HAZARD AND ITS CONTROL MEASURES IN WELDING AND FABRICATION OUTFITS IN MINNA METROPOLIS OF NIGER STATE

BY

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DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA,
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**A PROJECT SUBMITTED TO THE
DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA,
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AWARD OF BACHELOR OF TECHNOLOGY (B.Tech) IN
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DECLARATION

I Saeed, Muhammad Nuruddeen with Matric No. 2014/1/53149TI an undergraduate student of the Department of Industrial and Technology Education certify that the work embodied in this project is original and has not been submitted in part or full for any other diploma or degree of this or any other University.

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Name and Matric No.	Signature & Date

CERTIFICATION

This project has been read and approved as meeting requirement for the award of B.Tech degree in METAL WORK Technology of the department of Industrial and Technology Education. School of Technology Education, Federal University of Technology, Minna.

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ABSTRACT

The study is to determine the Hazard and its Control Measures in Welding and Fabrication Outfits in Minna Metropolis of Niger State. The study possesses three specific objectives to guide the study which are to identify the level of workers compliance with safety and health practices in welding and fabrication operations, identify the possible causes of hazard, risk and accident in welding and fabrication operation and the possible control measures to curtail and avert hazard and accident in welding and fabrication operations. Three (3) corresponding research questions and null hypotheses is tested at 0.05 level of significance. The research design is a descriptive survey, the population of the study comprises of fifty (50) welder and (10) supervisors. The data was analyzed by computing the mean and t-test statistics. Mean was used to answer the research questions while Independent t-test was used to test the hypotheses at 0.05 level of significance. The findings of the study revealed identifying the needed for adequate orientation should be given to welders on safety and precaution, fire extinguishers should be available in all welding and fabrication shops, exposure to scientific and technical development and provision for adequate ventilation, as The study concluded that the effectiveness of welders activities is reliant on hazard free working environment that poses no to threat to the lives and well-being of welders, welding environment depends largely on the development of a safe working environment and safety posters should be placed in welding shops and defaulters of safety measures penalized to serve as deterrent to others that may want to ply the same road. The study recommended that the adequate lightning and ventilation should be provided for in all fabrication outlets, seminars should be organized periodically to enlighten welders on safety and government should support welders with fund to upgrade their equipment.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

The identification and control of hazards is not a simple matter. It has become more difficult as the depth of technology has increased. Despite the advances in control technology, welders continue to be exposed to welding fumes and gases (Wallace, *et al.*, 2019). Physical hazards no longer lie on the surface accessible to a simple inspection. (Qureshi, 2017) had done a hazard and operatibility study in which potential hazards are identified by looking at the design in a dynamic manner.

There is, however, no single idea or system of hazard identification and control the most appropriate system vary to a small extent with the type of industry and processes involved. In fact, there is usually the need for a combination of methods to be used. Hazard management is a systematic identification, evaluation and control of hazard at all phases of the life cycle, (OSHA, 2019).

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the work pieces and adding a filler material to form a pool of molten material (the weld pool) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. (Osha, 2019).

Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction, and ultrasound. While often an industrial process, welding and fabrication may be performed in many different environments, including open air, under water and in outer space. Welding is a potentially hazardous undertaking and precautions are required to avoid burns, electric shock, vision damage, inhalation of poisonous gases and fumes, and exposure to intense ultraviolet radiation. Welding is a hazardous process burns to skin, flash burns to the eye and fire are some the more immediate and acute hazard (Ashby, 2015).

Until the end of the 19th century, the only welding process was forge welding, which blacksmiths had used for centuries to join iron and steel by heating and hammering. Arc welding and oxyfuel welding were among the first processes to develop late in the century. And electric resistance welding followed soon after. Welding and fabrication technology advanced quickly during the early 20th century as World War II drove the demand for reliable and inexpensive joining methods

Following the wars, several modern welding techniques where developed, including manual methods like shielded metal arc welding, now one of the most popular welding methods, as well as submerged arc welding, flux-cored arc welding and electros lag welding. Developments continued with the invention of laser beam welding, electron beam welding electromagnetic pulse welding and friction stir welding in the latter half of the century.

To prevent future injuries in welding and fabrication outfits in Nigeria, safety Act was established. Health and safety in the manufacturing industry is regulated by the factory Act in 1990. The provision of this Act have enable the federal government of Nigeria put in place statutory practice and structure for inspecting the health and safety conditions of the industry, for reporting accident and injuries in the industries and sanctioning non compliance statutory health and safety conditions .However such regulation practice and structure do not exist in some welding and fabrication industries therefore some welders are left to use their judgment on such important issues, the consequences are that welders commit little resources to maintaining health and safe working environment. To identify and evaluate hazards this have seriously increased job related hazards which thereby lead to job injuries and accidents because some workers are not aware of the various causes of job hazards let alone of how they can be manage and this has necessitate the researcher to specifically determine hazard and its control measures in welding and fabrication outfits in Minna metropolis of Niger State.

1.2 Statement of the Problem

Welding and fabrication industries have become one of the major industries in Nigeria and considered one of the most hazardous. Since the advent of crude oil, many multi-national oil companies depends on welding and fabrication industries for materials they use in processing their products. Welding is the infusion or joining of two materials which makes the job so hazardous. Today's welding and fabrication industrial sector face a stark reality of poor health and unsafe practices on the part of management and workers. Some of the hazard that occur in welding and fabrication industries could be traced to managerial negligence which include poor ventilation, poor incentives and remunerations, denial of financial emoluments, poor performance appraisal by management of the organization and negligence on the part of workers to use personal protective equipment (PPE) for safety. As a result of this, a large percentage of accidents in the welding and fabrication industry are caused by poor hazard management.

The unsafe practice and hazards that frequently occur in welding and fabrication industries is due to the fact that there is poor management appraisal and inability to identify potential hazards. With good supervision and management team with experts in identifying potential hazards, the rate of hazards was curtailed in fabrication industries. The necessity for the study is to unveil and determine hazard and its control measures in welding and fabrication outfits in Minna metropolis of Niger State.

1.3 Purpose of the Study

The study will specifically determine:

1. The level of workers compliance with safety and health practices in welding and fabrication operations in Minna metropolis.
2. The possible causes of hazard, risk and accident in welding and fabrication operation in Minna metropolis.
3. The possible control measures to curtail and avert hazard and accident in welding and fabrication operations in Minna metropolis.

1.4 Scope of the Study

The study is limited to welders in Minna metropolis of Niger state. The focus is to ascertain the possible hazards in a welding and fabrication outfits and come out with modalities to curb and prevent hazards and avoidable accidents.

1.5 Significance of the Study

The significance of this study cannot be over-emphasized. The study is significant to fabrication companies and welders. It was useful in sensitizing welders and fabrication workers on environmental safety. It will increase the safety awareness of welders and exposes the possible dangers associated with welding and how to prevent the hazards. it ascertains the health risk associated with welding fumes and gases (in welding operations). It affords researchers, welders and factory workers the opportunity to know more about welding operations in confined space and the importance of ventilation in welding and fabrication. Welders will benefit tremendously from the study as regards safety measures to secure their health and hence prolong their life span.

1.7 Research Questions

A carefully hatched research work is usually suffused with thought-provoking researched questions that aid the success of the research. Below are a few research questions formulated to regulate the research work. The researcher took cognizance of the research topic in proximity to the contemporary environment and the research limitation.

1. What is the level of workers compliance with safety and health practice in welding and fabrication operations in Minna metropolis?
2. What are the possible causes of hazard, risk and accident in welding and fabrication operations in Minna metropolis?
3. What are the possible control measures to prevent hazard and accident in welding and fabrication operations in Minna metropolis?

