ASSESSMENT OF SAFETY PRECAUTION AND RISK MANAGEMENT PRACTICES AMONG ROADSIDE ARC WELDER TECHNICIANS IN MINNA METROPOLIS

BY

ZEKERI, Salisu
2014/1/52015TI

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION,
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION,
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE.

AUGUST, 2021

ASSESSMENT OF SAFETY PRECAUTION AND RISK MANAGEMENT PRACTICES AMONG ROADSIDE ARC WELDER TECHNICIANS IN MINNA METROPOLIS

BY

ZEKERI, Salisu
2014/1/52015TI

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION,
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION,
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE.

AUGUST, 2021

DECLARATION

I hereby declare that this project titled: "ASSESSMENT OF SAFETY PRECAUTION AND RISK MANAGEMENT PRACTICES AMONG ROADSIDE ARC WELDER TECHNICIANS IN MINNA METROPOLIS" is a collection of my original research work and it has not been presented for any other qualification anywhere. Information from other sources (published or unpublished) has been duly acknowledged.

ZEKERI, Salisu
2014/1/52015TI
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE.

____
Signature & Date

CERTIFICATION

The project titled: "ASSESSMENT OF SAFETY PRECAUTION AND RISK MANAGEMENT PRACTICES AMONG ROADSIDE ARC WELDER TECHNICIANS IN MINNA METROPOLIS" by ZEKERI, Salisu with the matric number 2016/3/52015TI meet the regulations governing the award of the degree of Bachelor of Technology in the Department of Industrial and Technology Education, School of Science and Technology Education, Federal University of Technology, Minna and it is approved for its contribution to scientific knowledge and literary presentation.

Mall. A. Mustapha
Supervisor

____
Sign & Date

Dr. I.Y. UMAR
Head of Department

____
Sign & Date

____
External Examiner

____
Sign & Date

DEDICATION

This project work is dedicated to God Almighty.

ACKNOWLEDGEMENTS

My profound and unquantifiable gratitude goes to Almighty God for the wisdom guidance protection and strength He bestowed on me throughout my Programme in FUT MINNA despite all the challenges encountered. My special appreciation goes to my able supervisor and project coordinator Mall. A. Mustapha and Dr A.M. Hassan respectively for their guidance towards the successful realization of this project and to all Industrial and Technology Education department lecturers. Especially the Dean-Prof I.A. Gambari, Deputy Dean, Dr. A. M. Idris, H.O.D- Dr. I. Y. Umar, Prof A. S. Ma'aji, Prof. B. N. Atsumbe, Prof. R. O. Okwori, Dr. E. Raymond, Dr. G. A. Usman, Dr. R. Audu, Dr. B. M Mohammed, Dr. I. Dauda, Dr. AbudulKadir M, Dr. T. M Saba, Dr. C. O. Igwe, Dr. A. S. Owodunni, Dr. A. B. Kagara, Dr W. B. Kareem, Mr. I. K. Kalat, Mr. F. Abutu, Mrs F. C. Nwankwo, Mr. B. J. Ekhalia, Mr. .S. N. Yisa and nonacademic staff in the ITE department.

My wholehearted gratitude goes to my parents, Mr. Zekeri Sule and & Mrs. Hajarat for their regular support financially, spiritually and in other meaningful aspects, they have all kept me going.

ABSTRACT

The purpose of the study is to assess the safety precaution and risk management practice among roadside ARC welders in Minna metropolis. Three research objectives and three objectives were formulated to guide the study. A descriptive survey research design was adopted to obtain the pertinent information of the study. The targeted population for the study consists of one hundred and forty-five (145) participants with 60 roadside arc welders and eighty-five (85) customers. Based on the finding of the study on the identified safety precaution and risk management practice by roadside ARC welders, as well as factors affecting the adequate adoption safety precaution and risk management practices with the aim determine the strategies needed to improve the adoption standard practices to mitigate hazard in Minna metropolis, it could be concluded that; the roadside ARC welders are adequately ensuring safety precaution practice among these are; they ensured tight connection of wires, take caution while step on the ground to avoid electrocution, putting on personal protective eye device PPE, proper loading of a circuit, to avoid damage of devices or shock, regularly checking and maintenance of all used machines and so on. On the other hand, the roadside ARC welders do not take to risk management practice by roadside ARC welders, they lacking on; employees/Trainees working nearby protected from arc flash, use of signs reading danger, no smoking, availability of first Aid available, hazardous materials well-labelled and fire extinguishers. From the findings of the study it could be concluded that lack of technical know-how of the craftsmen on standard welding materials, inadequate enlighten on risk management, nonchalant Craftsmen does not abide by the safety guidelines, lack equipment to carry out operations on the site or workshop, poor quality of materials greatly influence the safety, poor planning workshop also affect the safety at work, incompetence supervision of the workshop activities, among other, are identified factors affecting the adequate adoption safety precaution and risk management practices by the roadside arc welder in Minna metropolis. Finally, it is concluded that the strategies needed to improve the adoption of standard practices to mitigate hazards in Minna metropolis. Among these are training on the craftsman on technical know-how of the standard welding materials usage, proper enlighten on risk management, guide the trainee Craftsmen on abiding by the safety guidelines, ensuring availability of equipment to carry out operations on the site or workshop and so on. Based on the conclusion of the study, the following recommendations are made; more enlightens programme should be organised for the roadside arc welder on proper safety precautions. Adequate sensitization programme should be organised for the roadside arc welder on risk management practice. Regulations bodies on welding practice should ensure all quality equipment are made available and proper training of craftsmen on welding activities. Sanction should be made on anyone who violates the safety precaution and risk management practice.

TABLE OF CONTENTS

Contents **Page**

LIST OF TABLES

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Welding operation is a highly engineered process that has evolved with evolving technology. In many developing countries, welding has become one of the most important occupational groups, owing to rapid urbanization and industrialization (ILO, 2015). Welding is an essential part of everyday life; from cars to high rise office buildings, aeroplanes to rockets, pipelines to highways, none of it would be possible without welding. This means there is a large population of people involved in welding. The International Standard Classification of Occupations (ISCO) defined welders as workers who join and cut metal parts using flame or electric arc and other sources of heat (Mbulingwe, 2011).

A welder or welder operator is a tradesman who specializes in welding materials together. Welders join pieces of metal by the use of heat, pressure, or both. In Nigeria, welding involves a large population of young people within the low socioeconomic class which puts them at a disadvantage in terms of occupational health and safety. This is because welding is usually an informally learnt occupation in most parts of the country. The informal sector contributes significantly to the economic development of the country. The operators of this sector are artisans with mainly primary education, and sometimes no formal education at all (Cooper *et al.*, 2015). There are varieties of welding processes but the commonest types in Nigeria are gas welding by the use of oxyacetylene flame and electric arc welding involving the use of electricity. This exposes them to the various risk associated with welding.

Risk is the likelihood that a person may be harmed or suffers adverse health effects if exposed to a hazard. For welders, several hazards are lying around them in their workplace. Considerable work has been done to identify the hazards that are associated with welding. Welding hazards include electric shock, burns, fire and explosions, radiation, heat, noise, fumes and gases. Welders are also exposed to noxious metal fumes containing a cocktail of metals like zinc, copper, cobalt, nickel, chromium, platinum, and their oxides leading to various respiratory dysfunctions and an influenza-like condition called metal fume fever. Exposure to any or all of these can be minimized by using an effective combination of control measures.Hence, the need for appropriate risk management.

Risk management (RM) is a concept that is used in all industries, from IT-related business, automobile or pharmaceutical industry, to the construction sector. Each industry has developed its RM standards, but the general ideas of the concept usually remain the same regardless of the sector. According to the Project Management Institute (PMI) (2010), project risk management is one of the nine most critical parts of project commissioning. This indicates a strong relationship between managing risks and project success. While RM is described as the most difficult area within construction management (Winch, 2102) its application is promoted in all projects to avoid negative consequences (Potts, 2015). One concept which is widely used within the field of RM is called the risk management process (RMP) and consists of four main steps: identification, assessment, taking action and monitoring the risks (Cooper *et al.*, 2015). In each of these steps, there are several methods and techniques which facilitate handling the risks. The Risk Management Assessment, or RMA, is the first step in developing a comprehensive risk management program. The RMA identifies, analyzes, and reports on an organization's material risk exposures. It provides a multi-dimensional view of risk, taking into account organization-wide enterprise risks and specific insurance-related exposures.

According to World Health Organization, there are about 250 million cases of work-related injuries per year worldwide (WHO, 2013). One of the jobs that contribute to these occupational injuries is non-industrial welding, especially in developing countries including Nigeria. Welders cut and join metal parts using flame electric arc or other sources of heat. There are three main classes of welding, namely, arc, oxyacetylene fuel and robotic welding. Some of the hazards of this occupation include ultraviolet (UV) and infrared radiation (IR) exposure, fumes and particulate generation, thermal burns, occupational heat stress, exposure to electromagnetic fields, and electrocution (Mbulingwe, 2011). Similarly, the excessive lighting (glare) and exposure to ultra violent UV radiation may lead to `arc eye' or `flash burn' injuries to the cornea, photo keratosis and double vision and consequent retinal damage (Sabitu, 2009). Repetitive industrial risk assessment needs to be done on each welding workplace for health surveillance evaluation, in order to ensure their safety.

