with the fire risk reduction rules. In the current work, the question formulated sought to establish current practices and the regulation in place and their implementation.

1. What are the fire safety risks in paint industries?
2. What are the fire safety and awareness measures put in place to mitigate against the fire risks?

3. What is the level of fire safety preparedness?
4. What are the fire safety compliance gaps with regard to the fire risk reduction rules legal notice 59?

## 1.6 Research Objectives

### 1.6.1 General objectives

The main objective of the study is to evaluate fire safety compliance in paint industries as stipulated in fire risks reduction rules Legal Notice 59 under Occupational Safety and Health Act 2007

### 1.6.2 Specific Objectives

1. To assess the fire safety risks in Nairobi paint industries.
2. To establish the Fire safety and awareness measures put in place.
3. To determine the level of fire safety preparedness in case of fire accidents /incidences.
4. To establish the compliance levels in adherence to the Fire Risk Reduction Rules Legal Notice 59.

## 1.7 Scope of the study

The study focused on two main regions within Nairobi Region. These are Industrial area and Kariobangi light industries which have most of the paint industries in the county. This study commenced in August 2014.The study covered thirty registered paint manufacturers and distributors within Nairobi. Twenty-three of them were sampled from Industrial area while the other seven were sampled from Kariobangi light industries.

## 1.8 Conceptual framework

Conceptual framework is a tool in research that aids a researcher to better comprehend the phenomenon that is under the study (Kisilu & Tromp, 2006).

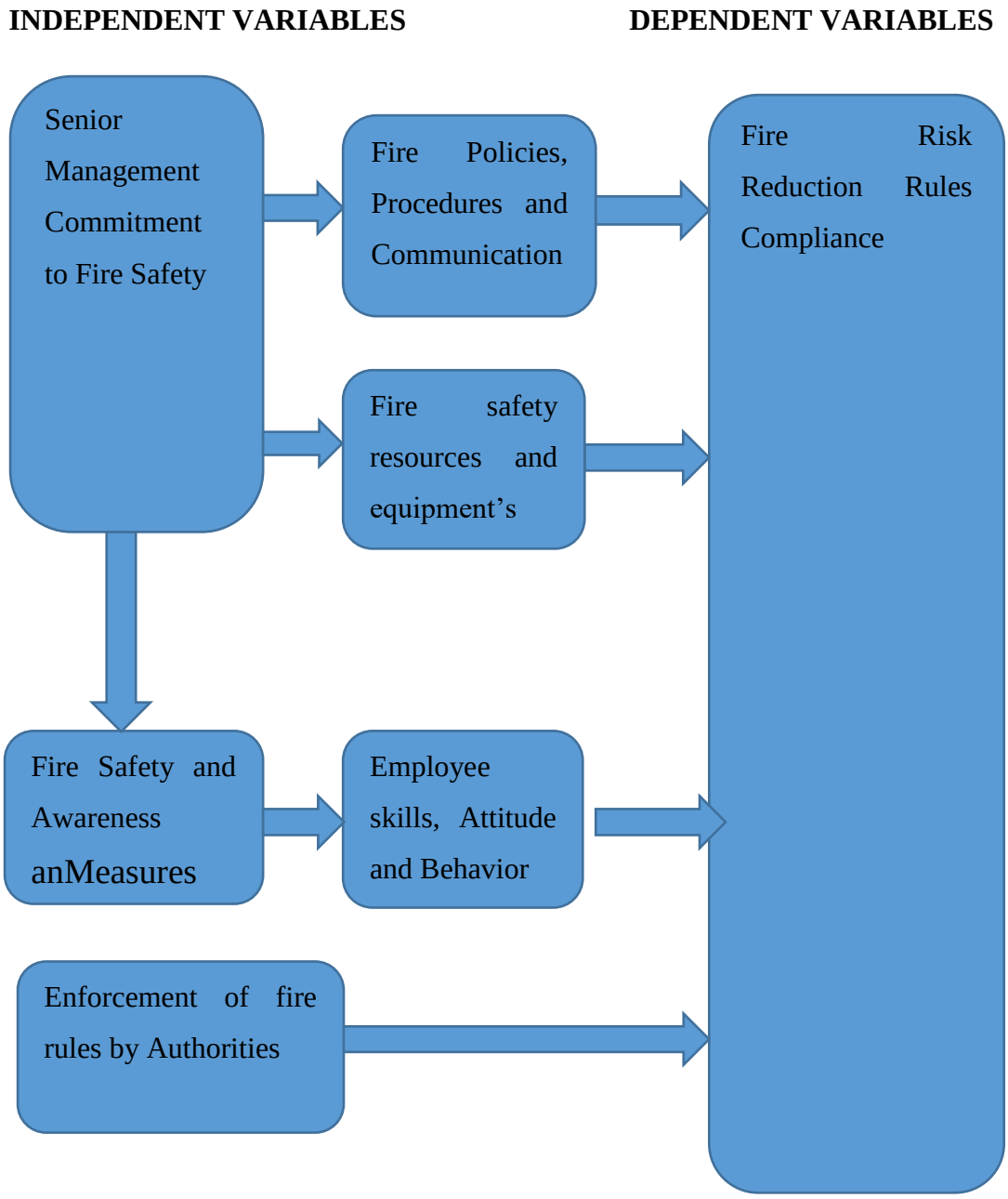


**Figure 1.1: Conceptual framework**

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 History of Fire Occurrences

Kenyan market has a number of players in the paint industry. The paint market experiences very stiff competition with the top three companies; Crown Paints, Basco Paints and Sadolin Paints taking a larger market share than others.

In Kenya, fire occurrences have been evidenced in various areas, with many incidences from manufacturing industries. To mention a few fire occurrences in recent past: Optimun Lubricants Ltd (may 2015), Vita Form Mattresses Factory (27/6/2015), Twiga Chemicals Ltd (18th February 2016), Oshwal Chemical Industry (March 2012), Shreeji Plastics Ltd (December 2012), Kappa Oil Refineries (October 2012), Unga Limited (November 2012) and Bizon Printing and Packaging (February 2012), Lab and Allied Ltd (October 2012), Matababu Wholesalers (June 2015),Yaduo Industries Ltd ( 20th February 2016) among many others ( Nairobi Fire Brigade data base 2016).Plate2.1 shows a fire incidence that occurred in a factory in industrial area.(2012).

**Plate 2.1: Fire incidence in a factory, Industrial area**

In the manufacturing industries, paint industries have more of the reported fire occurrences in Nairobi County according to statistics from DOSHS and Nairobi Fire Brigade as illustrated in Table2.1.

**Table 2.1: Fire incidences data of paint industries within Nairobi area.**

| Sn | Date | Company | Area | Fatalities | Injured | Source |
|---|---|---|---|---|---|---|
| **1** | 25/5/2012 | Picasso Chemicals | Kariobangi light industries | 8 | 20 | Doshs data base |
| **2** | 11/6/2012 | Kamdev Industries | Industrial area | 3 | 18 | NFB data base |
| **3** | 6/6/2012 | Matababu Paint Wholesalers | Gikomba | 1 | 5 | NFB data base |
| **4** | 25/3/2013 | Shivam Enterprises | Industrial area | 2 | 3 | Doshs data base |
| **5** | 22/4/2015 | Galaxy Paint Industries Ltd | Industrial area | 0 | 4 | NFB data base |
| **6** | 1/4/2016 | Crown Paint Factory | Industrial area | 0 | 3 | NFB data base |

## 2.2 Nature of Paints

Paint is defined as a liquid chemical compound that becomes solid and opaque after application to a surface. Paints exist in solid, liquid or gaseous suspension form and is commonly used for artwork or decoration, protecting and prolonging the life of natural and synthetic materials and acts as a barrier against environmental conditions. Paints are essentially a mixture of a solvent, a binder (that sticks to the surface) and a pigment (which provides color, opacity and protection of the surface concerned). (Clark, 1974).

There are two basic types of paint. These are oil-base (alkyd) and water-base (latex). Oil-based paints use thinner (petroleum-Base distillate) as a solvent and water-based paint use water as solvent. Solvents keep the paint flowing and act as a "carrier" for the binders and pigments. There are three basic components of paint namely pigment, binder, and solvent. The pigment is the color of the paint and is normally derived from another source, natural or synthetic, and is a granular solid that fixes with the other components to form an opaque surface. Cans of paints are displayed in plate 2.2.

**Plate 2.2: Cans of paints**

The binder or resin is the film-forming component of paint that adheres to a surface and holds its structure together while the paint hardens. Resin in paint is the binding agent that encapsulates the pigment and binds it to the surface being painted. They are also natural or synthetic and there are several versions that harden in different ways; additionally, the binder allows the paint to either dry or cure, which are different processes depending on evaporation or polymerization. Binders include synthetic or natural resins such as alkyds, acrylics, vinyl-acrylics, vinyl acetate/ethylene (VAE), polyurethanes, polyesters, melamine resins, epoxy, or oils. The Solvent is a main component in many paints and takes approximately 40% of the total paint content. It adjusts the hardening of the paint and the thickness, and helps

to carry the other components. It usually evaporates in the drying or curing process and does not affect the color or opacity of the paint. Some of the solvents used in paints are toluene, xylene, carbon tetrachloride, perchloroethylene, isopropyl alcohol, cyclohexanol, n-amyl acetate, methyl ethyl ketone, cyclohexane and methylene chloride. Paints can have various combinations of organic solvents as the diluent, including aliphatic, aromatics, alcohols, ketones and white spirit. Specific examples are organic solvents such as petroleum distillate, esters, glycol ethers, and the like. Sometimes volatile low-molecular weight synthetic resins also serve as diluents. (Waldie & John, 1983).

The main purposes of the solvents or diluent are to dissolve the polymer and adjust the viscosity of the paint. It is volatile and does not become part of the paint film. It also controls flow and application properties, and in some cases can affect the stability of the paint while in liquid state. Its main function is as the carrier for the non-volatile components. To spread heavier oils (for example, linseed) as in oil-based interior house paint, thinner oil is required. These volatile substances impart their properties temporarily. Once the solvent has evaporated, the remaining paint is fixed to the surface. A low boiling point is a desired property in many applications in which solvents are used, because the solvent must evaporate in order to leave behind the required film of coating, or of adhesive. But the fact that solvents may have a low boiling point may mean that they produce vapors at ambient temperatures which can ignite if the storage and process conditions are not suitably controlled. The volatility nature of the paint solvents is what makes the paint industries have high fire risks. Paint manufacturing companies seems to be fire-traps because they store a lot of highly flammable materials. In case of a fire occurrence, it becomes a big challenge to put it off. In addition their storage in the industries is wanting hence these kind of buildings collapse in minutes putting not only the firefighters' lives at risk by making evacuation a dangerous undertaking but also the loss is monumental due to the multiplicity of players affected. Plate 2.3 shows a section of paint production process.

**Plate 2.3: Paint production Process**

Due to high volatility nature of the solvents, a catalytic reaction can create a fire or explosion (for example, when two-pack epoxy paints are mixed and this creates heat). Fires may also be started by incorrectly stored flammable materials, paint and solvent soaked rags, or a buildup of paint residue in work areas or on equipment. Other Possible sources of ignition may include lit cigarettes, abrasive grinding wheels and other equipment that produces sparks, combustion motors, welding torches, hot surfaces, electrical short circuits, static electricity and portable electrical equipment like mobile phones among others. The fire-causing potential of solvents can be classified as "extremely flammable," "flammable," combustible," or "non-flammable." Extremely flammable means that even in cold weather (below -6.667°C), the presence of a flame, spark, or even static electricity can cause the solvent vapors to ignite. Flammable solvents can cause a flash fire in the range of room temperature (below 37.778°C), while combustible solvents must be heated above room temperature to ignite into flame. There is danger of fire and explosion where paints which contain flammable solvents are being used. This means naked flames, cutting and welding torches, gas fired heaters and materials which may give off sparks, whether electrical, mechanical, friction or static should not be near the

paints. Also, most Paint removers are flammable, they are a mixture of different solvents whose combined fire-causing potential is usually stated on product labels. (Waldie & John, 1983).

Flammable and combustible paint liquids are among the most fire hazardous materials in paint industries and are the major causes of fire. The picture in Plate 2.4 shows how the paint cans are stored after production awaiting delivery to the main store area.

**Plate 2.4: Paints stored after production**

## 2.3 History of Fire

Fire was invented by mankind at the beginning of time, early people used to light fire using friction concept by heating two rocks together to produce sparks. Fire also happens naturally when lightning strikes. Early man invention of on-purpose cooking fires is estimated at about one million years ago. Perhaps the last Ice Age, which ended about 10,000 BC, made people invent the idea of fires inside, to keep their caves warm (Brown *et al.*, 2009).

## 2.4 The Science of Fire

Fire is a process of combustion in which energy is released in form of heat and light. Fire is the rapid oxidation of a material in the exothermic chemical process of combustion, releasing heat, light, and various reaction products. The combination of fuel, oxygen and heat produces fire as illustrated by Dowd, 2002 in fire triangle shown in figure 2.1 making it easier and simple for people to understand fire. Fuel is anything which can burn; either in solid, gaseous or liquid form. Oxygen is the air that supports combustion. Heat is the minimum temperature at which a substance can ignite and is the source of ignition.

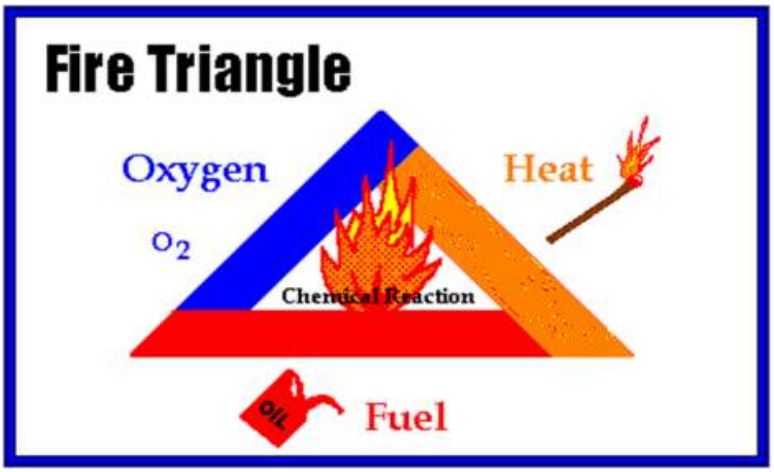


**Figure 2.1: Fire Triangle** (Dowd, 2002).

Fire can be started in different ways which includes:

- Direct ignition; throwing a cigarette butt and faulty electrical appliances.
- Explosion; gas explosion, dry grass ignition and lighting a stove.
- Spontaneous; heaped material i.e. saw dust, damp vegetable matter impregnated over a long period of time.
- Prolonged heat; stove pipes, chemical reaction like lime and acids. Friction; Shafts heating against each other (welding activities).
- Natural causes; thunder, earthquake etc.

## 2.5 Classes of Fire

Kenya has classified fire into four major classes according to fire risk reduction rules namely A, B, C and D (GOK, 2007). Class A are fires involving ordinary combustible materials such as wood, paper, and rubbish. Class B are fires involving flammable liquids which includes petrol, oil, grease, paints and thinners among others. Class C are fires involving flammable gases which include butane, acetylene gas, L.P.G, propane among others. Class D are fires involving burning of flammable and inflammable metals e.g. Potassium, Titanium, Zirconium, Lithium, and Sodium. Class E are fires involving electrical equipment e.g. computers printers, photocopiers among others.

## 2.6 Fire Extinguishing

Once fire has started, unless it is extinguished the next step is to spread and can do so in the following ways: Convection; which is circulation of super-heated gases e.g. liquids, smoke. Radiation; which is heat transmission through space e.g. from sun to earth and Conduction; which is heat energy traveling through solid materials e.g. through metals.

The combustion process continues in a chain reaction until one of the components is insufficient to support the reaction that's when the fire goes off. To suppress fire, one of the three components that supports fire must be removed or eliminated. This may be done by cooling (lowering temperature), smothering (separating oxygen from fuel and heat) or by starvation (removing the fuel burning).

Fire extinction is achieved by breaking the chain reaction between the bond of fuel, heat and oxygen. Portable fire extinguishers and fixed installation systems use various extinguishing agents to attack and break the chemical reaction of combustion directly and hence extinguish the fire. Smothering is eliminating oxygen; Starvation is removing the fuel while Cooling is removing heat in the combustion process as represented in figure 2.2.

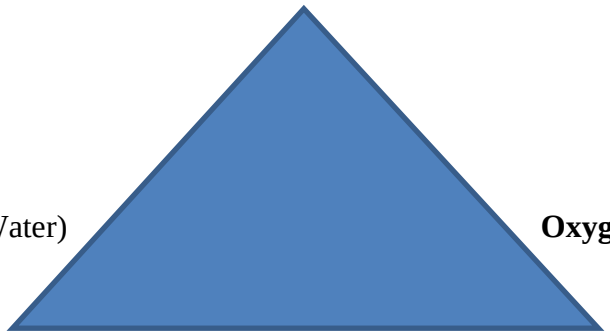


**Figure 2.2: Fire Extinguishing Triangle**

There are different types of fire extinguishers which extinguish different type of fires. They include; Water type fire extinguishers and hose reel which extinguishes class A fires, Carbon dioxide which extinguishes class E fires, Dry chemical powder which is a multi-Purpose fire extinguisher and extinguishes class A B and C fires, Air foam which extinguishes class B fires and finally fire blanket and sand. Inaccuracy choice of the type of extinguisher could easily lead to exaggeration of the fire, injuries and death (Tonui, 2009). Fire brigade extinguishing fire is displayed in plate 2.5.

**Plate 2.5: Fire brigade extinguishing fire.**

## 2.7 Fire Prevention and Protection

Fire prevention is taking beforehand actions that may curb fire from occurring. It involves making sure fire risks are controlled not to cause fire at any given time. Protection involves safeguarding people or property to ensure there is no harm or damage which may be caused by fire occurrence.

Fire prevention and protection are ways that help to control fire from happening and incase it happens the damage is controlled as well. This can be achieved by conducting fire risk assessments to help identify fire risks in the workplaces and put measures in place to reduce or control fire incidences.

Some ways of preventing fires in workplaces include;

- Regularly inspecting, testing and maintaining electrical installations and appliances.
- Ensuring machines are regularly inspected and maintained to avoid frictional heat.
- Keeping flammable materials in isolation and ensuring any flammables leaks or spillages are cleaned up immediately.
- Restricting smoking to suitable designated areas.
- Ensuring there is adequate security to prevent arson attack.

In the event of a fire, Fire detection is very important in warning people at early stage of fire hence able to extinguish it before it causes a lot of damage. They are designed to both detect a fire in its early stages and provide adequate warning to all occupants so that safe escape can be achieved (U.S. Department of Labour, 2001). Fire detection systems, fire suppression systems, fire alarm systems together with emergency lighting installations should be installed and well maintained in workplaces to ensure fire protection.

Escape signage should be clearly visible from all locations in the workplace and the signages on the fire exit doors prominently displayed (HMSO, 1999). The escape

routes should be clear of obstruction to ensure evacuation is easier hence protect people and property from more damages.

The workplaces should have well trained firefighting team to assist in evacuation of persons and help in putting off the fire. People should not be allowed back to the building on fire or even collect personal belongings unless clear escape is obvious. All persons should proceed to the assembly point for roll-call (Gold & Kogi, 1994).

All the above fire prevention and protection activities can easily be implemented by establishment of a Fire Safety Programme that includes inspections, fire drills, fire training, management procedures and communication.

