ASSESSMENT OF OCCUPATIONAL HAZARDS AND THEIR IMPACTS: A CASE STUDY OF METAL WORKING *JUA KALI* SECTOR IN NAKURU TOWN, KENYA

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Assessment of Occupational Hazards and their Impacts: A Case Study of Metal Working *Jua Kali* Sector in Nakuru Town, Kenya

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DECLARATION

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

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

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DEDICATION

This thesis is dedicated to my parents William and Priscilla, my daughter Stacey, my son Shem and my sister Zipporah for the support they accorded me in all endeavors undertaken in developing this thesis.

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First and foremost, praises and thanks to the God for His blessings throughout my research work and subsequent successful completion. I would like to express my deep and sincere gratitude to my research supervisors Professor Bernard Ikua and Dr. Robert Ongeri for providing invaluable guidance and support throughout this research.

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ACRONYMS AND ABBREVIATIONS

COPD	Chronic Obstructive Pulmonary Disease
COSHH	Control of Substances Hazardous to Health
DOSHS	Directorate of Occupational Safety and Health Services
EASHW	European Agency for Safety and Health at Work
MSDS	Musculoskeletal Disorders
OSH	Occupational Safety and Health
OSHA	Occupational Safety and Health Act
PPE	Personal Protective Equipment
SMMEs	Small, Micro and Medium Enterprises
WHO	World Health Organization
WRMSD	Work-related Musculoskeletal Disorders.

ABSTRACT

In many developing countries the conditions under which most of the workers in informal (*Jua kali*) enterprises operate are precarious and unsafe. Many workplaces in the informal sector have some inherent hazards. Informal sector workers often lack personal protective equipments and clothing. Multiple exposures to different hazards are mainly due to poor housekeeping and congestion in the workplaces. Occupational hazards lead to negative health and economic consequences on workers and on other persons in the proximity of working area. In this study occupational hazards and their associated impacts on metal workers in Nakuru town were assessed. Survey research design was used in the study and a target sample size of 288 was obtained using Yamane (1967:886) formula. Data were collected by a combination of questionnaires, observations and measurements at various *Jua kali* workplaces. Data analysis was carried out using descriptive and inferential statistics and presented in tables, graphs and descriptions. The study shows that cutting (20%), impacts (17%) and crushing (16%) are the most common mechanical hazards while welding fumes (40%), paints and solvents (35%) are the main chemical hazards in many *Jua kali* establishments. The use of uninsulated cables or cables with worn-out insulations (83.1%) was seen to be the leading electrical hazard. In regard to work related illnesses, stress (20.1%) fatigue (19.2%) and low back pain (15.9%) were observed to be the most frequent. Occupational injuries in this sector include cuts (20%), punctures (18%) and abrasions (17%). As relates to economic impacts, it was established that many workers have occasioned lost wages (93.2%), property damage (84.6%) and reduced working efficiency (80.1%) a as result of workplace incidences. The study shows that the micro and small enterprises in the informal sector are burdened with a wide variety of hazards which are related to their activities. The results of the study showed that majority of *Jua kali* artisans (85.5%) have little knowledge and training in occupational safety and health. In order to reduce work-related risks, it is proposed that the greater share of the health burden of occupational risks should be addressed by improving hygiene, ergonomics, work organization and hand tools safety. It is also recommended that interventions such as trainings to improve health and safety awareness and welfare among *Jua kali* workers be carried out.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

All over the world, workers in the informal sector are not adequately protected by health and safety legislations, consequently, they suffer higher rates of accidents and fatal injuries than workers in the formal industries (Chipunza, 2018). Occupational injuries in developing countries are a major concern. International Labour Organization (ILO) estimates that 250 million occupational injuries, 160 million work related diseases and 2.3 million deaths occur each year resulting in loss of roughly 4% of Gross Domestic Product (GDP) due to workers` compensation, loss of workdays, interruption of production, retraining and medical expenses (ILO, 2015).

In Kenya, the informal (*Jua kali*) sector has continued to play an important role in employment creation. According to the Economic Survey report published by Kenya's Central Bureau of Statistics, employment within the sector increased from 12.6 million persons in 2015 to 13.3 million persons in 2016, accounting for 83.1% of total employment (KNBS, 2017). The sector contributes 34% of the GDP, employs as much as 75% of the labour, provides goods and services, promotes creativity and innovation, and enhances entrepreneurial culture. Karanja (2013) reports that the explosive growth of the informal sector has brought with it more hazards including biological, mechanical, chemical and psychological hazards. Serlom *et al.* (2013) explains that excessive number of people and products in the workplace exposes workers to multiple hazards. In many small workshops, housekeeping is poor; tools and materials are usually out of reach and working postures that causes strain are common. There are a number of reasons for the poor occupational safety situations in informal sector, such as unhealthy and unsafe working environments, undesirable sanitary facilities, lack of, or inadequate safety equipments, and unsafe manufacturing methods (Mehdi *et al.*, 2016). While unsafe working environments cause most workplace injuries, human factors such as age, education, experience, level of intoxication and smoking are some of the inherent

factors. A study conducted by Rongo (2005) on health risks related to chemicals used in informal sector in Dar es Salaam indicated that workers dealing with metal work and manufacturing metal products are mostly exposed to soldering and paint fumes, lead and degreasing solvents such as sulphuric acid, ethanol and benzene. Wood workers are normally exposed to wood dust containing chemicals used to preserve the wood from insects and solvents used to soften vanish and glue in furniture making. Workers in garages are always exposed to welding fumes and sometimes to paint fumes/solvents if they happen to weld a surface with traces of paint or degreasing solvents. Muchiri *et al*. (2003) studied safety practices in *Jua kali* and reported that many *Jua kali* enterprises use obsolete production methods and raw materials of inferior quality. They also observed that in many *Jua kali* enterprises, there are several different activities taking place at the same time. As a result, workers are exposed to excessive noise far beyond the recommended maximum noise level of 90 dB(A) for an eight-hour working day (Kimani, 2011).

A study into health impact of occupational risks in the informal sector in Zimbabwe documented that annual rates of injury and illness in the informal sector were 131 injuries per 1,000 workers and 116 illnesses per 1,000 workers and that 19% of injuries resulted in some form of permanent disability (Loewenson, 1998). A study conducted by Rongo (2005) in Dar es Salaam Tanzania, to assess chemical exposure and health problems among the small-scale industries workers reported that more than 70% of workers surveyed suffered from skin burn, red eyes, headaches and chest/throat pains. Painters reported headaches when in contact with paint and thinner and when working in direct sunlight, while woodworkers reported mainly respiratory and eye problems. There was no data available from literature on Kenya's numbers of occupational injuries and fatalities for comparison. The values may be higher for the reason that higher populations in Kenya (up to 90%) seek opportunities in the informal sector compared to 60% of total populations in Latin America. According to 2017 Human Development Index (HDI) Kenya's rate of unemployment stands at 39.1% translating to approximately 4 in every 10 Kenyans of working age have no jobs (UNDP, 2018).

Data on the economic consequences of occupational accidents and diseases are very scarce, both in developed and developing countries. The most rigorous available study of the economic costs of occupational injuries and illnesses at the national level was produced in the United States where the study indicated that the economic burden of occupational injury and illnesses increased from $217 billion in 1992 to $270 billion in 2007 representing 71% increase (Leigh, 2011). Studies and estimates by many countries and ILO have shown that economic costs of work-related illness and injury would be equivalent to a range from 1.8%–6% of GDP (Takala *et al.*, 2013). According to Weil (2001) some economic cost of workplace injuries and illnesses are readily apparent. These include medical cost, lost time at work and administration of programs for those injured. Others however are difficult to quantify: loss of life, changes in future work activity and earnings of the injured, impacts on the household of the injured or ill workers diminishing quality of life. Currently there is very scarce data and information available in literature on economic impacts of occupational hazards in Kenya especially in informal sector. It is estimated that it is much higher than those of United States given that Kenya is a developing country.

The purpose of this study was to assess the health and economic impacts of these occupational hazards in *Jua kali* sector in Nakuru town which is located 160 km North West of Nairobi and is the fourth largest urban Centre in Kenya after Nairobi, Mombasa and Kisumu. The commercial sector in Nakuru contributes about 19% to the economy of the town. Scarce opportunities in formal employment has resulted in an increase of informal traders in central business district where *Jua kali* artisans, food sellers and hawkers have taken up available space (Lubaale *et al.*, 2013).

1.2 Problem Statement

Inadequate health and safety standards and occupational hazards are particularly evident among welders, painters and metal workers in informal sector. Poor working environments including makeshift premises and often unsatisfactory welfare facilities as well as missing occupational health services are causing large human and material losses. These result in the impairment of the health and general wellbeing as

well as quality of life of informal workers and their families. The protection of health, safety and welfare of informal sector workers is a challenge which requires to be addressed through collaboration of various stakeholders. The study assessed the occupational hazards and its impacts in metal working Jua *kali* sector.

1.3 Significance of Study

The study reveals the occupational hazards and impacts in the metal working *Jua kali* sector. It assessed both health and economic impacts associated with occupational hazards in this sector. The study findings are of importance to stakeholders and the government through the directorate of occupational safety and health services (DOSHS) for planning interventions to improve health and safety awareness and welfare among the metal working *Jua kali* workers.

1.4 Hypothesis

H_0 There are no occupational hazards in metal working Jua kali sector in Nakuru town.

H_0 Occupational hazards do not affect the health and economic wellbeing of metal working Jua kali workers in Nakuru town.

1.5 Objectives

1.5.1 Main Objective

To assess occupational hazards and their impacts in the *Jua kali* sector in Nakuru town, Kenya

1.5.2 Specific Objectives

i. To identify the incidence level of occupational hazards in metal working *Jua kali* sector
ii. To determine likely occupational health effects of identified occupational hazards in metal working *Jua kali* sector.

iii. To determine economic impacts of occupational hazards in metal working *Jua kali* sector.