Safety is the state of being "safe", the condition of being protected from harm or other non-desirable outcomes. Safety can also refer to the control of recognized hazards in order to achieve an acceptable level of risk. Reports from previous studies in Nigeria show high prevalence of work-related accidents or illnesses among welders. In a study by Okuga *et al*., 92% of welders reported injuries or illnesses related to work, with cuts and burns cumulatively accounting for 73% of all injuries. Other injuries reported include backache and chest pain (14%), eye injuries (6%) and hearing problems (6%).

In another study among welders in Kaduna, Nigeria, 85.3% of the subjects had experienced one or more work-related accidents or occupational hazards, and the most prevalent injury among them was cut/injuries to the hands and fingers (38.0%) (Mbulingwe, 2011). Given the rising prevalence of occupational injuries globally, there is a need for a greater focus on safety precautions.

Safety precautions are measures taken to ensure that something is safe and not dangerous. Adequate ventilation, use of personal protective eye devices (PPEDs),among others are various precautions that need to be taken.

In Nigeria, a lot of welders set up their work place by the roadside, predisposing them to roadside accidents from cars/ trucks that have lost control or from drunken drivers. They are also prone to trips and falls as a result of equipment, cables, machines and rails that might be lying on the floor leading to accidents (Sabitu, 2009). These are just but a few of the hazards that need to be assessed and tackled to reduce the dangers that are associated with welding. In metropolitan Minna, welders are usually located around mechanic workshops, motor spare-parts markets and along major highways where they establish privately owned small-scale workshops. This group has no organized occupational health service and their adherence to safety measures is unknown. This necessitates assessing the level of awareness of these hazards among welders in Minna metropolis and the safety measures and practices they adopt to safeguard their health, to make recommendations on ways of ameliorating the effect of the hazards.

1.2 Statement of the Research Problem

Exposure to occupational hazards has become an important public health problem globally due to urbanization and industrialization across the world (Hayashi, 2014). However, the World Health Organization (WHO) estimated that about 2 million people die each year as a result of occupational accidents and work-related illnesses or injuries (WHO, 2013). Furthermore, the International Labour Organisation stated that 268 million nonfatal workplace accidents result in an average of three lost days per casualty, as well as 160 million new cases of work-related illness each year (ILO, 2015).

According to Sabitu (2009), occupational hazards also account for 2.3% of Disability Adjusted Life Years (DALYs) lost among middle-income countries (Sabitu, 2009). In Nigeria, the real incidence of occupational accidents, fatalities, as well as deformities, is not well recorded. A Nigeria based study showed that between 1987 and 1991, there were 2,012 reported cases of industrial injuries among workers in Nigerian factories with an average of 402 accidents per year (Sabitu, 2009).

Welders are particularly observed to be prone to occupational hazards, which cause many health problems like impaired pulmonary functions, chronic bronchitis and intestinal disorder as a result of inhalation of gasses, cancer of the skin lung diseases, musculoskeletal diseases, wounds and burns. Welding work involves cutting and joining metals parts using flame or electric arc and other sources of heat, this sometimes leads to fire explosion, electrocution, lifelong disability and if proper precautions are not taken, assessment of the hazard control equipment, practices and knowledge of this roadside welders is pertinent in its existence since the majority of them are self-employed without formal education. Unsafe and unhealthy work practices such as lack of use of personal protective eye devices (PPEDs)have been observed among welders especially roadside welders in Nigeria.

Given the rising prevalence of occupational diseases and injuries globally, there is a need for a greater focus on preventive activities. Hence, the study sought to investigate into the assessment safety precaution and risk management practice roadside ARC welder in Minna metropolis

1.3 Purpose of the study

The purpose of this study is to assess the safety precaution and risk management practice among roadside ARC welders in Minna metropolis. Specifically, the study seeks to:

1. identify the safety precaution practices by roadside ARC welder technicians' in Minna metropolis.
2. identify the risk management practices by roadside ARC welder technicians' in Minna metropolis.
3. determine the factors affecting the adequate adoption safety precaution and risk management practices by the roadside arc welder technicians' in Minna metropolis.
4. Determine the strategies needed to improve the adoption of standard practices to mitigate hazards faced by roadside arc welder technicians' in Minna metropolis.

1.4 Research Question

The following research questions are posed to guide the study.

1. What are the safety precautions practice by roadside arc welder technicians' in Minna metropolis?
2. What are the risk management practices by roadside arc welder technicians' in Minna metropolis?
3. What are the factors affecting the adequate adoption of safety precaution and risk management practices by the roadside arc welder technicians' in Minna metropolis?
4. What are the strategies needed to improve the adoption of standard practices to mitigate hazards by the roadside arc welder technicians' in Minna metropolis?

1.5 Scope of the Study

The study is delimited to assessing the roadside arc welder risk management and safety precaution practices. The study is further limited to look into the risk management practice adopted among roadside arc welders in Minna Niger State. The study assesses the roadside welder exposure to hazard so far, a factor contributing to the incidence risk management practice adopted and finally, strategies needed to adopted risk management practice by roadside arc welder technicians' in Minna metropolis Niger State.

1.6 Significance of the Study

This study will be of great benefit to the: Welders, National Emergency and Management Authority(NEMA) (Niger State Branch), general public and Metal Work Student.

The findings of the research work will be of great benefit to the welders in adopting the standard practices needed to be adopted to combating any disastrous events in the metalwork and related industry. It will enlighten the arc welders on the causes of hazard, the effect and the various management practices that are needed to reduce the frequent occurrence of the incidence.

The outcome of this study will be of immense benefit to the National Emergency and Management Authority (NEMA), in giving awareness campaigns on the various hazard and risk management practices adopted by the roadside arc welder, as well as the effect on the safety of the employers and properties.

The study would be of immense benefit to the general public by ensuring excellent service delivery in terms of safety precautions in risk management practices.

The study will also be resourceful the metalwork students in adding knowledge already existing literature on risk management practices

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Framework

Definition of Weld Quality

Welded joints are often the weakest part of many complex load-carrying structures, and the weld quality directly affects the structural integrity (Nykänen et al., 2005). It is not obvious how to characterise the parameters that affect the fatigue life of the structure. Björk et al. point out that: "Weld quality, like quality, in general, often is done by comparisons on a better-or-worse scale. This may work when to choose between alternatives, but to determine weld quality on a single product or a single weld is much more difficult. The reason is that genuine and unambiguous definitions of weld quality must be stated and agreed. Unfortunately are such definitions not agreed" (Björk et al., 2008). The traditional welding procedures and acceptance limits for a weld has mainly evolved based on the expected weld quality from a skilled welder.

Figure 2.1 Theoretical Framework

Welded joints are often the weakest part of many complex load-carrying structures, and the weld quality directly affects the structural integrity (Nykänen, et al., 2005). It is not obvious how to characterise the parameters that affect the fatigue life of the structure. Björk et al. point out that: “Weld quality, like quality, in general, often is done by comparisons on a better-or-worse scale. This may work when to choose between alternatives, but to determine weld quality on a single product or a single weld is much more difficult. The reason is that genuine and unambiguous definitions of weld quality must be stated and agreed. Unfortunately are such definitions not agreed” (Björk et al., 2008). The traditional welding procedures and acceptance limits for a weld has mainly evolved based on the expected weld quality from a skilled welder conditions (Gregory, 1992). This has resulted in what is considered as good workmanship, and the focus is on easily observed physical characteristics of the weld rather than the real effects on structural integrity (Marquis et al., 2006). In an evaluation of six international and national standards of welding quality criteria, it could be concluded that the requirements, in general, are created on workmanship rather than fatigue properties. One standard applies to fitness for purpose, but it is used for nuclear power plants and is not widespread (Shaw, 2011).

The major problem relates to the fact that a good looking weld often is a good weld, and a weld with a poor appearance, may or may not be a poor weld (Miller, 1997). In some cases, when the root is critical it is known that the welding procedures giving the best root properties do not give the best appearance. (Åstrand, 2015a).

In practice on the work shop floor, a high-quality weld is most often the same as a good looking weld. Most people are using their eyes to make a judgement of the weld quality. However, the correlation between this “weld quality” and fatigue life is very low and eventually also harmful for the welding industry. It is common that the weld root is critical, but most efforts are made to fulfil throat thickness requirements and visual appearence of the weld. It typically gives overwelding and a reduced welding speed. In order to determine the weld quality relating to fatigue life, it is essential to consider the load conditions and the purpose of the weld. A weld with excellent quality for one purpose can have inappropriate properties.

2.1.1 Gas Metal Arc Welding

This section gives a background of the welding process and the welding parameters and the physics that affects the weld geometry. The aim is to show which parameters to adjust in order to get certain weld geometry and to explain the reason why.

GMAW is today the most used process within the industry with over 50 % of the deposited metal (TWI, 2013). The process could be divided into MIG- and MAG welding depending on the shielding gas used where MIG uses an inert gas such as argon or helium whereas MAG uses an active gas such as mixtures of argon, carbon dioxide, CO2, and oxygen (Weman, 2007).