1.7 Hypotheses

The following null hypothesis was tested at 0.05 level of significance.

H_{01} There is no significant difference between the mean responses of welding workshop supervisors and the welders on the level of workers compliance with safety and health practice in welding and fabrication operations

H_{02}There is no significant difference between the mean responses of welding workshop supervisor and the welders regarding the possible causes of hazard, risk and accident in welding and fabrication operations

H_{03}There is no significance difference between the mean responses of the welding workshop supervisor and the welders on the possible control/preventive measures to prevent hazard and accident in welding operations

CHAPTER TWO

2.0 LITERATURE REVIEW

This chapter dealt intricately with review of related literature organized under the following subheadings**.**

1. The concept of welding and fabrication
2. Welding and fabrication hazards control
3. Control measures of occupational hazards
4. Causes of hazard in welding and fabrication workshop
5. Risk Analysis of Hazards
6. Relevance of Ventilation in Welding
7. Summary of Review of Related literature

2.1 The concept of welding and fabrication

Welding is a material joining process in which two or more parts are coalesced (joined together)at their contacting surfaces by a suitable application of heat or pressure.In some welding process, a filler materialis added to facilitate coalescence.Welding is most commonly associated with metallic partsbut for plastics also it is used.

Welding is a fabrication process whereby two or more parts are fused together by means of heat, pressure or both forming a join as the parts cool. Welding is usually used on metals and thermoplastics but can also be used on wood. The completed welded joint may be referred to as a weldment. Some materials require the use of specific processes and techniques. A number are considered 'unweldable,' a term not usually found in dictionaries but useful and descriptive in engineering (Welding Institute, Cambridge).

In welding and fabrication, the parts that are joined are known as a parent material. The material added to help form the join is called filler or consumable. The form of these materials may see them referred to as parent plate or pipe, filler wire, consumable electrode (for arc welding). Consumables are usually chosen to be similar in composition to the parent material, thus forming a homogenous weld, but there are occasions, such as when welding brittle cast irons, when filler with a very different composition and, therefore, properties is used. These welds are called heterogeneous.

Welding is used in virtually every industry, so welders need to be creative in choosing the right welding type and joint style. Here are some common ways to join two pieces together:

Edge joint, T-joint, Corner joint, Lap joint, Butt joint

A welder chooses the type of joint after carefully considering the materials and application. Does the material need to withstand heavy sheer loads or torsional loads? This can affect the best type of joint and which weld type is used.

Types of Welds

All types of welds can be divided into two categories: pressure welding and fusion welding. Pressure welding uses heavy pressure at or above the melting point of the base material. Fusion welding focuses heat at the edge of the material and doesn’t require external pressure. Many fusion welds use an inert gas to improve the strength and other features of the weld. Here are the most common welding styles used:

Gas tungsten arc, Shielded-metal arc, Flux-cored arc, Gas metal arc, Plasma arc, Electron-beam, Laser beam, Electro slag, Atomic hydrogen welding.

The nine varieties above can be divided into three categories: friction, arc, and electron beam. Friction welding uses mechanical friction and can be used even for wood and aluminum applications. It doesn't use filler metals or requires a shielding gas, so it's being used in various industries to firmly bond wood and lightweight aluminum products.

Arc welding is the most popular and familiar style. Whether you pick up a manual, automatic, or semi-automatic welder, it is important to learn how to create successful joints with an arc welder. TIG, MIG, GTAW, and other common welding styles all fall under this category.A high-tech welding style is laser welding. This style is commonly automated and used for deep welds. Electron beam welding requires a vacuum, while laser beam welders can be used in air.

2.2 Welding and Fabrication Hazards Control

A hazard is a potential source of harm. Substances, events, or circumstances that can constitute hazards when their nature would allow them, even just theoretically, to cause damage to health, life, property, or any other interest of value. The probability of that harm being realized in a specific *incident*, combined with the magnitude of potential harm, make up its risk, a term often used synonymously in colloquial speech *(*Smith Keith, 1992).

Welding and fabrication hazards include electric shock. During the arc welding process, live electrical circuits are used to create a pool of molten metal. Therefore, when welding, you are at risk of experiencing an electric shock. Electric shock is the most serious hazard posed by welding and can result in serious injuries and fatalities, either through a direct shock or from a fall from height after a shock. You are also at risk of experiencing a secondary electric shock should you touch part of the welding or electrode circuit at the same time as touching the metal you are welding.

A welder is particularly at risk if the work space is in electrically hazardous conditions. These include welding:

In damp conditions.

While wearing wet clothing.

On metal flooring or structures.

In cramped conditions where you are required to lie, kneel or crouch.

Burn:the combination of high-temperature welding arcs, UV rays and molten metal means you are prone to severe burns when welding. These burns can affect the skin or eyes and can be very serious. They can also happen very quickly.

Burns usually occur when welders think they can skip taking precautions for a few quick welds. This is bad practice. If a welder follows outlined precautions, hazards and burns was curtailed and drastically reduced.

Welding using safe personal protective equipment

Welding Safety Precautions

Ensuring high levels of safety is vital when undertaking any welding activity. Ignoring your PPE and safe working practices can have serious repercussions and might even lead to fatalities. Therefore, you should follow the safety precautions below to protect yourself at work.

Always Wear Appropriate PPE

Welding helmets with side-shields: Welding helmets protect you from UV radiation, particles, debris, hot slag and chemical burns. It's important that you wear the right lens shade for the work you are carrying out. Follow the manufacturer's guidelines and gradually adjust the lens filter until you have good visibility that does not irritate your eyes. You should also use a fire-resistant hood under your helmet to protect the back of your head.

Respirators: Respirators protect you from fumes and oxides that the welding process creates. Your respirator must be suitable for the work you are carrying out.

Fire resistant clothing: Fire resistant clothing protects you from heat, fire and radiation created in the welding process and shields you from burns. It should have no cuffs, and pockets must be covered by flaps or taped closed. You should not use synthetic clothing. Instead, opt for leather and flame-resistant treated cotton.

Ear protection: Ear protection protects you from noise hazards. It's important you wear ear protection that is appropriate for the noise created in your workplace, and use fire resistant ear muffs if there is a risk of sparks or splatter entering the ear.

Fire disaster: Ensure a workspace is free of flammable material. You should avoid keeping flammable materials in the vicinity of welding processes as sparks, heat and molten metal splatters produced in the welding process could potentially set flammable material on fire.

Noise Hazards

When carrying out welding activities, exposure to loud, prolonged noises is imminent and unavoidable in most cases. A loud noise is considered to be above 85 dB(A), and welding activities such as flame cutting and air arc gouging can produce noise levels of over 100 dB(A). This can be very damaging to the ears and can result in hearing impairment.

Regular or immediate exposure to loud noises can cause permanent noise-induced hearing loss.

Noise-induced hearing loss can have the following side effects:

- Ringing in the ears, known as tinnitus.
- Occasional dizziness, known as vertigo.
- Increased heart rate.
- Increased blood pressure.

Exposure to UV and IR Radiation

Looking at the intense bloom of UV light produced when welding, without appropriate PPE or welding curtains, can result in a painful and sometimes long-lasting condition called arc-eye. Many factors can affect the severity of a flash burn injury, such as distance, duration and the angle of penetration. Long-term exposure to arc flashes could also potentially result in cataracts and lead to a loss of vision.

Other forms of eye damage include:

Foreign bodies entering the eye, including grit, sparks and dust.

Particulate fumes and gases, which could lead to conjunctivitis.