1.6 Scope and Limitation of the Study

The study assessed occupational hazards and its associated impacts in *Jua kali* sector. The study was carried out in Nakuru town and was limited to welders, painters and metal workers among the *Jua kali* operatives. Some would be study participants declined to take part in the study after sampling was complete due to suspicion that it may be used against them, and result in dismissal from work. However, the researcher was able to convince them to take part in the study since it was for their own good. Other limitations were cost of conducting study, ethical clearance and permit from the county government.

1.7 Conceptual Framework

A conceptual framework helps the researcher to conceptualize the relation among the variables in the study. In this study the independent variables are the occupational hazards that include: physical, chemical, biological and psychosocial hazards while the dependent variables are the health impacts and economic impacts of occupational hazards. The intervening variables include age, gender, status of employment, level of education, legal enforcement and level of awareness of workplace safety. Figure 1.1 is a diagrammatic representation of the relationship among these variables.

Independent Variables **Dependent Variables**

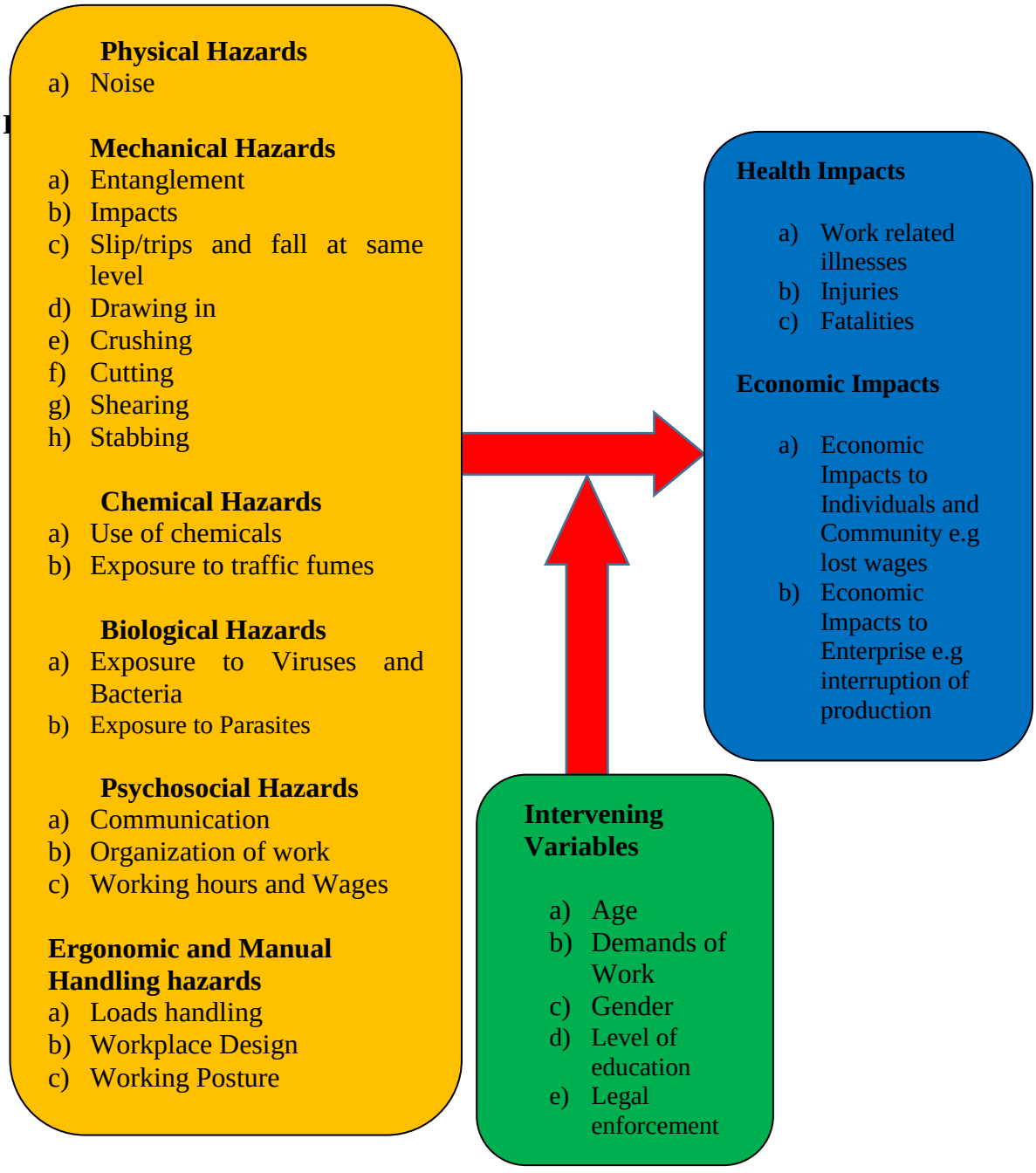

Figure 1.1: Diagrammatic Representation of the Variables

CHAPTER TWO

LITERATURE REVIEW

2.1 Employment in the Informal Sector

A review of literature on the informal sector indicates that employment in the sector is generally characterized as semi and unskilled employment, home based employment and low-income employment. In some surveys, 90% of informal sector workers have not undergone any training, gaining their knowledge and skills in service. (Karanja *et al.,* 2013). Managerial and skilled workers are scarce as these are often drawn into formal sector firms. Informal sector employment is often a response to scarcity of formal wage employment, through small scale entrepreneurship, often capitalized from home savings and formal sector wages. It also includes small scale businesses avoiding the costs of government regulations and control. In urban areas, informal sector enterprises include a very wide range of industries, occupations and working situations. These include street food or market vendors, small automotive and machine repair shops, small-scale manufacturers such as garments, shoes or handicraft, waste recyclers, beauty parlours and transport drivers, amongst others. According to UNHSP-HABITAT (2006) the informal economy constitutes a significant proportion of the working population in Kenya: 61% of the 14 million labor force work in non-agricultural employment, while 35% of urban and 59% of rural households respectively are involved in informal sector.

In Kenya the terms informal sector, the micro and small-business sector and the *Jua kali* can be used interchangeably. Sessional Paper No. 2 of 1992 defines the category of an enterprise by the number of its employees. Thus, micro enterprises are those that employ between one and five employees; small-scale enterprises employ between 6 and 10; and small-scale industry 11 to 49 persons. An enterprise may fall within any of these categories but be considered to be formal because it is formally registered, has permanent structures, pays taxes and is licensed. A similar-sized enterprise may be described as informal or *Jua kali*, because it operates on temporary premises, even though it may actually be licensed. It consists primarily of manufacturing and repair shops. These activities take place in open yards,

undeveloped urban plots or even on street pavements. Often the facilities provide merely a roof, sometimes not even this. Usually *Jua kali* are concentrated in designated areas in or around towns where hundreds or even thousands of workers pursue their economic activities (Menya *et al.*, 2012).

2.2 Occupational Safety and Health in *Jua kali* Sector

It is instructive to note that the ILO first studied the informal economy in Kenya in 1972. The use of the phrase *Jua kali* to refer to the informal economy was in use at the time, and still in use today. The *Jua kali* sector is required to be regulated through the department of small, medium and micro enterprises (SMMEs) or *Jua kali* within the ministry of labour and human resources development. The regulation is complemented by industrial associations that have been collaborating with the government to build industrial sheds or work places in urban areas where they operate. The ones that comply with basic labour and occupational safety and health practices are given priority in government contracts. As in most African countries, the labour and occupational laws do not discriminate against the informal economy in Kenya. Occupational Safety and Health Act (2007) and the subsidiary legislation apply equally to all organizations. However, it is not effectively implemented and enforced. Individual workers do not have access to sound OSH advice and training, and are often exposed to risks to their safety and health without adequate protection (ILO, 2013).

In addition, the informal economy is normally ignored by the labour and occupational safety and health inspectorates. Efforts have been made in policy, legislation and enforcement to apply labour and occupational safety and health regulations as well as through education, training, awareness rising and peer influence among others. It is observed by Theuri (2012) that entrepreneurs in the informal sector lack resources to implement the directorate's recommendations or maintain a good standard of safety and health. Furthermore, entrepreneurs lack necessary information and most do not have suitable premises.

2.3 Occupational Hazards

Occupational health hazards can be described as the potential of a substance, person, activity or process to cause harm. Occupational health risk is the possibility of suffering health impairments from exposure to a hazard that originates in the working environment (Hughes *et al.,* 2012). Occupational risk is determined both by the level and the duration of exposure to hazards. Workers in developing countries tend to work longer in the presence of occupational hazards than those in more developed countries. It is estimated that between 50% and 70% of the workforce in developing countries is exposed to these types of hazards (Renton *et al.*, 2012).

According to surveys carried out by the ILO in the Philippines, Nigeria, Senegal and Tanzania, while hazards varied according to occupation, some of the most prevalent problems were: poor lighting, lack of ventilation, excessive heat, poor housekeeping, inadequate work space and working tools, lack of protective equipment, exposure to hazardous chemicals and dusts and long hours of work. The most prevalent health impairments were musculo-skeletal disorders and low back pain; allergic reactions and other respiratory disorders; physical strain, fatigue and stress. Injuries from tools were also frequent. (ILO, 2011). Due to high production demands and poor work organization, the tools used and facilities for lifting and transportation are often inadequate and worn out. These linked with repetitive movements, carrying of heavy loads and awkward postures cause unnecessary strain, fatigue and injuries to workers in informal sector (Steven, 2017). There is no legal maximum weight to lift at work, however there are guidelines which set out the recommended safe maximum weight for lifting at work. Recommended maximum weight limit should be adjusted depending on how the load is being lifted, how close to the body the weight is held and how high or low the weight is lifted (Hughes *et al.,* 2012). The guidelines suggest that the maximum weight men should lift at work is 25Kg.This is for loads held close to the body at around waist height

2.3.1 Physical hazards

Workers in informal sector are exposed to a number of physical hazards due to the nature of their activities and poor state of premises they work in. According to Menya *et al.* (2012) *Jua kali* premises are in open yards or street pavements and often without roofs thus workers are exposed to all weather elements most importantly the hot sun. A study conducted by Rongo (2005) on informal sector in Tanzania reported that workers were exposed to high levels of noise and heat. Surveys conducted on *Jua kali* premises shows that the most prevalent problems were poor lighting, inadequate ventilation, excessive heat and noise (Theuri, 2012).In a study conducted by Eguvbe and colleagues (2017) on small and medium scale manufacturing industries in Nigeria, the average environmental dust concentration and psychosocial hazards were found to be higher in the small scale industries (2.3mg/m^3 and 52.1%); as compared to the medium scale industries (1.1mg/m^3 and 26.3%) respectively. This may probably be due to the fact the medium scale industries' manufacturing processes are more automated with less noise, unlike most of the small-scale industries that operate most of the time with noisier and old-fashioned machineries in open spaces outdoors with more dust exposure. Acceptable levels of noise are equivalent to continuous noise not exceeding 85 dB(A) for an 8-hour work shift. (OSHA,2007). The hazards in the garages were researched by Australia Retail Motor Industry in 2002.The results of the study are summarized in Table 2.1.