The process was first invented in the USA for Aluminium welding in 1949. During the 1950s, the process became popular also for welding of carbon steels using CO2 or Argon-CO2 gas mixtures (TWI, 2013). GMAW is well suited for mechanised welding using robots since it can continue for a long time without electrode changes (Weman, 2007).

In the process, an electric arc is created between the workpiece and a consumable wire electrode, which is melting into a common weld pool. The weld pool is protected from the atmosphere by a constant flow of a shielding gas from a gas nozzle surrounding the wire. The wire, which is continuously fed forward, serves as both a heat source and a filler metal. In the welding torch, a contact tube of copper is used to transfer the welding current to the welding wire.

The process has most often a positive charge on the wire and a power source with a constant voltage. The wire feed set the welding current since the current is adjusted to get a burn-off rate equals to the feed speed. This principle gives higher current for a short electrode stick-out since the preheating of the wire is lower. Depending on the application the sickout is set to values from 5 to 25 mm. Sheilding gas mixtures and filler wire types and diameter (usually 0.6 -1.6 mm) are selected depending on the application.

2.1.2 Welding Parameters

In GMAW different arc types, caused by the shielding gas mix, arc voltage and welding current, settings are created with various principles for metal transfer as shown in Figure 7. There are three primary metal transfer types: short circuiting, globular and spray arc (Iordachescu and Quintino, 2008).

For short circuiting welding, the heat input is low, and this transfer mode is more suitable for thinner materials. The metal transfer is executed by a large droplet at the wire tip which grows and has a diameter bigger than the wire before it transfers to the weld pool. The sequence of droplet growth, short circuit and transfer can be repeated up to 200 times per second. If the current during the short circuit becomes too high, the process will cause an increase of spatter (Weman, 2007).

2.2 Conceptual Framework

Welding is a process of permanently joining two materials through localized coalescence resulting from a suitable combination of temperature, pressure and metallurgical conditions. Depending upon the combination of temperature and pressure from a high temperature with no pressure to high pressure with low temperature, a wide range of welding processes has been developed (Asogwa, 2017)

2.2.1 Classification of Welding Process

American Welding Society (2005) classified the welding processes as different in the manner in which temperature and pressure are combined and achieved. Welding Processes can also be classified as follows (based on the source of energy):

1. Gas Welding

- Oxyacetylene

- Oxyhydrogen

2. Arc. Welding

- Carbon Arc

- Metal-Arc

- Submerged Arc

- Inert-gas-Welding

TIG and MIG

- plasma arc

- Electro-slag

3. Resistance Welding

- Spot

- Seam

- Projection

- Butt Welding

- Induction Welding

4. Solid State Welding

- Friction Welding

- Ultrasonic Welding

- Explosive Welding

- Forge and Diffusion Welding

5. Thermo-Chemical Welding

- Thermit Welding

- Atomic H2 Welding

6. Radiant Energy Welding

- Electron Beam Welding

- Laser Beam Welding

To obtain coalescence between two metals, there must be a combination of proximity and activity between the molecules of the pieces being joined (Asogwa, 2017). Sufficient to cause the formation of common metallic crystals. Proximity and activity can be increased by plastic deformation (solid-state welding) or by melting the two surfaces so that fusion occurs (fusion welding).

In solid-state-welding, the surfaces to be joined are mechanically or chemically cleaned before welding while in fusion welding the contaminants are removed from the molten pool by the use of fluxes. In the vacuum of outer space, the removal of the contaminant layer is quite easy and welds are formed under light pressure.

2.2.3 Condition for Obtaining Satisfactory Welds

To obtain satisfactory welds it is desirable to have:

1. A source of energy to create union by fusion or pressure
2. A method for removing surface contaminations
3. A method for protecting metal from atmosphere contamination
4. Control of weld metallurgy

Source of Energy

The energy supplied is usually in the form of heat generated by a flame, an arc, the resistance to an electric current, radiant energy or mechanical means (friction, ultrasonic vibration or explosion). In a limited number of processes, pressure is used to force the weld region to plastic conditions. In fusion welding the metal parts to be joined melt and fuse together in the weld region. The word fusion is synonymous with melting but in welding, fusion implies union. The parts to be joined may melt but not fuse and thus the fusion welding may not take place. (Zakhari, 2016)

2.2.4 Importance of Welding

Welding is used as a fabrication process in every industry large or small. It is a principal means of fabricating and repairing metal products. (Liss, 2018) The process is efficient, economical and dependable as a means of joining metals. This is the only process that has been tried in space. The process finds its applications in air, underwater and in space.

Applications of Welding

1. Welding finds its applications in the automobile industry, and in the construction of buildings, bridges and ships, submarines, pressure vessels, offshore structures, storage tanks oil, gas and water pipelines, girders, press frames, and water turbines.
2. In making extensions to the hospital building, where construction noise is required to be minimum, the value of welding is significant.
3. Rapid progress in exploring space has been made possible by new methods of welding and the knowledge of welding metallurgy.
4. The process is used in critical applications like the fabrication of fission chambers of nuclear power plants
5. A large contribution, welding has made to society, is the manufacture of household products like refrigerators, kitchen cabinets, dishwashers and other similar items.
6. It finds applications in the fabrication and repair of farm, mining and oil machinery, machine tools, jigs and fixture, boilers, furnaces, railway coaches and wagons, anchor chains, earthmoving machinery, ships, submarines, underwater construction and repair (Antonini, 2017).

2.2.5 Selection of a Welding Process

Welding is a joining process. Ideally, a weld should achieve a complete continuity between the parts being joined such that the joint is indistinguishable from the metal in which the joint is made. Such an ideal situation is unachievable but welds giving satisfactory service can be made in several ways. The choice of a particular welding process will depend on the following factors.

1. Type of metal and its metallurgical characteristics
2. Type of joint, its location and welding position
3. End use of the joint
4. Cost of production
5. Structural (mass) size
6. Desired performance
7. Experience and abilities of manpower
8. Joint accessibility
9. Joint design
10. Accuracy of assembling required
11. Welding equipment available
12. Work sequence
13. Welder skill

Frequently several processes can be used for any particular job. The process should be such that it is most, suitable in terms of technical requirements and cost. These two factors may not be compatible, thus forcing a compromise. Welding is one of the principal activities in modern fabrication, shipbuilding and offshore industry. The performance of these industries regarding product quality, delivery schedule and productivity depends upon structural design, production planning, welding technology adopted and distortion control measures implemented during fabrication. The quality of welding depends on the following parameters: Skill of Welder, welding parameters, shielding medium and working environment, work layout, plate edge preparation, fit-up and alignment, protection from wild winds during-on-welding, dimensional accuracy, correct processes and procedures as well as suitable distortion control procedures in place. The mentioned parameters are of utmost importance in welding and fabrication processes (Agma-Acon, 2015). Welding and Fabrication is one of the trade courses offered in the Technical colleges in Nigeria, the trade course prepares the products for craftsmanship training as welder and fabricator. Antonini, (2017).

Welders are required to make, join and repair the metal parts for a massive range of machinery, equipment and structures while Fabricators are involved in the creation and repair of either light (water tanks, ducting, metal chains) or heavy metals (i.e. building structures, ships' hulls, bridges). As a fabricator, you are likely to specialize in either light metal fabrication - including ducts, water tanks, metal chairs, and aircraft parts or in heavy metal fabrication - including building structures, ships hulls, and bridges. As a welder, a person is likely to find employment in one of the following types of organizations: Architectural, Agricultural, Marine, Transport, Structural, Heavy automotive or General engineering. Students in the welding and fabrication trade course (welding and structural steel) will gain the fundamental skills required to gain employment as a welder. These include skills in Interpreting drawings, making calculations, Industry safety, Thermal cutting, Arc welding and MIG welding (Marek and Starzynski 2015). According to Banta (1993), the qualities and characteristics that employers look for in prospective employees can be categorized as follows: knowledge, skills, and attitudes or traits. Areas within knowledge include technical skills as they relate to the job, basic adult literacy and application of one's knowledge. Components within the skills area include communication, ability to work with people, organization and management skills, research, and computing skills. Research examining how survey data from employers are collected indicates that institutions use either a "broadside" method in surveying, for example sending surveys to employers without identifying specific individuals, or by gathering information about specific graduates. For the last survey method, permission must be sought from the former student before surveying the employer. (Isah and Okojie, 2018)

Types of Welding

(a) Fusion Welding – melting base metals

– Arc Welding (AW) – heating with electric arc

– Resistance welding (RW) -heating with resistance to an electrical current

– Oxyfuel Welding (OFW) -heating with a mixture of oxygen and acetylene (oxyfuel gas)

– Another fusion welding -electron beam welding and laser beam welding

(b) Solid-State Welding no melting, no fillers

– Diffusion welding (DFW) – solid-state fusion at an elevated temperature

– Friction welding (FRW) – heating by friction

– Ultrasonic welding (USW) – moderate pressure with ultrasonic oscillating motion

Welding Operation

i. 50 types of processes (American Welding Society) AWS (2008)

ii. Applications: Constructions, Piping, pressure vessels, boilers and storage tanks, Shipbuilding, Aerospace, Automobile and Railroad

iii. Welder - manually controls the placement of welding gun

iv. Fitter assists by arranging the parts before welding

v. Welding is inherently dangerous to human workers

vi. High temperatures of molten metals,

(c) Fire hazard fuels in gas welding,

(d) Electrical shock in electric welding

(e) Ultraviolet radiation emitted in arc welding (a special helmet with a dark viewing window) and

(f) Sparks spatters molten metal, smoke, and fumes (good ventilation).

