

Pollution Threats of Roadside Welding in Maiduguri, Borno State

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Abstract

Roadside welding is one of the most important sources of Environmental pollution in Maiduguri. Scrap metals, welding electrodes, grinding disks, welding dust, fumes, gases and other multiple hazardous substances are produced which pose negative effects on the environment and human health. This study aimed to assess the pollution threats of roadside welding in Maiduguri, Borno State. A systematic random sampling technique was employed to select 295 roadside welders. Questionnaires, interviews and field observation were used for data collection. The findings revealed that only 18% of the respondents have high awareness of the Environmental Effects of Welding. The major Environmental Effects of Welding in the study area is Air Pollution from the Emission of Fumes and Gases as revealed by 53% of the respondents. The study also indicates that Scrap Metals were the major waste and by-product produced during welding and were mostly disposed of in the general waste bin as ascertained by 68% of the respondents, these metals are considered environmental pollutants with significant consequences when polluting the physical environment and interact with the biological component in the environment. The study recommends regular monitoring of welding sites for pollution and indiscriminate waste disposal by agencies responsible for safeguarding the environment and health of the populace. The study also established the need for raising environmental awareness among road welders through the implementation of awareness campaigns.

Keywords: *Pollution, Threat, Roadside, Welding*

Introduction

Today in Nigeria and the rest of the world, the environment suffers from many ailments and faces numerous problems that affect the lives of human beings. Man, in his effort to satisfy his basic needs engaged in activities that are detrimental to the environment. Environmental pollution causes the most dangerous threats to life and prevents the ability of the environment to aid in the continuation of life and its renewal to meet human needs. Pollution is defined as the introduction into the environment of substances harmful to humans and other living organisms. Pollutants are harmful solids, liquids, or gases produced in higher-than-usual concentrations that reduce the quality of our environment (Manisalidis *et al.*, 2020). Right from the beginning of human activities, a permanent conflict between the environment and man remains. The environment in ancient times used to represent all that was unknown to man at that time. His main concern was his fears about the evil wind, volcanoes, earthquakes and predators so that he could sustain himself. However, with time, the situation changed the human beings became the source of danger to the environment

due to factors like technological and industrial progress the increase in population and the consequent depletion of natural resources (Shayaa Al-Shayaa., 2012).

Welding is an essential manufacturing process in many industries around the world. According to the United States Department of Labor (2017), about 382,730 people were employed as welders, soldiers, and brazers in 2016. The most common employers for welding activity are architectural and structural metals manufacturing, automobile manufacturing, aerospace industry, shipbuilding industry, and many others. Welding is a process in which two or more pieces of metal are joined together by the application of heat, pressure or a combination of both. The welding processes most commonly employed today are gas and electric welding. Welding is a profession that requires a skilled workforce and presents excellent professional remuneration for the service (Abhinay, 2019). In Nigeria and many third-world countries, many industrial workshops such as welding workshops, and mechanical and electrical workshops are located by the roadsides and in residential areas where their customers could easily have access to them.

Welding is a hazardous process that emits various toxic metals and gaseous pollutants. The toxic metals are emitted in the form of minute particles that can be inhaled and transported to the inner parts of the lungs easily. Epidemiological studies have shown that air pollution is strongly connected with health problems and fatality, and welding fumes is not an exception, as there are some concerns about carcinogens in welding fumes (Genchi *et al.*, 2020). It is also associated with adverse health effects on kidneys, respiratory, reproductive and nervous systems. Approximately, up to two per cent (3 million people) of the working population from different backgrounds in industrialized countries are subjected to welding fume exposure (Abhinay, 2019).

Environmental pollution may occur through industrial, commercial or domestic activities of man. This happens when substances resulting from human activities enter the environment. The environment is said to be polluted when the concentration of these substances attains levels which may cause discomfort and/or harm to man, fauna and flora of the environment. The pollution of the environment has been found to result from man's determination to match desire with production through the establishment of various industries with the potential to pollute the environment (Manisalidis *et al.*, 2020).