Undertaking in welding activities will expose you to invisible gaseous fumes, including ozone, nitrogen oxides, chromium and nickel oxides, and carbon monoxide which can easily penetrate into your lungs. Depending on the gas or fume, the concentration and duration of your exposure, the resultant damage can be severe.local exhaust ventilation is much and explosions, radiation, heat, noise, fumes and more effective in controlling welding gases. Exposure to any or all of these can be dangerous because of fumes and gases. It can be minimized by using an effective combination of fumes and gases close to the source and control measures. One hazard is less readily noticeable but has both acute and long-term chronic effects of welding fume. Fumes are solid particles that originate from welding consumables, the base metal and any coatings present on the base metal. Despite advances in control technology, welders continue to be exposed to welding fume and gases (Wallace, *et al.*, 2014).

2.3 Control Measures of Occupational Hazards.

The prevention of occupational hazards is much more effective and usually cheaper if it is considered at the planning stage of any work process and workplace rather than as control solution of already existing hazardous situation. This applies first to the planning of new processes or factories, to ensure that hazardous substances are only used if necessary. If they are necessary, then emissions inside and outside the workplace, as well as waste generation should be minimized. The work place and the job should be planned so that hazardous exposure is either avoided or kept to an acceptable minimum (WHO Dept. of protection of the Human Environment 2003).

According to Ogden (2013) "If the material is likely to offer an investigation hazard, smoking, eating and drinking in the work place should be forbidden. Such activities should be restricted to designated areas with adequate washing facilities. Personal care including teeth brushing, washing hands and cleaning nails, showering and washing hair, before eating and after the work are important measures whenever there is the possibility of dust contamination. Workers must be properly trained about the hazards and risks from the substances used the control measures, and any exposure monitoring. The workers are often the people who have the fullest knowledge of what happens during work, and their views should be sought on what leads to exposure and the effectiveness of control.

Once sampling results are returned, facility management must determine what (if any) corrective action is needed. For instance, if results show that exposure limits are being exceeded, a respiratory protection program should be implemented until a permanent control can be developed. In its ‘‘occupational safety and health Guideline for Welding Fumes,’’ OSHA notes several methods to control exposure to welding fume and its individual constituent.

- Process enclosure;
- Local exhaust ventilation (LEV);
- General dilution ventilation;
- PPE

Other control methods include using welding rods or wire that produce a low fume (since some 90 percent of the fume (ELCOSH “Hazard Alert”2). then purchasing an LEV system, remember that it must be an easy to move and adjust; other wise, employees may not use it. A NIOSH study of two portable units found that the unit which performed best was the cheapest and lightest of two (ELCOSH “Cheap Light/weight”). According to Ashby, (2002), Employees must also be aware of other protective measures namely;

- Remove all paints and solvents before welding or touch cutting.
- Use the safest welding method for the job.

For example, stick welding creates less fumes than flux core welding. Also requires specific control measures for welding materials that contain certain metals, such as precautionary labels on welding materials containing cadmium or fluorine compound.

ANSI Z49 1-1967, safety in welding and cutting, published by American welding society cautioned that, welding may produced fumes and gases hazardous to health. Avoid breathing these fumes and gases. Use adequate ventilation.

According to Korczynski,(2000) “numerous studies have been conducted in the welding industry” 936); “the majority of the articles produced on the welding industry cited inadequate/ lack of any form of ventilation in the work place’ (943).

For example, a study conducted by the work place safety and health branch in Manitoba, Canada, found similar results. Eight welding companies with a total of 44 welders participated in the study Korczynski, (2000) “welding activities range from large work pieces such as agricultural pens, grain handling equipments and transformers, to custom work on smaller pieces for the food industry. The type of welding identified in all companies was electric arc welding and 90 percent was MIG on mild steel. The reminder was either MIG stainless steel or tungsten inert gas on aluminum” (Korczynski 939, 940). A total of 42 welders were monitored for personal exposure to welding fumes. Nearly 60 percent were overexposed to manganese and 19 percent were exposed to iron (Korczynski940). “Two welders from two different companies had the two highest manganese exposures. Both had worked in isolated welding state fume to move quickly the filters, it was still passing through the welder’s breathing zone.

These units moved 740cubic ft. of air per minute and were positioned to pull the fume out of the welder’s breathing zone. The units are lightweight and are easily manipulated by employees. The combination of local exhaust and general ventilation reduced the amount of welding fume exposure to 51 percent. This study was performed 0ver a six (6) month period at a final cost, including improvements implemented, of $46,000. Although less-expensive methods were available, this approach best fit the firm’s current and future needs.

As a NOISH literature review on welding and lung cancer revealed, welders have a 40 percent increased risk of developing occupationally induced lung cancer (Korcyznski 937). This fact is compounded by the continued lung cancer (Korcynski937), This fact is compounded by the continued introduction of new welding processes, technique and materials (Wallace *et al* 2004). As a result, welding will likely be a high priority for regulators and, thus, for industry in the coming years.

Breathing zone: See examples of local exhaust ventilation for welding below. The most effective way to reduce exposures is to eliminate the offending substance or process. This to be effective, local exhaust ventilation must: is not practical, however, in most instances. Be close to welding arc or flame where the ventilation is the most common way of controlling fumes, gases and heat are generated and exposure to fumes, gases and heat in welding have enough velocity to draw away the operations. There are two types of ventilation or local exhaust ventilation.

2.4 Causes of hazard in welding and fabrication workshop

Hazard is something potentially capable of causing accident in varying form and severity from cut and bruises to serious illness, disability or death. Risk is the combination of severity of accident with the likelihood of it occurring. Accidents are by their nature unplanned and uncontrolled events. Laufer and ledbetter (2015) described accident as chance-caused events that are normally not given to direct observation but rather most methods are based on post-factum measurement.

Accidents do not necessarily have to be injurious or damaging events but it can interrupt or disrupt the completion of an activity. Accident can result in direct and indirect cost. Direct costs of construction accident are medical bills, premiums for compensation benefits, liability and property loss. Indirect costs associated with accidents are: (1) Loss time of injured employee (2) Cost of work stoppage of other employees from curiosity, sympathy, and providing assistance; and (3) Lost of supervisory time from assisting injured employee, rearranging work crews because of lost employee. It has been established that the reduction of hazardous events is fundamental to good construction safety management because it is these events that have the potential to cause accidents which may result in injuries and fatalities (Carter and Smith, 2013).

It is therefore pertinent to undertake risk assessment. A risk assessment is a careful examination of those things in the process of work or in the workplace that could cause harm to people. It also covers finding out whether enough precautions have been taken or more should be done to prevent harm. The essence is to ensure that no one gets hurt or becomes ill. What is most important is deciding whether a hazard is significant and if it is covered by satisfactory precautions so that the risk is small. The project supervisory team and their styles can also influence the hazard vulnerability and safety performance during construction process.

For instance in a study by Hinze and Raboud (2002) on building construction in Canada to assess the extent of how company policies and practices influence workers safety in term of frequencies of injury, the result showed that company-level practices influences safety performance.

Safety performances were found to be better on projects by companies that employed a full time safety officer; that exhibited stronger top-management support for safety performances of their supervisors. The result also showed that job pressures, in particular, those imposed by budgetary constraints were found to adversely affect safety performance.

On injury analysis, there are various theories, but an interesting theory concerning importance of minor injuries state that for every one injury causing loss of time at work, there are 29 minor injuries and 300 accidents which do not cause personal injury (Betts, 2002; Oribuyaku, 2009).

The theory was based on study of many cases (in thousands) and it follows that by reducing occurrence of minor injuries a proportionate number of serious and major injuries was prevented. It is against this background that safety assessment and pursuit should be geared towards identification of hazards, assessment of risks, determination of their significance, evaluation of the available corrective measures, and the selection of the optimal remedies. Actions to ensure safe access and safe working areas must also be regularly reconsidered as construction proceeds otherwise safety may be compromised.