Table 2.1: Hazards in the Motor Industry (Australia retail Motor Industry, 2002)

Item No.	Injury	Hazards Examples
1	Being hit by moving objects	a) Flying particles in eyes when using grinders b) Tools falling from hoists, high shelves & mezzanines c) Dust, grease and oil particles dropping into eyes when under car
2	Hitting against moving objects	d) Injuries from use of hammers, pliers, electric drills, forklifts, vehicles etc and especially where workplace is cluttered, cramped or poorly lit
3	Manual handling	e) Working on vehicles in cramped postures for long periods of time f) Bending over low engine bay for extended periods g) Using force to break large components free e.g. trucks, tractors
4	Hitting Stationary Objects	h) Knocking or slipping against vehicles, benches and fixed equipment, i) particularly in cluttered work areas
5	Muscular Stress while lifting, carrying or putting down objects	j) Fitting/removing doors & windows, wheels & tyres.

2.3.2 Chemical Hazards

Use of chemicals is common in garages, wood workshops and metal workshops. For example, in welding and soldering, chemicals such as lead, soldering flux, sulfuric acid and benzene are commonly used. In a survey of *Jua kali* workers in Kenya several harmful hazardous chemical exposures were identified such as lead fumes in battery reclaiming shops, asbestos dust among brake repair workers, solvents among car painters and ultra violet rays exposure among welders (Menya *et al.*, 2012). A study by Rongo *et al*. (2004) on occupational exposures in Tanzania reported that more than 70% of welders indicated to have suffered from skin burns, red eyes, headaches and chest/throat pains. Painters reported headaches when in contact with paint and thinners. Wood workers reported mainly respiratory and eye problems. Exposure to chemicals from car batteries was associated with respiratory tract problems, dizziness and headaches. Wood workers exposed to wood dust were also exposed to chemicals in a very passive manner. The chemicals in wood dust are in form of its natural substances such as resin acids or monoterpenes and or preservatives (Lyon, 2012).

ILO estimates that of the 2.2 million occupational fatalities, 439,000 are caused by chemicals and of the 160 million cases of work-related disease; 35 million are due to chemicals. In addition, ILO estimates that 10% of all skin cancers are attributable to workplace exposure to chemicals. The main routes of chemical exposure are inhalation, skin contact and ingestion. Toxicity depends upon the nature of chemical, its physical state, the route, the concentration and duration of exposure.

2.3.3 Biological Hazards

Exposure to biological agents (viruses, bacteria and parasites) occurs in informal occupational environments due to lack of sanitary facilities, clean drinking water and adequate waste disposal facilities. Tuberculosis infection and ingestion of contaminated water leading to Cholera or other water borne diseases, among workers in dusty, congested and poor water supplied environments, are examples of occupational diseases (Renton *et al.*, 2012). Workers in informal premises located near rivers face an additional problem of mosquito bites. Poor housekeeping presents

a suitable breeding environment for mites and jigger infestation (Muchiri, 2003). Infection with HIV/AIDS virus has been attributed to weakening of strength and stigmatization which may put workers more at risk of suffering accidents (ILO, 2003). Many of the small-scale enterprises operate in ramshackle structures, lack sanitary facilities or potable water, and have poor waste disposals. These conditions expose workers in the informal sector to hazardous biological agents; a recipe for communicable illnesses (Theuri, 2012)

2.3.4 Psycho-Social Hazards

Social conditions at work can also damage workers' health. Frequently, these conditions manifest themselves in stress and its consequences. Social conditions that can be injurious to health include long working hours, low wages; management style based on the exclusion of workers from the decision-making process; lack of communication and poor organization of work; and strained interpersonal relationships between managers and employees (Takahashi, 2017). Stress at work has been associated with elevated risks of cardiovascular diseases, particularly hypertension, and mental disorders (Oluoch *et al.*, 2017). Workers in informal sector are forced to work for long hours since returns are directly proportional to production and also because most small and micro enterprises cannot afford to employ the required work force (Theuri, 2012). These workers face greater demand or have lower control over the work processes, two factors which has been associated with higher levels of stress, higher levels of dissatisfaction and more adverse health outcomes (Kortum *et al.*, 2014).

2.4 Occupational Impacts

The occupational impacts have been disintegrated into health and economic. A major challenge in collection of data on injuries, fatalities and their economic costs is lack of adequate reporting. This may be due to several reasons which include:

i. Inadequate coverage of workforce by reporting systems.
ii. Workers whose status is self-employment, the growth of outsourcing, leased employment, and other such arrangements makes questions of coverage and liability more complicated.

iii. Workers may not even know what compensation rights they may have or what the procedure is for filing a claim.
iv. Workers whose employment is insecure are less likely to file even if they do know their rights, for fear of losing their job (ILO,2012).

Thus, it is possible that figures that are given here may be lower than actual for lack of a reliable reporting system. However, Takala *et al.* (2012) argues that where there is a reliable reporting system, there is likely to be a constant ratio between fatal and nonfatal accidents. Countries with more sophisticated reporting systems such as Finland and United States, observed ratios of 1 fatal accident per 750 nonfatal accidents is a conservative estimate and 1 fatal accident per 1,000 nonfatal accidents is an alternative estimate.

2.4.1 Health Impacts

A fatal injury was defined by ILO (1998) as such if the period between the time of the accident and the victim's death does not exceed six months. It was also defined as an occupational injury leading to death within one year of the day of the occupational accident causing the injury. A non-fatal injury was deemed to result to no lost time or loss for up to three days.

Globally 2.3 million deaths take place; due to occupational injuries (318,000 deaths) and work-related diseases (2,022,000 deaths) annually (Takala *et al.,* 2013). The biggest killers are work-related cancer (32%); work-related circulatory diseases (23%), cardiovascular and stroke; communicable diseases (17%), in particular, in developing countries and farming, and occupational accidents (18%) (Takala *et al.,* 2013). A survey carried out by Loewenson (1998) on informal sector in Zimbabwe found a much higher burden of ill health in the informal sector than is reported in recognized national databases. The survey found reported annual rates of injury and illness in the informal sector as 131 injuries and 116 illnesses per 1,000 workers. These rates exceeded those in the formal sector by a factor of 10 in the case of injury and of about 100 in the case of illness, but this is attributable to acknowledged underreporting even in formal sector systems. Work processes in small scale industries present risks of physical injuries such as cuts, burns, hearing impairments

resulting from loud noises and eye injuries due to excessive UV radiations and respiratory dysfunctions due to noxious metal fumes inhaled (Okuga *et al.*, 2012).There are also health effects associated with psychosocial hazards such stress at work and exhaustion in addition to effects of ergonomic hazards that mainly involve musculoskeletal problems such as muscle sprains, muscle pain, dislocations and fractures. According to a study conducted by Menya (2012) on occupational risk factors in *Jua kali* industries in Eldoret, 26% of the interviewees indicated to be suffering from at least one of the health problems related to their specific job or exposure. Twelve mentioned complaints related to breathing or chest difficulties and eleven complained of eye problems. Two workers complained of each of the following categories: musculoskeletal problems, work injuries and skin problems.

2.4.2 Economic Impacts

Hazardous working conditions not only harm informal sector workers' health but also decrease the enterprise's productivity and therefore its' income (Karanja *et al.*, 2013). Awareness of adverse long-term effects of poor and hazardous working conditions as well as of how to improve workers' protection and business practices to increase productivity is very low among the micro-entrepreneurs**.** Data on the economic consequences of occupational accidents and diseases are very scarce, both in developed and developing countries. The most rigorous available study of the economic costs of occupational injuries and illnesses at the national level was produced in the United States, where it was estimated that they represent approximately 3% of the gross domestic product (GDP) in 1992 (Leigh, 2011). Occupational injury and fatalities are matters of health, but they are matters of economics as well. Identification and measurement of economic costs as a result of occupational injuries and fatalities are important in understanding and appreciating critical risks. Further, ILO (2012) observes measurement of costs provides a basis on trade-off between the 'costs of improving the conditions of work, in order to reduce the incidence of injury and disease' against the costs of work-related injuries and fatalities. The ILO estimates that about 4% of GDP worldwide is lost because of work-related diseases and injuries (Takala, 2002).

2.4.2.1 Economic Impacts to Individuals and Community

The economic costs to individuals and communities are a predicament of persons in precarious employment and informal entrepreneurs. Precarious employment is identified as temporary employment, leased employment, "self-employment" (where the nominally self-employed worker works at the location and under the direction of another enterprise), part-time employment, and multiple employments (Danesi, 2011). Pressure to maximize output and minimize time, which makes precarious workers attractive to some employers, also leads them to take risks and expose themselves to hazards (Salminen, 1995).

Workers in informal sector are exposed to higher risk relative to their industry and occupation. This is because of poor systems and organization of work, the informality of supervision and production expectations, low level of capitalization and technology, low productivity and irregular employment relationship. It is possible that groups at lower levels of economic echelons have higher exposure to hazards and consequently are more prone to accidents. Such a situation, Renton *et al* (2000) argues, stems from the choices, rational or otherwise, that enterprise, workers, and governments make in their pursuit of economic goals.