In all types of welding processes, fumes and gases are formed as air pollutants. The most common gases emitted during welding are ozone, nitrous gases and carbon monoxide. Phosphine and phosgene are the other gases that may be produced during welding which are harmful to the environment. The wastes produced in welding workshops are potential environmental pollutants that need to be given serious attention. Welding activities generate many types of waste and by-products such as scrap metals, welding electrodes, grinding disks, welding dust and powder that may contain various hazardous metal oxides that are considered environmental pollutants with significant consequences when polluting the physical environment and interact with the biological component in the environment (Golbabaie and Khadem, 2015).

Welding, as an industrial process, causes serious impacts on the environment depending on its operation mode and the technological equipment. Gases are also generated from welding, which may include carbon monoxide, carbon dioxide, sulphur dioxide, ozone and nitrogen oxides. In the earth's atmosphere, these gases act as a "greenhouse gas" which plays a major role in global warming and anthropogenic climate change. Human activities are altering the carbon cycle and have contributed substantially to climate change by adding CO₂ and other heat-trapping gases to the atmosphere. (Golbabaie and Khadem, 2015).

As a result of literacy, poverty and inadequate planning in most developing countries, many human activities co-exist with one another. For instance, welding workshops, mechanical workshops, restaurants and refuse dumps are sited close to one another or even in a residential area without considering the environmental and health implications on the people. This is not so in developed countries of the world. In the U.S.A. for example, the United States Environmental Protection Agency (USEPA) is responsible for the provision of information on environmental pollutants. Such detailed information is scanty in developing countries like Nigeria even though there has been an appreciable level of urbanization (Adekeye, *et al.*, 2011).

The activities of roadside welders in Maiduguri hurt the environment by generating waste, and polluting water, air, and the soil in which plants grow. Although welding being a tool in industries, especially the construction industries was a great success in terms of technology, society, and the provision of multiple services. However, without any doubt, global environmental pollution is considered an international public health issue with multiple facets. Social, economic, and legislative concerns and lifestyle habits are related to this major problem. Urbanization and industrialization are reaching unprecedented and upsetting proportions worldwide. Therefore, it is against this background that this study is aimed at assessing the Pollution threats of roadside welders in Maiduguri with the view of making possible recommendations that will ameliorate the environmental threat of roadside welding in Maiduguri.

