STRATEGIES FOR EFFECTIVE MANAGEMENT OF POLLUTIONS IN IRON AND STEEL PRODUCTION IN AJAOKUTA STEEL INDUSTRY, KOGI STATE

BY

IBRAHIM, ABDULLAZEEZ ILEMONA

2014/1/53398TI

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

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A PROJECT SUBMITTED TO THE DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION, SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF TECHNOLOGY (B.Tech) IN INDUSTRIAL AND TECHNOLOGY EDUCATION

APRIL, 2023

DECLARATION

I hereby declare that this project titled: **"STRATEGIES FOR EFFECTIVE MANAGEMENT OF POLLUTIONS IN IRON AND STEEL PRODUCTION IN AJAOKUTA STEEL INDUSTRY, KOGI STATE"** is a collection of my original research work and has not been presented for any other qualification anywhere. Information from other sources (published or unpublished) has been duly acknowledged.

IBRAHIM, ABDULLAZEEZ ILEMONA
2014/1/53398TI
FEDERAL UNIVERSITY OF TECHNOLOGY,
MINNA, NIGERIA.

Signature & Date

CERTIFICATION

The project titled: "**STRATEGIES FOR EFFECTIVE MANAGEMENT OF POLLUTIONS IN IRON AND STEEL PRODUCTION IN AJAOKUTA STEEL INDUSTRY, KOGI STATE**" by IBRAHIM, ABDULLAZEEZ ILEMONA (2014/1/53398TI) meets the regulations governing the award of degree of Master of Technology of the Federal University of Technology, Minna and it is approved for its contribution to knowledge and literary presentation.

Mr. I. K. Istifanus ____________________
Supervisor Signature & Date

Dr. T. M. Saba ____________________
Head of Department Signature & Date

____________________ ____________________
External Supervisor Signature & Date

DEDICATION

This project is dedicated to Almighty ALLAH.

ACKNOWLEDGEMENTS

All thanks and adoration is due to Almighty God who gave me health, strength, wisdom and ability to carry out this research work successfully.

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ABSTRACT

The research was designed to determine the effective management of pollutions in iron and steel company Ajaokuta, Kogi State. The specific purpose of this study is to determine the various causes of pollutions, effects of pollutions and strategies to be adopted for increasing health and safety awareness among workers and its environment. And three null hypotheses tested at 0.05 level significant guided the study. Survey research design was adopted for the study and questionnaire was used to solicit information from the respondents. The targeted population of the study comprised of craftsmen and technicians. The total population for the study was one hundred and seventy two (172) which consist of ninety seven (97) craftsmen and seventy five (75) technicians in the iron and steel production company. Data obtained was analyzed using mean, standard deviation and z-test statistics. The findings of the study revealed that when pollutions are identified, it will definitely encourage effective management and curb the major effects on the workers and the environment in iron and steel production. Based on the findings, it was recommended that iron and steel production industries should encourage their worker through frequent training programs and provision of personal protective equipment's, implementation and practice of environmental laws and regulation in iron and steel production

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

The impact of iron and steel in any economy is usually tremendous because of its production and consumptions which measure the rate and levels of industrialization. Iron and steel are the most widely used engineering materials for production, construction, fabrication, and manufacture of items, including ships, vehicles, military hardware, among others; This explain why the per capita consumption of iron and steel are index for assessing development in the economy of any nation.

The availability and development of iron and steel sector is essential for industrial growth, increased engineering capacity and enhancement of technical skills. Iron and steel are integrated complex product of ferrus metal. Williams (2002) defined iron as a chemical element with chemical symbol Fe, and atomic number of 26. When iron and oxygen react in the present of water or moisture, rust (iron oxide) is formed. Corrosion is another good example that describes the disintegration of materials such as iron and steel; iron oxidizes so easily and rarely found in pure metal form on the earth surface. It is removed from ore (rock containing important minerals and element)

Steel is a well-known and commonly used alloy made from iron and small amount of carbon or sometimes other element. Steel can be around 1000 time stronger than iron in its pure form. Iron and steel products play a major role in people's life whether it's used for building construction, construction of car skeleton (chassis), bridge construction, and other domestic materials used for pleasure. In this regards, production of iron and steel companies is instrumental to personal life as well as to the development of the nation's economy.