The most important economic cost is the worker's lost wages during the period of absence from work and possible reduced wages after return to work, either of which may or may not be a social cost, depending on whether otherwise unemployed substitute workers are found to do the same tasks (ILO, 2012). A workplace injury that leads to functional limitations which creates, in turn, a work-related disability will result in economic losses to society if that disability diminishes the worker's current and future productivity relative to what it would have been in the absence of the injury(Leigh, 2011). Productivity decrease may arise because of reduction in work hours, shift to a new job and/or employer that require less human capital and result in lower pay, or withdrawal from the labour force for a period of time or entirely (Zhang *et al.*, 2011).

The second major economic element is the cost of medical treatment, care during the period of disability, and rehabilitation. Santana *et al.* (2013*)* estimate the direct health

care costs and socioeconomic consequences of work injuries by a prospective longitudinal study of workers identified in the emergency departments of public hospitals in Brazil. They report that approximately half the cases suffered loss of earnings, and female workers were more frequently dismissed than male workers. The most frequently reported family consequences were the need for a family member to act as a caregiver and difficulties with daily expenses. Total costs for treatment and rehabilitation of work injuries were approximately US$40,000; half of that was out-of-pocket costs paid by relatives or workers themselves. Most out-of-pocket costs were related to transport and purchasing medicines and other wound care products. Data in Kenya on direct cost of injuries and diseases are scarce due to under reporting mainly due to a gap in the enforcement of occupational safety and health laws. There are also no guidelines for the informal sector owners on recording occupational accidents and diseases (ILO, 2013).

2.4.2.2 Economic Impacts to Enterprise

From an occupational safety and health policy view, the decisions of the employer concerning what production methods to use, how to implement them, and how to incorporate safety and health concerns are important. Knowledge of costs of poor working conditions provides incentive to evaluate cost of improving those conditions (Dorman, 2000). Hazardous working conditions not only harm the informal sector workers' health but also decrease the enterprise's productivity which in turn decreases income because of poor health and the inability to work effectively (Theuri, 2012).

Two authors propose a means of differentiating direct and indirect costs to an enterprise. Simonds and Grimaldi (1989) propose that costs which have a reimbursement on injury or a fatality be regarded as direct while the non-reimbursed are regarded as indirect. Dorman (2000) proposes a distinction be made from the accounting books. If a cost appears in the accounting book, then that cost is regarded as a direct cost. Although not exactly the same, the lists of direct and indirect costs resulting from these approaches will be similar to those found in most of the literature.

A possible list of direct costs to an enterprise have been identified as victim's lost wages, concurrent and future, not replaced through workers' compensation; victim's medical expenses not compensated through workers' compensation or other employer paid insurance; time and resources expended by the victim's household in nursing and recuperation; lost household production by the victim; public medical subsidies applied to health services received by the victim; public subsidies, such as tax exemption, to the workers' compensation system; environmental contamination in the vicinity of the enterprise; productivity no longer available to society due to premature death (ILO, 2011).

A possible list of direct costs to an enterprise are: interruption in production immediately following the accident, morale effects on coworkers, personnel allocated to investigating and writing up the accident, recruitment and training costs for replacement workers, reduced quality of recruitment pool, damage to equipment and materials, reduction in product quality following the accident, reduced productivity of injured workers on light duty and overhead cost of spare capacity maintained in order to absorb the cost of accidents

2.5 Summary and gap analysis

This chapter has presented a review of status of global informal sector as well as Jua *kali* sector in Kenya. It has been noted that most *Jua kali* workplaces operate in open yards, and workers largely use old-fashioned techniques, equipments and tools. These conditions, coupled with high production demands in the sector exposes workers to a high number of occupational risks such as noise induced hearing loss, physical and musculoskeletal injuries. Further these informal enterprises lack sanitary facilities, potable water and means of waste disposal.

In addition, workers in the *Jua kali* sector suffer economic cost related to poor management of workplace safety and health. Data on accidents, injuries and their economic cost are lower than actual due to inadequate reporting systems.

From the literature review, it was seen that no research has been previously conducted on occupational safety and health status of *Jua kali* sector in Nakuru town. This research therefore sought to identify occupational hazards present in this sector in relation to their impacts on health and economic wellbeing of *Jua kali* workers in Nakuru town.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes how data were collected and analyzed based on the objectives of the study. It also describes the research framework and design of the study.

3.2 Design of the study

Descriptive cross-sectional study was used in this study since the variables under study were not manipulated. According to Mugenda and Mugenda (2003) descriptive research design seeks to obtain information that discloses the existing phenomenon. In this case, the phenomena were occupational hazards (independent variables) and health and economic impacts (dependent variables) in the Jua-kali sector in Nakuru town.

3.3 Target population

The population in this study consists of metal working *Jua kali* operators both male and female mainly engaged in welding, spray-painting and metal work as well as other mechanical work in Nakuru town which is located 160 km North West of Nairobi and is the fourth largest urban centre in Kenya after Nairobi, Mombasa and Kisumu. The commercial sector in Nakuru contributes about 19% to the economy of the town. The informal sector comprises 18% of all the commercial activity space. *Jua kali* sector in Nakuru plays a very important role in generating employment to a large proportion of the population. The high population density greatly compromises the principles of health, safety and environmental quality (MCN/ Republic of Kenya/ UNCHS/ABOS-BADC, 1999).

3.4 Sample and sampling technique

A sample is a subset of the population, which is selected to represent the whole study population and must bear all the characteristics of the population. According to

Kenya national bureau of statistics, economic survey report of 2015 the population of metal working *Jua kali* sector workers in Nakuru town was estimated as 1000 workers. Yamane (1967:886) provides a simplified formula to calculate sample sizes. Yamane formula is amongst the extensively used formulas for calculating the sample size when population is finite (Sarmah,2012).

$$\mathbf{n} = \frac{N}{1+N(e)^2} \qquad (1.0)$$

Where: n = Sample size, N = Population

e = Level of precision (Standard value= 0.05)

$$n = \frac{1000}{1+1000(0.05)^2}$$

n= 288

The targeted sample size is taken as 288. Three zones within Nakuru town were selected each having a high concentration of metal working Jua kali workplaces.60 metal working *Jua kali* workplaces were then randomly selected following a walk-through survey of each zone. Workers within the selected workplaces were randomly selected and requested to be interviewed. A simple random sampling technique was used which is the selection of items in to the sample based on random selection. The advantage in simple random sampling is that, each member of the population has an equal and known chance of being selected.

3.5 Data collection instrument

Quantitative and qualitative data were collected by the use of questionnaires, a sound level meter and a pretested checklist. The structured questionnaire was important, as it gave respondent freedom to express their views objectively and collection of social demographic information, occupational hazards and its impacts on health and economy of the respondents. Use of pretested checklist by the researcher captured

other key information left out by the respondents but key to research objectives. The researcher used a Sound level meter (SLM) shown in figure 3.1 conforming to IEC61326-2-2 standard to measure maximum noise level for different activities. Table 3.1 shows the technical specification of the sound level meter used.

Figure 3.1: A photograph of UNI-T UT353 sound level meter used to measure sound level.

Table 3.1: Sound level meter technical specification

Model		**UNI-T UT353**
Measurement Range		30-130dB
Resolution		0.1dB
Accuracy		±1.5dB
Response Rate		31.5Hz-8KHz
Sampling Rate	Fast	125ms
	Slow	1000ms

Source: UNI-T (Sound level meter manufacturer)

3.5 Data collection procedure

3.5.1 Questionnaire

The questionnaire was divided into three sections. Each section had simple straightforward statements with clear instructions on how to fill it. Every section had a five-point Likert scale to assess the perceptions of the respondent regarding each statement in the scale. The score ranged from 1-5 and the respondents were required

to tick on the desired box regarding their view on the statement. The respondents were issued with the questionnaires and requested to fill it in and hand back. The respondents who could not read and write were guided by the enumerators in filling in questionnaires through a face-to-face interview.

3.5.2 Pretested Checklist

The pretested checklist was used to collect information on occupational hazards present at every workplace identified in the sample as workers continued with normal routines. Exposure to hazards was rated as 'Yes' and 'No'. If a hazard is identified at a given workplace it is categorized as a 'Yes' and if it does not exist as a 'No'.

3.5.3 Sound Level Meter

The workplaces noise levels were measured using sound level meter. SLM was placed next to operator's ear to measure perceived noise level and at two metres from the noise source. This was to establish the noise level perceived by other workers within the same workplace. Average noise levels were obtained for similar activities in workplaces that were sampled. Total A-weighted average sound pressure levels were calculated using equation (2) in which Lpt, is the total noise level for all the noise sources when all are in simultaneous operations, n is the number of noise sources in workplaces that were sampled, L_{pi} is sound level for a given noise event.

$$L_{pt} = 10log_{10}\left[\sum_{i=0}^{n} log^{-1}\left({}^{LP_i}/_{10}\right)\right] \qquad (2.0)$$

3.6 Reliability and Validity of the Research Instrument

Reliability is measure of the degree to which a research instrument yields the same data after repeated trials. The reliability of the instrument was improved through pilot testing and pre-testing. Pilot study was carried out outside the three zones that had been sampled for the study.10 respondents were drawn from this zone. Isaac and Michael (1995) suggested 10 to 30 respondents are adequate sample size for pilot

studies. The instrument was modified on the basis of pilot test before administering it to the study respondents.

Validity is the determination of whether research instruments measure what is purported to measure. The validity of research instrument was based on expert's opinion who checked on the content of validity, the extent to which the instruments measured what they intended to measure (Mugenda and Mugenda, 2003). The study supervisors and other research experts helped reviewing the validity of the instrument. They made the necessary corrections on it whereby ambiguous items were rephrased and final instruments to be produced. The questionnaire was prepared based on the research objectives and necessary modifications and adjustments were made before actual data collection.

3.7 Data analysis and presentation

Cronbach's α formula was used to test reliability and validity of the research instrument. Data were organized, tabulated and analyzed using quantitative descriptive statistics such as means, standard deviations, frequencies and percentages. Means and standard deviations were used to measure response disparity for Likert-scale questions. SPSS 21.0 computer software was used to carryout data analysis. Results of analysis were summarized in appropriate frequency tables, graphs and pie-charts.