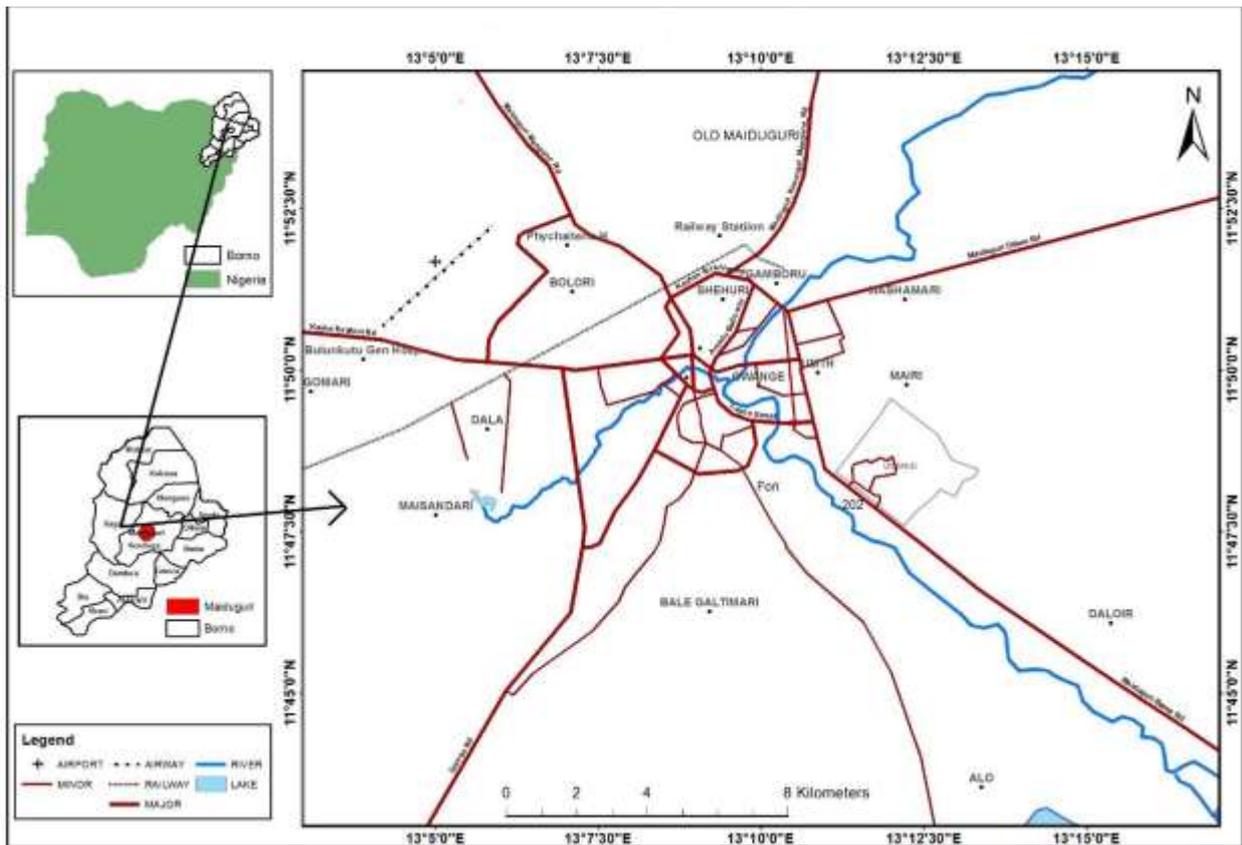
Aim and Objectives

The study aims to examine the Pollution threats of roadside Welders in Maiduguri Borno state. The specific objectives are to:

- i. Determine the level of awareness of roadside welders on the environmental effects of welding.
- ii. Identify the types of waste generated during the welding processes and their disposal methods.
- iii. Identify the environmental effects of metal welding workshops in the study area.

The Study Area

The study area is Maiduguri Metropolis, the capital of Borno State. Maiduguri is located at the Northeastern corner of Nigeria on Latitude $11^{\circ} 43' N$ and $11^{\circ} 52' N$ and Longitude $13^{\circ} 05' E$ and $13^{\circ} 15' E$. It covers a total area of 543 km², which makes it the largest city in the Northeastern region of Nigeria.



Source: Cartography lab, Geography Department, UNIMAID (2019)