(g) Automation - Machine, Automatic and Robotic welding

2**. The Weld Joint**

(a) Types of Joints

i. Butt joint

– Corner joint

– Lap joint

– Tee joint

– Edge joint

• **Types of Welds**

– Fillet weld

– Groove weld

– Plug and slot welds

– Spot and seam welds

– Flange and Surfacing welds

2.1.5 Physics of Welding

Coalescing Mechanism: Fusion via high-density energy

Process plan to determine the rate at which welding can be performed, the size of the region and power density for fusion welding

Powder density (PD): where P = power entering the surface, W (Btu/sec); and

A = the surface area, mm2 (in2)

i. With too low power density, no melting due to the heat conducted into work

ii. With too high power density, metal vaporizes in affected regions

iii. Must find a practical range of values for heat density.

(a) In reality, pre & post-heating and non-uniform

(b) For a metallurgical reason, less energy and high heat density are desired.

Welding methods

Arc welding techniques are still the most common. The process may be manual metallic arc (MMA), metal inert or active gas (MIG or MAG), submerged arc (SAW), tungsten inert gas (TIG) or plasma, to name only the more common ones. All require electricity to create the arc and a molten weld pool is formed that joins the two pieces of metal. Arcs generate, to a greater or lesser degree, radiation spanning ultraviolet to infrared and metal evaporation that condenses to fume. Each of these aspects has implications on the health and safety of the welder.

Gas welding is rarely used in production now, but oxy-fuel gas processes are still prevalent for cutting. These rely on melting and expelling metal from the plate so protection is required both to observe progress and to avoid being burnt by flying metallic particles.

Resistance welding looks like a relatively innocuous process as the molten metal is contained within sheets of solid material, but metal ejection can occur and injure an unwary operator. There is an increasing application of lasers in welding. These are necessarily high power and capable of inflicting serious injury at a significant distance if wrongly directed.

Electron beams used for welding are usually contained within a vacuum chamber, but an out-of-chamber variant is being developed that will need at least the same precautions as laser welding.

Friction welding, especially friction stir, also plays a significant part in the modern fabrication shop. This, and other solid-state processes, avoid the radiation problems of arc welding but introduce the risk of entanglement in rotating parts if not adequately guarded.

A specific process, aluminothermic welding, is used for joining rail track. This relies on the highly exothermic reaction when aluminium and iron oxide are ignited to create molten metal that is cast into the joint gap. The risks here are similar to casting in a foundry, misdirection of superheated molten metal having the gravest consequences.

Welding is not confined to metals; these days plastics are welded by hot gas, electrically heated plates, vibration and a host of other techniques. Plastics melt at lower temperatures than are common with metals but they still present burn hazards. Fabrics and composites are also welded.

Welding introduces hazards but does not need to be dangerous. In the following sections, we look at each of the hazards associated with welding and its ancillary operations, comment on the level of risk for the various processes and materials and identify the precautions and PPE required for safe operation.

Hazards to health – Noise

Welding is usually only one of many processes required to fabricate or manufacture something. Several of these processes can generate significant noise hazards.

Sheet metal work usually requires guillotining and hammering or pressing to form components. Thicker metal is often ground to prepare an edge for welding. During MMA welding, slag can be removed with chipping hammers or grinders. Air-arc gouging or pneumatic burr grinding may be used to remove incorrectly deposited weld metal. All of these processes create noise at a potentially damaging level.

The Control of Noise at Work Regulations 2005 defines a lower exposure action value as a daily or weekly personal noise exposure of 80 dB (A-weighted, i.e. with frequency response simulating the human ear); an upper exposure action value as a daily or weekly personal noise exposure of 85 dB (A-weighted); an exposure limit value of a daily or weekly personal noise exposure of 87 dB (A-weighted); and an absolute peak noise level of 140dB. It should be remembered that an increase of 3dB is equivalent to doubling the noise.

No employee shall be exposed to noise levels above the peak level or consistently above the limit of 87dB, though these levels take into account the effect of wearing hearing protection.

With a noise level above the lower action limit, hearing protection should be available on request to employees. In conditions above the upper level of 85dB, the employer must make hearing protection available and ensure that it is worn. Also, the employee is obliged to make use of such PPE provided.

Guillotining and hammering can easily achieve 95 to 100dB, grinding may reach 105dB and air carbon arc gouging creates noise levels over 110 decibels. Some welding processes are noisy in their own right – MIG may emit noise at around 90dB; friction welding of steel and vibration welding of hard plastics can also emit high levels.

To comply with the Regulations, an employer has to conduct a risk assessment of the noise in the working environment and do all that is possible to reduce the level so far as is reasonably practicable. Where the upper action level is exceeded, the employer must designate the area as a hearing protection zone using appropriate signage and ensure that employees and others entering it wear hearing protection. BS EN 352/1 to 3 defines the hearing protection equipment to be used.

Furthermore, health surveillance records that include hearing tests must be kept and be made available to employees on request.

Radiation hazards

The most intense radiation occurs in laser or electron beam welding. These beams are of sufficient power to vaporise metals they impinge upon. If allowed to contact a human body, they would do severe harm. The most logical method of protection is to isolate the operator and other staff from the beam by containment. Most electron beam guns operate in a high or partial vacuum so are wholly within a chamber. Moreover, the equipment generating the beam is substantial and fixed so the direction is always towards the work piece. Lasers can be transmitted via long glass fibres and there is more likelihood of inadvertent positioning of the exit from the fibre. However, the laser needs focussing to create full power and the welding head that achieves this is held by a robot. Normal workshop practice with robots is to govern the machine by interlocks such that no operation can occur until all personnel are outside of an enclosure and safety switches set. Solid wall cells with interlocks on the doors are an excellent means of separating the operator from the machine.

Arcs emit radiation omni directionally. All emit ultraviolet light to a greater or lesser extent; in MIG welding of aluminium, the emission is intense. The unprotected eye can be seriously harmed by ultraviolet light from any arc process. Arc eye or welders' flash, an immensely uncomfortable irritation of the eye, may result from even short-duration flash exposure to a welding arc. Arc eye is caused by inflammation the action of UV radiation on the outer surface of the eyeball; long exposure could cause permanent damage.

Ultraviolet radiation also affects the skin causing severe burning. Long-term exposure of the skin to UV can induce skin cancers though there is no evidence that welders are more prone than others to melanoma.

Visible light is also very strong in a welding arc. In principle, this could adversely affect the retina of the eye but the human reaction is to close the eyes when submitted to intense visible light so in practice this is not an issue.

Infrared radiation is felt as heat. Welding arcs, particularly those at higher currents, will quickly burn exposed skin. The long-term effect of IR on the eye is to increase the opacity of the lens (i.e. to form cataracts) but, again, there is no evidence that welders are more prone to this than the general population. Radiation, both UV and IR, from arc welding is so pronounced that welders must use filtering to complete the task and this may ensure that they do not receive long-term exposure.

Submerged arc welding, where the arc between a continuous wire electrode and the work piece is completely covered by a bed of granulated flux which protects the arc zone, is one arc process that does not emit radiation to a harmful level. Considerable heat may be given off, but eye and skin protection can be similar to that for general workshop practice.

PPE to guard the skin against welding radiation is given in BS EN 470-1:1995 'Protective clothing for use in welding and allied processes. Welders should ensure that their heads are protected by a hood. It is easy to forget that UV will penetrate even a good head of hair and cause burning of the scalp; many welders are, of course, without even that covering!

Eye protection is covered by BS EN 169:2002 ‘Personal eye protection. Filters for welding and related techniques. This has an informative Annex A 'Guidelines on selection and uses' that shows recommendations for filter grades for the various welding processes.

A modern approach to filters for eye protection is to use auto-darkening lenses. Helmets with such lenses have a detector that darkens the lens to a specific grade within milliseconds of being stimulated by the presence of an arc. These are also covered by a standard, BS EN 379:2003.

Work areas where welding is taking place should be screened from the surroundings by transparent tinted plastic curtains. These are defined in BS EN 1598:1998.

Electromagnetic field hazards

High currents in arc welding can give rise to magnetic fields larger than those experienced in other workplaces. Operators should avoid wrapping cables around themselves to prevent unnecessary exposure to magnetic fields, and also avoid being pulled off balance.

Heart pacemakers may be affected by large electromagnetic fields, though the effect depends on the type of pacemaker and the medical condition it is controlling. An operator fitted with a pacemaker should discuss its use in magnetic fields with a doctor before returning to the welding workplace. Visitors should also be made aware of the presence of high electromagnetic radiation in the vicinity of welding to ensure their safety.