2.5 Risk Analysis of Hazards

For any industry to be successful it should meet not only the production requirements, but also maintain the highest safety standards for all concerned. The industry has to identify the hazards,and the associated risks and bring the risks to tolerate level on a continuous basis. Risk assessment is a systematic method of identifying and analyzing the hazards associated with an activity and establishing a level of risk for each hazard. The hazards cannot be completely eliminated, and thus there is need to define and estimate an accident risk level possible to be presented either in quantitative or qualitative way. (Amol,2011)

Qureshi (2015) had done a Hazard and operability study (HAZOP) in which potential hazards and identified by looking at the design in a dynamic manner

- To identify the nature and scale of the dangerous substances;
- To give an account of the arrangements for safe operation of the installation, for control of serious deviations that could lead to a major accident and for emergency procedures at the site;
- To identify the type, relative likelihood and consequences of major accidents that might occur, and
- To demonstrate that the manufacturer (operator) has identified the major hazard potential of his activities and has provided appropriate controls.

Khan and Abbasi (2014) proposed optimal risk analysis (ORA) which involved the following:

1. Hazard identification and screening.

2. Hazard analysis using qualitative hazard assessment by optimal hazard and operability study (optHAZOP).
3. Probabilistic hazard assessment by modified fault tree analysis (MFTA).
4. Consequences analysis which include development of accident scenarios and damage potential estimates.
5. Risk estimates.

Carpignano*et al*. (2016) applied quantitative risk analysis (QRA) for drawing conclusions concerning serious accidental events with the occurrence frequency and the consequences. The QRA approach they selected was based on reservoir analysis and management systems (RAMS) such as preliminary Hazard Analysis (PHA), Failure mode effect and critical analysis (FMECA), Fault Tree Analysis (FTA), Event Tree Analysis (ETA) and cause consequences analysis and were able

- To identify accident initiating events and accidental sequence.
- To classify these sequences into frequency categories
- To determine the related consequences with respect to workers, population and the environments.

Dujim (2017) identified hazards for six different techniques for disposing decommissioned welding materials and ammunition. Use has been made of functional modeling as a basis for hazard identification. Risk levels are estimated based on general accident rates in the chemical industry. The disposal techniques are “open burning” (OB), “open detonation” (OD), “closed detonation” (CD), “fluidized bed combustion” (FBC), “rotary kiln (RK) incineration”, “mobile incineration” and comparative risk levels for alternative disposal techniques for ammunition have been derived using hazard identification based on functional modeling of the techniques in combination with the required manpower to perform the operations.

Khan *et al.* (2001) developed safety weighted hazard index (SWeHI). In quantitative terms SWeHI represents the radius area under moderate hazard (50% probability of fatality/damage).

In mathematical term it is represent as

SWeHI =B/A

Where B = Quantitative measures of damage that can be caused by unit/ plant

A= credits due to control measures and safety arrangement.

Lambert *et al.* (2001) used Hierarchical Holographic Modeling (HHM) for identification and management of risk source and prioritize the identified source of risk based on their likelihood and potential consequences and provided with options of risk management in terms of their costs and potential impacts on the acquisition schedule.

Bell and glade (2003) have done a risk analysis focusing on risk to life. They calculated land slide risk and occurrence of potential damaging events as well as the distribution of the elements at risk and proposed the following approach for risk evaluation:

RISK= HAZARD * CONSEQUENCES * ELEMENT OF RISK

Jelemensky*et al.* (2003) applied quantitative risk analysis followed by qualitative hazard identification to determine potential event sequences and potential incidents. From quantitative risk analysis risk estimation is done and individual fatality rate are calculated

Kecojevic and Radomsky (2004) studied about welding, loader and truck safety and found out the severity and number of accidents involving loader and trucks are higher when compared to other operations. They established fatal categories and causes of accidents and control strategies are discussed and evaluated to increased hazard awareness.

Dziubinski *et al.* (2006) studied basic reasons for pipeline failure and its probable consequences taking individual and societal risk into consideration and proposed methodology of risk assessment for hazards associated with hazardous substance transport in long pipelines. Taking that methodology as example, subsequent stages of risk analysis were considered paying special attention to the applied techniques and calculation models. A specific feature of this methodology was a combination of qualitative and quantitative techniques which offer a possibility of a full risk assessment for long pipelines.

Laul *et al.* (2006) identified hazards (chemical, electrical, physical, and industrial) and potential initiators that could lead to an accident. Hazard analysis is used to evaluate identified hazards. Hazard analysis is done by "what if check list", Hazard and operability (HAZOP) analysis, Failure Mode and Effect Analysis (FMEA), Fault Tree Analysis (FTA) Event Tree Analysis (ETA) and provided methods together with the 8

Nor *et al.* (2008) studied risk related to loaders and dozers and were assessed and ranked. The hazards "failure to follow adequate maintenance procedure" and "failure of mechanical /electrical/ hydraulic components" were the most severe and frequent hazards for the loaders and they fell into the category of high risk.

Hasssan*et al.* (2009) carried out a Quantitative Risk Assessment (QRA) into basic steps including system definition, Hazard Identification, Frequency Analysis, Consequences Modeling, Risk calculation and Assessment to determine the safest route for the transportation of hazardous material.

Wang *et al.* (2009) applied HAZOP analysis to determine if the operation has potential to give rise to hazardous situation and found the range of hazardous events. They identified the route by which each of the hazardous events could be realized. After HAZOP analysis they introduced

MO-HAZOP program which calculates probability of an event which is the product of probabilities of every factor.

Orsulak *et al.* (2010) presented an application of a risk assessment approach in characterizing the risk associated with safety violations in underground bituminous mines in Pennsylvania using the mine safety and Health Administration (MSHA) citation database. In this study quantitative risk assessment is performed, which allowed determination of the frequency of occurrence of safety violations (through associated citations) as well as the consequences of them in terms of penalty assessment.

The health risks and effects associated with welding gases and fumes are determined by:

- The length of time that you are exposed to them
- The type of welding you do
- The work environment
- The protection you use.

All welding and fabrication processes produce hazardous gases. Gases are invisible to the eye, and may or may not have an odour. The heat in both the flame and the arc, and the ultraviolet radiation from the arc, produce gases such as carbon monoxide, carbon dioxide, oxides of nitrogen and ozone. Other gases and vapours may be produced as by-products from the breakdown of solvent or coatings on the metal. Gases used for arc shielding, or as a fuel, are also given off during welding.

Welding also produces fumes. Fumes are formed when hot metal vapours cool and condense into very small particles that stay suspended in the vapour or the gas. The particles may be metal or metal compounds, and are often smaller than one micrometer (one-fiftieths) the width of the human hair). Fumes may be visible or not. Welding “smoke” is an example of a visible fume. But even if the fume can’t be seen, its particles are still present. Gases vapours and fumes enter the body through the air we breathe. Different gases and fumes affect us in various ways. A healthy body can rid itself of some gases and fumes without lasting effects. Gases such as carbon dioxide and argon, for example, are relatively non-toxic unless inhaled in large quantities. However, gases such as carbon monoxide, nitrogen oxides and ozone are extremely toxic.

The health effects of inhaling fumes depend on the type of fume inhaled. Iron oxides, which are produced during most manual welding processes, are relatively non-toxic. The effects, as currently known, are not permanently unless tobacco smoke or other substances, such as silica and asbestos, have already affected your lungs. Effect such as breathing problem tends to disappear over time once exposure is reduced or stopped. Fumes such as those produced during the welding of stainless steel may produce serious and long-lasting problems. These can include chronic breathing difficulty and cancer, in the case of exposure to chromium.