Figure 1.1: Showing Maiduguri Metropolis

Methodology

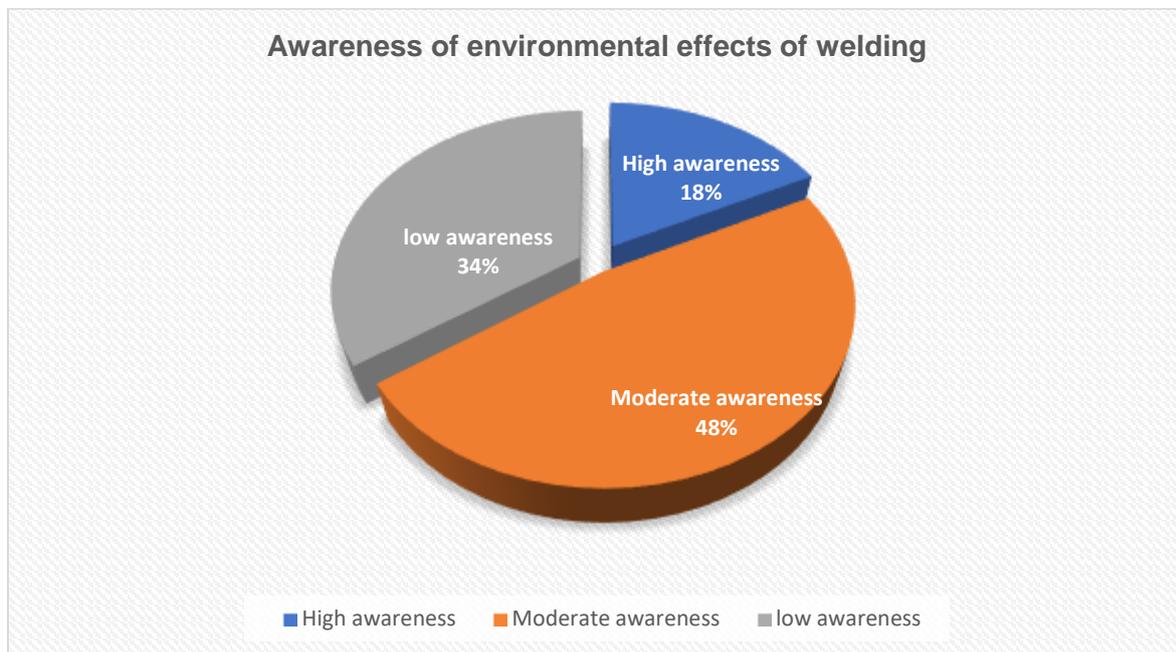
The study was carried out among roadside welders in Maiduguri Metropolis from March 2021 to October 2021. A systematic Random sampling technique was employed in selecting 295 respondents from the list of 1400 welders who have registered with the Welders' Association (Records of Welders Association, 2019). Informed consent was obtained from prospective welders before the commencement of the study. Data for the study were collected through structured questionnaire administration, field observation and interviews. The questionnaire consists of both open and close-ended questions and is divided into four sections. Section A elicits information on socio-demographic characteristics of roadside welders, section B background information on welding, section C environmental effects of welding and section D elicits information on types of waste generated during the welding processes and their disposal methods. The questionnaire was validated by experts in the Department of Geography, University of Maiduguri. A pilot study was conducted and the questionnaire was pre-tested and validated among 10 welders. Some of the questions were rephrased for clarity based on observations made during the pre-test. Data for the study were analysed using descriptive statistics of frequency distribution tables and percentages. The data was cleaned, validated and analysed using SPSS version 20.

Results and Discussion

Level of Awareness of Environmental Effects of Welding

On the level of awareness of the environmental effects of welding, Awareness variables were measured on a five-point Likert scale with possible responses including strongly agree, agree,

strongly disagree, disagree and undecided. The environmental effect of welding awareness was summed to create the scale of measurement on a 95-point scale so that a score of >70% indicates high awareness, 50-70% indicates moderate awareness and <50% indicates low awareness respectively. Data indicates that only 18% of the respondents have a high awareness of the environmental effects of this profession. 48% moderate awareness and 34% low awareness. The reported 18% high awareness of the environmental effects of welding might be due to the fact the majority of roadside welders received their training through hands-on apprenticeship training rather than attending formal welding schools. The implication of this finding is that awareness plays an important role in the Management of the environment. Awareness activities can be used to reinforce positive attitudes and fortify a safe working environment among welders in the study area. A similar study on industrial workers in Riyadh observed that 31% of workers had high awareness (Shayaa Al-Shayaa., 2012). The proportion is slightly higher than observed in this study.