3.8 Ethical consideration

Ethical approval for the study was obtained from the county government. Verbal consent was both obtained from the employers and workers. Details of the research participants remained secured and kept confidential.

CHAPTER FOUR

RESEARCH RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents interpretations of the findings and discussion. Data is presented appropriately by use of descriptive statistics such as percentages, means and standard deviation. The general objective of this study was to determine effects of occupational hazards and its impacts in the *Jua kali* sector in Nakuru Town, Kenya.

4.2 Preliminary Results

This section covers the preliminary results of the study. The result includes reliability test and validity test and response rate.

4.2.1 Reliability and Validity Test

Cronbach's α was used to test reliability of the instrument. A coefficient of 0.7 and above shows high reliability of data (Saunders, 2009).

Table 4.1: Cronbach's Alpha Reliability Coefficients for variables of the Study

Constructs/Variable	Number of Statements	Cronbach Alpha	Comment
Mechanical Aspects	6	0.800	Reliable
Chemical Aspects	5	0.755	Reliable
Electrical Aspects	6	0.831	Reliable
Housekeeping Aspects	5	0.810	Reliable
Ergonomic Aspects	5	0.765	Reliable
Physical Aspects	6	0.780	Reliable

The Cronbach's α test of the instrument resulted in a value of 0.735 which is greater than 0.7, thus the questionnaires were reliable. This indicates that the data collected using the above-mentioned instruments was reliable for analysis.

4.2.2 Response Rate

Out of the 288 respondents, 230 of them participated in the study. This constitute a response rate of 79.9%. Out of these questionnaires, 214 were considered fit for use in the study. This accounted for 74.3 percent of the respondents. The other 16 questionnaires had highly significant levels of missing information. The remaining cases represented an adequate response rate for the precision and confidence required in this study. Mugenda and Mugenda (2003) stated that a response rate of 55% and above is good enough for statistical reporting.

4.3 General information on respondents

This section covers the response obtained from respondents in terms of the general information, that is, occupation of the respondent and level of education.

4.3.1 Gender

Of the 230 respondents, 180 were male, representing 84.1%, while 34 were female, representing 15.9%. This shows that the metal working *Jua kali* sector is a male dominated sector.

4.3.2 Occupation of the respondent

Analysis of the occupations of the respondents showed that 42.5% were metal workers, 32.7% were welders and 24.8% were painters.

Table 4.2: Occupation of the respondent

Occupation of the respondent	Frequency	Percentage (%)
Metal worker	91	42.5
Welder	70	32.7
Painter	53	24.8
Total	**214**	**100**

4.3.3 Distribution of respondents by level of education

The respondents were asked to indicate their highest level of education. Table 4.3 shows that majority of the workers at 39.2% had primary level of education. Workers who had attained secondary education were 36%, 14.5% were graduates from tertiary colleges, while those with no formal education were 10%. This indicates that majority of metal working *Jua kali* workers in Nakuru town have no prior training in health and safety provided in formal training.

Table 4.3: Distribution of respondents by level of education

Academic level	Frequency	Percentage (%)
Tertiary college	31	14.5
Secondary	77	36
Primary	84	39.2
No education	12	10.3
Total	**214**	**100**

4.4 Mechanical Hazards

The study sought to establish which mechanical hazards are at workplace. Figure 1 shows the various mechanical hazards and their frequency of occurrence. It can be seen in this figure that the most frequent hazards were cutting and impact at 20% and 17% respectively, while the least common is entanglement (8%).

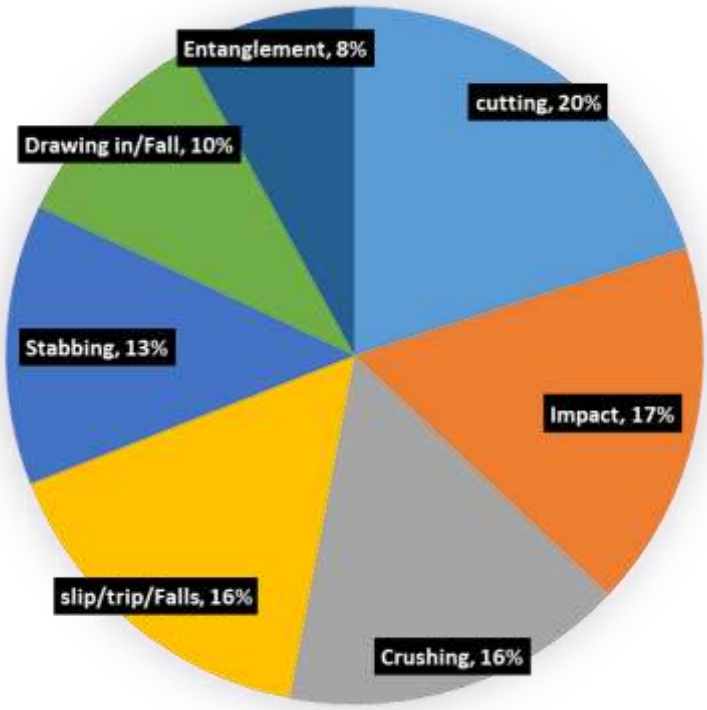

Figure 4.1: Mechanical hazards

These findings are mainly attributed to use of poorly maintained hand tools and lack of provision and use of personal protective equipments (PPEs). Owing to insufficient resources most *Jua kali* artisans cannot afford good quality tools and PPEs. Menya et al (2012) indicated that a significant number of mechanical hazards in Eldoret's *Jua kali* sector are mainly attributed to use of old and obsolete procedures. The causes of injuries can be easily managed and contained if the workers are adequately informed on occupational safety and how to avoid various injuries at the workplace. For example, provision of information on the appropriate protective wear against each type of hazard would greatly enhance their preparedness levels towards such hazards at the workplace.

4.5 Chemical Hazards

4.5.1 Types and prevalence of chemicals used

In regard to exposure to chemical hazards, it was observed that 59.3% of respondents use chemicals in their place of work while 40.7% do not use chemicals. Some of the hazardous chemicals noted in their workplaces were categorized into acids, alkalis, solvents, dust, and fumes. Paints and solvents were the most common, found in 35% of the workplaces studied. Fumes, dust and acid/alkalis were in 30%, 28% and 7% of the workplaces, respectively. The chemicals can cause health problems when ingested, inhaled or upon contact with the skin.

4.5.2 Exposure to fumes at workplace

On the issue of exposure to fumes at workplace, the study revealed that majority of the workers (87.3%) were exposed to fumes as shown in table 4.5

Table 4.4: Fumes exposure at workplace

Fumes exposure	Frequency	Percentage (%)
Yes	187	87.3
No	27	11.7
Total	**214**	**100.0**

Out of those exposed, 40% were exposed to welding fumes, 25% to exhaust fumes,18% to paint vapours and 17% to adhesive vapours. These are shown graphically in Figure 4.2.

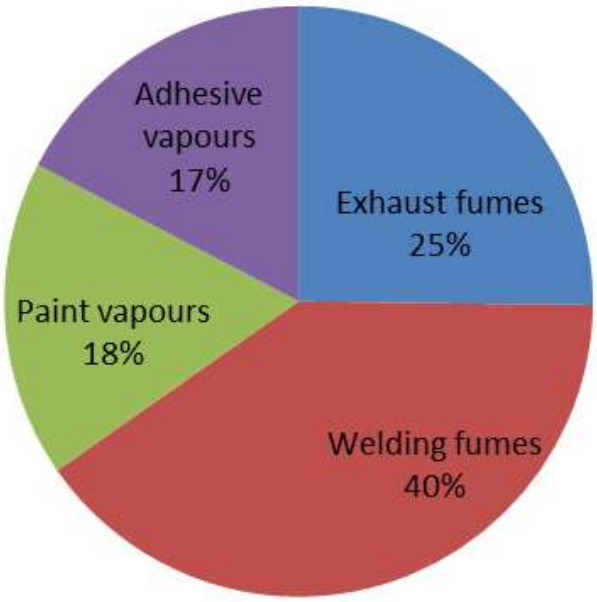

Figure 4.2 Fumes exposure

Majority of workers in *Jua kali* are thus exposed to a range of hazardous chemicals through inhalation, ingestion or absorption via skin. It was observed that workers do not use personal protective equipment such as nose/mouth masks, goggles, gloves and overalls (Photo 2). In addition, air circulation is inadequate due to poor ventilation in many workplaces. These results are consistent with those of Rongo (2004) whose study on occupational exposure and health problems in small scale industries (SSI) in Tanzania indicated that workers were exposed to high levels of exhaust, spray painting and soldering fumes. Welders were exposed to welding fumes. Workers and employers in *Jua kali* sector were found to be aware of these chemicals health hazards but not on proactive measures to control these hazards.

4.6 Electrical Hazards

In regard to electrical hazards, it was found out that 83.1% of the workplaces use either worn-out or un-insulated wires which is a major electrical hazard (Photo 6). Further, it was observed that some equipment were connected directly to power

source without plugs while others were connected through unearthed plugs (Photo 6). The results of various connection methods used in the sector are shown in table 4.5.

Table 4.5: Types of equipment connections to the power source

Reasons	Frequency	Percentage (%)
Directly without plugs	66	30.8
Through an earthed plug	79	36.9
Through an unearthed plug	58	32.3
Total	**214**	**100.0**

Use of uninsulated or cables with worn-out insulation cables was identified as one of the major electrical hazards in *Jua kali* sector. From the observations, it was noted that majority of welders connected their equipments to the power source using cables with worn-out insulation thus exposing them and other operatives to risk of electrocutions. Lack of awareness in electrical safety pose a safety risk in many informal establishments with resultant fires because of presence of flammable materials and makeshift nature of their premises (Nag *et al*,2016).

4.7 Hazards emanating from poor housekeeping

The study in this part aimed at identifying the status of various workplace housekeeping aspects. Data were collected using 5-level likert scale, with responses of strongly disagree (1), disagree, (2), Neutral (3), agree (4) and strongly agree (5). The mean for the responses for each aspect was computed. The findings are summarized in table 4.6.