Health effects of fumes, gases and organic vapours during welding and fabrication, lists examples of the health effects of exposure to materials present during common welding and fabrication situations. In the table, “acute effects” refers to effect that occur immediately or quickly, while “chronic effects” refers to those that take a long time to appear. Metal fume fever is an example of a common acute effect of exposure to several types of welding fumes. This reaction consists of flu-like symptoms, including alternating chills and high fever. Symptoms usually last one or two days and then subside, although their onset may be delayed. It is possible to experience both acute and chronic effects from a brief exposure to large quantities of a substance, or from repeated exposures to smaller quantities of a substance.

The early symptoms of harmful exposure to most substances produced during welding are similar. These may consist of irritation of the eyes, nose, respiratory system and sometimes the skin (such as "nickel itch," caused by exposure to nickel fumes). Coughing, a tight chest or chest pains, headaches, nausea, vomiting and fatigue may also be some persistent symptoms. Since these symptoms are common to many other illnesses, it is important to determine whether or not they are related to work.

Occupational exposure limits (OELs) are the maximum permissible concentrations of a hazardous substance that most healthy adults may be repeatedly exposed to without suffering adverse health effects. Remember, these limits assume the individual exposed to the substance is a healthy adult. There may be increased risk, for example, for a smoker, a person with pre-existing health problems or individuals who suffer from allergies. Welding gases and fumes do not normally cause immediate health problems. However, if over the years of working as a welder, you breathe in gases, vapours and fumes in quantities greater than the OELs, it is likely that your health will suffer.

2.6 Relevance of ventilation in welding and fabrication

Welding inside vessels presents additional hazards. Welding may release products that have penetrated the metal. for example metal from tanks used by oil and gas industry may be contaminated with sulphur. Welding performed on these tanks may release sulphur fumes. (Amol, 2013).

The amount of ventilation and the welder's proximity to the work are two other important variables that influence exposure to a welding gas or fume.

You can reduce exposure to welding fumes and gases by talking these four steps;

- Substituting less hazardous flux materials

- Introducing engineering controls, by using enclosures and improving ventilation
- Developing administrative controls, such as implementing work-rest schedules and safe-work practices
- Wearing respiratory protection.

Prevailing winds in outdoor or semi-outdoor situation, air movement can provide natural ventilation. Its effectiveness, however, depends on whether the day is windy or calm, and whether you are working upwind or downwind. Using welding curtains spark enclosures or hoardings when working outside prevents exposure to natural air movement and therefore prevents effective ventilation.

General ventilation in indoor location and confined spaces, draft fans or air-movers provides general or dilution ventilation. A well-designed and well maintained ventilation system is usually effective for most situations involving clean, uncoated, mild steels. However, the only means of judging if the system is doing its job is to take regular airflow measurements and to sample for exposure. Vent hoods often fail to protect welders because they are poorly designed and located. To properly design and locate the vent hood system you must have a good understanding of the types of contaminants being produced, and of the work procedures and characteristics of the work area. Airflow checks must also be done regularly with a measuring instrument. The checks will ensure that the equipment is working as designed. When using vent hoods, make sure that the exhaust discharges outside the room or confined space.

Effective ventilation is the first step to controlling exposure. Ask your employer to check the ventilation system regularly. Before starting work, check that the fan operates properly and the filters are clean. Learn how to use the exhaust system correctly.

Know what materials and hazards you are dealing with. Make sure you read the Material Safety Data Sheet (MSDS) supplied with welding electrodes. It contains information you need to know and understand. Your employer is responsible for having up-to-date MSDSs at the work site and providing you with WHMIS (Workplace Hazardous Materials Information System) training. If you are self-employed, ask your contractor or supplier for a copy of the MSDS. Read the MSDS and take the precautions it describes.

Evaluate the work situation. Are you in a confined space with or no ventilation? What type of metals are you welding? Are the work pieces clean? Are the work pieces coated, painted or covered with a film degreasing solvent? Whenever possible, weld on clean metal only. Remove all coatings or paints that are within 5 – 10 centimeters of the weld area.

Use respiratory equipment when necessary. The risks of exposure to gases and fumes are high for plasma-arc cutting and for arc gouging and cutting. They are also high when welding stainless and high-alloy steel, as well as galvanized, coated and painted steels, even when air-movers and draft fans, or wide-open work areas provide good ventilation. Always use respiratory equipment under such conditions. With poor ventilation and no local exhaust, most jobs, whatever the welding process, will require a respirator. (Ashby, 2009). (Ogden, 2000) advised that: Every attempt should be made to avoid or minimize exposure by other methods before resorting to personal protective equipment (PPE), especially respiratory protective equipment (RPE). A respirator, particularly of the mask type, is not easy to wear for long periods; it can be very uncomfortable, especially in hot or cramped conditions, and workers may be tempted to remove it. Moreover, uncontrolled airborne dust may spread and affect people who are distant from the task, so it is better to prevent the occurrence of dust exposure in the first place. Another problem is that PPE is fallible, and may not give the protection assumed; moreover, it offers no environmental protection. Finally, PPE and especially RPE must be conscientiously cleaned and maintained to remain effective, which often makes them a costly option; poor maintenance makes any PPE ineffective.

Summary of literature Review

This chapter has made an attempt to review and give highlight on the relevant areas of concern which are closely linked with the topic of this research work. This include welding and fabrication hazards control which include: electric shock, burns, fire local exhaust ventilation is much and explosions, radiation, heat, noise, fumes and more effective in controlling welding gases. Control measures were discussed; this applies first to the planning of new processes or factories, to ensure that hazardous substances are only used if necessary. If they are necessary, then emissions inside and outside the workplace, as well as waste generation, should be minimized, considering the whole life of the process and the products. Ventilation this deals with general ventilation which is limited which is limited in safe work practices should exist for all welding and fabrication hazards. Activities including handling and storage of compressed gas cylinders and oxy-acetylene or heat and humidity can usually be controlled with electric arc welding equipment. Relevance of ventilation in welding which talks about outdoor or semi-outdoor situation, air movement can provide natural ventilation. Its effectiveness, however, depends on whether the day is windy or calm, and whether you are working upwind or downwind. Using welding curtains, spark enclosures or hoardings when working outside prevents exposure to natural air movement and therefore prevents effective ventilation.

This chapter also looked on the risk analysis of hazards, the industry has to identify the hazards, assess the associated risks and bring the risks to tolerable level on a continuous basis.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

This chapter describes the research design, Area of the Study, Population of the study, instrument for data collection, Validation of the instrument, administration of the instrument, Method of data collection method of data analysis and decision rule.

3.1 Design of Study

This study used a survey research design. A survey design is to answer questions that have been raised, to solve problems that have been posed or observed, to assess needs and set goals, to determine whether or not specific objectives have been met, to establish baselines against which future comparisons can be made, to analyze trends across time, and generally, to describe what exists, in what amount, and in what context. The survey design is considered the best design for this study because of the type of information needed for this investigation. In support of this Nworgu, (2017), stated that a research design is plan or blueprint which specifies how data relating to a given problem should be collected and analyzed.

3.2 Area of the Study

The area of the study is restricted to two local governments in Minna metropolis which are Bosso and Chanchaga local government. The study was carried out in metal welding and fabrication outfits in Bosso and Chanchaga local government area in Minna metropolis only.

3.3 Population

The target population for this study is 50 welding outfits in the local government areas that constitute Minna metropolis. This is Chanchaga and Bosso local government areas. The shops are listed below.

3.4 Sample and Sampling Technique

Ten welding outfits (shops) was randomly sampled in the two local government areas of the metropolis. A supervisor and five (5) welders was randomly sampled for the study. This gives a total of ten (10) supervisors and fifty (50) welders.