Fire drill is an important exercise for instilling skills on evacuation procedures and consequences of fire are completely avoidable if safety requirements are observed. Training must meet the goal of reducing the number of fires and thus reduce death and injury among workers, and the financial loss on organizations (Cote, 1991).

**2.8 Legislative Provisions on Fire safety.**

Fire safety in factories started long time under Factories and Other Places of Work Act, which was then amended to occupational safety and health Act, 2007. Fire Risk Reduction Rules Legal notice LN 59 of 2007 is a subsidiary rule in the OSH act 2007. The legislation provides fire safety guidelines to ensure enough fire safety management to all workplaces.

On location and storage of highly flammables, the law requires to be kept in designated areas, be in limited amounts and stored in fire resistant receptacles.(Section four to eight of the rules).

On labelling and marking: flammable substances should be marked with bold letters and no smoking signs placed in strategic visible positions. According to Kennedy (2003) the purpose of stringent standards for storage of highly flammable standards is to prevent the spread of fire either to the material or from the material during an outbreak.

Ventilation is paramount and the legislation provides for adequate free flow of fresh air in section eleven and if this is not possible, a provision of exhaust ventilation system is necessary. The construction materials of the building should be made of fire resisting structures and able to withstand the fire and smoke for a while for purposes of evacuation as prescribed in section five.

On housekeeping, section thirteen and fourteen directs proper housekeeping which should be maintained and passageways not obstructed at any given time. Finished products, by-products and waste should be removed from the workroom immediately they are produced. Fire exists should have clear signage's and not obstructed.

The legislations also provide for the establishment of firefighting team in all workplaces. The fire team together with all other workers must be trained on proper use of firefighting appliances and evacuation procedures. The firefighting team must also undergo basic training on firefighting and first aid as explained in section twenty to twenty-two.

A Fire drill must be carried out at least once every Twelve months and workplaces should have assembly point(s) where all persons can be accounted for after an evacuation, they should be designated and known by all workers as specified in section twenty-three and twenty-four.

The legislation directs in section twenty-nine to thirty-two that Firefighting appliances should be maintained and inspected. Testing of fire extinguishers cylinders to be carried out every twelve months and should be selected for the correct class of fire depending on the type of combustible materials in the workplace.

In section thirty-three and thirty-four, the law guides on color coding of pipes for identification purposes hence pipes carrying water should be red in color and should be connected to a water storage tank of at least ten thousand liters of water for fighting fire. The law also requires fire safety audit to be carried out annually in all workplaces by an approved fire safety auditor.

Fire Safety policy should be formulated by all workplaces to show the commitment of the senior management on its implementation in writing and signed. The policy must have evacuation procedures, maintenance and inspection of firefighting appliances, training of workers and assignment of responsibilities as directed in section thirty-four and thirty-six. For effective evacuation procedure during a fire emergency, means of communication in form of alarms and signage's that do not depend on regular power should be provided. Fire Detection Systems such as Smoke and fire detectors should be connected to audible and visual flashing devices to easily notify people on the fire occurrence.

Other laws with Fire Safety Provisions include Section 154 of Local Government Act, Cap 265 which mandates local authorities to guide businesses and workplaces in taking necessary steps for prevention and extinguishing fires.

Sections two hundred and eleven to two hundred and four of the Local Government (Adoptive Laws) (Building) Order of 1968 provides for fire resistance in all buildings. It gives specifications of internal walls for fire resistance and management of fires in buildings through the provision of means of escape in case of fire. Sections thirty-one and ninety-eight of the Energy Act, No. 12/2006 provide for safe transportation of petroleum and petroleum products. Environmental, health and safety laws also give permits and licenses for electrical energy, petroleum and natural gas handlers who are subject to compliance.

Sections ninety-three to ninety-six of Explosives Act, Cap one hundred and fifteen regulate restrictions on manufacture, storage, importation, exportation, movement and usage of explosives and the management of fires arising from them in accordance with the act which is enforced by the ministry of environment and mineral resources.

Section forty-nine of the Standards Act, Cap 496 mandates Kenya Bureau of Standards (KEBS) to assist and cooperate with the Government, Local Authorities and any other public body in preparation, framing and securing the adoption and practical application of any specifications or codes of practice. In regard to fire safety, there are standards on transportation of fuel and other flammable materials

including safe handling of gas cylinders, firefighting equipment for example the automatic electrical fire alarm systems standards and personal protective equipment standards.

The Safety Standards Manual for Schools developed by the Ministry of Education in 2008 provides specifications on the building of dormitories and classrooms among other measures to prevent deaths in schools. In the manual, every school need to set up a safety committee to look into all safety measures and schedule practice drill sessions for fire and other emergencies regularly (Ministry of Education, 2008).

The Public Health Act, Cap 242 under section one hundred and twenty-six A provides that every council shall make by-laws that require adequate provision for the escape of the occupants of any building in the event of outbreak of fire.

**2.9 Fire risks Assessment.**

Fire risk assessment is a careful examination of what, in an individual's work could cause fire harm to people so that one can weigh up whether she/he has taken enough precautions or should do more. The purposes of assessment is to identify the extent of the fire risk, to assess the likelihood of a fire occurring and thirdly to identify any additional precautions that may be needed, or control systems that do not function adequately (HSE, 2006).

Fire risks depends on various factors ranging from type of building, materials present, people at risk, safety measures in place, people's perception among others. The fire risks are combination of low probability with high extent of damage and though theoretically the damage can occur at any time, it is scarcely to be expected.

Generally, risk assessment is part and parcel of any basic risk management model (Bischoff, 2008). It involves 4 major steps:

- First step is where analysis of the risk is carried out through estimation of the risk, source identification and evaluation.

- The second step involves risk treatment or handling where measures dealing with avoiding the risk, optimizing or reducing it, transferring and/or retaining the risk are comprehensively analyzed.
- The third step is risk acceptance
- The fourth step is risk communication.

There are two types of fire risk assessment methods. These are quantitative and semi quantitative or ranking methods (Engert & Lansdowne, 1999). Quantitative methods include the CRISP (Computation of Risk Indices by Simulation Procedures), FiRECAM (Fire Risk Evaluation and Cost Assessment Model), The Building Fire Safety Evaluation Method (BFSEM), FIERA system (Fire Evaluation and Risk Assessment), Petri net to Fire Safety Analysis, Fire Risk Assessment with Reliability Index β and Probabilistic Methods which include Event tree, Fault tree, Decision tree and Influence tree analyses (European Commission, 2003). Ranking methods or semi-quantitative methods are used in a wide range of applications. The researcher first identifies the factors that affect the level of safety or risk, which represents positive features (increase the level of safety) and negative features (decrease the level of safety). The importance of each factor has to be decided by assigning a value then operated by some combination of arithmetic functions to achieve a single value. The value can be called as "risk index "and is a measure of the level of safety/risk in the object and it is possible to compare this to other similar objects and to a stipulated minimum value (European Commission, 2003).An advantage of fire ranking methods is their simplicity, they are considered as very cost-effective tools. Another advantage of this method is the structured way in which the decision making is done. This facilitates understanding of the system for persons not involved in the development process and makes it easier to implement new knowledge and technology into the system.

There are a number of ranking methods being used to assess fire risks in different workplaces, buildings and processes. These includes:

- Fire Safety Evaluation System (FSES) is a risk index method which treats risk and safety separately and is used in health care facilities.

- Specific Commercial Property Evaluation Schedule commonly used in insurance industry for buildings.
- Dow Fire and Explosion Index (FEI) method which identifies and assesses thermodynamic properties of the dominant combustible materials in individual operations or units of a process plant.
- Hierarchical approach where Five different "decision making levels" of hierarchy are used and a matrix of fire safety goals versus more specific fire safety features is usually constructed.
- SIA 81 – Gretener Method which is used to evaluate and compare the level of fire risk of alternative concepts by grading the elements of a building and their performance.
- Fire Risk Assessment Method for Engineering (FRAME) is for calculating fire risks in buildings and helps to define a sufficient and cost effective fire safety concepts.
- Fire Risk Index Method which is used for all types of ordinary apartment buildings is a simple method of deducing the level of safety in buildings and lastly the Risk Value Matrix Method which has been used in this research (Mallet & Brnich, 1999).Though the Risk Value Matrix method is based on semi-quantitative terms the numbers involved are purely relative, so that they have no absolute significance. The risks are made up to two elements: the probability that an event will occur and the consequences of that occurrence. The relative contributions that these two elements make to the risk can vary considerably.

The overall risk is called risk value and is defined by the simple formula as "Risk value = fire hazard value x fire risk value". The size of the risk value becomes the basis for categorizing the building as being of high, normal or low risk (Health Service Executive, 2007).

The quantification of fire hazard is done by describing it as being negligible, slight, moderate, severe and very severe and by assigning numerical values to each description from '1' to '5'. In a similar way fire risks are described as being unlikely, possible, quite possible, likely and very likely and also by assigning numerical values

to each description from '1' to '5'. If the risk formula is applied to all possible combinations of fire hazard values and fire risk values a set of 25 numbers can be obtained. When putting all the numbers in a two-dimensional grid a risk value matrix will exist. Table 2.2 shows fire risk assessment matrix reference.

**Table 2.2: Fire Risk Assessment Matrix Reference** (Source: HSE, 2007)

| **Probability And Severity** | **Minor Injury** | **Lost Time/Ill Health** | **Major/ More Than 3 Days** | **Permanet Disability** | **Fatal/ Site Loss** |
|---|---|---|---|---|---|
| **Highly Unlikely** | 1 | 2 | 3 | 4 | 5 |
| **Unlikely** | 2 | 4 | 6 | 8 | 10 |
| **Possible** | 3 | 6 | 9 | 12 | 15 |
| **Probable** | 4 | 8 | 12 | 16 | 20 |
| **Certain** | 5 | 10 | 15 | 20 | 25 |

## 2.10 Possible causes of fire in paint industries.

Paint manufacturing industries have a higher risks of fire occurrences which may be due to;

a) Hot works which is commonly equated with welding and torch cutting, however it also include brazing, burning, heating, and soldering which pose fire hazards. This is because the sparks and molten material, which reach temperatures greater than 537.778°**C**, can easily travel more than 10.668 meters.
b) Faulty equipment and machinery are also major causes of industrial fires. Heating and hot work equipment are typically the biggest problems e.g. furnaces that aren't properly installed, operated, and maintained. In addition, any mechanical equipment can become a fire hazard because of friction between the moving parts may create heat or sparks. Faulty electrical installations can be a significant potential of fire ignition sources. It is that imperative that occupiers maintain the highest standards of electrical safety (Stokes, 2007).

c) Poor housekeeping creates the right environment for a fire to take place, providing both a place where ignition can occur together with a ready source of fuel. It may also create obstructions to the escape routes (Cote, 1991). Also Placing of trash bins along corridors and lobbies might result in smokers discarding lighted cigarette butts into them resulting in the burning of combustible materials inside (McKenzie, 2008).
d) We cannot rule out fires caused by arson attacks as clearly put by Mostue, 2011 that many building fires are arson-initiated where in certain cases; purported victims were eventually proven to be the culprits themselves with fraudulent intentions in seeking redress.
e) Failure to smoke in designated areas among others

These fire causes can be preventable by following proper safety procedures:

- Training personnel on the hazards associated with hot works and using permit to work system for all hot works.
- Proper maintenance of mechanical and electrical equipment's by following recommended cleaning and maintenance procedures, including lubrication.
- Practicing proper housekeeping procedures
- Storing flammable liquids properly.
- Supervising the work properly and providing personal protective equipment to workers among others.

Loss from a fire can be measured in physical injury to employees, visitors and anyone near the premises, damage to premises and its contents and financially through loss of business, poor reputation and through court action. But statistics show that the majority of fires could be prevented from happening or at least reduce the consequences (Naito, 1994).

Fires may be caused by people actions or omission, either through their actions which may be accidental, deliberate or malicious through their failures to take appropriate precautions while working.

The prevention of fire therefore depends majorly on people. When people have an understanding of the nature and behavior of fire, they will be in a better position to recognize fire hazards and to take preventive measures.

Fire safety in workplaces can be well achieved by establishing policies and procedures and ensuring proper implementation of the same. It should involve Conducting fire hazard analysis, establishing fire prevention and emergency procedures, Providing fire safety training, Implementing regular housekeeping routines, Inspecting and maintaining equipment's and systems etc.

Aftermath of paint factory fire kariobangi light industries is displayed in plate 2.6.

**Plate 2.6: Aftermath of Paint factory fire, Kariobangi light industries**

# CHAPTER THREE

# MATERIALS AND METHODS

## 3.1 Study design

The study utilized descriptive research design because it is a fact-finding mission. Descriptive research is suitable when one studies things as they are in the field without manipulating variables and also gives views and feelings from the respondent regarding issues like where, how and whom. (Babbie, 2002). Both qualitative and quantitative data was collected and used for the study.

The study used the descriptive research method focusing on survey research type; participants answered questions administered through interviews or questionnaires. The research questions were formulated in a clear and easy to comprehend manner. The researcher used both open-ended and closed-ended questions. Open-ended questions allowed for a greater variety of responses from participants. The data was then coded for ease to analyze statistically. The research focused on the management and the workforce in all the 30 paint manufactures and distributors.

## 3.2 Study area and target Population

### 3.2.1 Geographical location of paint industries in Nairobi

Paint industries are quite a number in Nairobi County. The study focused on the paint industries located in Industrial area and Kariobangi light industries. Nairobi Industrial area is located approximately 7km from Nairobi CBD to the South while Kariobangi light industries is located approximately 9 km from Nairobi CBD to the East (Map 3.1).

### 3.2.2 Geographical location

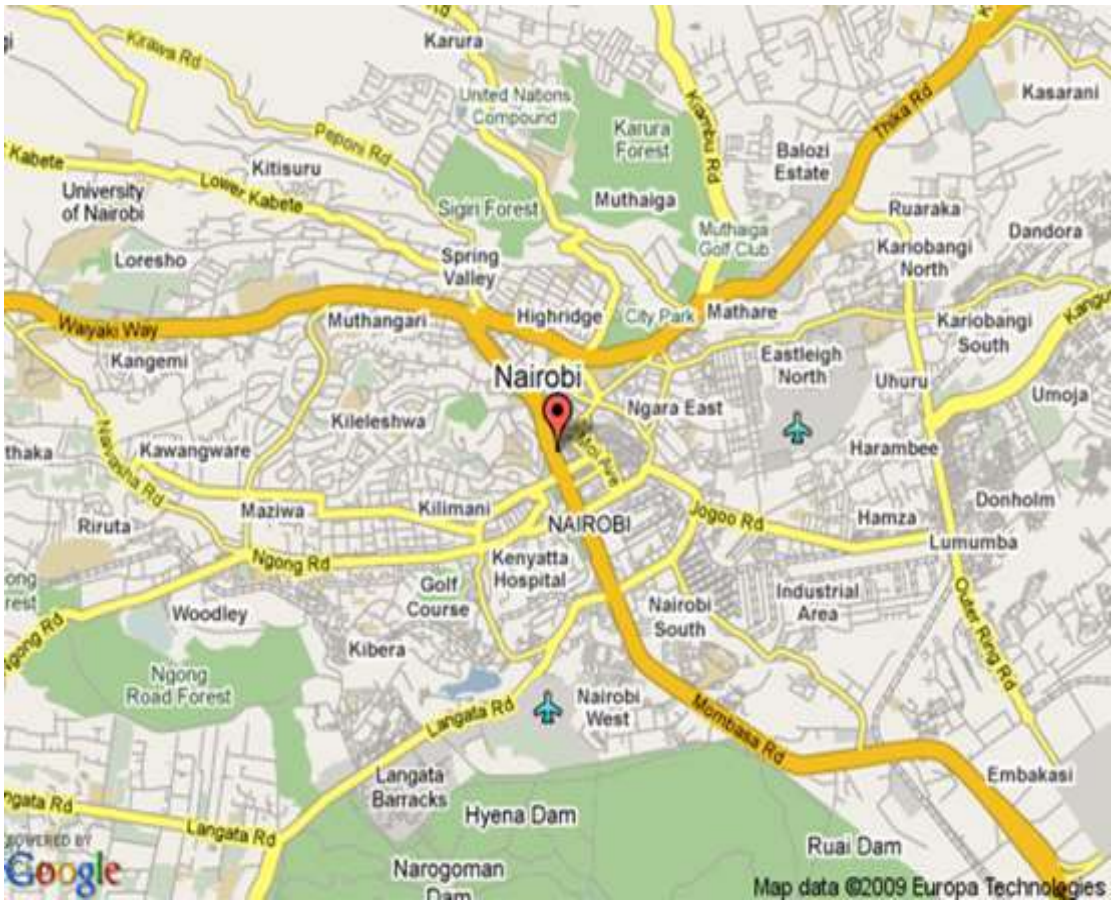


**Figure 3.1: Industrial area and Kariobangi light industries**

### 3.2.3 Sample Population

The study population comprised of management and workforce staff in the 30 paint industries. It focused on 23 companies within Industrial area and 7 companies within Kariobangi light industries. The total study population was 6936 workers in the 30 paint industries. Majority of the companies in Industrial area were registered by Directorate of Occupational Safety and Health Services (DOSHS) compared to few from Kariobangi light industries.

### 3.2.4 Sample size for questionnaire distribution

For determination of the sample size for questionnaire administration, the researcher applied the following formula, (Bartlett *et al.*, 2001): -

$$n = \frac{X^2 \times N \times P(1-P)}{ME^2 \times (N-1) + (X^2 \times P \times (1-P))}$$

Where;

n=Sample size

X= The standard variant value at 1.96 for 95% confidence level

N= Population size of 6936

P= The half-half chance of picking a choice, expressed as decimal of 0.5

ME= The margin of error at 95% level of confidence, expressed as decimal of 0.05

Using the above formula, the sample size was determined.

$$n = \frac{1.96^2 \times 6936 \times 0.5(1-0.5)}{0.05^2 \times 6935 + (1.96^2 \times 0.5 \times (1-0.50))}$$

$$n = \frac{26{,}645.338 \times 0.25}{17.3375 + 0.9604}$$

$$n = \frac{6661.3345}{18.2979} = 364.049$$

Therefore

$$n = 364.049$$

Using the above equations, the sample size for the study was 364 workers at Confidence level of 95% with margin error of 5.0%.