The iron and steel industry is one of the central creating and managing pattern of technology change. Iron and steel productions are companies that designs, develops, manufactures, markets and sells the world iron and steel sheet metals, (sunkel, 2003).

The structures of the iron and steel as well as its refinishing workers are exposed to many dangers. A large number of accidents occur in the iron and steel production. These sometimes result to death, permanent or temporary injuries. According to National Institute for Occupation Safety and Health (NIOSH, 1993) shows that more than seventy percent of accidents and injuries that occur in iron and steel production are caused by inadequate and poor management of pollution in the iron and steel companies while less than thirty percent are caused by the means that are beyond management control. Industrial pollution is situations that possess a level of threat to life, health, property and environment as a result of some contamination of air, sound, soil or water by the discharge of harmful substances.

The Occupational Safety and Health Act (OSHA, 1994) defined pollution as the phenomena either natural or man-made that can endanger a group of people, their belongings as well as their environment if they do not take precautions. Pollution is typically referred to excessive amount of waste, which contain harmful poisons that are released to the environment air, water and soil which make it unpleasant to life, health and properties surrounding the affected environment. Pollution is usually caused by people, through the waste produced by car, the factories that produced the consumable materials, the power plant that produced the gas and electricity, among others (Calister, 2002). The Occupational Safety and Health Act (OSHA 1996) also defined pollution as a source or situation with potential for harm in term of injury or ill health, damage of business, environment and also lead to loss of life. The types of pollution that are commonly found in iron and steel production are air,water and soil pollution.

Noise pollution arises from the presence of heavy machine operation and the operation of blast furnace for the extraction of iron from its ore. This type of pollution is commonly observed among workers in the machining operation unit, packing plant unit as well as materials loading unit. Air pollution is another form of pollution that emanate from introduction of particulates, biological molecules' or emission of some chemicals into the atmosphere. The amount of fuel required to heat and cool home and other buildings also contributes huge amount of air pollution. Air pollution damage earth's atmosphere and harm plant and animals (including humans). This type of pollution is mostly common among workers in the spray application unit, power utilities unite, operations unit, chemical storage and handling unit, as well as maintenance unit.

Water pollution springs from the discharge of some chemicals, death or disease plants and animals, and other type of microbes in to the surroundings water of the working environment. (Al-Shuibi, 1991). The contaminated water or polluted water causes infection and parasitic diseases to the workers in the iron and steel company as well as the people living in the environment. Soil or land pollution arise as a result of adequate and frequently discharge of toxic chemicals such as lead, mercury, hydrofluoric acid and chlorine gas to the surrounding soil thereby making the soil unfertile and poor for agricultural uses; Although, this type of pollution does not frequently occur in the iron and steel production unlike the noise and air pollution. If all these types of pollution are not effectively managed they will cause harm not only to the workers of the iron and steel sector but also to its environment and people living close to the working environment. Pollution in iron and steel production has led to an increase in the rate of accidents occurrence in iron and steel production which has also caused loss of property and life and has reduced the productivity of some iron and steels companies. For pollution to be minimized it must be identified and valued through effective management process.

Effective management of pollution is a systematic identification, evaluation and control of pollution at all phases of life circle, (OSHA 1997). According to Health and Safety Executive (HSE, 1995) effective management of pollution is a process of reducing the level of risk in the working environment through pollution identification, risk assessment and control.