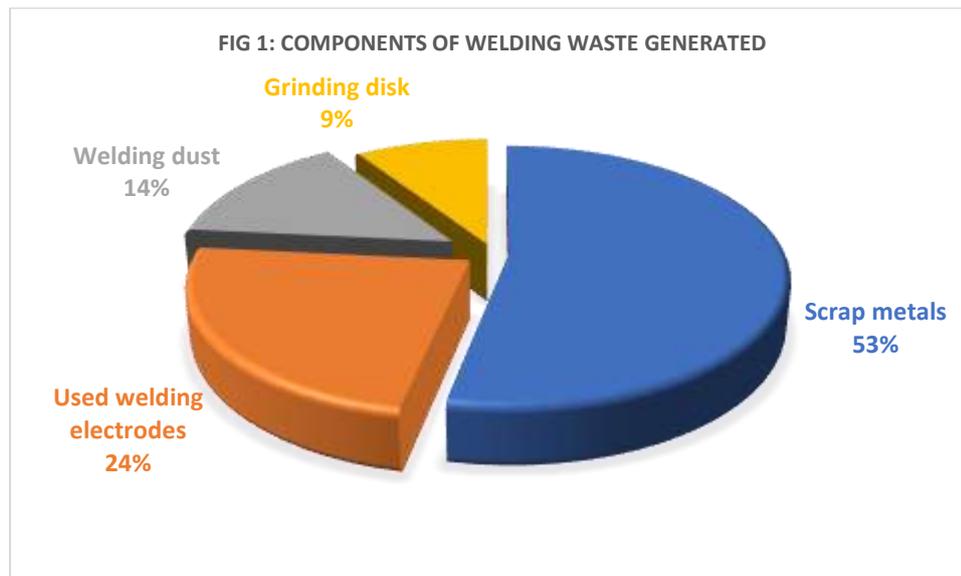


Source: Fieldwork, 2021

Components of welding waste

Figure 1 below shows the components of welding waste generated during welding operations. The major components of welding waste include scrap metals, used welding electrodes, grinding disks and metal dust. Data indicate that slightly more than half (53%) of the waste generated comprises scrap metals, this was followed by used welding electrodes (24%) as it was considered the most demanded consumables by welders for their welding work. welding dust constitutes 14% and grinding disk 9% respectively. The composition of welding waste identified in this study illustrated the potential adverse effects of welding waste on the environment due to its hazardous nature. Welding waste components which include welding electrodes, metal dust and grinding disks are known to contain various hazardous metal oxides such as aluminum oxide, silicon carbide, zirconium oxide, manganese compounds and zinc compounds (Abhinay, 2019). These metals are considered environmental pollutants with significant consequences when polluting the physical environment and interacting with the biological components of the environment. A similar study conducted by Adekeye, *et al.*, (2011) showed that welding waste is a source of serious metal pollution in soil.

Additionally, exposure to hazardous metal oxides from welding waste could lead to various adverse effects in humans. Long-term or excessive exposure to manganese and zinc compounds can cause Parkinson's-like disease and other neurological effects. Furthermore, exposure to metal oxides also leads to other health issues including serious respiratory problems and reproductive effects (Genchi *et al.*, 2020). In Malaysia for instance, metal and metal-bearing wastes were classified as scheduled waste and require management according to the specified regulations in Environmental Quality (Scheduled Wastes) Regulations 2005 (Noor *et al.*, 2019).