3.5 Instrument for Data Collection

The questionnaire was the main instrument use by the researcher, questionnaire was the research instrument consisting of series of questions and other problems for the purpose of gathering information from respondents. The questionnaire used in this study consist of (4) sections (A-D) i.e. Section A, consists of instructions and personal data to guide the respondents on how to complete the questionnaire. Section B, have 13 items that deals with (1) the level of worker's compliance with safety and healthy practice in welding and fabrication operations (2) Section C deals with the possible causes of hazard, risk and accident in welding outfits. (3) Section D deals with control measures to prevent hazard and accident in welding and fabrication operations.

The questionnaire items for this research questions was (41). All items used four point rating scale as stated below.

Strongly agree (SA) =4 points

Agreed (A) =3 points

Disagreed (D) =2 points

Strongly disagreed (SD) =1 points

3.6 Validation of the instrument

The instrument was validated by three experts. The validator's suggestions were used to draft the final draft of the instrument before the administration of the instrument. This is to ensure that the instrument is capable of eliciting necessary information needed for the study.

3.7 Method of Data Collection

The instrument for the study was administered to the respondents by the researcher and with the aid of one research assistant from the workshop and within the area selected for this research.

3.8 Method of Data Analysis

The data collected was analyzed using mean. Standard deviation and t-test and used to test the hypothesis. A four point rating scale of Strongly Agree (SA-4), Agree (A-3), Disagree (D-2) and Strongly Disagree (SD-1) was used Decision Rule.

The mean of 2.50 was used as decision point for every questionnaire item. Consequently any item with mean response of 2.50 and above was considered agreed and any item with a mean below 2.50 was considered disagreed and the hypothesis was tested at 0.05 level of significance with t-critical value of 1.98.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

This chapter deals with the presentation and analysis of data with respect to the research questions and hypotheses formulated for this study. The result and data analysis for the research were presented first, followed by those of the hypothesis tested for the study.

4.1 Research Question One

What is the level of workers compliance with safety and health practices in welding and fabrication operations in Minna metropolis?

Table 4.1: Mean responses of respondents on the level of workers compliance with safety and health practices in welding and fabrication operations.

S/N	Items	X_1	X_2	X_t	Remark
1	Welders usually put on protective clothes.	3.06	3.56	3.59	Agreed
2	Workers in welding shops are careless about safety.	3.65	3.54	3.59	Agreed
3	Flammable liquid is used with utmost precaution.	3.06	3.68	3.64	Agreed
4	Welding tools are well taken care of by welders.	3.25	3.58	3.41	Agreed
5	Accident is unavoidable in welding shops.	3.35	3.30	3.52	Agreed
6	Uneducated welders do not use protective wears.	3.58	3.09	3.74	Agreed
7	Workers are punished for disobeying safety rules.	3.59	3.05	3.54	Agreed
8	Welders are given orientation before handling tools.	3.55	3.58	3.56	Agreed
9	Ventilation is provided for in all fabrication shops.	3.65	3.06	3.69	Agreed
10	Welders have fire extinguisher in their shops all times	3.69	3.68	3.68	Agreed
11	Supervision of welders is not given priority.	3.69	3.64	3.66	Agreed
12	Waste materials are well disposed in fabrication shops	3.66	3.05	3.56	Agreed
13	Non insulation of electric cables of welding machine.	3.47	3.58	3.52	Agreed

Key
N_1= 100, N_2= 50
N_1 = number of welders, X_1= mean of welders
N_2=number of welding workshop supervisors, X_2= mean of welding workshop supervisor
X = Average mean of welders and welding workshop supervisor

The data in table 1 shows that the entire respondent agreed with the items with mean score ranging from 3.52-3.69 respectively.

4.2 Research Question Two

What are the possible causes of hazard, risk and accident in welding and fabrication operations?

Table 4.2: Mean responses of respondent on the possible causes of hazard, risk and accident in welding and fabrication operations.

S/N	Items	X_1	X	Xt	Remark
14	Careless handling of working tools.	3.52	3.38	3.45	Agreed
15	Careless disposal of waste materials.	3.38	3.32	3.35	Agreed
16	Care-free attitude of workers during operation.	3.64	3.48	3.56	Agreed
17	Wrong utilization of equipment.	3.43	3.48	3.45	Agreed
18	Inadequate knowledge of the work being done.	3.48	3.44	3.46	Agreed
19	Ignorance of operational ethics of welding.	3.43	3.44	3.43	Agreed
20	Careless handling of sharp edged tools.	3.57	3.42	3.49	Agreed
21	Usage of wrong tools to perform a task	3.55	3.64	3.59	Agreed
22	Fabrication in wet and humid environment.	3.61	3.38	3.49	Agreed
23	Usage of non insulated electrode holder.	3.59	3.62	3.6	Agreed
24	Lack of adherence to safety precautions.	3.53	3.66	3.35	Agreed
25	Inadequate understanding of safety rules.	3.59	3.54	3.56	Agreed
26	Performing tasks with outdated welding equipment	3.06	3.58	3.59	Agreed
27	Wrong wiring and electrical connections.	3.54	3.36	3.29	Agreed

Key
N_1= 100, N_2 = 50
N_1= number of welders, X_1 = mean of welders
N_2 = number of welding workshop supervisor, X_2 = mean of welding workshop Supervisor
X= Average mean of welders and welding workshop supervisor

The data in table 2 shows that the entire respondents agreed with the items with mean score ranging between 3.35-3.60 respectively.

4.3 Research Question Three

What are the possible control measures to prevent hazard and accident in welding and fabrication operations?

Table 4.3: Means responses of respondents on the possible control/preventive measures to prevent hazard and accident in welding and fabrication operations.

S/N	Items	X_1	X_2	Xt	Remark
28	Proper disposal of waste material	3.06	3.58	3.59	Agreed
29	Provision for adequate ventilation.	3.69	3.68	3.68	Agreed
30	Adequate orientation programme for welders	3.05	3.84	3.67	Agreed
31	Procurement of fire extinguishers	3.62	3.06	3.61	Agreed
32	Proper handling of tools	3.64	3.48	3.56	Agreed
33	Routine maintenance of welding tools and equipment	3.05	3.74	3.62	Agreed
34	Adherence to safety rules and precaution	3.35	3.62	3.45	Agreed
35	Using the right tool for tasks	3.54	3.05	3.52	Agreed
36	Control of distractions and carelessness	3.43	3.56	3.49	Agreed
37	Keeping equipment in good working condition	3.43	3.52	3.47	Agreed
38	Organizing sensitization exercise for new welders	3.46	3.48	3.47	Agreed
39	Using correctly protective wears	3.53	3.66	3.59	Agreed
40	Adhering strictly to ethics of welding and fabrication	3.47	3.37	3.4	Agreed

Key
$N_1 = 100$, $N_2 = 50$
N_1= number of welders, X_1= mean of welders
N_2= number of welding workshop supervisor, X_2= mean of welding workshop supervisor
X= Average mean of welders and welding workshop supervisor

The data in table 3 shows that the entire respondents agreed with the items, with mean score ranging between 3.30-3.68 respectively.

4.4 Hypothesis One

There is no significant difference between the mean responses of welding workshop supervisors and the welders on the level of workers compliance with safety and health practice in welding and fabrication operations in Minna metropolis.

Table 4.4: t-test analysis of the respondent regarding the challenge faced by welders in carrying out welding operations.