Fume and deposits

The exposure of welders' lungs to fume is a topic deserving of a full article. It has been covered in this publication. I shall not repeat the advice, other than to note that, like the hazard of noise, a risk assessment must be made and all steps taken to reduce the levels before resorting to PPE. Another, less publicised, the hazard is that of ingestion of toxic material. Some arc welding processes raise the temperature of materials to their boiling point. Conditions within and immediately surrounding the arc allow many chemical reactions to take place such that the fume generated may contain compounds, not in the original materials. The coarsest of the particles formed condense to create deposits alongside the weld. These are usually removed by the welder to improve visual inspection of the bead. This is typically achieved with a wire brush, followed by wiping with the gloved hand. The gloves, therefore, become coated and, in removing them at breaks, so do the welder's hands. If inadequate attention is given to handwashing before smoking or eating, the deposit can be ingested.

Most fluxes and metals give little cause for concern in this respect but lead, cadmium, beryllium and barium require consideration. Soldering with lead-based solders was an issue as lead can transfer easily to the hands directly from the solder. This problem has now been addressed by a RoHS Directive; since July 2006, soldiers must be lead-free. There is also a set of regulations, 'Control of Lead at Work', that must be complied with if welding of lead is to be undertaken.

Cadmium is present in significant proportion in some silver soldiers. Whilst fume generation is low during soldering, there is a possibility of cadmium and cadmium oxide deposits forming beside the joint. Beryllium is added to copper to give a strong hardening effect. Copper-beryllium alloys are used for electrodes of resistance welding machines but occasionally attempts are made to weld them. Beryllium readily forms an oxide that will deposit beside the weld.

Some all-positional self-shielded flux-cored wires use barium compounds to achieve good weld metal properties and positional welding capability. Deposits of barium oxide and carbonate can be formed alongside welds with these consumables. These compounds are known toxins and in such cases, extra attention should be given to the possibility of ingestion in the risk assessment carried out. The responsibility is initially on the employer to understand the dangers and to minimise them. He must then inform and train the employees to take reasonable precautions to personal hygiene and the frequent replacement of overalls and gloves.

Mechanical hazards

The environment in which a welder works has several hazards that are not specific to the welding process itself. Manual handling of heavy awkward metal components is often required. The thinner, lighter metal sheet may have sharp edges. Slips, trips and falls may be more likely as welding often requires thick cables to be spread across the floor. Standard workshop safety and protection practices should be used to counter these problems. Welders need training in materials handling, both manual and with mechanical lifting assistance; protective gloves, overalls and boots must be worn; cabling on the floor should be minimised and signed or marked as a trip hazard.

There are, however, more hazards that are a direct result of the joining process itself. During welding, sparks and molten metal can be ejected. These are most common in arc welding but can also occur in resistance and some friction processes (e.g. linear friction welding of titanium). In mechanised processes, guards should be used to contain the flying particles. This is not possible in manual welding so the PPE worn by the operator must be capable of protecting the body. All clothing should be fire-resistant and the use of leather aprons, jackets, chaps, etc. is recommended.

Friction welding is a mechanical process using equipment that rotates or oscillates the faying pieces. In this respect, it is similar to equipment in a machine shop, except that it can be significantly larger, or in the case of micro-friction welding, smaller. The precautions required are therefore similar to those in a machine shop; the work should be screened by guards, operators should not have loose clothing, long hair, dangling jewellery, etc., but there may be specific requirements created by the size of the equipment that can only be defined by risk assessment.

One of the more serious dangers is from the persistent use of vibrating hand tools: grinders, scaling hammers, pneumatic burrs, etc which can lead to long-term illness – hand-arm vibration syndrome, also known as 'white finger' or 'dead hand'. The HSE publishes an RHS Inspection Pack 'Hand-arm Vibration' which shows that action may be required with as little as 30 minutes per day use of a chipping hammer. Once more, employers are required to carry out risk assessments to identify potential problems from vibration.

Electrical safety

The majority of welding techniques rely on electrical power. This is usually transformed from three-phase 440V mains to something appropriate for the process. Any breakdown in the insulation either before or after the welding set can expose the user to the risk of electrocution. PPE, eg gloves and rubber-soled boots, can mitigate the damage but should not be considered the first line of defence. A regular inspection and maintenance schedule should be in place to ensure that all wiring is to the required standard.

Arc welders work with an open circuit between the electrode and the work piece. There is therefore a risk that by mishandling – touching both the electrode and the work piece – a current path could be established through the welder's body. Whilst the welding voltage (ca 20V) is not high, the open-circuit voltage can be considerably higher (80 to100V). The risk of damage, and possibly fatal, electrocution is real.

Another aspect to be considered is the return path of the current. Good, direct earth return from the work piece to the welding set is essential. It not only allows consistent parameters to be set to give optimum welding conditions for the product but protects personnel. With an indeterminate return, the current path can track through an earthed metallic structure in the vicinity putting a wide variety of people at risk.

Gases

Much of the gas used in welding and allied processes is supplied compressed in metal cylinders. Although several are inert or of low activity chemically, eg argon, helium, carbon dioxide, they pose a risk on two counts – their weight and the possibility of sudden escape of gas. Gas cylinders are heavy, gross weights can exceed 80kg, and should be manually handled minimally and with great care. When sited in a store or on the shop floor, they must be held in a purpose-built stand, restrained within it by a chain. A tall cylinder falling is a dangerous object that can inflict considerable bodily harm.

A much greater danger exists with the use of inert gases in welding, eg argon, helium, nitrogen and carbon dioxide. Argon is denser than air and accumulates at the bottom of confined spaces. Welders working in confined spaces with inert gases have died of asphyxiation. Adequate forced ventilation must be provided in such spaces and the welder should be provided with breathing apparatus providing as appropriate for the task. Where a welder may be placed at risk by working in a confined space, a risk assessment should be carried out under the Confined Spaces Regulations 1997.

All equipment used in gas processes, regulators, flashback arrestors, hoses, non-return valves and blowpipes, should be regularly inspected and maintained under manufacturers recommendations.

Risk assessment and training

As has been commented throughout this piece, the key to creating a safe environment for welders is to anticipate potential hazards, move to minimise their levels, provide adequate protection for personnel and give comprehensive training in identifying risk and dealing with it.

Welding Safety Hazards

Welding operations present several hazards to both those undertaking the activity and others in the vicinity. Therefore, it's important that you are aware of the risks and hazards welding poses, and understand what precautions you can take to protect yourself.

Welder Using PPE to Carry out a Job Safely

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 a part of the welding or electrode circuit at the same time as touching the metal you are welding.

You are particularly at risk if you work 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.

Noise Hazards

When carrying out welding activities, you are likely to be exposed to loud, prolonged noises. 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:

1. Ringing in the ears, known as tinnitus.
2. Occasional dizziness, known as vertigo.
3. Increased heart rate.
4. 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:

1. Foreign bodies entering the eye, including grit, sparks and dust.
2. Particulate fumes and gases, which could lead to conjunctivitis.

Poor Welding Practice without eyewear

Exposure to Fumes and Gases

Undertaking welding activities will expose you to invisible gaseous fumes, including ozone, nitrogen oxides, chromium and nickel oxides, and carbon monoxide which can easily penetrate your lungs. Depending on the gas or fume, the concentration and duration of your exposure, the resultant damage can be severe.

Illnesses caused by welding fumes and gases include:

Pneumonia: Regular exposure to welding fumes and gases can result in a lung infection which could then develop into pneumonia. While antibiotics can usually stop the infection, severe pneumonia can result in hospitalisation, serious illness and fatalities.

Occupational asthma: Chromium oxides and nickel oxides produced by stainless steel and high nickel alloy welding can both cause asthma.

Cancer: All welding fumes are internationally considered ‘carcinogenic’.

Metal fume fever: Welding or hot work on galvanised metal and high steel weld fume exposure can often result in 'flu-like symptoms, which are usually worse at the start of the working week. You might have heard that drinking milk before welding will help you avoid developing metal fume fever, but this is a myth.

Throat and lung irritation, including throat dryness, tickling of the throat, coughing and tight chests.

Burns: The combination of high-temperature welding arcs, UV rays and molten metal means you are susceptible 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 you follow our outlined precautions, you should be able to prevent burns.

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

Your employer or manager must provide you with appropriate Personal Protective Equipment (PPE). The PPE you receive will include:

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.

Boots and gloves. Insulated, flame-resistant gloves and rubber-soled, steel toe-capped safety shoes shield you from electric shocks, heat, fire, burns and falling objects.

Avoiding welding hazards by using PPE

To receive full protection from your PPE, you must not:

Roll-up sleeves or trousers. Rolling up your clothes will leave you susceptible to molten metal or sparks getting caught in the folds, which could potentially lead to severe burns. You should also never tuck your trousers into your work boots.

Remove your helmet while welding. You must always wear your helmet when welding and when in the vicinity of another welder. While the intensity of the radiation produced decreases the further you are from a welding arc, those less than 10 metres away are still susceptible to arc-eye. Therefore, it’s important that you remain behind welding curtains or wear the correct PPE, even if you aren’t the worker carrying out the welding operation.

Receive Appropriate Training

Before starting any welding work, it's important that you receive adequate training in the use and safety of your work. E-learning courses provide an easy, cost-effective and flexible training opportunity.

expert icon Need Welding Safety Training?

Our Welding Health and Safety Training Course raises awareness of the risks presented by welding operations. It helps you to understand the risks that must be avoided and provides knowledge of how to carry out your welding activities safely.

Ensure Your Workspace is Well Ventilated.