**Table 3.1: Sample size distribution**

| | Company name | Total workers | Sample % | Each sample | Returned |
|---|---|---|---|---|---|
| **1** | Alfa coat Industries | 171 | 2.5 | 9 | 7 |
| **2** | Apex paints | 171 | 2.5 | 9 | 9 |
| **3** | Afro Industries Ltd | 95 | 1.4 | 5 | 5 |
| **4** | Bob Industries | 133 | 1.9 | 7 | 5 |
| **5** | Bosco products (k) Ltd | 553 | 8 | 29 | 26 |
| **6** | Beaver Industries | 95 | 1.4 | 5 | 5 |
| **7** | Crown paint (k) ltd A | 381 | 5.5 | 20 | 20 |
| **8** | Crown paint (k) ltd B | 495 | 7.1 | 26 | 26 |
| **9** | Colour Up ltd | 133 | 1.9 | 7 | 6 |
| **10** | Dreamcoat ltd | 133 | 1.9 | 7 | 5 |
| **11** | Grand Paints | 152 | 2.2 | 8 | 8 |
| **12** | Glory paints A | 114 | 1.6 | 6 | 5 |
| **13** | Glory paints B | 133 | 1.9 | 7 | 5 |
| **14** | Galaxy paints ltd | 286 | 4.1 | 15 | 13 |
| **15** | Ideal Manufacturing ltd | 267 | 3.8 | 14 | 14 |
| **16** | Kamdev enterprise ltd | 114 | 1.6 | 6 | 6 |
| **17** | Kenind paints ltd | 171 | 2.5 | 9 | 7 |
| **18** | Molecular Kenya Ltd | 419 | 6 | 22 | 20 |
| **19** | Nayan product (K) Ltd | 324 | 4.7 | 17 | 17 |
| **20** | Orion paints | 305 | 4.4 | 16 | 16 |
| **21** | Pinnacle paints | 133 | 1.9 | 7 | 7 |
| **22** | Prime coating | 171 | 2.5 | 9 | 8 |
| **23** | Sadoline paints | 381 | 5.5 | 20 | 20 |
| **24** | Solai enterprises | 248 | 3.6 | 13 | 13 |
| **25** | Shivam enterprises ltd | 229 | 3.3 | 12 | 11 |
| **26** | Spectra chemicals ltd | 210 | 3 | 11 | 11 |
| **27** | Smart coating | 286 | 4.1 | 15 | 14 |
| **28** | Suncoat chemicals | 267 | 3.8 | 14 | 13 |
| **29** | United paints | 210 | 3 | 11 | 10 |
| **30** | Maroo polymers | 152 | 2.2 | 8 | 8 |
| | Total | 6936 | 100 | 364 | 340 |

**Source:** (DOSHS workplace database, 2016)

### 3.3 Research instrument

The study employed questionnaires and structured participatory observations using a prepared checklist in the collection of information. There were two types of questionnaires, for management and for workforce. The management questionnaire was designed in two main parts. Part A relate to personal information and Part B aimed at obtaining the opinion of the respondents about the essential fire safety measures put in place and fire safety preparedness. The workforce questionnaire was designed in three parts, Part A on personal information, part B on fire risks and fire safety awareness and part C on factors affecting implementation of FRRR 2007.The checklist was formulated from the FRRR Legal notice 59, and was used to conduct a facility tour aided by in house safety officer looking into fire risks, safety measures and preparedness.

Apart from the questionnaires, the researcher administered face to face interviews to some managers and workforce and used checklist to conduct inspections on fire safety compliance.

### 3.4 Data Collection.

Stratified simple random sampling procedure was used and the distribution of the questionnaires in the individual companies was done using the tippet random table to get the specific persons to be sampled. The number of questionnaires administered in each workplace was based on the percentage of the workers in a workplace in relation to the total population.

The data was collected for 12 months with the help of two research assistants. There were two sets of questionnaires aimed at getting specific information on fire safety from both management and workforce in the companies. The questionnaires were dropped in the identified companies and picked up after they were filled up. However, sometimes the researcher mingled with the workers as they filled the questionnaires as illustrated in (Plate 3.1, 3.2 and 3.3).

**Plate 3.1: Overseeing data filling.**

**Plate 3.2: Explaining questions to workers.**

**Plate 3.3: Confirming completion of data filling.**

### 3.5 Data Processing and Analysis

After the fieldwork, the obtained data was coded numbered and classified under different variables for easy identification and then summarized for ease of interpretation. All the questionnaires had part 1 and 2.Part 1 was designed to obtain personal data of the respondent and the response for part 2 of the questionnaire was rated with ordinal measures 1 to 3, with Yes, No and Not sure taking the values 1,2 and 3 respectively. The workforce questionnaire had an additional part 3 on factors affecting fire safety implementation and was based on Likert's scale of five ordinal measures as follows with its rating scale;(Mugenda, & Mugenda, 1999).

1=Strongly disagree (1.00<mean index<1.50)

2= Disagree (1.50<mean index<2.50)

3=Not sure (2.50<mean index<3.50)

4=Agree (3.50<mean index<4.50)

5=Strongly Agree (4.50<mean index<5.00)

The checklist was measured on scale of 4 ordinal measures rated as follows;

4= Good ((3.50<mean index<4.50)

3 = Satisfactory (2.50<mean index<3.50)

2 = Average (1.50<mean index<2.50)

1 = Poor (1.00<mean index<1.50)

The mean index was used for ranking variables as per the response rate.

**Mean Index =** $\sum$ ***(μ* n)/N***

Where; **u** is the weighing of each factor given by the respondents

**n** is the frequency of respondents

**N** is the total number of respondents

Correlation techniques were also used to analyze the primary data of quantitative nature .A statistical package (SPSS) and Ms Excel was used to analyze the data.

The result of the analysis was organized, summarized and presented using tables, pie charts, bar graphs among others. Descriptive statistics such as mean, mode, median were used to present the characteristics of data.

### 3.6 Pilot testing

A pilot study was conducted in 5 paint industries to measure the validity and reliability of the research instruments in the study. The pilot study targeted a sample size of 59 respondents in which 52 filled the questionnaires making a response rate of 88.1%.

### 3.7 Ethical considerations

Permission was sought from all the paint industries visited using the university introduction letter and the researcher's request letter to help carry out the research. (Appendices V and VI).

The confidentiality of the respondents was protected by ensuring the respondents were not required to put their names in the questionnaire hence no coercion or undue influence was exercised.

# CHAPTER FOUR

# RESEARCH FINDINGS AND DISCUSSION

This chapter describes the analysis of data followed by a discussion of the research findings. The raw data was transformed making it easy to understand and interpret. These results are presented in various systems to make it possible to interpret population characteristics, comparisons and associations of data.

## 4.1 Population characteristics

### 4.1.1 Response Rate

The study targeted a sample size of 364 respondents in which 340 completely filled the questionnaires making a response rate of 93.4 %. Babbie (2002) argues that in descriptive survey research, response rate above 50 percent is adequate for data analysis. Mugenda (1999) also asserts that a rate of 50 percent or higher is adequate for data analysis. This implies that 93.4% response rate was very adequate for data analysis.

### 4.1.2 Demographic characteristics of the Management and Workforce

#### 4.1.2.1 Gender of the Management and Workforce

One hundred and twenty-two management personnel were interviewed, ninety-nine persons from Industrial area and twenty-three persons in Kariobangi light industries. Two hundred and eighteen workforce personnel were interviewed with one sixty-seven persons from Industrial area and fifty-one persons in Kariobangi light industries. All the workers interviewed were on permanent employment and were well trained for their respective job.

From the findings, a greater number (70.9%) of the respondents were male while female were 29.1% in all the facilities with inconsiderable percentage difference in representation between management and workforce as indicted in Table 4.1This signifies that most of the paint industries are male dominated.

**Table 4.1: Respondents' Demographics**

**Management**

| Variable | Frequency | Percent |
|---|---|---|
| **Gender** | | |
| Male | 96 | 78.7 |
| Female | 26 | 21.3 |
| Total | 122 | 100.0 |

**Workforce**

| Variable | Frequency | Percent |
|---|---|---|
| **Gender** | | |
| Male | 145 | 66.5 |
| Female | 73 | 33.5 |
| Total | 218 | 100.0 |

#### 4.1.2.2 Education Level of Management and workforce

Education level is very important in gauging the understanding levels of the workers in regard to fire safety. Educated workers will understand better fire risks, fire control measures, fire preparedness as well as fire rules compliance and vice versa hence the importance of looking at workers education level.

The study has shown that 46.7% of managers had form four education level and below and 53.3% had attained college level and above education. On work force, 53.2% had college education and above, 45% secondary education while 1.8% had primary education. Hence the study reveals that most of the workers are learned with over fifty percent having college and above education level for both workforce and management as illustrated in Table 4.2. With the high education level, the workers are easy to train and are able to understand fire safety management systems easily.

**Table 4.2: Education level**

**Management**

| Variable | Frequency | Percent |
|---|---|---|
| **Level of education** | | |
| Primary level | 6 | 4.9 |
| Secondary level | 51 | 41.8 |
| College level and above | 65 | 53.3 |
| Total | 122 | 100.0 |

**Workforce**

| **Level of education** | | |
|---|---|---|
| Primary level | 4 | 1.8 |
| Secondary level | 98 | 45 |
| College level and above | 116 | 53.2 |
| Total | 218 | 100.0 |

#### 4.1.2.3 Work duration of Management and Workforces

From the research findings shown in figure 4.1, slightly below fifty percent (47.5%) of managers had worked for four years and below showing high turnover. However, a small number of managers (6.6%) had worked for over 12 years. Additionally, 60.5% workforce had worked for four years and below with only 6.5 % of workforce working more than eight years as shown in figure 4.2.

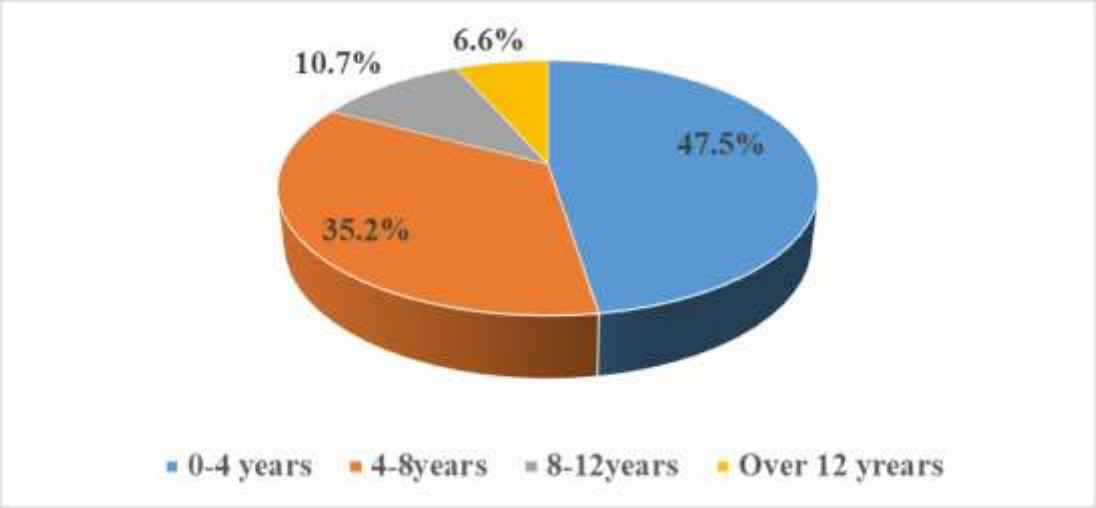


**Figure 4.1: Management number of years at workplace**

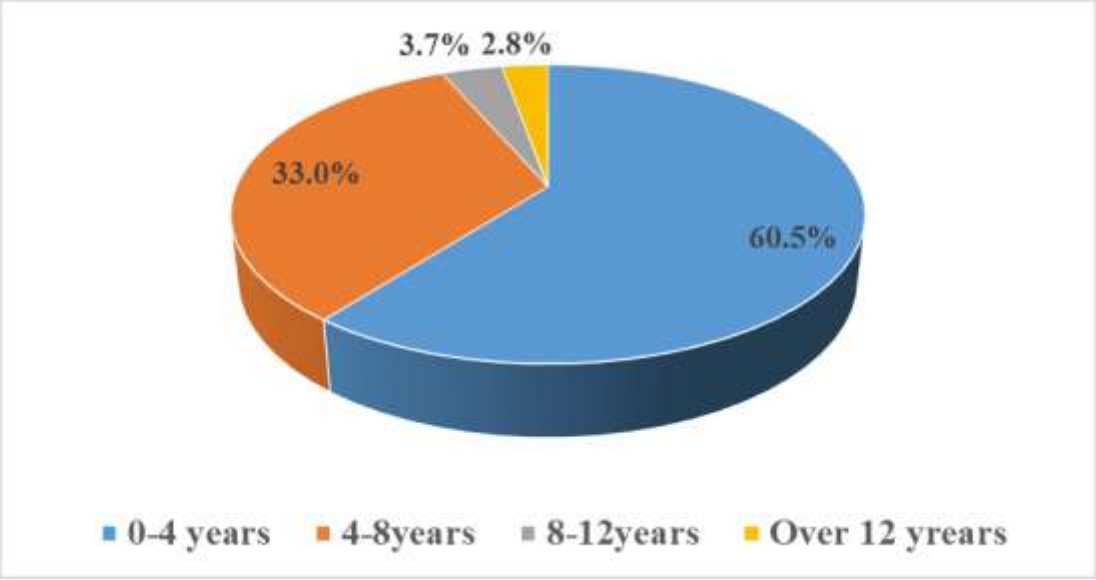


**Figure 4.2: Workforce number of years at workplace**

#### 4.1.2.4 Test of Associations

The researcher sought to find any association between gender, education level and work duration and a significant association was found between gender and work duration in the workforce with ($\chi^2$=20.871, df=3, p-value=0.000) with no significant association in management ($\chi^2$=6.005, df=3, p-value=0.111). In both management and workforce, there were no significant association in gender and level of education with (($\chi^2$=1.748, df=2 p-value=0.417) and ($\chi^2$=4.543, df=2, p-value=0.103) respectively .Generally high turnover was evident in both management and workforce however in workforce, female (80.8%) turnover was higher than male (50.3%).

The research findings indicate that a greater number of workers (55.9%) both management and workforce were educated with high school and college education and have worked for a period of less than 4 years before switching carrier and this relationship was statistically significant for management ($\chi^2$=36.084, df=6, p-value=0.000) and workforce ($\chi^2$=50.008, df=6, p-value=0.000) as shown in appendix VIII. It was however noted that quite a number of workers (44.1%), both managers and workforce had worked for more than 4 years implying that they have experience and were conversant with handling paints. This results were also found to be statistically reliable based on Cronbach's alpha value of 0.765 for management and 0.629 for workforce as illustrated in appendix VI and VII respectively.

### 4.2 Fire risks

Flammables are major fire risks factors, the research sought to find how they were stored and handled. 23% of workplaces had poor ways of handling flammables as well as 13% had poor storage of flammables hence exposes the facilities to high potential for fire occurrences. The findings are not in line with fire rules that every occupier shall ensure that highly flammable substances are stored in suitable fixed storage tanks in safe positions, or in suitable closed vessels kept in a safe positions in the open air (FRRR, 2007).The other major risk factor identified was electricity, where the researcher sought to find their compliance with the electrical safety rules

and how they handled electrical equipment's. Most of workplaces (70%) had average compliance in handling of electrical appliances. The facility tour found out there were open sockets and loose electrical wires which is a fire risks factor and agrees with Fraser-Mitchel 2007 that "faulty electrical installations can be a significant potential source of fires".17% of workplaces had poor machine layout which is also a fire risk factor in terms of inaccessibility to emergency escape routes in case of any fire eventuality. The escape routes must remain structurally intact and smoke free to allow safe passage of occupants from the building. (Torero et al, 2012). This information shows major fire risks factors which need to be urgently addressed. It was however clearly evident that in all workplaces, flammables materials were well labelled and marked for easy of identification and usage. Fire risks in workplaces are displayed in figure 4.3.

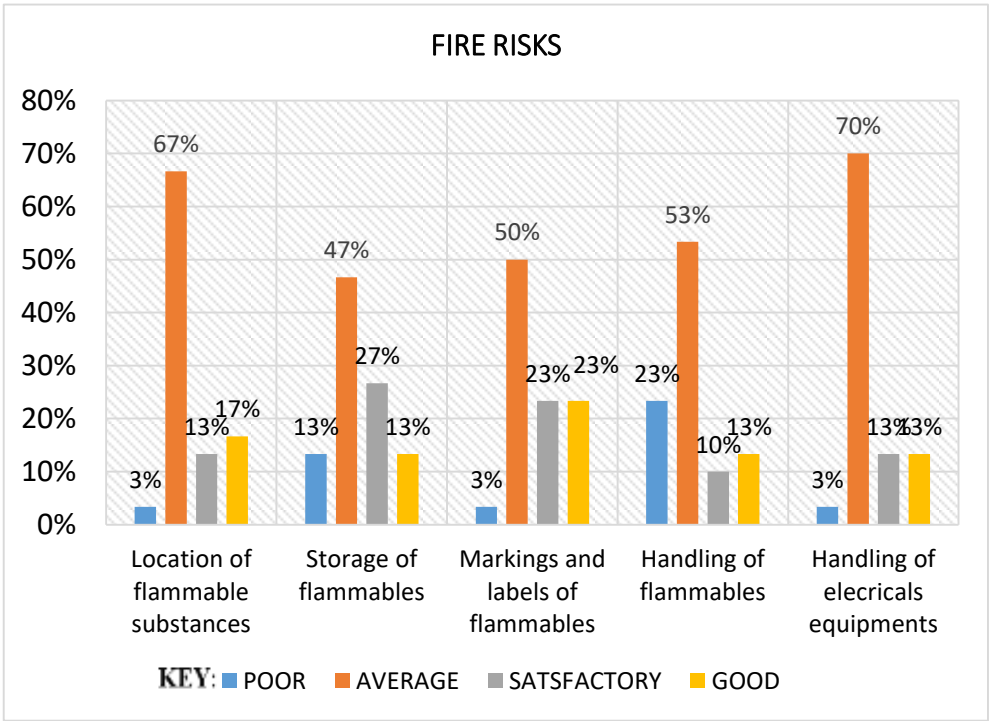


**Figure 4.3: Fire risks in the workplaces.**

The researcher sought to find out whether there is any association between the fire risks factor and workplace locations and no much significant association was found. However, a slight significance was noted in storage of flammables with ($\chi^2$=7.740, df=3, p-value=0.052). With a greater number (85.7%) of the facilities in Kariobangi light industries area complying averagely and below and only 14.3% complying satisfactory. On the other hand, slightly below half (47.3%) of the facilities in Industrial area had satisfactory compliance and 52.2% had average compliance. It was clearly evident that paint industries in Industrial area are more compliant to fire risks reduction rules than Kariobangi light industries hence the need to enforce compliance in Kariobangi light industries since they are prone to fire disasters. The research reliability test on fire risks in checklists was found to be (Cronbach's alpha 0.901). Signifying the data is reliable as shown in appendix V.

### 4.2.1 Fire incidences

The research sought the frequency of fire occurrences from management, where the obtained data showed that 72.1% of the paint industry had experienced the fire incidence, 25.4% had not while 2.5% were not sure of the question or were more economical with the response as shown in figure 4.4.

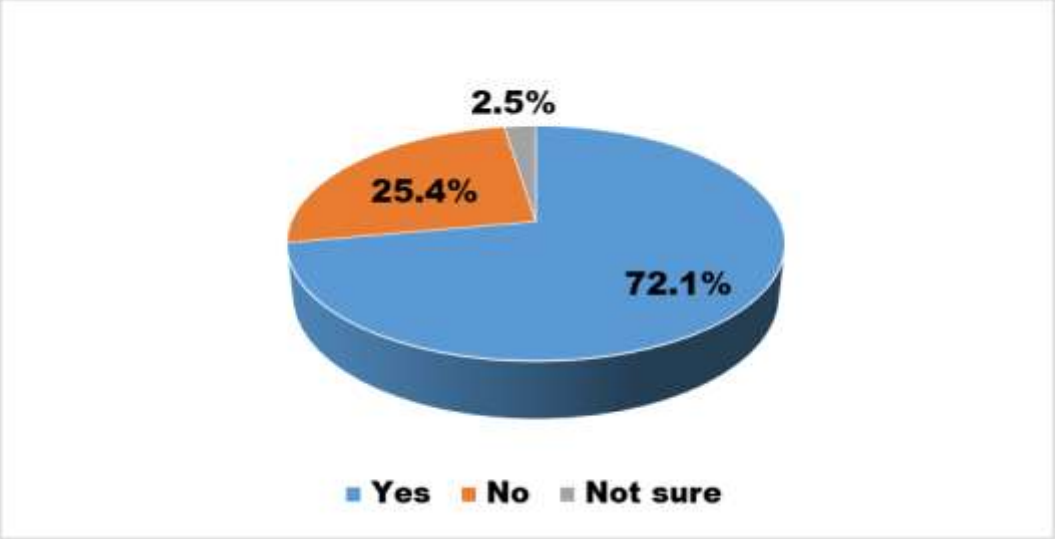


**Figure 4.4: Fire occurrences in workplaces**

The study established poor recording of fire incidences where only 32.8% agreed to record the incidences while 55.7% had not recorded and 11.5% were not sure whether the recordings were done or not as shown in figure 4.5. A comparison of fire occurrence's and their recording revealed that there was statistically significant with ($\chi 2$=33.408, df=4, p-value=0.000) as shown in appendix IX .The study also revealed that, out of the 72.1% fire occurrences only 44.3 % had recorded them while 43.2% had not recorded and 12.5% were not sure. This had a moderate reliability value of (Cronbach's alpha 0.457 ) due to low level recording as shown in appendix VI. The poor recording of fire occurrences deprives statistical information to researchers who can get statistical data hence find ways to curb the increase of fire occurrences. The study further reveals that most of the fire incidences occurred in Kariobangi light industries (78.3%) than Industrial area (70.7%). However, there was no statistical significance association between fire incidences and location of the industries with ($\chi 2$=1.276, df=2, p-value=0.528. as illustrated in appendix IX.