Management of pollution encompasses many types of industrial and production operations from the manufacturing, storing, and handling process (EPA, 2002). Understanding and identifying pollution is a key component of knowledge; it is often the first activity in effective pollution management and may occur early in the product research or in product development (Agbu, 1996). Therefore this study is out to determine strategies for effective management of pollutions in iron and steel company Ajaokuta Kogi State

1.2 Statement of the Problem

The iron and steel production have become one of the major production companies in Nigeria and understandably one of the most pollution's companies in most economies. Today iron and steel sector face a stark reality eroding health and safety treating endemic due to inability to manage pollution effectively. Some of the accident that occur in iron and steel production could be traced back to poor pollution management which includes inadequate design, inadequate pollution identification, poor supervision, poor administration, poor pollution control, inadequate training of workers. The increase in accident rate in the iron and steel production can be as a result of poor pollution management. Failure to identify and understand pollution hazard during the design and production stage of manufacturing industries causes problems directly and indirectly to the individual as a worker and also to the environment. Therefore Iron and steel industry requires high level to maintain a healthy and safety iron and steel working environment for the workers and the individual. Thus, this study was designed to determine the strategies for effective management of pollutions in Ajaokuta iron and steel company Kogi State.

1.3 Purpose of the Study

The purpose of this study is to determine the strategies for effective management of pollutions in iron and steel production, specifically, the study intends to determine:

1. Various causes of pollution in iron and steel production
2. The effects of pollution in iron and steel production
3. The strategies to be adopted for increasing health and safety awareness among workers and its environment in iron and steel production.

1.4 Significance of the Study

The beneficiaries of this study are the craftsmen, technicians, production supervisor, Government, policy makers and the society at large.

The craftsmen would benefit from this study as regards to preventive measures to be taken in order to prevent them from situation that poses a level of threat to life as they perform their tasks directly. The study also will provide the technicians the knowledge of the havoc that pollutions cause and as well enlighten them on the effect of air emission during coke heating. It would also help the production supervisors to identify the source of these pollutions and help them to minimize the threat it causes to life and properties of the surrounding environment.

The study will be of great benefits to the government and policy makers by identifying causes and preventive measures of pollution, thereby enacting environmental laws and regulation that will save guides the life and properties of any community. The society at large will also benefits from this study as they spend less for medication if the knowledge on how to curb some contamination of air, sound, soil and water is known. If iron and steel production safety guidelines are properly implemented the result of these findings it will help in reducing harms and accidents in iron and steel production as well as in metal technology workshop.

1.5 Scope of the Study

This study focused on effective management of pollution in iron and steel production, as regards to the causes of pollutions, effects of pollution and strategies to be adopted for increase health and safety awareness among the workers and its environment..

1.6 Research Questions

The following questions will guide the study in carrying out the study.

i. What are the causes of pollution in iron and steel production?

ii. What are the effects of pollution in iron and steel production?

iii. What are the strategies to be adopted to increase health and safety awareness among workers and its environment in iron and steel production?

1.7 Hypotheses

The null hypotheses is tested at 0.05 level of significance.

H_{01}: There is no significant difference in the mean responses of craftsmen and technicians on the causes of pollution in iron and steel production.

H_{02}: There is no significant difference in the mean responses of craftsmen and technicians on the effect of pollution in iron and steel production.

H_{03}: There is no significant difference in the mean responses of craftsmen and technicians on strategies to be adopted to increase health and safety awareness among workers and its environment in the iron and steel production.

CHAPTER TWO

2.0 REVIEW OF RELATED LITERATURE

The review of related literature was carried out under the following sub headings.

Iron and steel production.

Pollution in iron and steel production.

Pollution Management

Safety and Health Measures in iron and steel production.

Pollution control and prevention.

Summary of the related literature

2.1 Iron and Steel Production

The production of steel at an integrated iron and steel plant is accomplished using several interrelated processes. The major operations are; coke production, sinter production, iron production, iron preparation, steel production, semi-finished product preparation, finished product preparation, heat and electricity supply, and handling and transport of raw, intermediate, and waste materials. The interrelation of these operations is depicted in a general flow (Akande, 2011).

The sintering process converts fine-sized raw materials, including iron ore, coke breeze, Limestone, mill scale, and flue dust, into an agglomerated product, sinter, of suitable size for charging into the blast furnace. The raw materials are sometimes mixed with water to provide a cohesive matrix, and then placed on a continuous, travelling grate called the sinter strand. A burner hood, at the beginning of the sinter strand ignites the coke in the mixture, after which the combustion is self-supporting and it provides sufficient heat, 1300 to 1480°C (2400 to 2700°F), to cause surface melting and agglomeration of the mix (Adebimpe, 2011). On the underside of the sinter strand is a series of wind boxes that draw combusted air down through the material bed into a common duct, leading to a gas cleaning device.