S/N	ITEMS	X_1	X_2	SD_1	SD_2	t-cal	Remark
1	There is no constant power supply carry out welding operations.	2.70	3.13	1.06	1.13	-1.13	NS
2	Availability of funds to practice welding	2.75	3.25	1.05	0.89	-1.49	NS
3	Lack of fire extinguishers in work shops	2.6	2.2	1.5	1.1	-1.3	NS
4	Lack of adequate orientation for welders	2.8	2.5	1.02	1.13	-1.2	NS
5	Careless attitude to safety precaution	2.1	2.9	1.03	1.09	-1.1	NS
6	Lack of satisfactory incentives for workshop workers	2.6	2.9	1.03	1.16	-1.12	NS
7	Poor supervision of welders	2.0	2.4	1.05	1.12	-1.11	NS
8	Bad attitude to work	2.8	2.1	1.02	1.17	-1.14	NS
9	Poor sanitation culture	2.5	2.3	1.05	1.13	-1.13	NS
10	Inadequate supply of necessary equipment.	1.6	2.81	1.20	1.20	-2.03	S
11	Uneducated welders do not dress with safety in view	2.2	2.3	1.2	1.16	-2.03	NS
12	Workers are punished for disobedience	2.1	2.5	1.9	1.14	-2.04	NS
13	Flammable liquid is used	2.0	2.2	1.6	1.21	-1.4	NS

The result displayed on Table 4 above shows the comparison between master welders and apprentice welders. Data indicated that every item in this category has a calculated t-value less than the t-critical value ±2.0 hence hypothesis Ho3 for this items were upheld at 0.05 level of significance.

4.5 Hypothesis Two

There is no significant difference between the mean responses of welding workshop supervisors and the welders regarding the possible cause of hazard, risk an accident in welding and fabrication operations in Minna metropolis.

Table 4.5: t-test analysis of the possible causes of accidents in welding operations.

S/N	ITEMS	X_1	X_2	$S.D_1$	$S.D_2$	t.cal	Remark
14	Usage of grounded tools for operation	3.52	3.3	0.55	0.69	-1.23	NS
15	Using wrong tool for a particular work	3.58	3.09	0.53	0.30	-4.66	NS
16	Improper clothing during work	3.65	3.06	0.57	0.53	0.52	NS
17	Lack of knowledge on the work being done	3.69	3.68	0.56	0.51	0.10	NS
18	Inadequate understanding of safety rules	3.69	3.64	0.52	0.59	0.50	NS
19	Use of electric cables not properly insulated for welding machines	3.47	3.58	0.55	0.53	-1.16	NS
20	Carrying of sharp working tools not by handle	3.38	3.32	0.59	0.62	0.56	NS
21	Working with obsolete tools and equipment	3.55	3.58	0.59	0.53	-0.31	NS
22	Improper maintenance of welding tools and equipment	3.66	3.05	0.53	0.67	1.45	NS
23	Lack of observing safety precautions in welding operations	3.06	3.56	0.80	0.75	0.17	NS
24	Welding in wet, damp or humid condition	3.65	3.54	0.65	0.70	0.17	NS
	Not using correct wiring connector						
25	Not using all-insulated electrode holder	3.25	3.58	0.89	0.53	-2.8	NS
26	Wrong utilization of equipment	3.06	3.54	0.66	0.51	-0.81	NS
27	Careless attitude of workers during	3.59	3.05	0.49	0.67	0.85	NS
28	Working operation	3.35	3.07	0.79	0.46	-3.39	NS

KEY:
N_1= Number of master welder
N_2= Number of apprentice welder
SD_1= Standard deviation of master welder

SD_2= Standard deviation of apprentice welder
NS = Not significant
S = Significant

The result shown on table 5 indicates the comparison between master welders and apprentice welders. Data reveals that all items in this category has a calculated t-value less than the t-critical value ±2.00 hence, hypothesis Ho_2 for these items were upheld at 0.05 level of significance.

4.6 Hypothesis Three

There is no significant difference between the mean responses of welding workshop supervisor and the welders on the possible cause/preventive measures to prevent hazard and accident in welding operations in Minna metropolis.

Table 4.6: t-test analysis of the respondents regarding strategies to be adopted to ensure compliance with safety rules and regulations in welding operations.

S/N	ITEMS	X_1	X_2	SD_1	SD_2	t-cal	Remark
29	Workers are provided with safety wears	1.76	2.81	1.20	1.20	2.03	S
30	Protective wears are used correctly	3.12	3.32	0.73	0.58	-1.58	NS
31	Sensitization exercise is organized for new welders	3.65	3.94	1.00	0.94	0.44	NS
32	Equipment are kept in good condition	2.50	1.87	1.21	1.14	-0.16	NS
33	Control of distractions and carelessness	2.95	3.25	0.77	1.15	1.68	NS
34	Using the right tool for tasks	3.50	3.81	1.01	8.01	0.78	NS
35	Adherence to safety rules and precaution	2.27	2.36	0.90	1.13	1.06	NS
36	Routine maintenance of welding tools and equipment	3.42	3.51	0.98	0.61	-0.70	NS
37	Proper handling of tools	3.02	3.94	1.15	1.08	-2.47	NS
38	Procurement of fire extinguishers	2.98	2.68	0.90	1.04	1.94	NS
39	Proper disposal of waste material	2.98	2.68	0.90	1.04	1.94	NS
40	Provision for adequate ventilation	2.25	2.13	1.03	1.13	0.30	NS

The result shown on table 6 above shows comparison between master welders and apprentice welders. Data revealed that all item has a calculated t-value less than the t-critical value ±2.00 hence, hypothesis H_{o3} for these items were upheld at 0.05 level of significance except for 29 which has a t-calculated value above the t-critical value of ±2.00 thus, Ho3 was rejected for this item.

4.7 Findings of the Study

1. Welders do not always comply with safety measures
2. Fire extinguishers are not available in all welding and fabrication shops
3. Adequate orientation is not given to welders on safety and precaution

Findings related to control measures to prevent hazard and accident in welding and fabrication operations.

1. proper waste disposal
2. adequate orientation programme for welders
3. procurement of fire extinguishers
4. using the right tool for tasks
5. control of distractions and carelessness
6. using correct protective wears
7. provision for adequate ventilation

4.8 Discussion of Findings

The findings on the level of compliance with safety and health practice in welding and fabrication operations revealed that inadequate knowledge and exposure of welders to some health tips pose them to danger of hazard and accident during operation. This aligns with the work of Zainab Kure (2016) which stated that 'a lot has been done by government to improve the training of welders on usage of modern scientific welding equipment through empowerment scheme" A good and efficient skilled artisan in welding allied trade could be produced since there is new invention in technology and op to date system of training should be adopted in the teaching of practical skills.

The findings on the possible causes of hazard, risk and accident in welding and fabrication operations revealed that using wrong tools for a particular task , improper clothing (not wearing safety cloth) during work and operation, lack of knowledge on how work is being done. This work goes in line with Ledbetter and Laufer (2017). They described accident as chance-caused events that are normally not given to direct observation but rather most methods are based on post-factum measurement. The further explained that accidents do not necessarily have to be injurious or damaging events but it interrupt or disrupt the completion of an activity. An accident can result in direct and indirect cost. Direct cost of construction accidents are:

- loss of time of injured employee
- cost of work stoppage of other employees from curiosity, sympathy and providing assistance

It has been established that the reduction of hazardous events is fundamental to good construction safety management.

The findings on the possible control measures to prevent hazard and accident in welding and fabrication operations revealed that every welder must be conscious ready to curtail accident in welding and fabrication shops. Cullen (2018) opined that one way to obtain to obtain compliance with safety regulations is through enhancing employee's knowledge, understanding and commitment which can be achieved through safety programmes. Bratton and Gold (2019) posited that safety training for new employees is particularly beneficial because accidents are highest during the early months on a new job.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary of the Study

The purpose of this study is to assess hazard and its control measures in welding and fabrication outfits in Minna metropolis of Niger state. The first chapter discussed the safety and health practices, the concept of welding and fabrication and possible hazard in welding outfits in Niger State. The purpose of the study was highlighted to identify the measures to be adopted to curtail and control hazards in welding and fabrication outfits and lastly, the challenges faced by welders in carrying out welding operations.