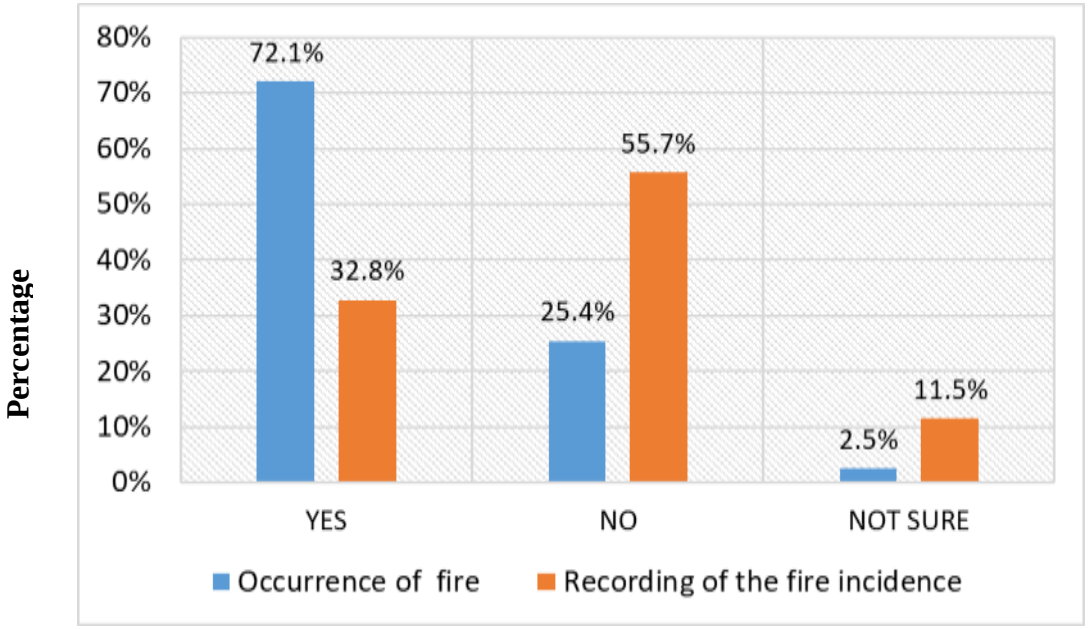


**Figure 4.5: Fire incidences and recording in workplaces**

### 4.3 Essential fire safety measures in paint Industries

The second objective of this study was to establish the essential fire safety measures put in place in the paint industries.

Responses from the checklists shows that majority of the workplaces have complied with safety measures on average (60% compliance) as seen in figure 4.6. Measures to Control smoke was highest at 67% followed by housekeeping and flammables stores ventilation at 57% and 53% respectively.Poor housekeeping creates the right environment for a fire to take place, providing both a place where ignition can occur together with a ready source of fuel. It may also create obstructions to the escape routes (Cote, 2011). The research reliability test on fire safety measures in the checklists was found to be Cronbach's alpha 0.882 signifying the data is reliable as shown in appendix V

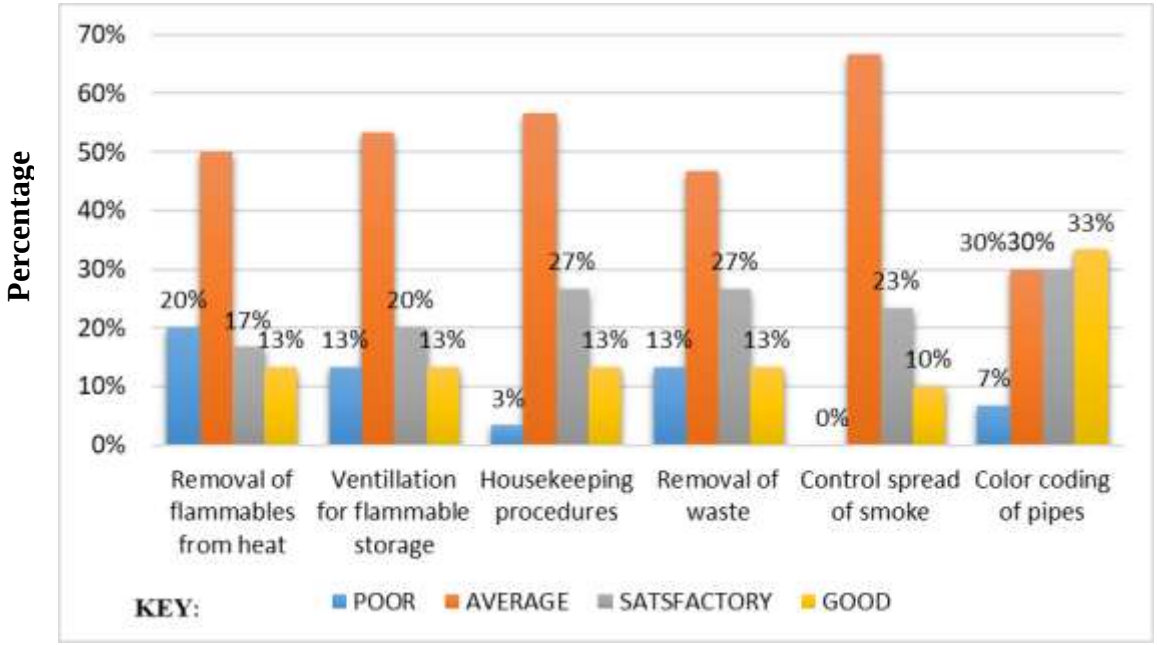


**Figure 4.6: Fire safety measures in workplaces**

The study also found that 20% of workplaces had poor measures of removing flammable from heat as well as 13% of workplaces had poor ways of waste removal and poor ventilation in areas where flammables are stored which is alarming and needs urgent improvement.

Workforce responses on safety measures showed that 89% were in agreement that safety measures were put in their workplaces. Appropriate labelling and marking of flammables as well as notices prohibiting smoking were highest at 100% followed by flammables kept away from hot surfaces 98% while 90% had put measures to prevent electrical fires. It was however noted that 14% of respondents had not seen appropriate storage for flammable materials in their workplaces as well as 13% were in agreement that there was no Safe handling and transportation of flammables within the workplace. These are major risks to fire and need to be addressed.20% of respondents were not sure whether there were measures put in place to prevent ignition of flammables and this shows poor awareness level on flammables to the workers. Fire safety awareness measures need to be created in workplaces to ensure workers are well enlightened.

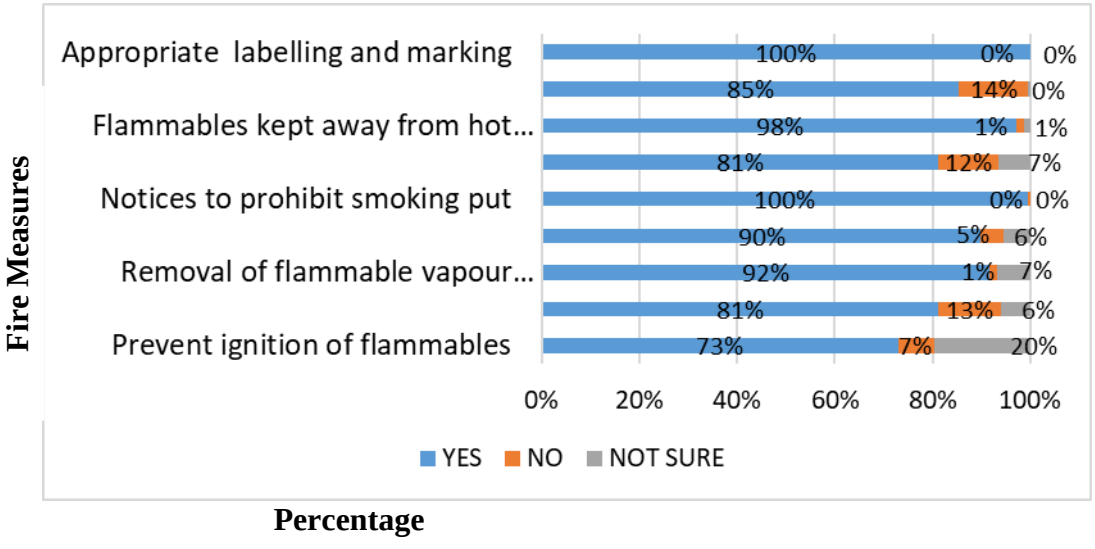


**Figure 4.7: Workers response to fire safety measures**

The study discovered that 84% of manager's response indicated that fire extinguishers were being serviced as required and 66% agreed on regular inspection on fire alarm system as shown in figure 4.3.3. However 56% of mangers response indicated that there were no documentation of fire incidences. It was however noted with concern that 30% of manager's response were not sure whether the fire safety audits were conducted annually as required by the law. Also 30% had collectively agreed on non-implementation of safety policy. This is a failure by senior management who are mandated to support and implement the fire policy alongside making sure fire audits are done annually as required by the law. This data was found to be reliable with Cronbach's alpha of 0.734 for management and 0.670 for workforce as shown in appendix VI and VII respectively.

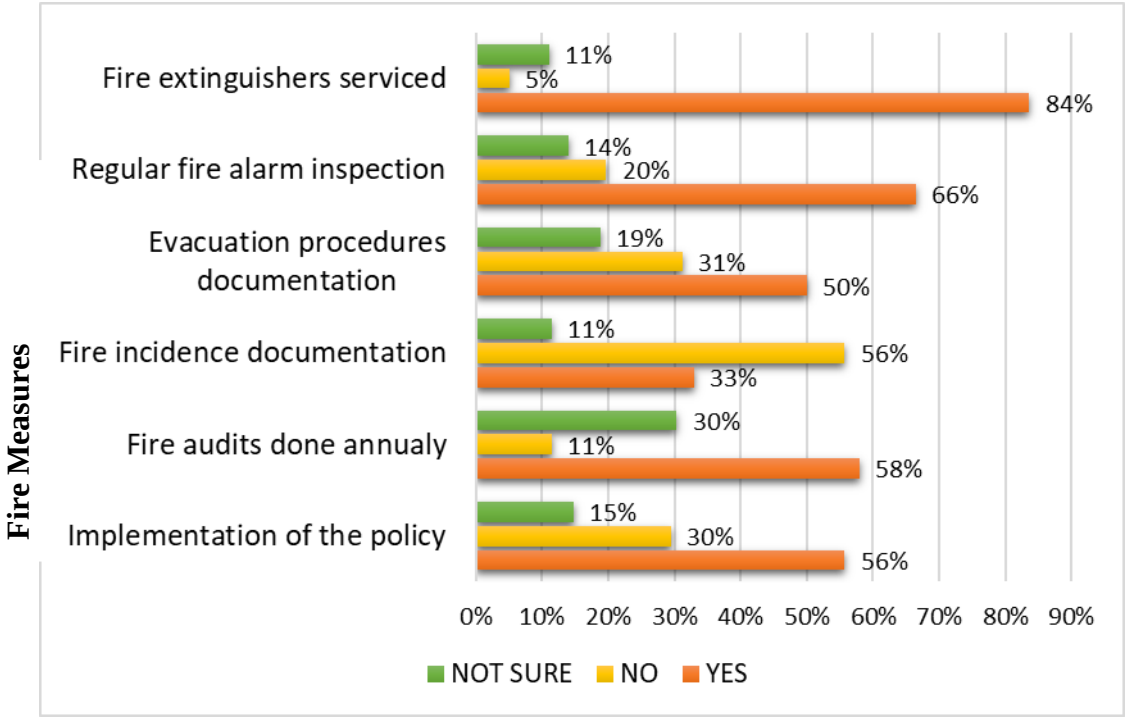


**Figure 4.8: Management response to fire safety measures**

### 4.3.1 Comparison of fire safety measures in industries

The study sought to find any significant relationship between place of location and the fire safety measures put in place and found there was a statistical significance in servicing of fire extinguishers and regular inspection of fire alarms with $x^2$ (df=2) =18.924 since p<.000 and $x^2$ $x^2$ (df=2) =19.502 since p<.000 respectively between kariobangi and industrial area. There was also a significant association in safe handling and transportation of flammables between Industrial area (86.2%) and Kariobangi light industries (64.7%) at 95% confidence level with $x^2$ (df=2) =12.901 since p<.000 as shown in appendix X

### 4.4 Fire safety awareness

Fire safety awareness is a key component in terms of fire disaster management as workers decision in case of an emergency will be a factor of deciding their safety. The responses of both management and workforces on fire safety awareness in place are represented in a frequency analysis table 4.3 using Likert scale for comparison.

**Table 4.3: Essentials fire safety awareness**

| **Questions** | **Frequencies** | | | | |
|---|---|---|---|---|---|
| | ***Yes*** | **No** | **Not Sure** | **Mean Index** | **Rank** |
| Visitors awareness | 33 | 72 | 17 | 1.87 | 1 |
| Aware of fire risk reduction rules | 38 | 174 | 6 | 1.85 | 2 |
| Have read fire safety policy | 52 | 163 | 3 | 1.78 | 3 |
| Fire safety procedure posted | 211 | 7 | 0 | 1.76 | 4 |
| Presence of fire safety policy | 89 | 22 | 11 | 1.36 | 5 |
| Sufficient training and instructions | 89 | 30 | 3 | 1.3 | 6 |
| **Aware of fire rescue services** | **121** | **1** | **0** | **1.01** | **7** |

The results revealed that most of paint industries had put in place awareness measures to ensure all workers are well enlighten on fire safety. Workers awareness on fire rescue services was leading with 99% mean index 1.01, sufficient training and instructions (73% mean index 1.3), Presence of fire safety policy (73% mean index 1.36), However majority of the workers were not aware of fire risk reduction rules (79.8% mean index 1.85) and have not read the fire policy (75% mean index 1.78). The study also showed that 59% of the industries had not put fire risks and general fire precautions awareness to visitors and only 27% had the awareness program. This data was statistical reliable with (Cronbach's alpha 0.496) for management and (Cronbach's alpha 0.541) for workforce on awareness level as shown in appendix VI and VII respectively.

A greater number of workers had sufficient training which conform to those of Okungu (2006) who recommended appropriate training in fire disaster preparedness for all workers.

The study also established that the workers had full knowledge of the fire extinguishers in regard to their location, accessibility and distribution as per risk factors in the workplace as shown in figure 4.9. This shows proper awareness on fires extinguishers was properly done and will help in case of a fire eventuality.

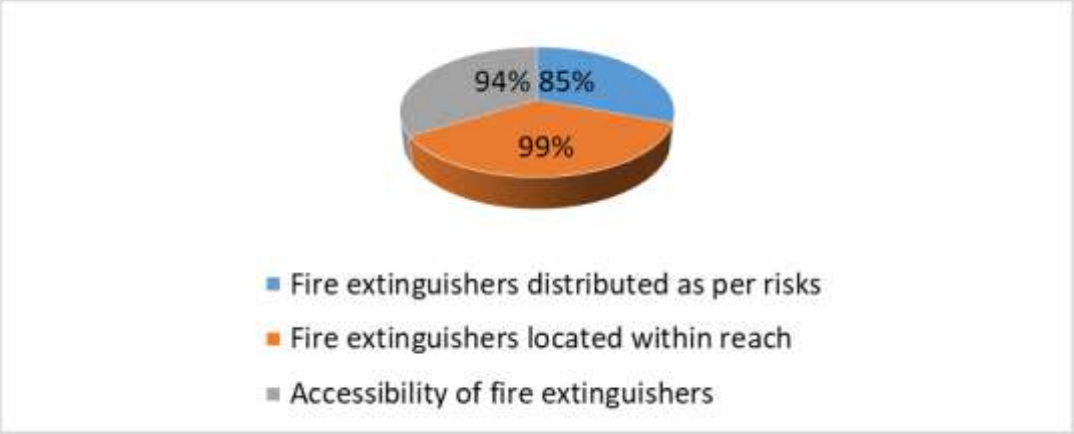


**Figure 4.9: Workforce response on fire extinguishers**

### 4.4.1 Comparison of fire safety awareness

On workforce fire safety awareness, the study revealed that all workers in Kariobangi light industries area have not read the fire safety (100%) unlike Industrial area where 31.1% have read it and this association was statistically significant with $x^2$ (df=2) =22.464 since p<.000. On awareness of fire risk reduction rules, Only 2% of Kariobangi light industries workers and 22% of Industrial area workers were aware of the fire risk reduction rules and this association was statistically significant with $x^2$ (df=2) =16.308 since p< 0.000. Majority of industries in Kariobangi light industries area had not put safety awareness for visitors (73.9%) unlike Industrial area where 33% had visitors awareness and this association was statistically significant with $x^2$ (df=2) =11.736 since p<.003. In spite of Industrial area workers showing more safety awareness, its evident that 67% of the workers have not read the policy and 76.6% are not aware of fire risk reduction rules as shown in appendix XI hence more focus should be put in fire safety awareness.

The study showed that 73% of the workplaces had fire safety policy and on the other hand 75%of the workers have not read it as shown in figure 4.10.

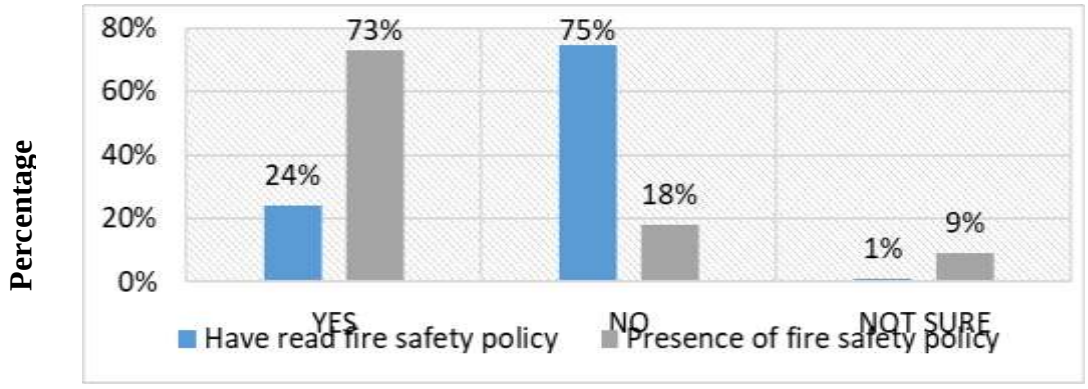


**Figure 4.10: Workers response on presence of fire policy and reading.**

### 4.5 Fire safety preparedness

Fire safety preparedness is an integral part in fire safety. This study sort to find out how well paint industries in Nairobi were prepared in case of fire occurrence. It revealed that most of the industries had average (60%) and satisfactory (75%) compliance in fire preparedness. Slightly below fifty percent (47%) workplaces had average compliance on means of emergency communication while 43% of workplaces had satisfactorily complied with water storage for extinguishing fire as shown in figure 4.11.