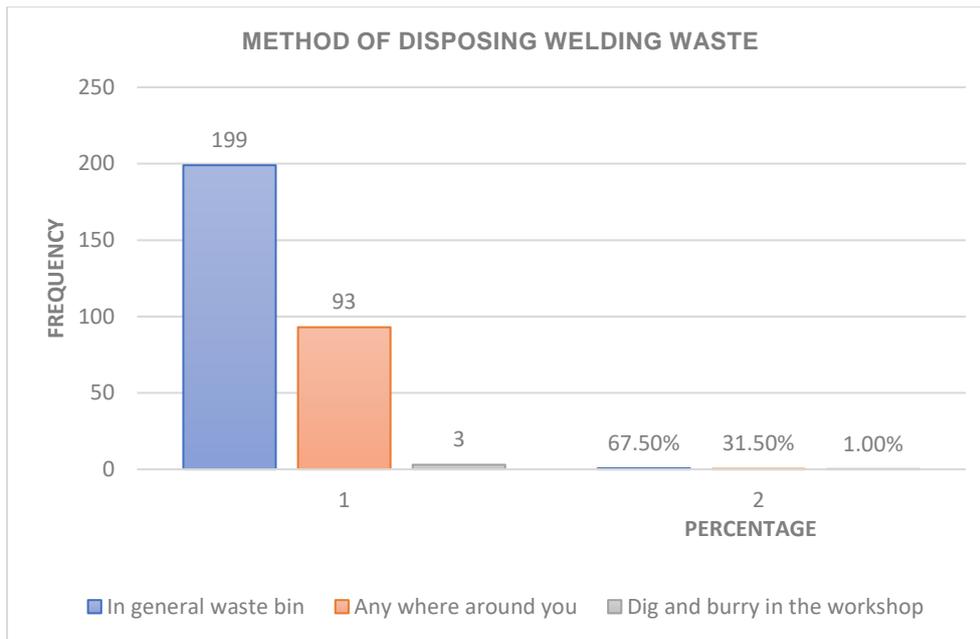


Fieldwork, 2021

Methods of Disposing Welding Waste

The wastes produced in welding workshops are potential environmental pollutants that need to be given serious attention. Welding operation generates waste that contains various hazardous metal oxides (Hazardous waste) that are considered pollutants which has significant consequences to the environment. Welding is a hazardous process that emits various toxic metals that require special management.

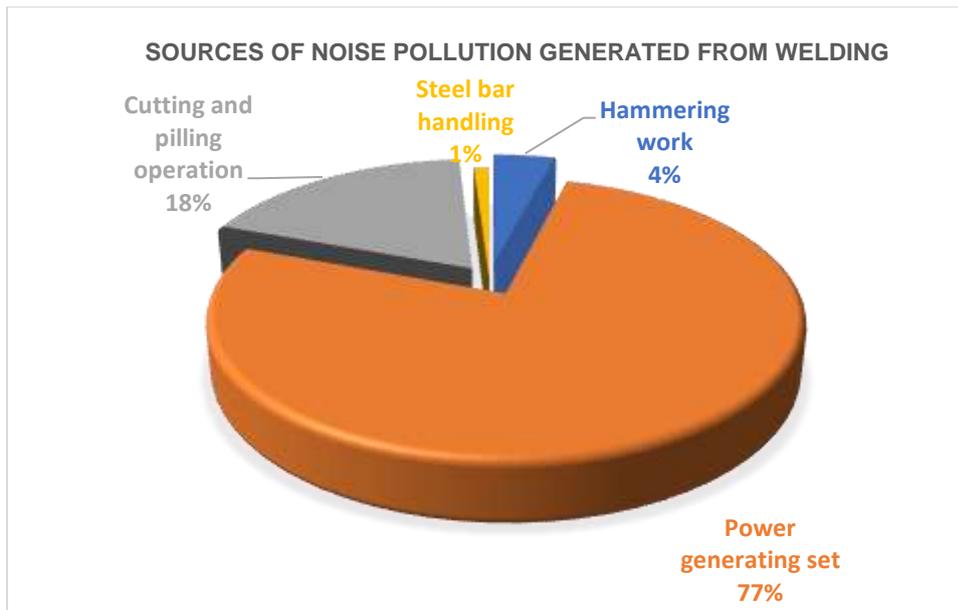
Hazardous Waste Management entails procedures and policies to deal with hazardous waste in a way that will not pose problems to man and the environment. A sustainable hazardous waste management system involves waste control from cradle to final disposal and even pollution monitoring (Amadi and Okeke, 2017). Results on the method of disposing of welding waste indicate that 67.50% of the respondents dispose of their welding waste in the general waste bin, 31.50% dispose of any were around them and only 1% dig and bury it in the workshop. This finding implies that Hazardous waste generated during the welding operation often requires sorting, and transporting to an approved treatment, storage, or disposal facility because of its potential threats to public safety and the environment. According to Iyyanki and Vali (2017), hazardous waste management is a major challenge in urban areas throughout the world. Without an effective and efficient waste management program, the waste generated from various human activities both industrial and domestic, can result in health hazards and hurt the environment.