The fused sinter is discharged at the end of the sinter strand, where it is crushed and screened. Undersize sinter is recycled to the mixing mill and back to the strand.

The remaining sinter product is cooled in open air or in a circular cooler with water sprays or mechanical fans. The cooled sinter is crushed and screened for a final time, then the fines are recycled, and the product is sent to be charged to the blast furnaces. Iron is produced in blast furnaces by the reduction of iron bearing materials with a hot gas. The large, refractory lined furnace is charged through its top with iron as ore, pellets, and/or sinter; flux as limestone, dolomite, and sinter; and coke for fuel. Iron oxides, coke and fluxes react with the blast air to form molten reduced iron, carbon monoxide (CO), and slag. The molten iron and slag collect in the hearth at the base of the furnace. The byproduct gas is collected through off takes located at the top of the furnace and is recovered for use as fuel (Agbu, 2007).

The impact of iron and steel in any economy is usually tremendous because of its production and consumption are measure of the rate and levels of industrialization. Iron and steel are the most widely used engineering materials for production, construction, fabrication, and manufacture of items, including ships, vehicles, military hardware, etc. this explain why the per capita consumption of steel is an index for assessing development in the economy of any nation. The availability and development of iron and steel sector, is essential for industrial growth, increased engineering capacity and enhancement of technical skills.

Industry Description and Practices: Steel is manufactured by the chemical reduction of iron ore, using an integrated steel manufacturing process or a direct reduction process. (Agbu, 2007). In the conventional integrated steel manufacturing process, the iron from the blast fur nace is converted to steel in a basic oxygen furnace (BOF). Steel can also be made in an electric arc furnace (EAF) from scrap steel and, in some cases, from direct reduced iron. BOF is typically used for high-tonnage production of carbon steels, while the EAF is used to produce carbon steels and low tonnage specialty steels. An emerging technology, direct steel manufacturing, produces steel directly from iron ore. This document deals only with integrated iron and steel manufacturing; that on Mini Steel Mills addresses the electric arc steel process and steel finishing processes. Steel manufacturing and finishing processes discussed in that document are also employed in integrated steel plants. See also Coke Manufacturing. In the BOF process, coke making and iron making precede steel making; these steps are not necessary with an EAF. Pig iron is manufactured from sintered, pelletized, or lump iron ores using coke and limestone in a blast furnace. It is then fed to a BOF in molten form along with scrap metal, fluxes, alloys, and high-purity oxygen to manufacture steel. In some integrated steel mills, sintering The (heating without melting) is used to agglomerate fines and so recycle iron –rich material such as mill scale.

Waste Characteristics: Sintering operations can emit significant dust levels of about 20 kilograms per metric ton (kg/t) of steel. Pelletizing operations can emit dust levels of about 15 kg/t of steel. Air emissions from pig iron manufacturing in a blast furnace include particulate matter (PM), ranging from less than10 kg/t of steel manufactured to 40 kg/t; sulfur oxides (SOx), mostly from sintering or pelletizing operations (1.5 kg/t of steel); nitrogen oxides (NOx), mainly from sintering and heating (1.2 kg/t of steel); hydrocarbons; carbon monoxide; in some cases dioxins (mostly from sintering operations); and hydrogen fluoride. Air emissions from steel manufacturing using the BOF may include PM (ranging from less than 15 kg/t to 30 kg/t of steel). Obot, O.W. (2011). For closed systems, emissions come from the desulfurization step between the blast furnace and the BOF; the particulate matter emissions are about 10 kg/t of steel. In the conventional process without recirculation, wastewaters, including those from cooling operations, are generated at an average rate of 80 cubic meters per metric ton (m3/t) of steel manufactured (Al-Shuibi, 1991). Major pollutants present in untreated wastewaters generated from pig iron manufacture include total organic carbon (typically 100–200 milligrams per liter, mg/l); total suspended solids (7,000 mg/l, 137 kg/t); dissolved solids; cyanide (15 mg/l); fluoride (1,000 mg/l); chemical oxygen demand, or COD (500 mg/l); and zinc (35 mg/l). Major pollutants in wastewaters generated from steel manufacturing using the BOF include total suspended solids (up to 4,000 mg/l, 1030 kg/t), lead (8 mg/l), chromium (5 mg/l), cadmium (0.4 mg/l), zinc (14 mg/l), fluoride (20 mg/l), and oil and grease. Mill scale may amount to 33 kg/t. The process generates effluents with high temperatures. Process solid waste from the conventional process, including furnace slag and collected dust, is generated at an average rate ranging from 300 Pollution Prevention and Abatement Handbook.