Good ventilation is important when welding as it removes airborne gases and particles from your work area. You may need to employ a combination of ventilation strategies to combat all the pollutants created in the welding process. You might also need to use respirators if your ventilation strategies don't reduce your exposure enough.

Ensure Your 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.

2.2 Related Empirical Studies

Ekenedo and Amadi (2016) conducted a study on Hazard Control Needs Assessment of Roadside Welders in Rivers East Senatorial District Rivers State. The population of the study comprises all Road Side Welders in the LGAs in Rivers East Senatorial District. To achieve this purpose descriptive survey design was employed and a self-structured validated questionnaire was used to collect data from 912 Roadside welders from Rivers East Senatorial District, Rivers State. The instrument for data collection was tagged Hazard Control Needs Assessment of Roadside Welders Questionnaire (HCNARWQ) with a reliability index of 0.76. This was modified to suit the study. The data collected were analyzed using Simple percentages and frequency tables for the research questions, while Chi-square (X^2), and was used to test the hypotheses at 0.5 alpha level of significance. The findings of the study showed that Roadside welders in Rivers East Senatorial District, Rivers State have equipment, knowledge and hazard control practice needs. More so, demographic variables such as age, educational status, training and location of the workshop influenced hazard control measures used by roadside welders. Finally, it was concluded that knowledge of hazards of Roadside welders has influenced hazard control equipment and practices. It was recommended that periodic inspection of the roadside welder's workplace by the Ministry of Labour and productivity through its agencies will build consciousness on the welders, reduce the impact of hazards, enhance performance, prevent accident and injury hence maintain longevity of life while at the workplace.

Awosan, Makusidi, Ibrahim, Suleiman, Magaji and Mbatifuh (2017), also conducted research on Knowledge and Safety Practices Related to Exposure to Physical and Chemical Hazards among Welders in Sokoto, Nigeria. The workplace is an important part of man's environment, and no occupation is free of hazards. Due to the upsurge in construction activities (many of which involve welding) sequels to the increasing urbanization and industrialization across the world, exposure to occupational hazards has become an important public health problem globally. This study was conducted to assess the knowledge and safety practices related to exposure to physical and chemical hazards among welders in Sokoto, Nigeria. A cross-sectional descriptive study was conducted among 280 welders selected by systematic sampling technique. Data were collected with a set of a standardized, semi-structured, self-administered questionnaire, and analyzed using the IBM SPSS Version 20 statistical computer software package.

Berhe, Desalegn and Tesfaye (2019) investigated the awareness of occupational hazards and utilization of safety measures among welders in Aksum and Adwa Towns, Tigray Region, Ethiopia. An institution-based cross-sectional study was conducted from February 25 to March 10, 2013, among welding factory workers. +e study included 278 workers selected by simple random sampling, and data were collected by using structured and pretested questionnaires. +e data were entered and analyzed using SPSS version 16 statistical package. Logistic regression analysis was carried out to found the effect of the independent variables on the dependent variables. Result. One hundred thirty-five (51.9%) respondents knew occupational hazards and 225 (86.5%) workers used personal protective equipment. Variables such as work experience, work type, safety training, work regulation, and guideline had significant association with the knowledge of respondents: (AOR: 0.44 (0.19, 0.99)), (AOR: 0.38 (0.22, 0.65)), (AOR: 0.33 (0.17, 0.63)), and (AOR: 0.31 (0.15, 0.67)), respectively. Educational status, work experience, safety training, and availability of work regulation were found to be associated with PPE use (AOR: 13.20 (10.65, 16.46)), (AOR: 0.03 (0.003, 0.34)), (AOR: 0.02 (0.01, 0.09)), and (AOR: 0.06 (0.02, 0.21)), respectively. The authors concluded and recommended. Nearly half of respondents knew occupational hazards and a high proportion of study subjects were used personal protective equipment. Safety and health training was the common factor to increase knowledge and personal protective usage practising habits. Employers and other responsible bodies should encourage training and regular supervision should be made including on workers' safety and well-being.

2.3 Summary of Literature Review

This chapter reviewed the study in regards to the theoretical, conceptual and empirical studies. From the reviewed literatures it could be deduce that risk management and safety precaution at work place mot especially at welder workshop cannot be comprised.

Various concept of risk management and safety precaution has proven the significance of adequate safety precaution and risk management. It is similarly observed form the empirical studies that few or no research has been conducted within Minna metropolis. this motivated the present study to investigate into the assessment safety precaution and risk management among roadside arc welder in Minna metropolis

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Design of the Study

The research design used in carrying out this study was the survey research design. The survey research design was chosen as an appropriate method for the research as it seeks the view of people about a particular issue that concerns them, give room for research to study the group of people and items to source for information from the respondents. (Sambo, 2012).

3.2 Area of the Study

The study covered some selected Roadside Mechanics in Minna Metropolis Niger State. Minna, the capital of Niger State is situated between latitude 09°36'45"N and longitude 06°31'12"E. Minna has a population of 291,905 as of the 2006 population census count making it the biggest city in Niger State. Minna is about 135km away from the Federal Capital Territory and 300km away from Kaduna city.

3.3 Population of the Study

The targeted population for this study consist of one hundred and forty-five (145) participants with 60 roadside arc welder and eighty-five (85) customers.

3.4 Sampling and Sampling Techniques

Since the population size is of considerable size, hence no sampling techniques were used.

3.5 Instrument of Data Collection

A constructed questionnaire titled "Assessment of Safety Precaution and Risk Management Practice by Roadside Mechanics Questionnaire (ASPRMPRMQ)" was used to get the desired information from the students. The questionnaire was divided into two parts (A and B). Part A will be for the collection of information on personal data of respondents while Part B which consist of sections (A - D), Section A will address research question one which contains item....., Section B will address research question two and Section C will address research question three finally Section D will address research question four.

3.6 Validation of the Instrument

The designed questionnaire will be submitted to the project supervisor for vetting, correction and approval before distributing it to the respondents.

3.7 Reliability of the Instrument

The reliability of the research instrument will be used to determine using a split-half test using the odd and even-numbered items to form the two halves. The two halves will have administered to a sample of arc welders in Bida since the area is not selected for the main study. The Cronbach alpha test will be used to determine the reliability of the instrument.

3.8 Method of Data Collection

The researcher will collect the needed data through the use of a questionnaire and its administration in the selected customers and arc welder. The administration of the questionnaire will be carried out by the researcher and two other research assistants. A total of 145 copies of the questionnaire will be distributed to obtain responses from the students and retrieved on the spot by the researcher and research assistant.

3.9 Method of Data Analysis

Responses from the questionnaire was analyzed using the descriptive statistics of frequency counts, percentage, mean and standard deviation and t-test. Descriptive statistics of frequency counts and percentages were used in analyzing demographic variables and mean and standard deviation will be used for the research questions. While t-test will be used for the hypotheses testing at 0.05 level 0f significance.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Analysis of Research Questions

4.1.1 Research question one

What is the safety precaution practice by roadside ARC welders?

Table 4.1 Safety Precaution Practice by Roadside ARC Welders

Statement	$\bar{x}$	SD	Remark
Ensuring all connected are in tight connection	3.42	0.43	Agree
Always take caution while step on the ground to avoid electrocution	3.14	0.56	Agree
I regularly wear a personal protective eye device PPE in to avoid lighting or spark into the eye	3.94	0.25	Agree
The regular use of respirators, moderate my respiratory transmission	2.49	0.39	Disagree
Ensuring proper loading of the circuit, to avoid damage of devices or shock	3.65	0.23	Agree
Avoiding welding hazards by regularly checking and maintenance of all used machines	2.52	0.92	Agree
I update my knowledge on appropriate welding practices	3.41	0.27	Agree
I update Knowledge of how to carry out your welding activities safely.	2.26	0.68	Agree
I ensure my workspace is well ventilated.	3.45	0.26	Agree
Ensure Your Workspace is Free of Flammable Material	2.57	0.44	Agree

Table 4.1 shows the respondent responses on safety precaution practices by roadside arc welders. From the table, it was disclosed that; ensuring all connections are in tight connection, always take caution while step on the ground to avoid electrocution, wear of personal protective eye device PPE in to avoid lighting or spark into the eye, proper loading of a circuit, to avoid damage of devices or shock, regularly checking and maintenance of all used machines, updating knowledge on appropriate welding practices, updating Knowledge on how to carry

out your welding activities safely, ensure my workspace is well ventilated and ensuring workshop is free of flammable material with mean value ($\bar{x}$) of 3.42, 3.14, 3.94, 3.65, 2.52, 3.41, 2.26, 3.45 and 2.57 respectively are safety precaution practice by roadside arc welders. While their responses only disagree on the regular use of respirators, moderate my respiratory transmission with a mean value of ($\bar{x}$) 2.49.

4.1.2 Research Question two:

What is the risk management practice by roadside ARC welders?