On compliance of fire escape exits and fire appliances, 23% of the workplaces had good (90%) compliance each and none had poor compliance. The study also revealed that 33% of workplaces had poor compliance in installation of fire detectors while Means of evacuation and communication had complied by only 10% which is poor. Comparing place of location and the safety preparedness, the study showed there is no statistical significance relation between workplaces in Kariobangi light industries and Industrial area. The research reliability test on fire safety preparedness in the checklists was found to be (Cronbach's alpha 0.903) signifying the data is reliable as shown in appendix V.

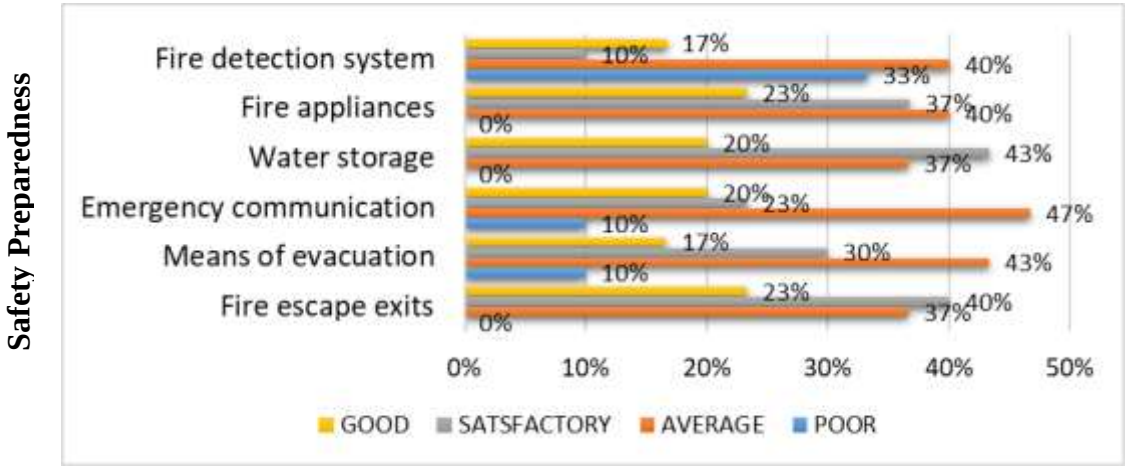


**Figure 4.11: Workplace fire safety preparedness**

The responses of both management and workforces on fire safety preparedness put in place in the paint industries are represented in a frequency analysis table using Likert scale for comparison as shown in table 4.4.

**Table 4.4: Workers response on fire preparedness**

| Fire Preparedness Factors | Yes | No | Not Sure | Mean Index | Rank |
|---|---|---|---|---|---|
| Evacuation of disabled | 8 | 100 | 14 | 2.05 | 1 |
| Presence of fire suppression system installed | 52 | 119 | 47 | 1.98 | 2 |
| Escape routes obstructed | 26 | 191 | 1 | 1.89 | 3 |
| Presence of emergency lighting system during evacuation | 68 | 108 | 42 | 1.88 | 4 |
| Periodic fire drills done | 44 | 60 | 18 | 1.79 | 5 |
| Presence of fire detection and warning measures | 82 | 118 | 18 | 1.71 | 6 |
| Functional firefighting team | 80 | 30 | 12 | 1.44 | 7 |
| Presence of assembly point | 121 | 1 | 0 | 1.02 | 8 |
| Presence of alarm system | 216 | 1 | 1 | 1.013 | 9 |
| Presence of exit signs | 217 | 1 | 0 | 1.004 | 10 |
| Presence of enough fire extinguishers | 122 | 0 | 0 | 1 | 11 |
| Presence of escape routes | 218 | 0 | 0 | 1 | 12 |

The results show the paint industries have good fire safety preparedness measure in place to ensure safety in case of any fire occurrence. With presence of escape routes and enough fire assembly points leading at 100% and mean index 1 each, presence of assembly point (99% mean index 1.02) and functional firefighting team at 66% mean index 1.44. The study also showed majority had their escape routes not obstructed (87.2 % mean index 1.89),had not put evacuation systems for disabled persons (82% mean index 2.05 )as well as not installed fire detection systems(54.1 % mean index

1.71), and suppression systems(54.6% mean index 1.98). 11.9% of workplaces had their escape routes obstructed which is a fire risk factor in terms of inaccessibility to emergency escape routes in case of any fire eventuality. The escape routes must remain structurally intact and smoke free to allow safe passage of occupants from the building. (Torero et al, 2012).This data was found to be statistically reliable with (Cronbach's alpha 0.735) for management and (Cronbach's alpha 0.648) for workforce as shown in appendix VI and VII.

### 4.5.1 Statistical significance comparison for fire safety preparedness

Generally, all the industries have poor preparedness in evacuation of disabled (7%), installation of fire suppression (24%), fire detection (38%) and emergency lighting (31%). The study revealed that 44% of industrial area workplaces have conducted periodic fire drills while in Kariobangi light industries none of the workplace had conducted fire drills and this association was statistically significant with $x^2$ (df=2) =17.341 since p<.000. Also 40% of industrial area workplaces had installed emergency lighting system while only 1.9% had done that in Kariobangi light industries and this association was also statistically significant with $x^2$ (df=2) =28.166 since p<.000. Inspite of both industries having poor evacuation for disabled persons, Kariobangi light industries workplaces had only 3.9% compliance while industrial area had 23.3% compliance in evacuation of disabled persons and this association was statistically significant with $x^2$ (df=2) =10.845 since p<.004. It was however noted that only 1.9% of Kariobangi light industries workplaces had installed fire suppression system unlike 30.5% of industrial area and this association was also statistically significant with $x^2$ (df=2) =18.337 since p<.000 as shown in appendix XII. The study also revealed that all workplaces (100%) had escape routes with 12% obstructing the escape routes which is a risk factor in fire preparedness.

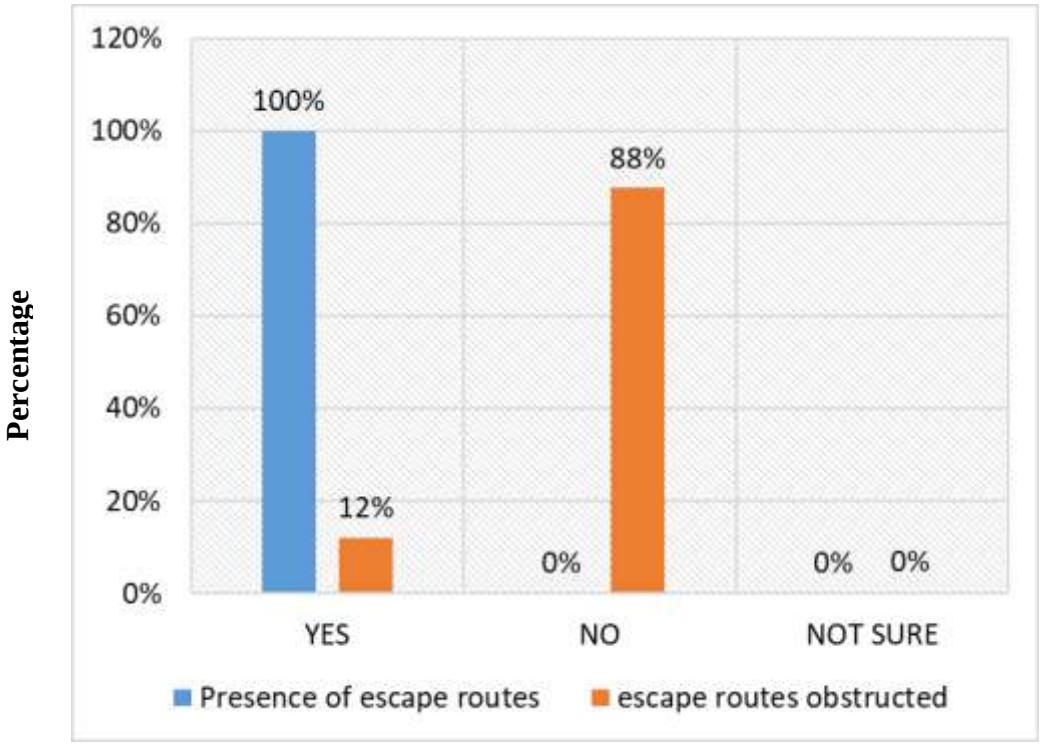


**Figure 4.12: Workers response to presence of escape routes and their obstruction.**

### 4.6 Fire safety compliance

The study also sought to establish whether the workplaces were complying with the fire risk reduction rules. The data from the checklist shows 60% of workplaces have poor compliance in notification of fire occurrences, 23% had not done fire safety audits and 20% had no fire safety policies. In spite of that, slightly above fifty percent have (54%) have complied by satisfactory and above on maintenance of fire extinguishers. The research reliability test on fire safety compliance in the checklists was found to be (Cronbach's alpha 0.882) signifying the data is reliable.

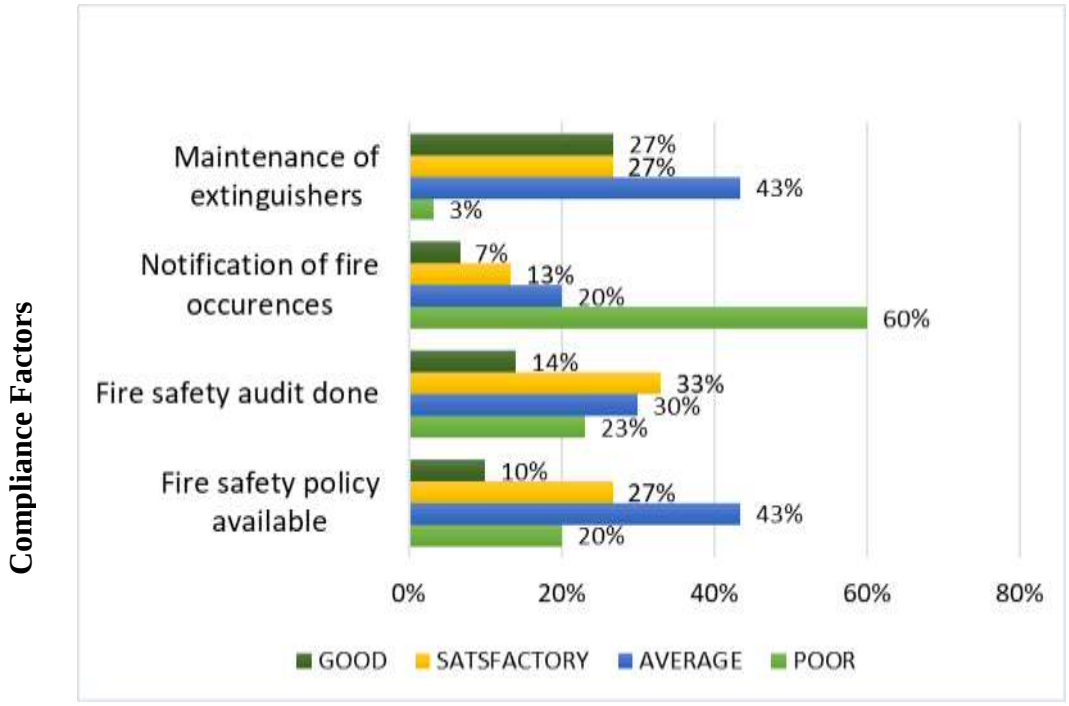


**Figure 4.13: Compliance with fire risk reduction rules.**

The data from management showed that fire safety compliance on implementation of fire safety policy was at 56%, regular fire alarm inspection at 66% and annual fire audits was at 58% as displayed in figure 4.14.This shows there is room for improvement to ensure that they comply more that 75%.It was however noted with concern that 30% of the workers were not sure whether the fire audits were done or not and this shows poor awareness of fire safety procedures. The reliabity test of this data was 0.819 (Cronbach's alpha) as illustrated in appendix VI. Workplaces should enlighten their workers when organizing such procedures as well as get more advice from the fire auditors when they are conducting physical inspections in their workstations.

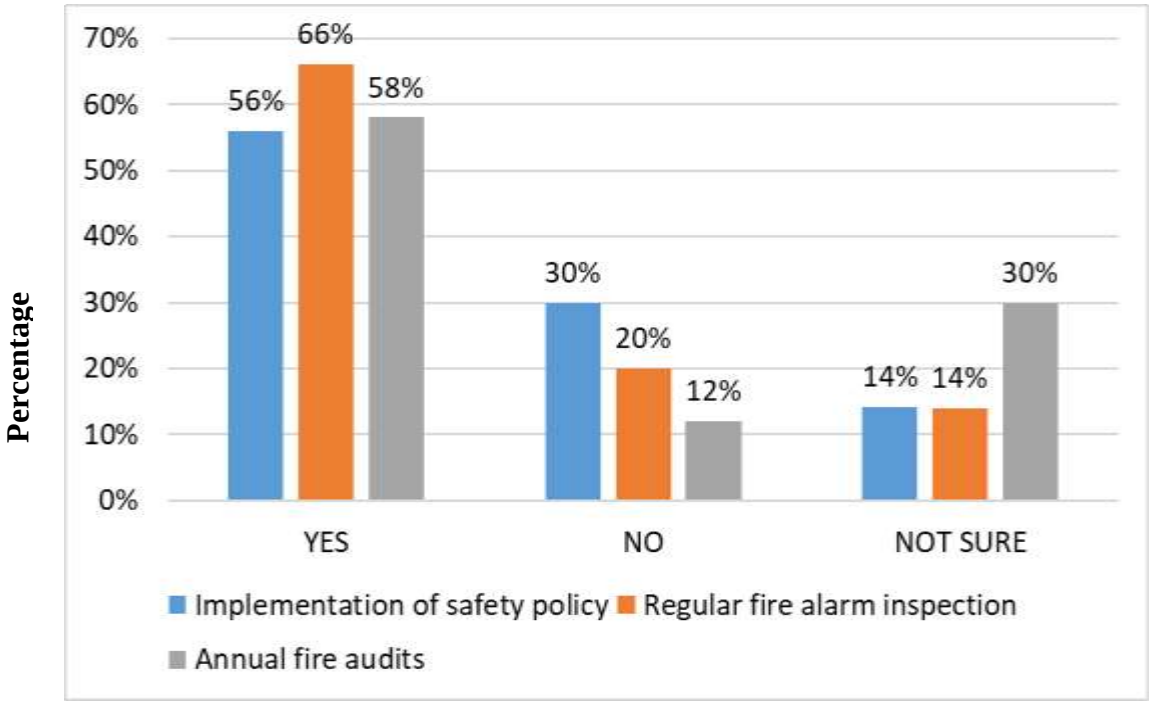


**Figure 4.14: Management response to fire safety compliance**

### 4.6.1 Statistical significance comparison for fire safety compliance

The study revealed that 73.7% of industrial area workplaces conducted regular fire alarm inspection unlike Kariobangi light industries area where only 34.7% conducted the inspections and this association is significant with $x^2$ (df=2) =19.502 since p<.000. The study also revealed that 88.9% of industrial area service fire extinguishers often unlike Kariobangi light industries area where 60.9% does servicing of fire extinguishers and this association was statistically significant with $x^2$ (df=2) =18.924 since p<.000 as shown in appendix XIII

### 4.7 Factors affecting implementation of fire risk reduction rules

According to the fire risk reduction rules, majority (71%) of the workforce are in agreement that there is lack of information about fire safety. A greater number of workers (78%) believe there is enough funds to cater for fire safety.40% of workforce agree that there is lack of comprehensive fire safety policy to guide them through fire safety implementation which needs to be addressed as shown in figure 4.15.

77% of workforce agree that there is lack of support from management in regard to implementation of fire risk reduction rules while 70% are in agreement that there is absence of skilled workforce as well as there is inappropriate technology (68%) to help in fire safety in workplaces. This data was found to be statistically reliable with (Cronbach's alpha 0.830) as shown in appendix VII. These are concerns which need to be addressed to ensure better fire safety in all workplaces.

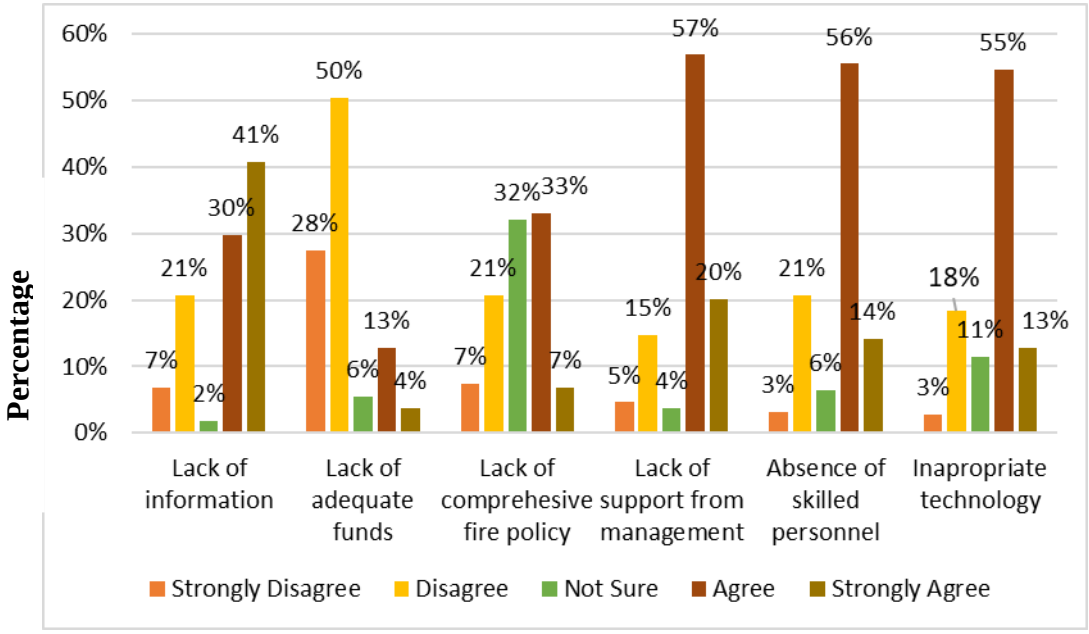


**Figure 4.15: Factors affecting implementation of FRRR**

### 4.7.1 Statistical significance of workplaces location and compliance factors

The researcher also sought to find out the significant associations between workplace locations and the various compliance factors and the study revealed that they all have significant relationship as shown in appendix I.

### 4.7.2 Comparison between the various responses between management and workforce

A two independent samples t-test was carried out to determine if there was significant difference between management and workforce responses on fire safety measures, fire safety preparedness and fire safety awareness in the industries. The mean value and standard deviation for each category (fire safety measures, preparedness and awareness) are displayed in Table 4.5.

The study revealed no significant difference between the management and workforce in responses about fire safety measures (P-value=0.238>0.05); fire safety preparedness (P-value=0.103>0.05) and fire safety awareness (P-value=0.960>0.05) as shown in table 4.6 below.