Pollution in Iron and Steel Production: Pollution is typically referred to excessive amount of waste, much of which contain harmful poison that are released in to the environment air, water and soil which possess a level of threat to life, properties and environment.

Noise Pollution: Steel making is one of the noisiest industries, although hearing conservation programs are decreasing the risk of hearing loss. The major sources include fume extraction systems, vacuum systems using steam ejectors, electrical transformers and the arc process in electrical arc furnaces, rolling mills and the large fans used for ventilation. At least half of noise-exposed workers will be handicapped by noise induced hearing loss after as little as 10 or 15 years on the job. Hearing conservation programmes, described in detail elsewhere in this research include periodic noise and hearing assessments, noise control engineering and maintenance of machines and equipment, personal protection, and worker education and training causes of hearing loss other than noise include burns to the eardrum from particles of slag, scale or molten metal, perforation of the drum from intense impulse noise and trauma from falling or moving objects. A survey of compensation claims filed by Canadian steelworkers revealed that half of those with occupational hearing loss also had tinnitus (McShane, Hyde and Alberti 1988).

Air Pollutants: Air pollutants from iron- and steel-making operations have historically been an environmental concern. These pollutants include gaseous substances such as oxides of sulphur, nitrogen dioxide and carbon monoxide. In addition, particulates such as soot and dust, which may contain iron oxides, have been the focus of controls. Emissions from coke ovens and from coke oven by product plants have been a concern, but the continuous improvements in the technology of steel-making and of emissions control during the past two decades, coupled with more stringent government regulations, have significantly reduced such emissions in North America, Western Europe and Japan (van Mensvoort, 2004). Total pollution control costs, over half of which relate to air emissions, have been estimated to range from 1 to 3% of total production costs; air- pollution control installations have represented approximately 10 to 20% of total plant investments. Such costs create a barrier to the global application of state-of-the-art controls in developing countries and for older, economically marginal enterprises. Air pollutants vary with the particular process, the engineering and construction of the plant, the raw materials employed, the sources and amounts of the energy required, the extent to which waste products are recycled into the process and the efficiency of the pollution controls. For example, the introduction of basic-oxygen steel making has permitted the collection and recycling of waste gases in a controlled manner, reducing the amounts to be exhausted, while the use of the continuous-casting process has reduced the consumption of energy, resulting in a reduction of emissions. This has increased product yield and improved quality.

Sulphur Dioxide: The amount of sulphur dioxide, formed largely in the combustion processes, depends primarily on the sulphur content of the fossil fuel employed. Both coke and coke-oven gases used as fuels are major sources of sulphur dioxide. In the atmosphere, sulphur dioxide may react with oxygen radicals and water to form a sulphuric acid aerosol and, in combination with ammonia, may form an ammonium sulphate aerosol. The health effects attributed to sulphur oxides are not only due to the sulphur dioxide but also to its tendency to form such respirable aerosols. In addition, sulphur dioxide may be adsorbed onto particulates, many of which are in the respirable range. Such potential exposures may be reduced not only by use of fuels with low sulphur content but also by reduction of the concentration of the particulates (Anyakwo, 2011) . The increased use of electric furnaces has decreased the emission of sulphur oxides by eliminating the need for coke, but this has passed on this pollution control burden to the plants generating electricity. Desulphurization of coke-oven gas is achieved by the removal of reduced sulphur compounds, primarily hydrogen sulphide, prior to combustion.