Source: Fieldwork, 2021

Sources of noise pollution generated from welding

The subject of noise is not easily understood by many as a physical pollutant. This is because the human ear gradually gets automatically adjusted to the sound level so that an increase in the sound level is not easily observed. According to the World Health Organization, noise in urban centres is considered the third most hazardous environmental type of pollution, preceded only by air (gas emission) and water pollution (WHO, 2005). Figure 2 below shows the sources of noise pollution generated from welding. The findings revealed that the majority (77%) of the respondents reported power-generating sets as the major source of noise pollution from welding. Exposure to noise over some time can result in impairment or loss of hearing. Kim *et al* (2011) revealed that permanent hearing damage can be caused by intense noise which can also induce “tinnitus,” a continuous or intermittent ringing, or other noises in the ear. Noise Pollution is fairly easy to detect in the environment, but the effects can accumulate over a long period so noise hazards can surprisingly be overlooked. Cutting and pilling operations accounted for a significant total of 18%



Source: Fieldwork, 2021

Environmental effects of welding

The result from the field observation and interview revealed that Environmental pollution in welding occurs as a result of a high percentage of heat that is released into the environment and materials including large amounts of gases and fumes. Also, some of the factors needed to carry out the welding include energy, mineral or organic substances (protective gases, cooling water, oils, grease and protective substances etc.). These consumables result in undesirable impacts on the environment and the lives of the populace. Furthermore, inert gases like carbon dioxide and argon are used to protect the welding region and prevent oxidation. They are used as shielding gases and also have undesirable impacts on the environment.

Concerning the environmental effects of welding, data indicates that air pollution from the emission of fumes and gases was the major environmental effect of welding as ascertained by slightly half (51.19%) of the respondents. This might be due to the following possible reasons; in all types of welding processes, fumes and gases are formed as air pollutants, high temperatures during the welding process, different substances in the arc are vaporized and the vapour condenses and oxidizes in contact with the air, leading to the formation of fumes, welding type and consumables such as filler metal, oil, grease and surface coatings which can be harmful for the environment. Air pollution may lead to various environmental impacts. Air pollution can adversely cause critical impacts on the atmosphere and natural environment in many ways. Welding, as an industrial process, causes serious impacts on the environment depending on its operation mode and the technological equipment. Gases generated from welding act as a “greenhouse gas” which plays a major role in global warming and anthropogenic climate change. Human activities are altering the carbon cycle and have contributed substantially to climate change by adding CO₂ and other heat-trapping gases to the atmosphere.

Undoubtedly, the environment and health of the populace is vulnerable to air pollution. In 2018, during the first WHO Global Conference on Air Pollution and Health, the WHO General Director, Dr Tedros Adhanom Ghebreyesus, called air pollution a “silent public health emergency” and “the new tobacco” (Manisalidis *et*

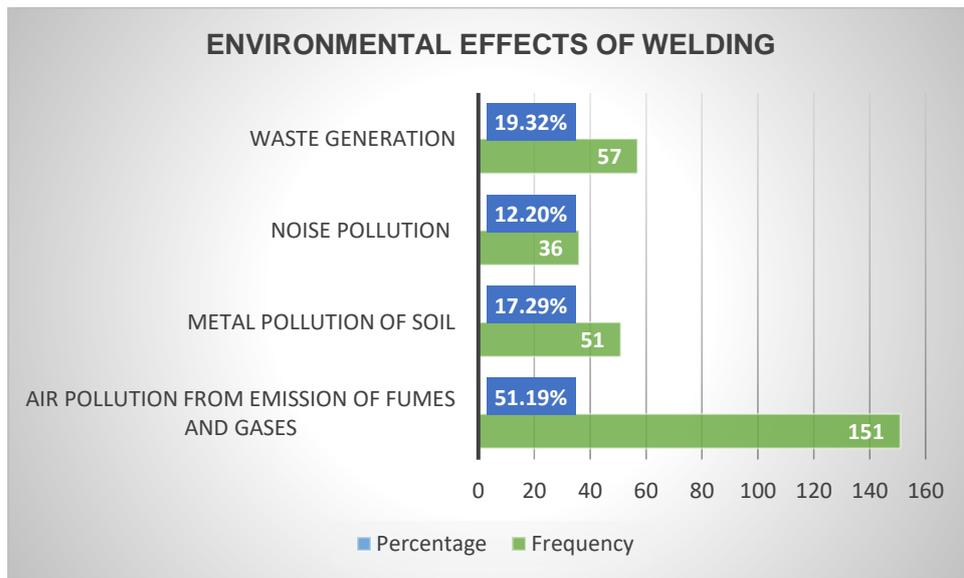
al., 2020). Despite the difficulty of eradicating the problem of anthropogenic environmental pollution, a successful solution could be envisaged as a tight collaboration of authorities and bodies to regularize the situation. Governments should spread sufficient information and educate people and should involve professionals in these issues to control the emergence of the problem successfully.