**Table 4.5: Group Statistics for management and workforce**

| | Groups | N | Mean | Std. Deviation |
|---|---|---|---|---|
| Fire safety measures | Management | 218 | 1.3555 | .21038 |
| | Workforce | 122 | 1.3866 | .26786 |
| Fire safety preparedness | Management | 218 | 1.5275 | .20706 |
| | Workforce | 122 | 1.5717 | .28834 |
| Fire safety awareness | Management | 218 | 1.4140 | .20166 |
| | Workforce | 122 | 1.4126 | .32652 |

**Table 4.6: Statistical significance between management and Workforce**

| Variable | t-value | P-value |
|---|---|---|
| **Fire Safety measures** | 1.183 | 0.238 |
| **Fire safety preparedness** | 1.633 | 0.103 |
| **Fire safety awareness** | 0.050 | 0.960 |

The above data explains why in case of fire incidence, the impact is very high on the facilities as both workforce and management in terms of coordination to evacuate and suppress the fire is very wanting.

### 4.7.3 Statistical significance on workforce responses to fire safety.

Group statistics for different industries are shown in table 4.7.

**Table 4.7: Group Statistics for different industries**

| Variables | Industries | N | Mean | STD. Deviation |
|---|---|---|---|---|
| Fire safety measures | Kariobangi Light Industries | 51 | 1.4779 | .12172 |
| | Industrial Area | 167 | 1.3181 | .21768 |
| Fire safety preparedness | Kariobangi Light Industries | 51 | 1.5515 | .18570 |
| | Industrial Area | 167 | 1.5202 | .21314 |
| Fire safety awareness | Kariobangi Light Industries | 51 | 1.5245 | .10314 |
| | Industrial Area | 167 | 1.3802 | .21227 |
| Compliance with FRRR | Kariobangi Light Industries | 51 | 3.8333 | .41899 |
| | Industrial Area | 167 | 3.1587 | .79801 |

From the study findings, there was a significant difference between industries in response to fire safety measures from the workforce (P-value=0.000<0.05); fire safety awareness (P-value=0.000<0.05) and compliance with FRRR (P-value=0.001<0.05) however there was no statistical significance between industries in response to fire safety preparedness (P-value=0.347>0.05) as illustrated on Table 4.8.

**Table 4.8: Statistical significance for different industries**

| Variable | t-value | P-value |
|---|---|---|
| **Fire Safety measures** | 6.670 | 0.000 |
| **Fire safety preparedness** | 0.943 | 0.347 |
| **Fire safety awareness** | 4.682 | 0.000 |
| **Compliance with FRRR** | 7.920 | 0.001 |

### 4.8 Compliance level in observing FRRR

The fourth objectives of this study was to establish the level of compliance gaps in observing the Fire Risk Reduction Rules legal notice 59 in paint industries. The research used observational check list to rank the fire risks and measures put in place as per the provisions of the fire risk reduction rules (FRRR L.N 59 2007 through conducting a facilities tour with the safety managers of the paint industries.

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

Compliance with provision of Fire Risk Reduction Rules was looked at using four components including; fire risks compliance, measures put in place, fire preparedness and management control. Scores were averaged for each component and results displayed in the tables 4.9-4.12.

### 4.8.1 Fire risks compliance

Fire risks compliance was composed of location of highly flammable substances; storage of flammable substances; marking and labelling storage for flammables; handling of flammables; ventilation for flammables storage; removal of flammables where there is heat; removal of waste; machinery layout and handling of electrical equipment as indicated in table 4.9.

**Table 4.9: Fire risks compliance**

| | **Fire Risks Compliance** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|---|
| FRRR | Location of highly flammable substances | | | √ | |
| FRRR | Storage of flammable substances | | √ | | |
| FRRR | Marking and labelling storage for flammables | | | | √ |
| FRRR | Ventilation for flammables storage | | √ | | |
| FRRR | Machinery layout | | √ | | |
| FRRR | Handling of electrical equipment | | | √ | |
| **Average Score** | | 2.6 | | | |

The overall score was 2.6 as displayed in Table 4.9 which indicates that in terms of fire risks compliance, most of the paint industries are average because they have complied with at least 60 % of the requirements of the Rules.

### 4.8.2 Fire measures in place

Looking at fire measures put in place in the paint industries, the following factors were considered. Removal of flammables where there is heat; control of spread of smoke; Removal of waste; Safe Handling of flammables; Fire alarm and detection system and House keeping the overall score of all these factors was 2.0 as displayed

in Table 4.10. This means that in terms of fire measures in place, the paint industries are average since compliance is at least 60% of the requirements of the Fire risks reduction rules.

**Table 4.10: Fire compliance measures**

| | | Fire Measures In Place | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| **i.** | FRRR | Removal of flammables where there is heat | | | √ | |
| **ii.** | FRRR | Control of spread of smoke | | | √ | |
| **iii.** | FRRR | Removal of waste | | √ | | |
| **iv.** | FRRR | Safe Handling of flammables | | √ | | |
| **v.** | FRRR | Fire alarm and detection system | | √ | | |
| **vi.** | FRRR | Housekeeping procedures | | √ | | |
| **Average Score** | | | 2.0 | | | |

### 4.8.3 Fire preparedness

Fire preparedness was composed of fire escape routes; Fire fighting appliances ; means of evacuation; means of emergency communication; emergency lighting; fire alarm and detection system; fire evacuation drills and fire assembly points; Emergency suppression; Water storage with an overall score of 2.6 as displayed in Table 411. This means that in terms of fire Preparedness paint industries have average compliance of at least 60% of the requirements of the Rules.

**Table 4.11: Compliance in fire preparedness**

| | Fire Prepairedness | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| **i.** FRRR | Fire escape routes | | | √ | |
| **ii.** FRRR | Fire fighting appliances | | | √ | |
| **iii.** FRRR | Means of evacuation | | | √ | |
| **iv.** FRRR | Means of emergency communication | | √ | | |
| **v.** FRRR | Emergency lighting | | √ | | |
| **vi.** FRRR | Maintenance and Servicing of fire extinguishers | | | √ | |
| **vii.** FRRR | Fire evacuation drills | √ | | | |
| **viii.** FRRR | Fire assembly points | | | √ | |
| **ix.** FRRR | Emergency suppression | | √ | | |
| **x.** FRRR | Water storage | | | | √ |
| **Average Score** | | 2.6 | | | |

### 4.8.4 Management Compliance

Management Control was measured using; fire safety policy availability; fire safety audit; trained fire fighting team; fire evacuation procedures available; good housekeeping and notification of fire occurrence with an overall score of 2.3 as displayed in Table 4.12 Therefore, in terms of Management compliance paint industries were average since compliance was at least 60% of the requirements of the Rules.

**Table 4.12: Management Compliance**

| | FRRR Compliance | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| **i.** FRRR | Fire safety policy available | | √ | | |
| **ii.** FRRR | Fire safety audit | | | √ | |
| **iii.** FRRR | Trained fire fighting team | | | √ | |
| **iv.** FRRR | Fire evacuation procedures available | | | √ | |
| **v.** FRRR | Good housekeeping | | √ | | |
| **vi.** FRRR | Notification of fire occurrence | √ | | | |
| **Average Score** | | 2.3 | | | |

# CHAPTER FIVE

# CONCLUSION AND RECOMMENDATION

This chapter gives the conclusion and the recommendation of the research study based on the findings from the collected data. Conclusions are derived from results of the analysis.

## 5.1 Conclusion

This study has established that majority of workers are skewed towards male, with more male representation in both management and workforce. It also found that most of the workers are well educated which would make them understand OSH issues as per the OSHA act 2007. Also, it's significant to note that some few managers are of primary level who have worked for more than eight years showing their experience of work have made them experts in paints hence they are given management position in various sections.

This study also revealed that there is high turnover in workforce and it's high on female than male workers. It was significantly evident that majority of the learned workers have shown high turnover either leaving for greener pastures or change of careers.

With the high workers turnover, it means more new workers are being recruited often and may not have the experience of handling flammables and as a result increase the risks of causing fires out of ignorance and negligence. Also more finance may be required to train the new workers on fire safety which is a cost implication to the company.

The first objective of the study sought to find out the fire risks found in the workplaces. The study evidently showed that fire occurrences have occurred in majority of paint industries and the major fire risks factors were mainly storage, handling and transportation of flammables and handling electrical equipment's in workplaces and the fire risks are in both raw materials and end products. This study has shown that most of the workplaces had complied with the fire risks reduction

rules at 60% in regard to storage of flammables, safe handling, labelling and transportation of flammables which is average and needs to be improved. The study has also found that handling of electrical equipment was wanting and needs to be improved because it can be one of the causes of electrical fires and this agrees with Gold and Koigi, 2009 who said that majority of fires in workplaces are caused by faulty electrical appliances and exposed cables. Also, poor housekeeping methods can increase the chances of fire occurrences hence the need to improve on housekeeping in workplaces. On workplace comparison, it was evident that most of workplaces in industrial area had good electrical safety and that flammables were kept in good ventilation, well labelled and marked as well as handled and transported safely. However, storage and handling of flammables in Kariobangi light industries was wanting which is a major fire risk factor. The study also found that most of the workplaces have experienced fire occurrences however, recording of fire incidences was poor hence preventing statistical information on monitoring fire occurrences.

The second objective of the study sought to find fire safety and awareness measures put in place in workplaces. Most of the paint industries were found to comply with at least 50% on handling of electrical equipment's, control of smoke, maintenance of fire appliances, housekeeping procedures, color coding and distributing fire appliances as per fire risks which is seen to be average compliance. Conjointly, most had ways to prevent ignition of flammables, safe handling and transportation of flammables and removal of flammable vapor from ignition. However compliance was poor on machine layout resulting to blockage of pass ways and exits which is a fire risk factor and needs to be addressed to ensure that the pass ways and exits are cleared for easy evacuation in case of any fire eventuality.

On fire safety awareness, the study revealed that majority of workers were well trained on fire safety and the workplaces had functional firefighting teams. However, there was poor fire safety awareness to visitors and contractors working within the work premises. A greater number of workers were not aware of fire risks reduction rules and had not read the fire safety policy in spite of the policy being there. Most workers were aware of evacuation procedure and fire rescue services as well as locations of fire emergency exits in their workplaces since they were well marked,

this supports Mostue (2001) who documented that awareness level of the fire safety management will help reduce the losses and damages suffered during fire outbreaks. It was however noted that some of fire emergency exits were sometimes blocked by packages of raw materials and finished products which could jeopardize evacuation in case of any emergency.

It was significantly noted that Industrial area workplaces had put more fire safety measures as compared to Kariobangi light industries mainly on functional fire fighting team, safe handling and transportation of flammables hence law enforcers should focus compliance on those areas.

The third objective of this study was to establish levels of fire safety preparedness. The research found that majority had complied on averagely (60%) mainly in sufficient fire exits and presence of evacuation procedures. It was evident there was adequate water storage and enough fire fighting appliances to help fight fire and this is in agreement with CFOA (2006) that fire safety appliances are quite essential in fighting and lack of these facilities would lead to major disasters. On the other hand, there was poor compliance in installation of fire detectors, emergency lighting system, emergency suppression system and evacuation of disabled persons both hearing and physical disability.

The study has also found that most of the workplaces do not conduct fire drills as required by the regulation. This is a wakeup call for the enforcers to ensure all workplaces comply with this requirement. The fire drills help eliminate mistakes that would otherwise occur during a real emergency. Evacuation procedures were well posted and most of the workers knew of actions to take in case of fire outbreak thus supporting Salvano (2002) recommendation that coordination is an essential ingredient in a disaster preparedness plan which means arrangements and preparations should be put in place not only to prevent a disaster, but also to be implemented once a disaster occurs. The study established most facilities had fire alarms which were audible enough and were regularly inspected. However, there is need to ensure the deaf persons as well are alerted in case of any fire eventuality. They can be alerted by signages or light signals. Most of the workplaces had enough

fire extinguishers which were well serviced and distributed as per fire risks and were easily accessible which is very important in fire safety preparedness.

The final objective was to find compliance levels with the fire risk reduction rules, the study showed Most of the workplaces had Fire safety policies which were being implemented partly and that only few workers had read the policy. This means there is lack of proper communication which needs to be improved. Majority comply with the requirement of conducting annual audits, however quite a number of workers were not sure whether the audits are done annually or not. Workplaces should be well sensitized on the importance of conducting annual fire safety audits and rectifying the recommendations highlighted by the fire safety auditors.

The study also sought to find factors affecting implementation of fire risk reduction rules in workplaces, majority of the workers agreed that there was lack of information on fire safety, lack of comprehensive fire safety policy, lack of support from management and lack of information for fire safety compliance, lack of appropriate technology as well as skilled workforce.

Based on the results of the study we accept the hypothesis that Fire safety compliance measures being undertaken by paint industries in Nairobi have led to reduction of fire incidences.

### 5.2 Recommendation

Based on the study, the data obtained from the research was only for the Nairobi County where most paint industries are situated. However, there is need for more research to be done from all other counties in the country to understand the magnitude of the fire safety concerns in the paint industry at large.

Due to high turnover of workers as the research has revealed, it’s recommended that further studies be done to find out why there is high workers turnover and find ways of generally maintaining workers who in turn will gain experience in handling paints hence prevent and control fire occurrences.

Its recommended that with the high risk of fire from the storage, transportation and handling of flammables, daily fire risk assessments on job assigned should be emphasized to help identify the fire risks and prevent or/and control them as emphasized by The Health and safety executive (2006) stating that Fire risk assessment is a critical activity that helps in the protection of workers as well as bringing an institution to be in compliance with the law of the land.

The study suggests that paint workplaces to have daily, weekly and monthly electrical inspection/maintenance schedules done by the electricians so that they can be able to correct faulty electrical appliances and electrical exposed cables which can cause electrical fires. Also Workplaces should record all fire incidences to help researchers get statistical information and also help monitoring fire incidences with the aim of finding root causes of fire and preventing future occurrences.

The study advocates for proper monitoring of measures put in place to control /prevent fire occurrences by both managements and government officials in regard to fire safety. Regular inspection should be done often by the relevant government agencies responsible for fire safety in paint industries as significant facilities had low compliance levels. Majorly law enforcers to focus on the few facilities which do not have adequate fire extinguishers and are not well serviced as well as not distributed as per the fire risks to ensure they comply.

The study proposes paint industries to institute mandatory fire safety induction programs to all new workers as well as to visitors and outside contractors to ensure fire safety awareness is achieved. Workplaces should also ensure continuous fire safety training to enhance awareness for both new and old employees, provide fire safety information to workers as well as having appropriate technology to enhance fire safety at work.

The study suggests proper systems to be put to aid evacuation of disabled persons both hearing and physical disability. There is need for law enforcers to ensure all paint industries have emergency lighting systems, alarm system, fire suppression systems and fire detection installed as well as ensure their routine inspection as per the law, this will help in evacuation as well as putting off fires as soon as it occurs

and ensure good fire safety preparedness. Also workplaces should ensure all emergency exits are not blocked but clear for easy movement.

The study urges the managements to ensure all workers read and understand the fire safety policy so they can be part of the implementation process which will enhance fire safety in the workplaces.

The study recommends that DOSHS officers to enforce the law as per fire risks reduction rules legal notice 59 and strategize on compliance campaign including conducting workshops, publishing essential fire safety rules among others in all paint industries within Nairobi County. It is further recommended that the officers inspect workplaces to ensure they comply with conducting annual fire audits, fire safety training and periodic fire drills because these will help the employees understand what to do in case of any fire emergencies.

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## APPENDICES

**Appendix I: Statistical significance of workplace location and compliance factors**

| Variable | Category | Place of location | | |
|---|---|---|---|---|
| | | Industrial area | Kariobangi light industries | Chi-Square |
| Lack of comprehensive policy | Strongly Disagree | 9% | 2% | $\chi^2$=27.939, df=4, p=.000 |
| | Disagree | 25% | 6% | |
| | Not sure | 35% | 21% | |
| | Strongly Agree | 26% | 57% | |
| | Agree | 5% | 14% | |
| Lack of support from management | Strongly Disagree | 6% | 0% | $\chi^2$=21.127, df=4, p=.000 |
| | Disagree | 19% | 2% | |
| | Not sure | 2% | 8% | |
| | Strongly Agree | 57% | 55% | |
| | Agree | 16% | 35% | |
| Absence of skilled personnel | Strongly Disagree | 4% | 0% | $\chi^2$=17.350, df=4, p=.002 |
| | Disagree | 25% | 6% | |
| | Not sure | 8% | 2% | |
| | Strongly Agree | 52% | 68% | |
| | Agree | 11% | 24% | |
| Inappropriate technology | Strongly Disagree | 4% | 0% | $\chi^2$=12.127, df=4, p=.002 |
| | Disagree | 22% | 6% | |
| | Not sure | 14% | 4% | |
| | Strongly Agree | 50% | 68% | |
| | Agree | 10% | 22% | |
| Lack of adequate funds | Strongly Disagree | 31% | 17% | $\chi^2$=12.225, df=5, p=.032 |
| | Disagree | 47% | 61% | |
| | Not sure | 7 % | 0% | |
| | Strongly Agree | 13% | 14% | |
| | Agree | 2% | 8% | |
| Lack of information | Strongly…Disagree | 9% | 0% | $\chi^2$=25.522, df=4, p=.000 |
| | Disagree | 27% | 0% | |
| | Not sure | 2% | 2% | |
| | Strongly Agree | 26% | 43% | |
| | Agree | 36% | 55% | |

**Appendix II: Check List**

The following checklist will be used to rate your company's compliance rate with provisions of the fire risk reduction rules legal notice 59 through conducting a facility survey with the manager in charge.

**Key rating**

4 – Good: Complies to at least 90%of the requirements of the rules

3 –Satisfactory: Complies to at least 75%of the requirements of the rules

2 – Average: Complies to at least 60%of the requirements of the rules

1 – Poor: Compliance is below 60%of the requirements of the rules

**Compliance with provisions on:**

| NO. | QUESTIONS | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 1 | Location of highly flammable substances | | | | |
| 2 | Storage of highly flammable substances | | | | |
| 3 | Marking and labeling for flammables | | | | |
| 4 | Handling of flammables | | | | |
| 5 | Ventilation for flammable storage | | | | |
| 6 | Removal of flammables where there is heat | | | | |
| 7 | Housekeeping procedures | | | | |
| 8 | Removal of waste | | | | |
| 9 | Machinery layout | | | | |
| 10 | Handling of electrical equipment's | | | | |
| 11 | Fire escape exits | | | | |
| 12 | Control of spread of smoke | | | | |
| 13 | Means of evacuation | | | | |
| 14 | Means of emergency communication | | | | |
| 15 | Fire detection system | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 16 | Firefighting appliances | | | | |
| 17 | Maintenance of fire extinguishers | | | | |
| 18 | Color coding of pipes | | | | |
| 19 | Water storage | | | | |
| 20 | Fire safety policy available | | | | |
| 21 | Fire safety audit | | | | |
| 22 | Notification of fire occurrences | | | | |

**BRIEF NOTES**

**Appendix III: Workforce Questionaire**

**QUESTIONNAIRE ON EVALUATION OF FIRE SAFETY COMPLIANCE IN PAINT INDUSTRY, NAIROBI COUNTY**

**Consent to participate in the study**

Am valentine Ngenyi Mutuku, a student at Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya. I'm conducting a study on **Evaluation of fire safety compliance in paint industry in Nairobi County** in fulfilment of masters' degree in Occupational Safety and Health.