Table 4.2 Risk Management Practice by Roadside ARC Welders

Statement	$\bar{x}$	**SD**	**Remark**
Work areas well-ventilated	2.67	0.23	Agree
Work areas well-lit location	3.03	0.22	Agree
Work stops if there is a smell of gas	3.86	0.60	Agree
Employees/Trainees working nearby protected from arc flash	2.39	0.30	Disagree
Work areas well-arranged	2.76	0.76	Agree
Work areas tidy	3.64	0.92	Agree
Signs reading danger, no smoking	2.07	0.27	Disagree
First Aid available at all times	1.76	0.68	Disagree
Hazardous materials well-labelled	2.42	0.26	Disagree
Fire extinguishers	2.34	0.64	Disagree

Table 4.2 unveils the respondent responses on risk management practice by roadside ARC welders. From the result, it could be deduced that the following risk management practice by roadside ARC welders, working areas well-ventilated, areas well-lit location, work stops if

there is a smell of gas, work areas well-arranged and work areas tidy with mean value 2.67, 3.03, 3.86, 2.76 and 3.64 respectively.

On the other hand, ensuring employees/Trainees working nearby protected from arc flash, signs reading danger, no smoking, first Aid available at all time, hazardous materials well-labelled and fire extinguishers are risk management practices not put into practice by roadside ARC welders.

Research Question three: what are the factors affecting the adequate adoption of safety precaution and risk management practices by the roadside arc welder in Minna metropolis.

Table 4.3: Factors Affecting the Adequate Adoption Safety Precaution and Risk Management Practices by The Roadside Arc Welder in Minna Metropolis

Statement	$\bar{x}$	SD	Remark
Lack of technical know-how of the craftsmen on standard welding materials	3.89	0.39	Agree
Inadequate enlighten on risk management	3.65	0.23	Agree
Nonchalant Craftsmen does not abide by the safety guidelines	2.52	0.92	Agree
Lack equipment to carry out operations on the site or workshop	3.41	0.27	Agree
Poor quality of materials greatly influence the safety	3.26	0.68	Agree
Poor planning workshops also affect the safety at work	3.33	0.51	Agree
Incompetence supervision of the workshop activities	3.56	0.46	Agree
The topography of the land as well as the weather condition of the workshop	2.61	0.51	Agree
Material shortage and management	3.29	0.72	Agree
Use of hard drugs by the craftsmen	2.86	0.82	Agree
Lack of commitment of workers on site	3.01	0.60	Agree
Inconsistent of adopted practices of by welding	3.33	0.51	Agree
Lack of maintenance of the material/ machines	3.56	0.46	Agree

Table 4.3 shows the respondent responses on factors affecting the adequate adoption of safety precaution and risk management practices by the roadside arc welder in Minna metropolis. The result on the table unveils that; lack of technical know-how of the craftsmen on standard welding materials, inadequate enlighten on risk management, nonchalant Craftsmen does not abide by the safety guidelines, lack the equipment to carry out operations on the site or workshop, poor quality of materials greatly influence the safety, poor planning workshop also affect the safety at work, incompetence supervision of the workshop activities, the topography of the land as well as the weather condition of the workshop, material shortage and management, use of hard drugs by the craftsmen, lack of commitment of workers on site, inconsistent of adopted practices of by welding and lack of maintenance of the material/ machines are identified factors affecting the adequate adoption safety precaution and risk management practices by the roadside arc welder in Minna metropolis with mean value ($\bar{x}$) of 3.89, 3.65, 2.52, 3.41, 3.26, 3.33, 3.56, 2.61, 3.29, 2.86, 3.01, 3.33 and 3.56 respectively.

Research Question Four: What are the strategies needed to improve the adoption of standard practices to mitigate hazards in Minna metropolis.

Table 4.4 Strategies needed to improve the adoption standard practices to mitigate hazard in Minna metropolis

S/N	Statement	$\bar{x}$	SD	Remark
1	Training on the craftsman on the technical know-how of the standard welding materials usage	2.91	0.42	Agree
2	Proper enlighten on risk management	3.33	0.36	Agree
3	Guide the trainee Craftsmen on abiding by the safety guidelines	2.78	0.43	Agree
4	Ensuring availability of equipment to carry out operations on the site or workshop	2.99	0.43	Agree
5	Ensuring the availability quality of materials greatly influence the durability	2.86	0.25	Agree
6	Adequate planning to ensure safety at work	3.78	0.13	Agree
7	Ensuring competent supervision at work/site	3.89	0.46	Agree

	Ensuring work are carried out at well conducive environment and weather condition of the site location	2.96	0.14	Agree
9	Discouraging the use of hard drugs by the arc welder	3.09	0.33	Agree
10	Ensuring commitment of workers on site	3.03	0.41	Agree
11	Ensuring consistent of standard adopted practices by welding	3.95	0.95	Agree

Table 4.4 shows the respondent responses on strategies needed to improve the adoption of standard practices to mitigate hazards in Minna metropolis. The result on the table unveils that; training on the craftsman on the technical know-how of the standard welding materials usage, proper enlighten on risk management, guide the trainee Craftsmen on abiding by the safety guidelines, ensuring availability of equipment to carry out operations on the site or workshop, ensuring availability quality of materials greatly influence the durability, adequate planning to ensure safety at work, ensuring competent supervision at work/site, ensuring work are carried out at well conducive environment and weather condition of the site location, discouraging the use of hard drugs by the arc welder, ensuring commitment of workers on-site, ensuring consistency of standard adopted practices of by welding with mean value ($\bar{x}$) of 32.91, 3.33, 2.78, 2.99, 2.86, 3.78, 3.89, 2.96, 3.09, 3.03 and 3.95 respectively.

4.2 Summary of Findings

1. The findings on research question one show the respondent responses on safety precaution practice by roadside arc welders. Among these are; ensuring all connections are in tight connection, always take caution while step on the ground to avoid electrocution, wear of personal protective eye device PPE in to avoid lighting or spark into the eye, proper loading of a circuit, to avoid damage of devices or shock, regularly checking and maintenance of all used machines, updating knowledge on appropriate welding practices, updating Knowledge on how to carry out your welding activities safely.

The findings on research question two unveils the respondent responses on risk management practice by roadside ARC welders among these are following risk management practice by roadside ARC welders, working areas well-ventilated, areas well-lit location, work stops if there is a smell of gas, work areas well-arranged and work areas tidy.

The findings on research question three shows the respondent responses on factors affecting the adequate adoption of safety precaution and risk management practices by the roadside arc welder in Minna metropolis. The findings unveil that; lack of technical know-how of the craftsmen on standard welding materials, inadequate enlighten on risk management, nonchalant Craftsmen does not abide among others are identified factors affecting the adequate adoption of safety precaution and risk management practices by the roadside arc welder in Minna metropolis.

The findings on research question four shows the respondent responses on strategies needed to improve the adoption standard practices to mitigate hazard in Minna metropolis, the result shows that; training on the craftsman on the technical know-how of the standard welding materials usage, proper enlighten on risk management, guide the trainee Craftsmen on abiding by the safety guidelines, ensuring availability of equipment to carry out operations on the site or workshop, ensuring availability quality of materials greatly influences the durability among others.

4.3 Discussion of Findings

The findings of the study on safety precaution practice by roadside arc welders disclosed the main activities of safety precautions is that; they ensured tight connection of wires, take caution while step on the ground to avoid electrocution, putting on personal protective eye device PPE, proper loading of a circuit, to avoid damage of devices or shock, regularly checking and maintenance of all used machines, ensure my workspace is well ventilated and ensuring workshop is free of flammable material among others. This is in line with the findings of (Okuga, 2012; Awosan*et al*., 2011).

The findings of the study also showed the risk management practice by roadside ARC welders. It was deduced that the following risk management practice by roadside ARC welders, working areas well-ventilated, areas well-lit location, work stops if there is a smell of gas, work areas well-arranged and work areas tidy, while they are lacking employees/Trainees working nearby protected from arc flash, use of signs reading danger, no smoking, availability of first Aid available, hazardous materials well-labelled and fire extinguishers. This is in line with that (Awosan *et al*. 2017; Berhe *et al*., 2019), the authors indicated in their findings that most craftsmen's arc welders do not take to risk management practice.

The findings of the study also unveiled that lack of technical know-how of the craftsmen on standard welding materials, inadequate enlighten on risk management, nonchalant Craftsmen does not abide by the safety guidelines, lack equipment to carry out operations on the site or workshop, poor quality of materials greatly influence the safety, poor planning workshop also affect the safety at work, incompetence supervision of the workshop activities, among other, are identified factors affecting the adequate adoption safety precaution and risk management practices by the roadside arc welder in Minna metropolis. This is also in line with the findings of (Awosan *et al*. 2017; Berhe *et al*., 2019).

Finally, the findings of the study showed the strategies needed to improve the adoption of standard practices to mitigate hazards in Minna metropolis. Among the are training on the craftsman on the technical know-how of the standard welding materials usage, proper enlighten on risk management, guide the trainee Craftsmen on abiding by the safety guidelines, ensuring availability of equipment to carry out operations on the site or workshop, ensuring availability quality of materials greatly influences the durability, adequate planning to ensure safety at work, ensuring competent supervision at work/site.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study is at investigating the safety precaution and risk management practice among roadside ARC welders in Minna metropolis. Based on the finding of the study on the identified safety precaution and risk management practice by roadside ARC welders, as well as factors affecting the adequate adoption safety precaution and risk management practices with the aim determine the strategies needed to improve the adoption standard practices to mitigate hazard in Minna metropolis. A descriptive survey research design was adopted.