Table 4.6: Housekeeping Aspects

Statement	Mean	Std. Deviation
The workplace is disorganized	4.2374	.31760
There is lack of routine cleaning at workplace	3.8749	.25971
There are loose cables or wires at a workplace	3.4013	.44548
There is lack of provision of a designated waste bins/area at a workplace	3.3984	.38604
There is lack of tool racks and equipments storage area at workplace	3.3537	.29589
There are spills at workplace	3.2582	.36306

It can be seen in this table that the means for all aspects assessed were above 3, which indicates general agreement that there is poor housekeeping in *Jua kali* workplaces. The response for the aspect 'The workplace is disorganized' had the highest mean of 4.23, followed by 'There is no routine cleaning at workplace' and 'There are loose cables and wires at workplace' with means of 3.87 and 3.4 respectively. These findings are similar to those of Theuri, (2012) who stated that many *Jua kali* enterprises operate in ramshackle structures that have poor housekeeping and lack waste disposal facilities. As previously mentioned *Jua kali* workplaces are normally overcrowded with people, finished products and raw materials placed within confined working spaces (Photo 5).

4.8 Ergonomics and manual material handling hazards

4.8.1 Loads handling at workplace

In regards to ergonomics and material handling, the study found that 58.4% of workers carry loads manually, 32.7% use trolleys, 6.2% use chain block and 2.7% use electrical hoists (Table 4.7).

Table 4.7: Loads handling at workplace

Handling Aspects	Frequency	Percentage (%)
Manual carrying	125	58.4
By use of Chain block	27	12.6
By use of Electrical hoists	19	8.8
By use of Trolleys	43	20.2
Total	**214**	**100.0**

When asked of how heavy the loads they lift or carry are at workplace 44.6% of workers lifted/carried loads ranging from 31 to 50 Kgs while only 7.8% of workers carried loads of above 81 Kgs. As observed in many *Jua kali* workplaces, lifting activities are repetitive and involves twisting and bending and also takes place in confined spaces. According to set guidelines recommended maximum weight for manual lifting is 25Kg (Hughes *et al*, 2012). There is increased risk of musculoskeletal disorders when manual handling is rampant. From the findings, many workers carry loads manually as compared to those who use mechanized means. Insufficient number of mechanized means of lifting and carrying in many *Jua kali* establishments is attributed to their low economic strength (Theuri,2012).

4.8.2 Working posture

In regards to suitability of working posture 56% indicated that they were comfortable while 44% indicated that they were uncomfortable. However, these responses were highly subjective. Over 94.0% of the workers indicated they had suffered from muscle strain at workplace while 73.8% reported headaches, low back pain and neck pain. These illnesses could be attributed to use of excessive force and repetitive movements. Contrary to claims by respondents that their working posture was comfortable, majority of them reported various forms of musculoskeletal disorders. These negate a majority response of a comfortable working posture. In a study conducted by Gikonyo (2008) amongst metal workers in Kamukunji, Kenya, 47% of workers squatted while working, 33.3% stood for long hours and 25% handled very

heavy loads. These awkward working postures and heavy loads were linked to several cases of musculoskeletal disorders (MSDS).

4.9 Physical Hazards

4.9.1 Exposure to Excessive Noise

Table 4.7 shows noise levels from different activities conducted at metal working *Jua kali* workplaces. Most of the activities conducted in *Jua kali* workplaces generated noise levels above the maximum allowable limit of 90 dB(A) for the eight-hour work shift. The total noise level at source L_{p0} and total noise level at 2m from source L_{p2} were calculated using equation (1) and obtained as 120.86 dB(A) and 117.69 dB(A), respectively. Welding operation generated average continuous noise level of 82dB(A) at source and 72.9 dB(A) as perceived at 2 metres from source.

Table 4.8: Noise levels for various activities

Activity	**Noise level in dB(A)**	
	At Source	**2m from Source**
Panel Beating	114.6	110.6
Grinding	106.45	99.8
Cutting	101.05	94.17
Hammering	114.42	112.15
Welding	82.1	72.9
Panel beating and grinding	115.23	111.32
Hammering, cutting and welding	114.21	112.07

Welding was the only activity whose average noise level was below maximum allowable limit of 90 dB(A) for eight-hour shift. These results were consistent with those of Kimani (2011) who indicated that the noise levels in Kamukunji metal fabricating sheds ranged from 72.0 to 113 dB(A). Various processes in *Jua kali* establishments are carried out at the same place at the same time.This lack of

segregation and enclosure of noisy operations exposes workers to dangerous noise levels with likely serious health implications. Factories and other places of work legal notice no.5 of 2005 requires an occupier of a workplace to implement noise control and hearing conservation measures when noise level exceeds 85 dB(A).

4.9.2 Work related injuries

On physical injuries at workplace 84% of workers indicated that they had accidents at workplace that resulted in various forms of injuries. Only 11% of workers indicated that they had not sustained any form of injury at their workplace Table 4.9 shows the distribution of work-related injuries at metal working *Jua kali* workplaces. At least 50% of metal workers and welders reported at least one work-related injury. More than 70% of welders reported to have sustained electrocutions and burns. Cuts (37.4%), eye injuries (27.3%) and bruises (25.8%) were most common amongst painters. Majority of metal workers reported punctures (92.8%), cuts (88.2%) and bruises (80.9%) as the most common work-related injuries sustained. The findings of this study are closely related to those of Menya *et al* (2012) whose study on occupational safety awareness amongst metal workers in Jinja, Uganda, showed that the most common work related injuries sustained were cut and burns accounting for 73% of all injuries sustained, eye injuries and hearing impairments each at 6% and the least common were fractures at 0.6%. Injuries sustained could be attributed to manual handling since few *Jua kali* operatives can afford mechanized operations.

Table 4.9: Percentage of work-related injuries per occupation

Work-related injury	Welders (n=70	Painters (n=53)	Metal workers (n=91)
Cuts	61.5	37.4	88.2
Punctures	46.1	24.2	92.8
Abrasion	15.6	32	76
Bruise	12.6	25.8	80.9
Burn/Scald	88.4	3.2	25.5
Electric shock	90.7	2.9	17.3
Eye injury	52.8	27.3	30.6
Crushes	35.6	6.8	63.6
Heat Strain	63.7	13	24.9
Amputation	0	0	1
Fractures	0	0	1

4.9.3 Work-related illnesses

In regards to work-related illnesses, occupational stress (22.9%), backpain (18.6%) and headaches (17.1%) were the leading amongst welders. Majority of painters complained of chest problems (34%), fatigue (20.8%) and occupational stress (18.9%). Metal workers mainly suffered from noise induced hearing loss and fatigue both at 22%. Figure 4.3 summarizes findings on nature and relative prevalence of work-related illnesses in metal working *Jua kali* sector.

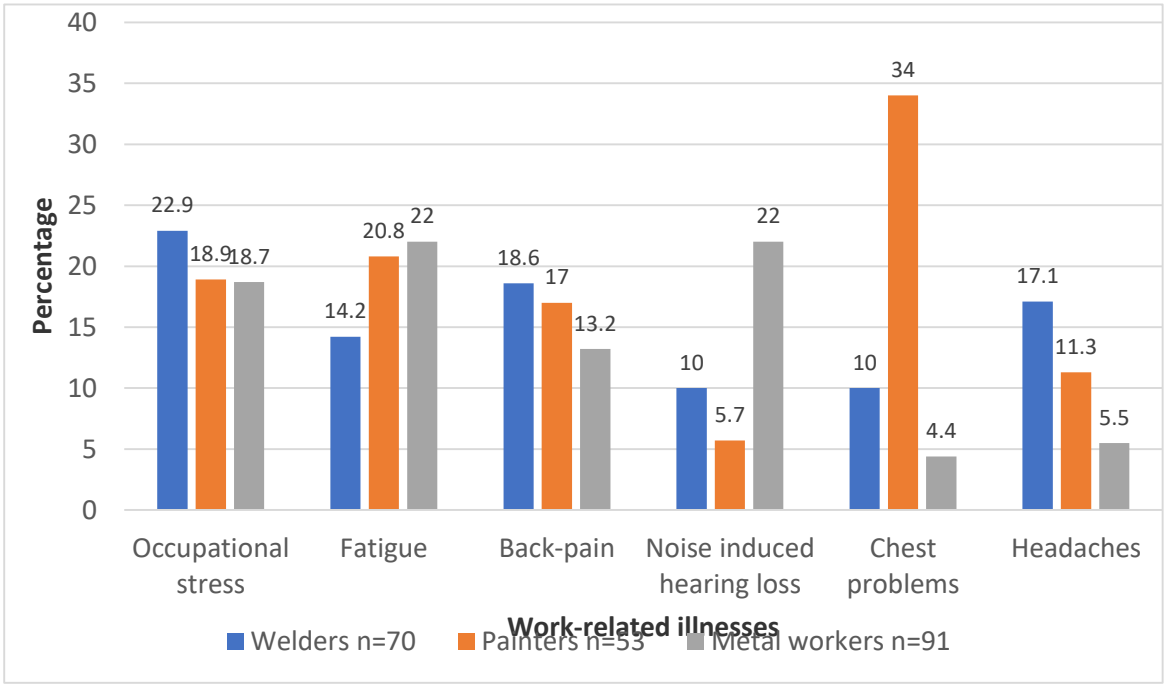

Figure 4.3: Nature and prevalence of work-related illnesses

Jua kali sector, being demanding in terms of physical effort, subject workers to psychological stress and fatigue due to the much pressure put upon the workers to meet production demands. Awkward working postures and repetitive motions subject workers to recurring back pains. Excessive noise and heat exposure and manual handling may also cause fatigue.