Your Company has been chosen among those to give a true representation in this study. I would appreciate if you participate in providing honest answers on the awareness and practice on fire safety compliance. This information is for academic purposes and is expected to provide information in regard to fire safety in the workplace. Whatever information you provide, will be treated with strict confidence and will not be shared with other participants, individuals or company. Participation in this study is voluntary and you may choose not to answer any individual question or all the questions. However I hope that you will participate in this study since your answer as one of the identified respondent is very important. Please feel free to ask any questions that you may have regarding the survey.

Signature of Respondent …… Date…….

| | | |
|---|---|---|
| Please return filled questionnaire to: | Valentine Ngenyi Mutuku<br><br>MSc Occupational Safety and Healthy<br><br>IEET | <br><br>Phone : 0723324307<br><br>E-mail :ngenyi@yahoo.com |

Kindly answer the following questions

NAME:

INSTITUTION:

**Part 1**

(Personal information on respondent)

1. Name of the respondent (optional)
   .....
2. Gender: Male ☐ ☐ Female
3. Highest completed level of education

   a) Primary level ☐ b) Secondary Level ☐ c) College Level (and above) ☐
4. How long have you worked in the institution?

   1. 0-4 YEARS ☐
   2. 4-8 ☐
   3. 8-12 ☐
   4. Over 12 yrs. ☐

**Part 2**

**The essential fire safety measures in paint industries**

The following section requests your input about the essential fire safety measures that are available in your company and your awareness. Please provide the answer to the best of your ability.

| NO. | QUESTIONS | YES | NO | NOT SURE |
|---|---|---|---|---|
| 1 | Are flammable liquids stored appropriately with good ventilation? | | | |
| 2 | Are flammables liquids well labeled and marked? | | | |
| 3 | Are measures in place to prevent dangerous flammable substances coming into contact with ignition sources? | | | |
| 4 | Are arrangements in place for the safe handling and transportation of dangerous substances? | | | |
| 5 | Are flammable materials kept away from hot surfaces and open flames? | | | |
| 6 | Are proper measures taken to remove flammable vapors from ignition sources? | | | |
| 7 | Are reasonable measures taken to prevent fires of | | | |

| | | | | |
|---|---|---|---|---|
| | electrical origin? | | | |
| 8 | Are notices put in place to prohibited smoking in-appropriate areas? | | | |
| 9 | Are there escape routes in the event of fire? | | | |
| | Are signs provided to indicate the emergency routes and exits? | | | |
| 10 | Are escape routes obstructed? | | | |
| 11 | Are the escape routes sufficient in relation to the number of people? | | | |
| 12 | Does the company have fire assembly points? If yes how many? | | | |
| 13 | Are arrangements in place to evacuate disabled persons? | | | |
| 14 | Are there emergency lighting systems provided during evacuation? | | | |
| 15 | Is the premises provided with adequate firefighting appliances? | | | |
| 16 | Are fire extinguishers located within reach? | | | |
| 17 | Are fire extinguishers selected and distributed according to the risks? | | | |
| 18 | Are extinguishers, hose reels and fire blankets readily accessible, unobstructed and ready for use? | | | |
| 19 | Is the premises provided with adequate fire detection and warning measures? | | | |
| 20 | Is the alarm audible throughout the building, and differentiated from other sounds? | | | |
| 21 | Are arrangements made for people with hearing disabilities? | | | |
| 22 | Are there fire safety procedures posted? | | | |
| 23 | Have you read your fire safety policy? | | | |
| 24 | Are there other fire suppression systems installed in the premises or parts of it? | | | |
| 25 | Are you aware of factories (Fire risk reduction) rules? | | | |
| 26 | Is the general defense against arson adequate? | | | |

Part 3

**Factors affecting the implementation of the fire risk reduction rules 2007**

Please provide the information below using the following scale where 5 represent strongly agree and 1 strongly disagree how your institution complies with the implementation of fire risk reduction rules legal notice 59

**Key rating**

5 – Strongly agree

4 –Agree

3 – Not sure

2– Disagree

1 – Strongly disagree

**Compliance with provisions on:**

| NO. | FACTORS | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 1 | The lack of information | | | | | |
| 2 | Lack of adequate funds | | | | | |
| 3 | Lack of comprehensive fire policy | | | | | |
| 4 | Lack of support from the management | | | | | |
| 5 | The absence of skilled personnel | | | | | |
| 6 | Inappropriate technology | | | | | |

**Appendix IV: Management Questionnaire**

**QUESTIONNAIRE ON EVALUATION OF FIRE SAFETY COMPLIANCE IN PAINT INDUSTRY, NAIROBI COUNTY**

**Consent to participate in the study**

Am Valentine Ngenyi Mutuku, a student at Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya. I'm conducting a study on **Evaluation of fire safety compliance in paint industry in Nairobi County** in fulfilment of masters' degree in Occupational Safety and Health.

Your Company has been chosen among those to give a true representation in this study. I would appreciate if you participate in providing honest answers on the awareness and practice on fire safety compliance. This information is for academic purposes and is expected to provide information in regard to fire safety in the workplace. Whatever information you provide, will be treated with strict confidence and will not be shared with other participants, individuals or company. Participation in this study is voluntary and you may choose not to answer any individual question or all the questions. However I hope that you will participate in this study since your answer as one of the identified respondent is very important. Please feel free to ask any questions that you may have regarding the survey.

Signature of Respondent …… Date…….

| | | |
|---|---|---|
| Please return filled questionnaire to: | Valentine Ngenyi Mutuku<br><br>MSc Occupational Safety and Healthy<br><br>IEET | <br><br>Phone : 0723324307<br><br>E-mail :ngenyi@yahoo.com |

Kindly answer the following questions

NAME:

INSTITUTION:

**Part 1**

(Personal information on respondent)

1. Name of the respondent (optional)
   .....
2. Gender: Male ☐ ☐ Female

3. Highest completed level of education

   a) Primary level ☐ b) Secondary Level ☐ c) College Level (and above) ☐

4. How long have you worked in the institution?

   1. 0-4 YEARS ☐
   2. 4-8 ☐
   3. 8-12 ☐
   4. Over 12 yrs. ☐

**PART 2 THE ESSENTIAL FIRE SAFETY MEASURES IN PAINT INDUSTRIES**

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

| NO. | QUESTIONS | YES | NO | NOT SURE |
|---|---|---|---|---|
| 1 | Does the workplace have a fire Safety Policy in place? | | | |
| 2 | Is the fire safety policy being implemented? | | | |
| 3 | Are procedures in place for summoning the fire and rescue service? | | | |
| 4 | Is there a suitable assembly point? | | | |
| 5 | Are there procedures in place for evacuation of disabled people who are likely to be present? | | | |
| 6 | Are persons employed to work in the premises provided with sufficient training and instruction? | | | |
| 7 | Does the workplace have a functional fire fighting team? | | | |
| 8 | Are action to be taken in the event of a fire known to | | | |

| | | | | |
|---|---|---|---|---|
| | the workers? | | | |
| 9 | Are fire drills carried out at periodic intervals? | | | |
| 10 | Are portable fire extinguishers and hose reels serviced by a competent person? | | | |
| 11 | Are there emergency lighting system to be used in case of fire ? | | | |
| 12 | Are there automatic fire suppression systems and are they regularly serviced by a competent person? | | | |
| 13 | Are procedures to be followed in the event of fire properly documented? | | | |
| 14 | Are fire audits and inspections done annually? | | | |
| 15 | What type of fire extinguishers are available in the workplace?(Please tick)<br><br>I. Water Type<br><br>II. Foam<br><br>III. ABC Dry Powder.<br><br>IV. Carbon Dioxide<br><br>V. Fire Blankets<br><br>Hydrant system | | | |
| 16 | Are there fire alarm systems? | | | |
| 17 | Are the fire alarm system regularly inspected by a competent person | | | |
| 18 | Do you have fire risks and general fire precautions made known to visitors/contractors? | | | |
| 19 | Have you experienced any fire incidence in this workplace? | | | |
| 20 | Are fire incidences recorded? | | | |
| 21 | How much water storage does the company have? | | | |
| 22 | Do you get any support from the government to implement fire safety compliance? | | | |

## Appendix V: Cronbach's Alpha on Checklists

### 1. FIRE RISKS

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .901 | .902 | 5 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Location of flammable substances | 9.57 | 8.737 | .808 | .734 | .869 |
| Storage of flammables | 9.60 | 8.248 | .830 | .721 | .863 |
| Markings and labels of flammables | 9.33 | 8.782 | .715 | .606 | .888 |
| Handling of flammables | 9.87 | 8.326 | .759 | .640 | .879 |
| Handling of electrical equipment's | 9.63 | 9.551 | .672 | .546 | .897 |

### 2. FIRE SAFETY MEASURES ON CHECKLISTS

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .882 | .888 | 6 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Removal of flammables where there is heat | 12.57 | 11.495 | .696 | .577 | .862 |
| Ventillation for flammable storage | 12.47 | 11.637 | .724 | .639 | .857 |
| Housekeeping procedures | 12.30 | 11.872 | .805 | .714 | .846 |
| Removal of waste | 12.40 | 11.628 | .715 | .567 | .859 |
| Control of spread of smoke | 12.37 | 12.930 | .695 | .570 | .865 |
| Color coding of pipes | 11.90 | 12.024 | .577 | .460 | .884 |

## 3. FIRE SAFETY PREPAREDNESS

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .903 | .906 | 6 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Fire detection system | 13.60 | 12.179 | .709 | .598 | .893 |
| Fire fighting appliances | 12.87 | 13.085 | .847 | .777 | .870 |
| Water storage | 12.87 | 14.602 | .596 | .369 | .904 |
| Means of emergency communication | 13.17 | 12.351 | .810 | .775 | .873 |
| Means of evacuation | 13.17 | 12.833 | .763 | .686 | .881 |
| Fire escape exits | 12.83 | 13.799 | .722 | .666 | .888 |

## 4. FIRE SAFETY COMPLIANCE

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .882 | .882 | 4 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Maintenance of fire extinguishers | 6.30 | 6.631 | .658 | .461 | .880 |
| Notification of fire occurrences | 7.40 | 6.041 | .746 | .578 | .848 |
| Fire safety audit done | 6.70 | 5.734 | .782 | .680 | .833 |
| Fire safety policy available | 6.80 | 6.097 | .794 | .704 | .830 |

## Appendix VI: Cronbach's Alpha on Management

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .765 | .754 | 19 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Gender of responder | 57.63 | 27.210 | -.117 | . | .778 |
| Level of education | 46.36 | 26.679 | -.025 | . | .779 |
| Worked duration | 37.08 | 30.935 | -.490 | . | .833 |
| Presence of fire safety policy | 57.48 | 22.648 | .622 | . | .733 |
| Procedure for fire rescue services | 57.84 | 26.899 | -.032 | . | .768 |
| Presence of assembly point | 57.83 | 26.871 | -.015 | . | .769 |
| Fire training and instructions | 57.55 | 23.390 | .655 | . | .736 |
| Functional fire fighting team | 57.40 | 22.044 | .698 | . | .725 |
| Presence of evacuation procedure | 57.77 | 25.798 | .253 | . | .761 |
| Periodic fire drills done | 57.06 | 23.360 | .462 | . | .745 |
| Fire extinguishers serviced | 57.57 | 23.074 | .532 | . | .740 |
| Presence of emergency ligting system | 57.15 | 23.730 | .396 | . | .750 |
| Presence of automatic fire suppression system | 57.25 | 22.484 | .675 | . | .729 |
| Fire evacuation procedures documentation | 57.16 | 22.893 | .458 | . | .745 |
| Fire audits done annualy | 57.12 | 21.233 | .581 | . | .731 |
| Presence of alarm system | 57.56 | 24.050 | .499 | . | .745 |
| Regular fire alarm inspection | 57.37 | 22.251 | .595 | . | .732 |
| Visitors induction of fire safety | 56.98 | 24.636 | .295 | . | .758 |
| Records of fire incidences kept | 57.06 | 24.104 | .382 | . | .752 |

## 1. FIRE SAFETY MEASURES

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .734 | .734 | 6 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Fire extinguishers serviced | 8.26 | 6.526 | .472 | .277 | .697 |
| Regular fire alarm inspection | 8.07 | 6.525 | .400 | .180 | .716 |
| Fire evacuation procedures documentation | 7.85 | 6.094 | .487 | .311 | .692 |
| Records of fire incidences kept | 7.75 | 6.848 | .392 | .187 | .717 |
| Fire audits done annually | 7.82 | 5.504 | .526 | .322 | .681 |
| Implementation of the policy | 7.95 | 6.014 | .552 | .379 | .673 |

## 2. FIRE SAFETY PREPAREDNESS

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .735 | .692 | 8 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Periodic fire drills done | 9.39 | 5.677 | .381 | .236 | .722 |
| Functional firefighting team | 9.73 | 5.025 | .637 | .474 | .659 |
| Fire extinguishers serviced | 9.89 | 5.319 | .536 | .356 | .685 |
| Presence of emergency lighting system | 9.48 | 5.822 | .325 | .154 | .735 |
| Presence of automatic fire suppression system | 9.57 | 5.106 | .667 | .511 | .655 |
| Presence of alarm system | 9.89 | 5.821 | .512 | .355 | .694 |
| Procedure for fire rescue services | 10.16 | 7.394 | -.039 | .040 | .753 |
| Presence of evacuation procedure | 10.10 | 6.767 | .252 | .114 | .736 |

## 3. COMPLIANCE ON FIRE SAFETY

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .819 | .797 | 8 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Presence of fire safety policy | 10.33 | 9.214 | .700 | .602 | .775 |
| Implementation of the policy | 10.10 | 9.461 | .522 | .342 | .801 |
| Presence of assembly point | 10.67 | 12.387 | -.043 | .025 | .839 |
| Fire training and instructions | 10.39 | 9.712 | .754 | .727 | .776 |
| Functional firefighting team | 10.25 | 8.931 | .747 | .651 | .767 |
| Periodic fire drills done | 9.90 | 10.106 | .413 | .293 | .816 |
| Regular fire alarm inspection | 10.21 | 9.574 | .500 | .342 | .804 |
| Fire audits done annually | 9.97 | 8.313 | .622 | .438 | .789 |

## 4. FIRE SAFETY AWARENESS

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .496 | .397 | 5 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Presence of evacuation procedure | 5.53 | 1.672 | .212 | .079 | .474 |
| Visitors induction of fire safety | 4.74 | 1.484 | .084 | .026 | .600 |
| Procedure for fire rescue services | 5.60 | 2.027 | -.102 | .018 | .541 |
| Presence of fire safety policy | 5.25 | .947 | .517 | .536 | .210 |
| Fire training and instructions | 5.31 | 1.109 | .598 | .555 | .187 |

## 5. FIRE RISKS

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .457 | .465 | 2 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Records of fire incidences kept | 1.30 | .263 | .303 | .092 | . |
| Any fire incidence | 1.79 | .400 | .303 | .092 | . |

## 6 .FIRE SAFETY TRAINING

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .842 | .860 | 2 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Functional fire fighting team | 1.30 | .259 | .754 | .569 | . |
| Fire training and instructions | 1.44 | .447 | .754 | .569 | . |

## Appendix VII: Cronbach Alpha on Workforce

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .629 | .602 | 28 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Gender of responder | 38.9495 | 17.495 | -.117 | . | .649 |
| Highest level of education | 37.7706 | 17.708 | -.164 | . | .657 |
| Worked duration in the company | 38.7982 | 18.761 | -.329 | . | .690 |
| Flammable storage with good ventilation | 39.1330 | 16.125 | .332 | . | .610 |
| Measures in place to prevent ignition of flammables | 38.8165 | 14.823 | .288 | . | .608 |
| Arrangements for safe handling and transportation of flammables | 39.0367 | 15.206 | .403 | . | .596 |
| flammables kept away from hot surfaces and open flames | 39.2523 | 17.074 | .061 | . | .629 |
| Measures to remove flammable vapor from ignition | 39.1330 | 16.097 | .215 | . | .618 |
| Measures to prevent electrical fires | 39.1284 | 16.149 | .218 | . | .617 |
| notices to prohibit smoking put | 39.2798 | 17.225 | .045 | . | .629 |
| Presence of exit signs | 39.2798 | 17.272 | -.037 | . | .630 |
| escape routes obstructed | 38.3991 | 17.052 | .033 | . | .632 |

| | | | | | |
|---|---|---|---|---|---|
| Escape routes sufficient as per no. of people | 38.9450 | 15.831 | .212 | . | .618 |
| Presence of assembly points | 39.2752 | 17.279 | -.041 | . | .631 |
| Arrangements to evacuate disabled | 38.4128 | 15.552 | .387 | . | .600 |
| Presence of emergency lighting system during evacuation | 38.4037 | 14.297 | .464 | . | .581 |
| Presence of adequate firefighting appliances | 39.0321 | 15.497 | .324 | . | .605 |
| Fire extinguishers located within reach | 39.2752 | 17.104 | .180 | . | .627 |
| Fire extinguishers distributed as per risks | 38.9908 | 15.272 | .271 | . | .610 |
| Accessibility of fire extinguishers | 39.2202 | 16.587 | .304 | . | .617 |
| Presence of fire detection and warning measures | 38.5734 | 15.084 | .367 | . | .598 |
| Is alarm audible and different from other sounds? | 39.2706 | 17.148 | .068 | . | .629 |
| Arrangements made for people with hearing disabilities | 38.2018 | 17.388 | -.089 | . | .638 |
| Are fire safety procedures posted? | 39.2523 | 17.001 | .153 | . | .625 |
| Have you read fire policy? | 38.5092 | 15.302 | .497 | . | .591 |
| Presence of fire suppression system installed | 38.3073 | 14.721 | .401 | . | .591 |
| Aware of fire risk reduction rules | 38.4312 | 15.601 | .438 | . | .598 |
| Is defense against arson adequate? | 38.6009 | 14.775 | .299 | . | .606 |

## 1. FIRE SAFETY MEASURES

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .670 | .692 | 10 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Measures in place to prevent ignition of flammables | 11.5275 | 6.029 | .281 | .231 | .669 |
| Arrangements for safe handling and transportation of flammables | 11.7477 | 6.475 | .355 | .276 | .642 |
| Measures to remove flammable vapor from ignition | 11.8440 | 6.888 | .231 | .151 | .664 |
| Measures to prevent electrical fires | 11.8394 | 6.937 | .232 | .218 | .663 |
| Fire extinguishers distributed as per risks | 11.7018 | 5.666 | .485 | .313 | .610 |
| Presence of adequate firefighting appliances | 11.7431 | 6.044 | .512 | .333 | .609 |
| Flammable storage with good ventilation | 11.8440 | 6.814 | .428 | .340 | .638 |
| Escape routes sufficient as per no. of people | 11.6560 | 6.282 | .361 | .266 | .640 |
| Arrangements to evacuate disabled | 11.1239 | 6.975 | .226 | .072 | .664 |
| Accessibility of fire extinguishers | 11.9312 | 7.244 | .362 | .217 | .655 |

## 2. FIRE SAFETY PREPAREDNESS

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .648 | .654 | 13 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Presence of fire suppression system installed | 16.3991 | 7.808 | .342 | .239 | .618 |
| Escape routes sufficient as per no. of people | 17.0367 | 8.358 | .228 | .280 | .640 |
| Presence of emergency lighting system during evacuation | 16.4954 | 7.210 | .491 | .443 | .585 |
| Presence of adequate firefighting appliances | 17.1239 | 8.256 | .302 | .281 | .626 |
| Fire extinguishers located within reach | 17.3670 | 9.404 | .240 | .265 | .647 |
| Fire extinguishers distributed as per risks | 17.0826 | 8.159 | .224 | .335 | .644 |
| Accessibility of fire extinguishers | 17.3119 | 9.073 | .284 | .240 | .637 |
| Presence of fire detection and warning measures | 16.6651 | 7.855 | .373 | .275 | .612 |
| Is alarm audible and different from other sounds? | 17.3624 | 9.449 | .088 | .089 | .650 |
| Are fire safety procedures posted? | 17.3440 | 9.397 | .116 | .133 | .649 |
| Is defense against arson adequate? | 16.6927 | 7.652 | .285 | .317 | .635 |
| Arrangements for safe handling and transportation of flammables | 17.1284 | 8.112 | .359 | .243 | .616 |
| Arrangements to evacuate disabled | 16.5046 | 8.196 | .408 | .270 | .611 |

## 3. FACTORS AFFECTING IMPLEMENTATION OF FRRR

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .830 | .831 | 5 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Lack of information | 13.9817 | 10.636 | .706 | .553 | .775 |
| Lack of comprehensive fire policy | 14.6376 | 13.421 | .543 | .344 | .819 |
| Lack of support from management | 14.0183 | 12.212 | .700 | .509 | .776 |
| Absence of skilled personnel | 14.1835 | 12.768 | .626 | .452 | .797 |
| Inappropriate technology | 14.1881 | 13.296 | .585 | .407 | .808 |

## 4. FIRE SAFETY AWARENESS

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .541 | .525 | 3 |

**Item-Total Statistics**

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Squared Multiple Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|---|
| Are fire safety procedures posted? | 3.6284 | .566 | .194 | .044 | .645 |
| Have you read fire policy? | 2.8853 | .231 | .498 | .249 | .162 |
| Aware of fire risk reduction rules | 2.8073 | .267 | .458 | .228 | .247 |

## Appendix VIII: Social Demographic Association

### Gender of the Responder * Worked Duration in the Company Cross Tabulation

**Workforce**

| GENDER | WORKED DURATION IN THE COMPANY | | | | Total |
|---|---|---|---|---|---|
| | 0-4 years | 4-8 years | 8-12 years | Over 12 years | |
| Male | 73 | 58 | 8 | 6 | 145 |
| Female | 59 | 14 | 0 | 0 | 73 |
| Total | 132 | 72 | 8 | 6 | 218 |

Significant- ($\chi^2$=20.871, df=3, p-value=0.000

High turnover of female workforce (80.8%) than male workforce (50.3%).