5.2 Implication of the Findings

This study is of great benefit to the: Welders, National Emergency and Management Authority(NEMA) (Niger State Branch), general public and Metal Work Student.

The findings of the research work are of great benefit to the welders in adopting the standard practices needed to be adopted to combating any disastrous events in the metalwork and related industry.

The study enlightens the arc welders on the causes of hazard, the effect and the various management practices that are needed to reduce the frequent occurrence of the incidence.

The outcome of this study is also of help to the National Emergency and Management Authority (NEMA), in giving awareness campaigns on the various hazard and risk management practices adopted by the roadside arc welder, as well as the effect on the safety of the employers and properties.

The study is highly resourceful the metalwork students in adding knowledge already existing literature on risk management practices.

5.3 Contribution to Knowledge

The study has immensely contributed to the field of craftsmanship in regard risk management and safety precaution practices.

5.4 Conclusion

It could be concluded that; the roadside ARC welders are adequately ensuring safety precaution practice among these are; they ensured tight connection of wires, take caution while step on the ground to avoid electrocution, putting on personal protective eye device PPE, proper loading of a circuit, to avoid damage of devices or shock, regularly checking and maintenance of all used machines and so on.

On the other hand, the roadside ARC welders do not take to risk management practice by roadside ARC welders, they lacking on; employees/Trainees working nearby protected from arc flash, use of signs reading danger, no smoking, availability of first Aid available, hazardous materials well-labelled and fire extinguishers.

From the findings of the study it could be concluded that lack of technical know-how of the craftsmen on standard welding materials, inadequate enlighten on risk management, nonchalant Craftsmen does not abide by the safety guidelines, lack equipment to carry out operations on the site or workshop, poor quality of materials greatly influence the safety, poor planning workshop also affect the safety at work, incompetence supervision of the workshop activities, among other, are identified factors affecting the adequate adoption safety precaution and risk management practices by the roadside arc welder in Minna metropolis.

Finally, it is concluded that the strategies needed to improve the adoption of standard practices to mitigate hazards in Minna metropolis. Among these are training on the craftsman on the technical know-how of the standard welding materials usage, proper enlighten on risk management, guide the trainee Craftsmen on abiding by the safety guidelines, ensuring availability of equipment to carry out operations on the site or workshop and so on.

5.5 Recommendations

Based on the conclusion of the study, the following recommendations are made;

1. More enlighten programmes should be organised for the roadside arc welder on proper safety precaution

s.

2. An adequate sensitization programme should be organised for the roadside arc welder on risk management practice.
3. Regulations bodies on welding practice should ensure all quality equipment is made available and proper training of craftsmen on welding activities.
4. Sanction should be made on anyone who violates the safety precaution and risk management practice.

5.6 Suggestion for Further Studies

1. Further study should also conduct a study factors contributing to inadequate risk management practice by roadside welder welders.
2. study should also conduct a study assess the qualification of practice by roadside welder welders as contributing factors to inadequate risk management practice.

REFERENCES

Agma-Acon, J. (2015). Occupational Health and Safety in Small Scale Industries in Uganda. Newsletter on Occupational Health and Safety Supplement 9(1): 46-48.

Antonini JM. (2003). Health effects of welding. Critic Rev Toxicol.;33(1):61-103.

Asogwa, S.E. (2017). A Grideto Occupational Health Practice in Developing Countries (2nd ed). Enugu: *Fourth Jimension. r on Occupational Health and Safety Supplement* 9(1): 46-48.

Banta, J. (1993). Oxyfuel Safety: It's Everyone's Responsibility. Weld. J. 2012, 91 (8), 48–53.

Berhe K. Park's textbook of preventive and social medicine. 16th Edition, India, Banasides Bharat Publishers 2000:557.

Cooper, J.S., Kim, I.S., Lee, J.H and Jung, S.M, (2015). An experimental study on the prediction of back-bead geometry inpipeline using the GMA welding process", Archives of Materials Science and Engineering 49(1), 53-61, 2011.

Desalegn, T. (2014). Knowledge and practices regarding safety information among textile workers in Adwa town," Science Postprint,. 1,(1), article e00015,.

Ekenedo A. Amadi, D. (2016). Children's and women's rights in Nigeria: A wake up call. Situation assessment and analysis. National planning commission/UNICEF, Abuja, Nigeria:173.

International Labor Organization (ILO).International Hazard Datasheet on Occupations (HDO). Available:https://www.ilo.org/safework/info/publications/WCMS-113135/langen/index.htm

Isah EC, Okojie OH, Isah AO.(2001). Street trading: an aspect of child labour in Benin City, Nigeria. *J Comm Med and Primary Health Care*, 13:48-52.

Isah EC, Okojie OH. (2006). Occupational health problems of welders in Benin City, Nigeria.*Journal of Medicine and Biomedical Research.; 5:64-69.*

Marek D. H.;&Starzynski ,. M. (2015). Safety with Lasers and other Optical Sources: A Comprehensive Handbook; Plenum Press: New York,

Sabitu, Z. Iliyasu, and M. M. Dauda, , (2009). Awareness of occupational hazards and utilization of safety measures among welders in Kaduna Metropolis, Northern Nigeria," Annals of African Medicine,l. 8(1), 46. Achen

Zakhari R. (2016) The Electromagnetic Spectrum and Chemical Hazards. In Occupational Health in Aviation: Maintenance and Support Personnel.

APPENDIX A

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION

Dear respondent

This questionnaire is designed to elicit information from the respondents on the assessment the safety precaution and risk management practice among road side ARC welders in Minna metropolis.

INTRODUCTION: Please, kindly give your respond on the questions in the questionnaire to provide a data base for this study as faithfully as possible and sincerely tick (√) the column, that best represents your perception about the above topic. The questionnaire is just for research purpose and any information provided about your view would be treated with confidentiality.

PART 1

PERSONAL DATA

I. Cadre: _______________

II. Gender: Male( ) Female( )

III. Experience: 1-5yrs( ) 6-10yrs( ) 11-15yrs( )

Please read this questionnaire items carefully and tick the response appropriate to each item. The response categories are:

SA =Strongly Agreed.= 4 points

A = Agreed = 3 points

D = Disagreed = 2 points

SD = Strongly Disagreed= 1 point

Question One:

What are the safety precaution practice by roadside ARC welders?

S/N	**Statement**	***SA***	**A**	**DA**	**SDA**
	Ensuring all connected are in tight connection				
92	Always take caution while step on the ground to avoid electrocution				
3	I regularly wear personal protective eye device PPE in to avoid lighting or spark into the eye				
4	The regularly use of respirators, moderate my respiratory transmission				
5	Ensuring proper loading of circuit, in order to avoid damage of devices or shock				
6	Avoiding welding hazards by regularly checking and maintenance of all used machines				
7	I update my knowledge on appropriate welding practices				
8	I update Knowledge of how to carry out your welding activities safely.				
9	I ensure my workspace is well ventilated.				
10	Ensure Your Workspace is Free of Flammable Material				

Question two:

What are the risk management practice by roadside ARC welders?

S/N	Statement	*SA*	A	DA	SDA
1	Work areas well-ventilated				
2	Work areas well-lit				
3	Work stops if there is smell of gas				
4	Employees working nearby protected from arc flash				

5	Work areas well-arranged				
6	Work areas tidy				
7	Signs reading danger, no smoking				
8	First Aid available at all times				
9	Hazardous materials well-labelled				
10	Fire extinguishers				

Question three: what are the factors affecting the adequate adoption safety precaution and risk management practices by the roadside arc welder in Minna metropolis.

S/N	Statement	*SA*	A	DA	SDA
1	Lack of technical know-how of the craftsmen on standard welding materials				
2	Inadequate enlighten on risk management				
3	Nonchalant Craftsmen does not abide by the safety guidelines				
4	Lack equipment to carry out operations on the site or workshop				
5	Poor quality of materials greatly influence the safety				
6	Poor planning workshop also affect the safety at work				
7	Incompetence supervision of the workshop activities				
	The topography of the land as well as the weather condition of the workshop				
9	Material shortage and management				
10	Use of hard drugs by the craftsmen				
11	Lack of commitment of workers on site				
12	Inconsistent of adopted practices of by welding				
13	Lack of maintenance of the material/ machines				

Question four: What are the strategies needed to improve the adoption standard practices to mitigate hazard in Minna metropolis.

S/N	Statement	SA	A	DA	SDA
1	Training on the craftsman on technical know-how of the standard welding materials usage				
2	Proper enlighten on risk management				
3	Guide the trainee Craftsmen on abide by the safety guidelines				
4	Ensuring availability of equipment to carry out operations on the site or workshop				
5	Ensuring availability quality of materials greatly influence the durability				
6	Adequate planning to ensure safety at work				
7	Ensuring competent supervision at work/site				
	Ensuring work are carried out at well conducive environment and weather condition of the site location				
9	Discouraging the use of hard drugs by the arc welder				
10	Ensuring commitment of workers on site				
11	Ensuring consistent of standard adopted practices of by welding				

APPENDIX B

CRONBACH'S ALPHA TEST FOR RELIABILITY

Reliability: OBJECTIVE 1-4.

Case Processing Summary

		N	%
Cases	Valid	26	100.0
	Excluded[a]	0	.0
	Total	26	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.835	44