4.10 Assessment of Economic Impacts of Occupational Hazards

4.10.1 Loss of property

The study in this part aimed at identifying the extent to which occupational hazards in metal working *Jua kali* sector affect economic livelihood of the workers. In the last 12 months, 83% of workers reported to have been involved in workplace accidents of which 84.6% had one occurrence while 15.4% had two or more of such occurrences where materials, products, tools and equipments were damaged. This is a quite significant economic loss to *Jua kali* operatives whose economic base is low therefore facing difficulties in raising capital to restart their businesses. In relation to

lost time due to injuries, of 83% of workers who reported to have been involved in workplace accidents, 42% were absent from work for one to three days,32% for four to six days and 9% for more than seven days. Only 17% of workers reported to have sustained injuries that did not result in lost time at work. According to Theuri (2012) wages for workers in *Jua kali* sector are directly proportional to production therefore, absence from work greatly impacts their daily earnings.

4.10.2 Types and prevalence of economic impacts of occupational injuries

A five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used to assess economic impacts of injuries arising from workplace hazards. The arithmetic means and standard deviations for the responses as received were then computed to assess the significance of each of the aspects investigated. The findings of this study are presented in Table 4.10.

Table 4.10: Mean scores of economic aspects due to occupational injuries

Type of economic Impact	*n*	Mean score	Std. Deviation
Reduction of income as a result of workplace injury(s)	214	4.6579	.43664
Reduction in working efficiency due to injury sustained.	214	4.0559	.32863
Incapacitation due to injury(s) sustained	214	2.5526	.36585
Change of occupation a result of injury(s) sustained.	214	2.0921	.55581
Injury(s) sustained affecting future earnings	214	1.8289	.58073

From the means in Table 4.10, it can be deduced that injuries that the workers have sustained at workplace have resulted in great reduction in the worker's incomes (mean = 4.66) and also a reduction in their working efficiency (4.06). Thus, lack of

safety at workplace has a substantial impact on the economic wellbeing of the *Jua kali* workers.

It can also be seen from the means that the injuries the workers have sustained have somehow incapacitated them (mean = 2.55). However, the injuries have not immensely affected their future earnings (mean = 1.83),

4.11 Occupational Hazards Checklist

A structured observation checklist was used to conduct hazard identification at random in metal working *Jua kali* workplaces within three zones in Nakuru town. 24 Observation aspects were categorized according to various forms of occupational hazards. An aspect was marked 'Yes' if 'indeed it was the case and 'No' if it is to the contrary. Observations were conducted in 60 *Jua kali* workplaces within Nakuru town. The observation findings are as shown in table 4.11.

Table 4.11: Prevalence of Occupational hazards in metal working *Jua kali* workplaces. (*n*=1440)

Workplace Hazard	Yes	No	Yes %
Biological	120	0	100
Mechanical	120	0	100
Ergonomics	168	12	93.3
Electrical	192	48	80
Chemical	185	55	77.27
Housekeeping	180	60	75
Physical	209	91	69.57

Biological and mechanical hazards were present in all *Jua kali* workplaces visited. Specifically, the hazards identified were lack of or dirty sanitary facilities and wholesome drinking water. Moreover, all machines and equipments lacked guarding thus workers were exposed to hazards associated with moving machine parts. In all

workplaces, workers were exposed to sharp edges of metal sheets, tools and finished products stored within confined workspaces (Photo 5). Ergonomic hazards were present in 93.3% of the workplaces visited. These included: awkward working postures and repetitive movements of *Jua kali* workers while carrying out their activities. When it come to manual loads handling, poor lifting techniques were observed which would be the cause of many complaints of musculoskeletal disorders. Housekeeping hazards were observed in 75% of the workplaces visited where there were no designated waste collection bins/areas and walkways. These workplaces were dirty and untidy (Photo 7). Working areas also served as storage areas for raw materials and finished products therefore clutched and disorganized.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The main objective of this study was to assess occupational hazards and their impacts in the *Jua kali* sector in Nakuru town. The study specifically sought to identify occupational hazards, health impacts of these hazards and also economic impacts of the identified hazards. The study therefore concluded that:

1. Mechanical and biological hazards were the most prominent in *Jua kali* sector. The leading mechanical hazards were cutting (20%) and impact (17%) which are attributed to lack of guarding on equipments/machines and exposure to sharp edges of materials, tools and equipments. The most common biological hazards were lack of or dirty sanitary facilities and absence of wholesome drinking water. Chemical hazards were exposure to welding fumes (40%), exhaust fumes (25%) and paints vapours (18%). Noise levels in most of the *Jua kali* workplaces were above the DOSHS recommended 90dB(A) which is overly hazardous.
2. As a result of exposure to workplace hazards, occupational stress (22.9%), chest problems (34%) and noise induced hearing loss (22%) were the leading work-related illnesses amongst welders, painters and metal workers respectively. The most recurrent work-related injuries among welders were electrocutions (90.7%) and burns (88.4%). Cuts (37.4%) and eye injuries (27.3%) were most frequently sustained by painters. Metal workers suffered from punctures (92.5%) and cuts (88.2%) inflicted by tools, equipments and materials.
3. On the issue of economic impact of the hazards, it was noted that the most common factors were property damages, reduction in income and working efficiency of the injured workers, arising from accidents at workplace.

5.2 Recommendations

5.2.1 Study Recommendations

Metal working *Jua kali* sector is burdened with a wide variety of occupational hazards which affect the health and economic wellbeing of its workers. Through collaboration with various stakeholders such as Directorate of Occupational health and Safety Services (DOHSS), ministry of industrialization, county government and *Jua kali* associations, prompt interventions need to be established in order reduce these occupational risks and their associated impacts through:

1. Enforcement of OSHA 2007 act to exhaustively regulate and protect those working in the *Jua kali* sector.
2. Organization of regular training and awareness programs on safety and health for *Jua kali* sector workers.
3. Simplification and translation to Kiswahili and local languages all Chemical safety data sheets in order to improve understanding on appropriate risk reduction advice, first aid procedures and adverse health effects of chemicals used in metal working *Jua kali* sector.
4. Ensuring that *Jua kali* workplaces are constructed and designed so as to incorporate various aspects of health, safety and work-related welfare. They should be equipped to react effectively to any emergencies.
5. Clearing of materials not in immediate use from the work area to create more room and improve workflow; and making pathways for organized work areas.
6. Fitting guards on machines such as those used for grinding, trimming, etc. The guards should limit unauthorized removal.
7. Introduction of programs for provision and maintenance of personal protective equipments and appliances to workers in *Jua kali* sector at subsidized prices.
8. Control of noise from noisy operations by means of enclosure. When allocating sheds to the *Jua kali* artisans, noisy ones should be segregated and enclosed.

9. Creation of an all-inclusive occupational injury and health insurance scheme for workers in Jua kali sector to combat effects of occupational accidents and diseases.

5.2.2 Recommendation for Further Research

Further research should be conducted to establish the effectiveness of Directorate of Occupational Safety and Health Services (DOSHS) and other stakeholders' interventions in improving safety and health in *Jua kali* sector in Nakuru town. The research should specifically look into awareness of workplace safety and health among *Jua kali* operatives, training needs assessment and effectiveness of enforcement of OSH laws in the sector.

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APPENDICES

Appendix I: Questionnaire

I am a student at the Jomo Kenyatta University of Technology, undertaking Msc Occupational Safety and Health. As part of my studies I am required to undertake research in my area of interest. The research purpose is to assess occupational hazards and impacts in the *Jua kali* sector in Nakuru town, Kenya. Information collected will be used for academic purposes only. Identity of the respondent and their answers will remain anonymous and strictly confidential.

SECTION A: PERSONAL INFORMATION *(Tick (√) where appropriate)*

1) Name of the respondent (optional)…….
   Mobile phone No (Optional) …….
2) Gender

   ☐ Male
   ☐ Female

3) Occupation of the respondent

   ☐ Metal worker
   ☐ Painter
   ☐ Welder
   ☐ Other *(Specify)*……..

4) Age bracket

   ☐ 15 – 20 years
   ☐ 21 -25 years
   ☐ 26- 30 years
   ☐ 31-35 years
   ☐ 36- 40 years
   ☐ 41-45 years

☐ 46 years and above

5)Highest level of education

☐ Primary

☐ Secondary

☐ College

☐ No education

6) Number of years worked in *Jua kali* sector

☐ 0 – 5 years

☐ 6 -10 years

☐ 11 – 15 years

☐ 16 – 20

☐ Over 20 years

SECTION B

B1 Mechanical Hazards

List the machines/equipments you use in your workplace, and indicate if they have safeguards and emergency stop switches.

Machine	Safeguards		Emergency stop	
	Yes	No	Yes	No
	☐	☐	☐	☐

(You may use extra sheet of paper)

1) Which of the following hazards are present at your workplace?

☐ Crushing
☐ Cutting
☐ Shearing
☐ Entanglement
☐ Impact
☐ Stabbing
☐ Slips/trips/ falls
☐ Drawing in/fall

Other (Specify)……

B2 Chemical Hazards

Does your work involve the use of chemical(s)?

☐ Yes
☐ No

If answer above is "Yes" which chemical(s) are used at your workplace? *(List them)*

i. ……
ii. ……
iii. ……
iv. ……

1) Have you ever been exposed to any fumes at the workplace?

☐ Yes
☐ No

If answer above is "YES" specify? *(Tick where appropriate)*

☐ Exhaust fumes
☐ Welding fumes
☐ Paint vapours
☐ Adhesive vapours
☐ Any other *(specify)*

B3 Electrical Hazards

Do the equipments used at your workplace have worn-out or uninsulated wires?

☐ Yes

☐ No

How are equipments connected to the power source? *(Tick as appropriate)*

Directly without plugs ☐

Through an earthed plug ☐

Through an unearthed plug ☐

What is the floor condition at your workplace where electrical appliances are used?

Always dry ☐

Always wet ☐

Sometimes wet ☐

B4 Housekeeping Hazards

How often do you clean and arrange your workplace?

Daily ☐

Fortnightly ☐

Monthly ☐

Never ☐

Please Tick in appropriate places against each statement.

Statement	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
There are no tool racks and designated equipments storage area at my place of work					
There is no routine cleaning at my place of work					
I feel like my workplace is clutched and disorganized					
There are no designated waste storage area/bins at my workplace.					
There are spills at my workplace that might result in slip hazards.					
There are loose cables and wires at my workplace that can cause trips and falls					

B5 Ergonomic (Manual Material handling) hazards

How are loads handled within the workplace?