**Management**

| GENDER | WORKED DURATION IN THE COMPANY | | | | Total |
|---|---|---|---|---|---|
| | 0-4 years | 4-8 years | 8-12 years | Over 12 years | |
| Male | 41 | 35 | 12 | 8 | 96 |
| Female | 17 | 8 | 1 | 0 | 26 |
| Total | 58 | 43 | 13 | 8 | 122 |

Not significant- $\chi^2$=6.005, df=3, p-value=0.111

#### GENDER OF RESPONDER * LEVEL OF EDUCATION CROSS TABULATION

**Workforce**

| GENDER | LEVEL OF EDUCATION | | | Total |
|---|---|---|---|---|
| | Primary Level | Seconday level | College and above | |
| Male | 4 | 70 | 71 | 145 |
| Female | 0 | 28 | 45 | 73 |
| Total | 4 | 98 | 116 | 218 |

Not significant- $\chi^2$=4.543, df=2, p-value=0.103)

**Management**

| GENDER | LEVEL OF EDUCATION | | | Total |
|---|---|---|---|---|
| | Primary Level | Seconday level | College and above | |
| Male | 6 | 40 | 50 | 96 |
| Female | 0 | 11 | 15 | 26 |
| Total | 6 | 51 | 65 | 122 |

Not significant- $\chi^2$=1.748, df=2 p-value=0.417

**LEVEL OF EDUCATION * WORKED DURATION IN THE COMPANY CROSS TABULATION**

**Management**

| LEVEL OF EDUCATION | WORK DURATION | | | | Total |
|---|---|---|---|---|---|
| | 0-4 yrs | 4-8 yrs | 8-12 yrs | over 12 yrs | |
| Primary | 0 | 0 | 3 | 3 | 6 |
| Seconday | 27 | 15 | 5 | 4 | 51 |
| College and above | 31 | 28 | 5 | 1 | 65 |
| Total | 58 | 43 | 13 | 8 | 122 |

Significant- $\chi^2$=36.084, df=6, p-value=0.000)

**Workforce**

| LEVEL OF EDUCATION | WORK DURATION | | | | Total |
|---|---|---|---|---|---|
| | 0-4 yrs | 4-8 yrs | 8-12 yrs | over 12 yrs | |
| Primary | 0 | 2 | 0 | 2 | 4 |
| Seconday | 58 | 28 | 8 | 4 | 98 |
| College and above | 74 | 42 | 0 | 0 | 116 |
| Total | 132 | 72 | 8 | 6 | 218 |

Significant- ($\chi^2$=50.008, df=6, p-value=0.000

55.9% of both management and workforce have worked for more than 4 years

44.1% of both management and workforce have worked for less than 4 years

## Appendix IX: Fire Risks Associations

**STORAGE OF FLAMMABLES * PLACE LOCATED CROSS TABULATION**

| STORAGE OF FLAMMABLES | PLACE LOCATED | | Total |
|---|---|---|---|
| | Kariobangi | Industrial area | |
| Poor | 3 | 1 | 4 |
| Average | 3 | 11 | 14 |
| Satisfactory | 1 | 7 | 8 |
| Good | 0 | 4 | 4 |
| Total | 7 | 23 | 30 |

Slightly significant- $\chi^2$=7.740, df=3, p-value=0.052

Kariobangi light industries-85.7% below average, 14.3% satisfactory and none was good.

Industrial area-52.2% below average, 47.8% satisfactory and above.

**FIRE INCIDENCE * RECORDS OF FIRE INCIDENCES KEPT CROSS TABULATION**

| FIRE INCIDENCE | RECORDS OF FIRE INCIDENCE KEPT | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| Yes | 39 | 38 | 11 | 88 |
| No | 1 | 29 | 1 | 31 |
| Not sure | 0 | 1 | 2 | 3 |
| Total | 40 | 68 | 14 | 122 |

Significant- $\chi$2=33.408, df=4, p-value=0.000

Out of the 72.1% fire occurrences only 44.3 % had recorded them while 43.2% had not recorded and 12.5% were not sure.

**LOCATION OF INDUSTRY * FIRE INCIDENCE CROSS TABULATION**

| LOCATION OF INDUSTRY | FIRE INCIDENCE | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| Kariobangi | 18 | 4 | 1 | 23 |
| Industrial area | 70 | 27 | 2 | 99 |
| Total | 88 | 31 | 3 | 122 |

Not significant -$\chi 2$=1.276, df=2, p-value=0.528

Kariobangi light industries 78.3% of fire incidences

Industrial area 70.7% of fire incidences.

**Appendix X: Fire Measures Associations**

## Location of industry * Fire extinguishers serviced

| LOCATION OF INDUSTRY | SERVICING OF FIRE EXTINGUISHERS | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| Kariobangi | 14 | 5 | 4 | 23 |
| Industrial area | 88 | 1 | 10 | 99 |
| | 102 | 6 | 14 | 122 |

Significant- $x^2$ (df=2) =18.924 since p<.000

Kariobangi light industries-60.8% Service fire extinguishers.

Industrial area-88% Service fire extinguishers

## Location of industry * Regular fire alarm inspection

| LOCATION OF INDUSTRY | REGULAR FIRE INSPECTION | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| Kariobangi | 8 | 12 | 3 | 23 |
| Industrial area | 73 | 12 | 14 | 99 |
| | 81 | 24 | 17 | 122 |

Significant- $x^2$ (df=2) =19.502 since p<.000

Kariobangi light industries-34.8% inspect fire alarm regularly.

Industrial area-73.7% inspect fire alarm regularly

## Location of industry * Arrangements for safe handling and transportation of flammables

| LOCATION OF INDUSTRY | SAFE HANDLING AND TRASPORTATION OF FLAMMABLES | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| kariobangi | 33 | 11 | 7 | 51 |
| industrial area | 144 | 17 | 6 | 167 |
| | 177 | 28 | 13 | 218 |

Significant- $x^2$ (df=2) =12.901 since p<.000.

Kariobangi light industries-64.7% Have good arrangements for safe handling and transportation of flammables

Industrial area-86.2% Have good arrangements for safe handling and transportation of flammables.

**Appendix XI: Fire Awareness Measures Associations**

## Location of industry * Aware of fire risk reduction rules

| LOCATION OF INDUSTRY | AWARE OF FIRE RISK REDICTION RULES | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| Kariobangi | 1 | 46 | 4 | 51 |
| Industrial area | 37 | 128 | 2 | 167 |
| | 38 | 174 | 6 | 218 |

Significant- $x^2$ (df=2) =16.308 since p< 0.000

Kariobangi light industries-1.9% are aware of fire risk reduction rules

Industrial area-22.2% are aware of fire risk reduction rules

## Location of industry * Have you read fire policy?

| LOCATION OF INDUSTRY | HAVE YOU READ THE POLICY ? | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| Kariobangi | 0 | 51 | 0 | 51 |
| Industrial area | 52 | 112 | 3 | 167 |
| | 52 | 163 | 3 | 218 |

Significant- $x^2$ (df=2) =22.464 since p<.000.

Kariobangi light industries- None has read the policy.

Industrial area-31.1% have read the policy

## Location of industry * Visitors induction of fire safety

| LOCATION OF INDUSTRY | VISITORS INDUTION TO FIRE SAFETY | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| Kariobangi | 0 | 17 | 6 | 23 |
| Industrial area | 33 | 55 | 11 | 99 |
| | 33 | 72 | 17 | 122 |

Significant- $x^2$ (df=2) =11.736 since p<.003.

Kariobangi light industries-73.9% Have No visitor’s induction on fire safety

Industrial area-33.3%  Have visitor’s induction on fire safety.

**Appendix XII: Fire Safety Preparedness Associations**

## Location of industry * Periodic fire drills done

| LOCATION OF INDUSTRY | PERIODIC FIRE DRILLS DONE | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| Kariobangi | 0 | 16 | 7 | 23 |
| Industrial area | 44 | 44 | 11 | 99 |
| | 44 | 60 | 18 | 122 |

Significant- $x^2$ (df=2) =17.341 since p<.000

Kariobangi light industries-None conducted fire drills

Industrial area-44.4% conducted fire drills

## Location of industry * Presence of emergency lighting system

| LOCATION OF INDUSTRY | PRESENCE OF EMERGENCY LIGHTING SYSTEM | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| Kariobangi | 1 | 33 | 17 | 51 |
| Industrial area | 67 | 75 | 25 | 167 |
| | 68 | 108 | 42 | 218 |

Significant- $x^2$ (df=2) =28.166 since p<.000.

Kariobangi light industries- 1.9% have emergency lighting system

Industrial area-40% have emergency lighting system

## Location of industry * Arrangement to evacuate disabled

| LOCATION OF INDUSTRY | ARRAGEMENT TO EVACUATE DISABLED | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| Kariobangi | 2 | 47 | 2 | 51 |
| Industrial area | 39 | 117 | 11 | 167 |
| | 41 | 164 | 13 | 218 |

Significant- $x^2$ (df=2) =10.845 since p<.004.

Kariobangi light industries- 3.9% have arrangement to evacuate disabled

Industrial area-23.3% have arrangement to evacuate disabled

**Location of industry * Presence of fire suppression system**

| LOCATION OF INDUSTRY | PRESENCE OF FIRE SUPPRESSION SYSTEM | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| Kariobangi | 1 | 38 | 12 | 51 |
| Industrial area | 51 | 81 | 35 | 167 |
| | 52 | 119 | 47 | 218 |

Significant- $x^2$ (df=2) =18.337 since p<.000

Kariobangi light industries- 1.9% have fire suppression system

Industrial area-30.5% have fire suppression system

**Appendix XIII: Fire Safety Compliance Associations**

## Location of industry *Regular fire alarm inspection

| LOCATION OF INDUSTRY | REGULAR FIRE ALARM INSPECTION | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| Kariobangi | 8 | 12 | 3 | 23 |
| Industrial area | 73 | 12 | 14 | 99 |
| | 81 | 24 | 17 | 122 |

Significant- $x^2$ (df=2) =19.502 since p<.000

Kariobangi light industries-34.7% Conduct regular fire alarm inspections

Industrial area-73.7% Conduct regular fire alarm inspections

## Location of industry *Fire extinguishers serviced

| LOCATION OF INDUSTRY | FIRE EXTINGUISHERS SERVICED | | | Total |
|---|---|---|---|---|
| | Yes | No | Not sure | |
| Kariobangi | 14 | 5 | 4 | 23 |
| Industrial area | 88 | 1 | 10 | 99 |
| | 102 | 6 | 14 | 122 |

Significant- $x^2$ (df=2) =18.924 since p<.000.

Kariobangi light industries- 60.9% services fire extinguishers

Industrial area-88.9% services fire extinguishers

**Appendix XIV: Letter of Introduction**

**VALENTINA NGENYI MUTUKU**

**P.O BOX 17486-00100**

**NAIROBI**

**20th August, 2014**

**To whom it may concern**

Dear Sir/ Madam

**REF: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN YOUR ORGANISATION**

I hereby request to conduct research in your Company as part of my thesis for the award of a Master's of Science Degree in Occupational safety and Health from Jomo Kenyatta University of Agriculture and Technology.

The research shall use a questionnaire – based survey entitled "**EVALUATION OF FIRE SAFETY COMPLIANCE IN PAINT INDUSTRY IN NAIROBI COUNTY**".

Your Company is among those identified for sampling. The data collected shall be confidential and its findings will not be used for any other purpose other than for academic purposes.

Please find attached an introduction letter from the University and a copy of my questionnaires.

Kindly consider my request.

Yours faithfully,

Valentina Ngenyi Mutuku

REG NO: EET32-2529/2012

## Appendix XV: University Recommendation Letter

JOMO KENYATTA UNIVERSITY
OF
AGRICULTURE AND TECHNOLOGY
INSTITUTE OF ENERGY AND ENVIRONMENTAL TECHNOLOGY
P.O. BOX 62000, NAIROBI, KENYA. Tel: (067) 52251/52711/52181-4, Fax: (067) 52164 Thika, Email:director@ieet.jkuat.ac.ke

30th May, 2014

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

**RE: VALENTINA NGENYI MUTUKU – EET32-2529/2012**

The above named person is a Master of Science Occupation Safety and Health (OSH) student in this Institute. She is currently involved in her research project on ***"Evaluation of Fire Safety Compliance in Paint Industry in Nairobi."***

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

Thank you.

PROF. R. KINYUA,
DIRECTOR, INSTITUTE OF ENERGY AND ENVIRONMENTAL TECHNOLOGY.

**Appendix XVI: Published Journal Paper**

**Appendix VII:** Published Journal Paper
*Researchjournali's Journal of Operations Management*
Vol. 4 | No. 2 October | 2018 83

# Evaluation Of Fire Safety Compliance In Paint Industry In Nairobi County

**Valentine Ngenyi**
*Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya P.O Box 62000-00200*

**Erastus Gatebe**
*Kenya Industrial Research and Development Institute Nairobi, Kenya, P.O Box 30650 -00100*

**Leonard Gitu**
*Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya P.O Box 62000-00200*

## ABSTRACT

Workplace fires is one of the greatest challenge to occupational safety of most industries worldwide. Manufacturing industries in the recent past have experienced several fire incidences which has led to loss of life, life threatening injuries, loss of business and investment opportunities. Fire safety disaster management systems are not well established in Kenya thus greatly affecting fire safety preparedness especially in manufacturing industries. This study has evaluated fire safety compliance in paint industries in Nairobi focusing on fire risks, fire safety measures in place, fire safety

awareness, fire safety preparedness as well as the gaps in observing fire risk reduction rules in the selected industries. Secondary data was obtained from Nairobi fire brigade, DOSHS and private security companies. Data was collected using questionnaires for both workforce and management. A checklist was also used to collect data from the facilities. Data was analyzed using appropriate analytical software and descriptive statistic carried out. The study targeted 6,936 workers in registered paint industries represented by a sample size of 364 giving a response rate of 93.4 %. This study has revealed that paint industry is male dominated (70.9%) and only 29.1% are females. Female workforce have higher turnover of 80.8% than male (50.3%) and the association was statistically significant with ($\chi^2$=20.87, df=3, p-value=0.000). Majority of the workers are educated with high school and college education and have worked less than 4 years and this relationship is statistically significant for both management (($\chi^2$=36.084, df=6, p-value=0.000) and workforce $\chi^2$=50.008, df=3, p-value=0.000). The study revealed 23.3% of paint industries had poor handling of flammables which is a high risk factor, with 85.7% in Industrial area and 14.3% from Kariobangi Light Industries. However, 23.3% of industries were above satisfactory level in compliance on handling of flammables and all were from Industrial area. The research has also found that 72.1% of the Industries had experienced fire incidences with only 32.8% recording them and this relation was statistically significant ($\chi$2=33.408, df=4, p-value=0.000).This work has also found that a greater number of workplaces had fire safety measures in place; measures to prevent electrical fires (90%), removal of flammable vapor from ignition (91.7%), no smoking Notices (100%) as well as proper labelling and storage of flammables (100%). In safe handling and transportation of flammables, 81.2% of the facilities had complied where 81.4% from Industrial area and 18.6% from Kariobangi Light Industries which was statistically significant at 95% confidence level with $\varkappa^2$(df=2) =12.901 since p<.002. On fire safety awareness, the results shows that 72.9% of the facilities were sufficiently trained on fire safety while 96.8% of workers were aware of fire safety procedures. However 59.0% of the industries had no fire safety awareness to visitors and only 27.1% had those facilities and all were from Industrial area and this association was statistically significant with $\varkappa$2 (df=2) =11.736 since p<.003.On fire safety policy, this research has found that 72.9% of industries had acquired the policy, However only 23.9% of the respondents knew the content of the policy document and this was from Industrial area facilities. This association was statistically significant with $\varkappa$2 (df=2) =22.464 since p<.000.This research has reported good fire safety preparedness with presence of escape routes and enough fire extinguishers at 100% as well as presence of assembly point and alarm system at 99%. On establishment of firefighting team, this study has found that 71.4% of managers had put firefighting teams in place with 90.0% from Industrial area and 10.0% from Kariobangi Light Industries and this relationship was statistically significance with $\varkappa^2$(df=2)

=17.52 since p<.000 at 95% confidence level.On the other hand, there was poor preparedness in evacuation of disabled persons (18.8%), installation of fire suppression (23.9%), fire detection (37.6%) and emergency lighting (31.2%).The study also revealed that all workplaces (100%) had escape routes, However 11.9% of the facilities had obstructed the escape routes which is a fire risk factor in terms of evacuation. On notification of fire occurrences to the relevant agencies, the study revealed that over 60% of industries had poor compliance but on fire audit slightly more than half (58.20%) carries out fire audits as stipulated by the law and inspects fire alarm system regularly (66.4%). On factors affecting implementation of fire risk reduction rules, the respondent reported that there was lack of information on fire safety, lack of comprehensive fire safety policy, lack of support from management in regard to finance, appropriate technology as well as skilled workforce. The overall level of compliance to fire risk reduction rules was found to be average on fire safety measures, awareness and preparedness. However, significant facilities had low compliance levels hence regular inspection by the relevant agencies is recommended. Owing to high risks of fire from the flammables, it's recommended that daily fire risks assessments on job assigned be emphasized to help identify the risks and control them.

**Key words:** Fire risks, fire safety measures, fire preparedness, fire safety awareness, fire compliance.