Chapter two examines the related literature in activities of welders regarding hazard and how to control it in Minna metropolis. it describes in detail concept of hazard in fabrication shops, causes of hazard and its control. It touches as well facilities and types of facilities available for the prevention of hazards in the workshop.

The third chapter hints on the research methodology adopted by the researcher which involves the descriptive survey design to carry out assessment of hazard and its control measures in welding and fabrication outfits in Minna as the area of study. The questionnaire was validated by two lecturers in the department which has a total population of 50 respondents. The has 40 items and it was analyzed using mean, standard and t-test. Finally, this study summarizes in chapter five, implications of the study were stated and discussed. The study was concluded and summarized.

5.2 Implication of the Study

The findings of this study was derived from the result of analysis of data has many positive implication on welders, government, the community, engineering students and apprentice in fabrication shops. The implication of the finding is that welders will identify potential hazard and its causes and the strategy to adopt to stay free of hazards, injury and danger while working. Welders will learn the necessity of safety precautions and why safety wears should be compulsorily used in welding outfits. Welders will learn the basic challenges in workshop and the solution. Welders will learn that partnership with government and private organizations are dependable strategies to adopt in order to standardize their activities.

5.3 Conclusion

The effectiveness of welders activities is reliant on hazard free working environment that poses no to threat to the lives and well being of welders. Welding environment depends largely on the development of a safe working environment. Safety posters should be placed in welding shops and defaulters of safety measures penalized to serve as deterrent to others that may want to ply the same road. Carelessness and recklessness in the shop should be controlled and stopped for safety purpose. If these are observed, the rate of hazard oriented accidents in welding fabrication shops in Minna metropolis will diminish.

5.4 Recommendations

Based on the findings of the study, the recommendations stated below were made.

1. Adequate precaution should be taken when using flammable liquid

2. Government should support welders with fund to upgrade their equipment

3. Safety wears should be worn promptly by all welders

4. Adequate lightning and ventilation should be provided for in all fabrication outlets

5. Equipment should be properly maintained.

6. Seminars should be organized periodically to enlighten welders on safety

5.5 Suggestions for further studies

The following suggestions are made for further study.

1. Assessment of the activities of roadside welders in Minna metropolis of Niger state

2. Assessment of safety habits of welders in Minna Niger state

3. Engaging the government and welders for excellent welding activities in Minna metropolis of Niger state.

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APPENDIX I

QUESTIONAIRE

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE

SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF INDUSTRIAL TECHNOLOGY EDUCATION

QUESTIONAIRE ON ASSESSEMENT HAZARD AND ITS CONTROL MEASURES IN WELDING AND FABRICATION OUTFITS IN MINNA METROPOLIS OF NIGER STATE.

SECTION A

Master welder ☐ **Apprentice** ☐

Section B-D below is research questions and their items. Kindly indicate by ticking (√) against each statement in appropriate column which describes the extent to which you agree with the statement by using the following key.

KEY:

SA -------- Strongly Agree

A ---------- Agree

D ---------- Disagree

SD -------- Strongly Disagree

SECTION B

Research question 1

What is the level of workers compliance with safety and health practice in welding and fabrication operations?

S/N	ITEMS	A	SA	D	SD
1	Welders usually put on protective clothes.				
2	Workers in welding shops are careless about safety.				
3	Flammable liquid is used with utmost precaution.				
4	Welding tools are well taken care of by welders.				
5	Accident is unavoidable in welding shops.				
6	Uneducated welders do not use protective wears.				
7	Workers are punished for disobeying safety rules.				
8	Welders are given orientation before handling tools.				
9	Ventilation is provided for in all fabrication shops.				
10	Welders have fire extinguisher in their shops all times.				
11	Supervision of welders is not given priority.				
12	Waste materials are well disposed in fabrication shops.				

SECTION C

Research question 2

1. What are the possible causes of hazard, risk and accident in welding and fabrication operations?

S/N	ITEMS	A	SA	DA	SD
13	Electric cables not insulated for welding machine.				
14	Careless handling of working tools.				
15	Careless disposal of waste materials.				
16	Care-free attitude of workers during operation.				
17	Wrong utilization of equipment.				
18	Inadequate knowledge of the work being down.				
19	Ignorance of operational ethics of welding.				
20	Careless handling of sharp edged tools.				
21	Usage of wrong tools to perform a task				
22	Fabrication in wet and humid environment.				
23	Usage of non insulated electrode holder.				
24	Lack of adherence to safety precautions.				
25	Inadequate understanding of safety rules.				
26	Performing tasks with outdated welding equipment				
27	Wrong wiring and electrical connections.				

SECTION D

Research question 3

What are the possible control measures to prevent hazard and accident in welding and fabrication operations?

S/N	ITEMS	A	SA	D	SD
28	Proper disposal of waste material				
29	Provision for adequate ventilation				
30	Adequate orientation programme for welders				
31	Procurement of fire extinguishers				
31	Proper handling of tools				
33	Routine maintenance of welding tools and equipment				
34	Adherence to safety rules and precaution				
35	Using the right tool for tasks				
36	Control of distractions and carelessness				
37	Keeping equipment in good working condition				
38	Organizing sensitization exercise for new welders				
39	Using correctly protective wears				
40	Adhering strictly to ethics of welding and fabrication				

S/N	SHOP NAME	LGA
1	Jonah metals	Bosso
2	Ibrahim Hashimu Fabrics	Bosso
3	Abdullah steel	Bosso
4	Ige Jonah	Bosso
5	Banbu works	Bosso
6	Habib Ibrahim iron	Bosso
7	Isalha Fabrication	Bosso
8	Husseini Welding	Bosso
9	Metal Sheet house	Bosso
10	Gbenga metal	Bosso
11	Danies shop	Bosso
12	Dan Wasa	Bosso
13	Tukur shop	Bosso
14	Joshua	Bosso
15	KB Aluminum and steel	Bosso
16	Rajah Usman steel	Bosso
17	Glorious Metal outfit	Bosso
18	Stone Gold Iron	Bosso
19	Metal Finest	Bosso
20	Wallace welders	Bosso

21	Best Fitters	Bosso
22	Ganiyu Metals	Bosso
23	Iron quality home	Bosso
24	Global Standard welders	Bosso
25	Johnson Metal and fabrication	Bosso
26	Abdullateef metal workshop	Chanchaga
27	Surajo Workshop	Chanchaga
28	Solo Fabrication	Chanchaga
29	Oga Sunday iron	Chanchaga
30	OgaMuri fittings	Chanchaga
31	Yazid Fabrication	Chanchaga
32	Aminu king of Metals	Chanchaga
33	Sunday James workshop	Chanchaga
34	Erena Workshop	Chanchaga
35	Yushau metals	Chanchaga
36	Salisu Workshop	Chanchaga
37	Dan Lami metals	Chanchaga
38	Ibrahim Sule workshop	Chanchaga
39	Gambari metal outlet	Chanchaga
40	Sule Finest iron	Chanchaga
41	Marathona workshop	Chanchaga
42	Metal doctors	Chanchaga
43	Grace fabrication	Chanchaga

44	Yusuf Ganiyu workshop	Chanchaga
45	Saleh metal touch	Chanchaga
46	Solid metal workshop	Chanchaga
47	Arafat workshop	Chanchaga
48	Nabeel Iron workshop	Chanchaga
49	Abubakar Iron and aluminum	Chanchaga
50	Yusuf metal and steel shop	Chanchaga