- ☐ Manual carrying
- ☐ By use of Chain block
- ☐ By used of Electrical hoists
- ☐ By use of Trolleys
- ☐ By use of Carts
- ☐ Other (Specify)

What is the weight limit of load you lift/carry at your workplace?

10-30 kg ☐

31-50kg ☐

51- 80kg ☐

81-100 kg ☐

101kg- Above ☐

B6 Physical Hazards

In your opinion are there equipments/operations which generate excessive noise at your workplace?

Yes ☐

No ☐

Have you ever been affected in any way by the noise?

Yes ☐

No ☐

If the answer in No. 2 is "Yes" How has it affected you?

☐ Speech interference (Shouting)

☐ Concentration interference

☐ Stress

☐ Fatigue

☐ Hearing damage

☐ High blood pressure

☐ Any other (specify)……

Is your working posture comfortable in regard to their working station?

Yes ☐

No ☐

If the answer in No. 6 is "No" have you ever suffered from the following health complaints?

Low back pain ☐

Knee pain ☐

Wrist pain ☐

Muscle strain ☐

Neck pain ☐

Arm pain ☐

Have you had any case of occupational injury?

Yes ☐

No ☐

If "Yes", specify the type of injury

☐ Cuts ☐ Concussion

☐ Puncture ☐ Bruise

☐ Heat strain ☐ Electric shock

☐ Crushing ☐ Fracture

☐ Amputation ☐ Strangulation

☐ Burn/Scald ☐ Abrasion

☐ Hearing impairment ☐ Eye injury

1) Have you ever suffered from work related illness?

Yes ☐

No ☐

2) If the answer in No. 10 is "Yes" specify the illness

Back pain	☐	Head aches	☐
Fungal infection	☐	Noise induced hearing loss	☐
Cancer	☐	Eye problems	☐
Tetanus	☐	Fatigue	☐
Occupational stress	☐	Chest problems	☐
Other *(Specify)*	☐		

SECTION C ASSESSMENT OF ECONOMIC IMPACTS OF OCCUPATIONAL HAZARDS

How much have you spent on medication as result of the illness/injury?

< Kshs 1000 ☐

>Kshs1000 <Kshs10, 000 ☐

>Kshs10, 000 < Kshs 20,000 ☐

>Kshs 20,000 ☐

Have you ever been absent from work as a result of work-related injury/illness in the last 12 months?

Yes ☐

No ☐

If the answer above is "Yes" Specify the number of days absent.

……. days

Has there been any property damage as a result of an accident in the last 12 months?

Yes ☐

No ☐

If "YES" specify type(s) of machine(s), equipment(s) or material(s) damaged.

Has your facility ever been closed as a result of a hazard or accident?

Yes ☐

No ☐

If the answer above is "YES", how many days was the facility closed?

……. Days

Approximate the loss of income incurred as result of the closure (*Specify in Kshs*)

Please tick in appropriate places against each statement.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
The injury I sustained in the course of my work has affected my working efficiency					
The injury(s) I sustained in the course of my work has incapacitated me.					
The injury(s) I sustained in the course of my work has led to reduction of my income.					
The injury(s) I sustained in the course of my work will affect my future earnings					
The injury(s) I sustained in the course of my work has caused me to change job.					

Appendix II: Occupational Hazards Checklist

Exposure/Hazard	No	Yes
CHEMICAL		
Are workers exposed to dust?		
Is there any exposure to Paint fumes?		
Are workers exposed to Exhaust fumes?		
Are workers in constant contact with Oil/lubricants?		
PHYSICAL		
Are workers exposed to Excessive noise?		
Are workers exposed to Direct sunlight?		
Is there no adequate supply of fresh clean air in the workplace?		
Is there no adequate lighting for the type of work being done?		
There is no adequate space provided for each worker in each workstation adequate?		
ERGONOMICS		
Is there use of excessive force and repetitive movements?		
workstation and seating not acceptable		
Are safe manual lifting techniques used?		
BIOLOGICAL		
There are no clean and adequate sanitary facilities?		
There is no clean potable water?		
MECHANICAL		
No proper guards or safeguards in place to prevent contact with, or entanglement in moving parts?		
Are workers exposed to sharp edges and objects		
ELECTRICAL		
Do any equipments have any worn out or un-insulated wires?		
Does any equipment have power drawn directly from the source without plugs or do not possess earthing?		
Do you observe any overloaded power sockets?		
Is there any cable trip hazard?		
HOUSEKEEPING HAZARDS		
Are there no designated walkways?		
Are there no designated storage areas?		
Workplace not clean and tidy?		
Waste collection bins/areas not allocated?		

Appendix III: Observation Photos

Photo 1: A makeshift structure used by *Jua kali* operatives which doubles up a store and work area.

Photo 2: A worker in *Jua kali* carrying out welding activity with no welding shield, gloves, overall and safety shoes.

Photo 3: A painter with no personal protective equipments; mask, gloves, overall and goggles.

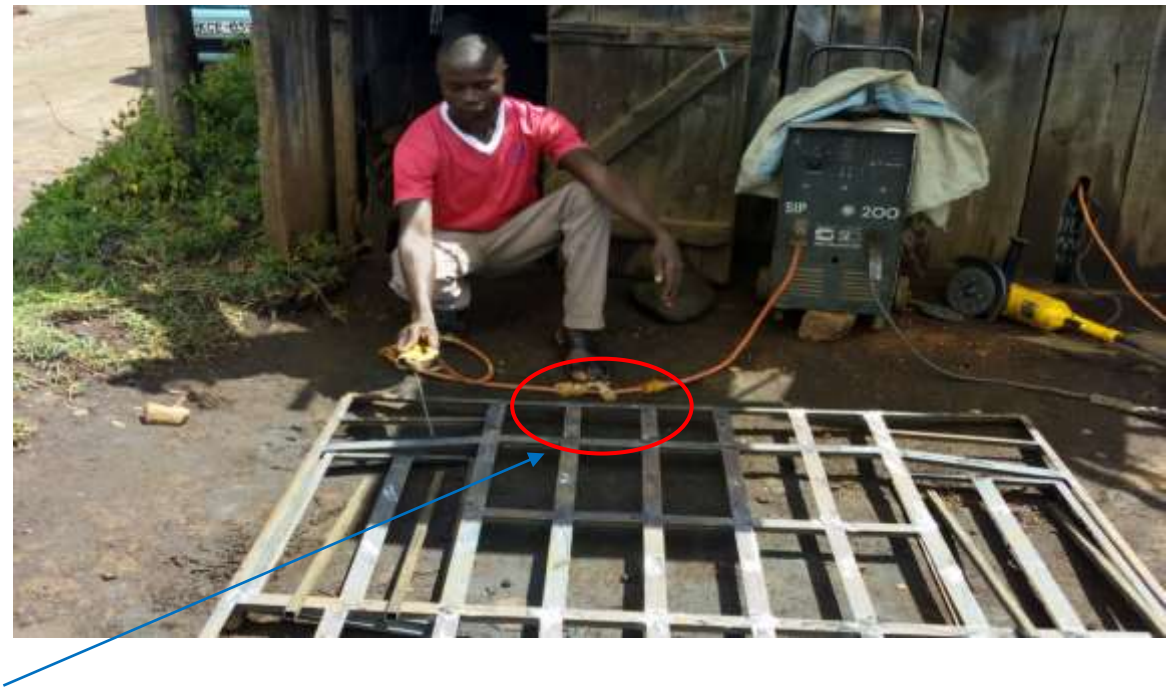

Photo 4: Worn out insulation on an electrical cable for arc welding machine.

Photo 5: Poor housekeeping evident in a *Jua kali* workplace. The workplace also serves as store for materials.

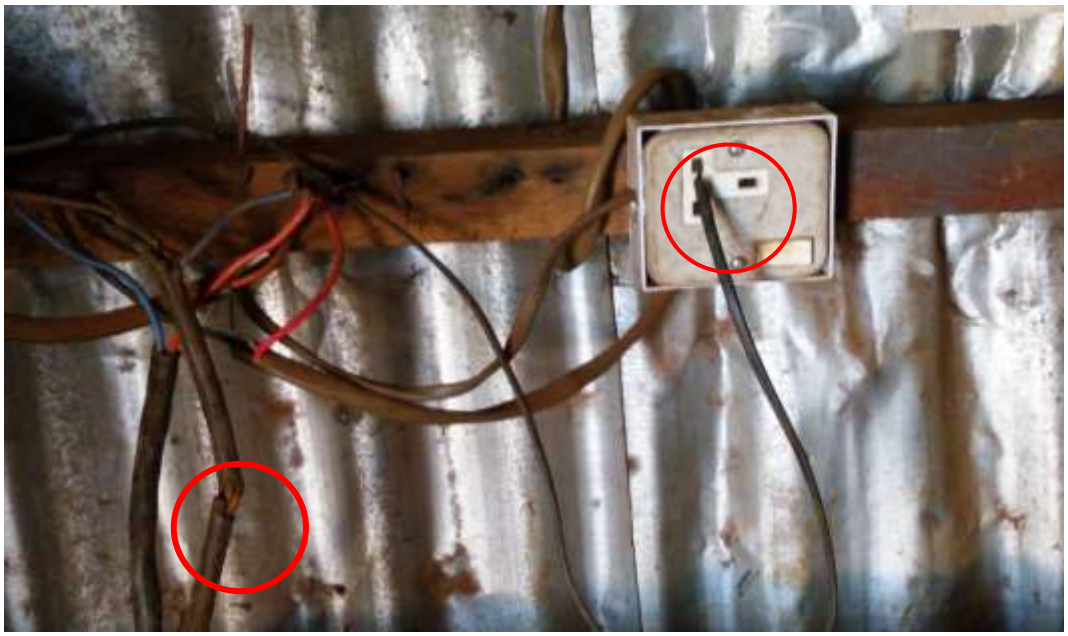

Photo 6: Naked electrical wires plugged directly into a socket without the use of a fused plug. Observed also are worn-out insulations on electrical cables, an electrical hazard.

Photo 7: Typical f*Jua Kali* workplace.