Furthermore, 17.29% of the respondents reveal metal pollution of soil as one of the environmental effects of welding. This might be attributed to the reported 53% of welders generating scrap metals during cutting and piling operations and hammering work. Corrosion of metals and batteries, use of metallic parts, building materials, lead petrol products, construction work, iron bending and welding of metals using electrodes may also contribute to heavy metals such as Arsenic, Copper, Iron, Nickel, Lead, Zinc, and Cadmium contamination in soils. The heavy metals present in soils can be transported to plants or animals by the action of water or wind. This may affect the quality of water and air. Inhalation, ingestion or dermal contact may pose a severe risk to the ecosystem and threaten human health. A Study conducted in Maiduguri showed a high concentration of metals in soil samples which was attributed to metal construction work, Iron bending and welding of metals (Dikwa *et al.*, 2019). Ashraf and Ali, (2007) also reported that heavy metals exert toxic effects on soil microorganisms hence resulting in the change of the diversity, population size and overall activity of the soil microbial communities and observed that the heavy metals (Cromium, Zinc and Cadmium) pollution influenced the metabolism of soil microbes in all cases. In general, an increase in metal concentration adversely affects soil microbial properties e.g., respiration rate, and enzyme activity, which appear to be very useful indicators of soil pollution. The uptake of heavy metals by plants and subsequent accumulation along the food chain is a potential threat to animal and human health (Briffer *et al.*, 2020) The absorption by plant roots is one of the main routes of the entrance of heavy metals in the food chain.

The high proportion of welders using power-generating sets has a significant effect on the environment as observed by 12.20% of welders who reported noise pollution as the environmental effect of welding. Hammering work, cutting and piling operations also contributed to noise pollution. Exposure to high occupational noise which results in health risks is commonly encountered in a variety of industrial processes. Its effects depend not only on the intensity but also on exposure time, frequency and the type of noise (Ahmed *et al.*, 2001). According to the World Health Organization (WHO, 2011), the effects of high levels of noise in the environment may lead to speech interference, reduction in productivity, high blood pressure, hearing defects, health disorders, sleep interference, cardiovascular effects, loss of concentration and absenteeism, and fatigue. Therefore, regulations limiting the levels of noise to which industrial workers are exposed have been instituted in many places. For example, in Nigeria, the National Environmental Standards and Regulations Enforcement Agency mandates industrial employers to limit factory noise to a value less than 85 dB (A) for 8 hours (NESREA, 2009) as prolonged exposure to continuous sound over this limit is potentially dangerous.

A study conducted by Harmadji and Kabullah (2004) showed that exposure to occupational noise of about 102 dB (A) intensity in a steel factory resulted in noise-induced hearing loss in 84% of the examined workers. Also, Mndeme and Mkoma (2012) observed that industrial machine noise in a cement factory ranges from 58.08 dB(A) to 104.82 dB(A) and a total of 82.5% of workers had various health defects as a result of exposure to such noise. Another related study (Atmaca *et al.*, 2005) observed that noise in several industries ranged between 75 and 107 dB (A) and resulted in several physical, physiological and psycho-social impacts

on the environment. Noise pollution is so omnipresent in the environment that people often fail to even notice it any more



Source: Fieldwork, 2021

Conclusion and Recommendations

It has been demonstrated in this study that hazardous waste generation, Noise pollution, and pollution of soil, water, and air are the most outstanding outcomes of roadside welding in Maiduguri. While welders appreciate the economic benefits derived from welding, the environmental implications are blatantly disregarded.

The study recommends regular monitoring of welding sites for pollution and indiscriminate waste disposal by agencies responsible for safeguarding the environment and health of the populace. The study also established the need for raising environmental awareness on the effects of welding on the environment among this economically viable group of workers through the implementation of awareness campaigns thereby reducing the potential risk to the environment.

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