Nitrogen Oxides: Like the sulphur oxides, oxides of nitrogen, primarily nitrogen oxide and nitrogen dioxide, are formed in fuel combustion processes. According to (Akinrinshola1993). They react with oxygen and volatile organic compounds (VOCs) in the presence of ultraviolet (UV) radiation to form ozone. They also combine with water to form nitric acid, which, in turn, combines with ammonia to form ammonium nitrate. These may also form respirable aerosols which can be removed from the atmosphere through wet or dry deposition.

Particulate Matter: Particulate matter, the most visible form of pollution, is a varying, complex mixture of organic and inorganic materials. Dust may be blown from stockpiles of iron ore, coal, coke and limestone or it may enter the air during their loading and transport. Coarse materials generate dust when they are rubbed together or crushed under vehicles. Fine particles are generated in the sintering, smelting and melting processes, particularly when molten iron comes in contact with air to form iron oxide (Anyakwo 2012). Coke ovens produce fine coal coke and tar emissions. Potential health effects depend on the number of particles in the respirable range, the chemical composition of the dust and the duration and concentration of exposure. Sharp reductions in the levels of particulate pollution have been achieved. For example, by using electrostatic precipitators to clean dry waste gases in oxygen steel making, one German steel works decreased the level of emitted dust from 9.3 kg/t of crude steel in 1960 to 5.3 kg/t in 1975 and to somewhat less than 1 kg/t by 1990. The cost, however, was a marked rise in energy consumption. Other methods of particulate pollution control include the use of wet scrubbers, bag houses and cyclones (which are effective only against large particles).

Heavy Metals: Metals such as cadmium, lead, zinc, mercury, manganese, nickel and chromium can be emitted from a furnace as a dust, fume or vapour or they may be absorbed by particulates. Health effects, in this process depend on the level and duration of exposure.

Organic Emissions: Organic emissions from primary steel operations may include benzene, toluene, xylene, solvents, PAHs, dioxins and phenols. The scrap steel used as raw material may include a variety of these substances, depending on its source and the way it was used (e.g., paint and other coatings, other metals and lubricants). Not all of these organic pollutants are captured by the conventional gas cleaning systems.

Radioactivity: In recent years, there have been reports of instances in which radioactive materials have inadvertently been included in the scrap steel. The physicochemical properties of the nuclides (e.g., melting and boiling temperatures and affinity for oxygen) will determine what happens to them in the steel making process. There may be an amount sufficient to contaminate the steel products, the by-products and the various types of wastes and thus require a costly clean-up and disposal. There is also the potential contamination of the steel-making equipment, with resultant potential exposure of the steel workers. However, many steel operations have installed sensitive radiation detectors to screen all purchased steel scrap.

Carbon Dioxide: Although it has no effect on human health or ecosystems at the usual atmospheric levels, carbon dioxide is important because of its contribution to the "greenhouse effect", which is associated with global warming. The steel industry is a major generator of carbon dioxide, more from the use of carbon as a reducing agent in the production of iron from iron ore than from its use as a \ source of energy. By 1990, through a variety of measures for blast furnace coke rate reduction, waste-heat recovery and energy saving, carbon dioxide emissions by the iron and steel industry had been reduced to 47% of the levels in 1960.

Ozone: Ozone, a major constituent of atmospheric smog near the surface of the earth, is a secondary pollutant formed in air by the photochemical reaction of sunlight on nitrogen oxides, facilitated to a varying degree, depending on their structure and reactivity, by a range of VOCs. The major source of ozone precursors is motor vehicle exhausts, but some are also generated by iron and steel plants as well as by other industries. As a result of atmospheric and topographic conditions, the ozone reaction may take place at great distances from their source. van Mensvoort, M.E.F. (2004).

Waste Water Contaminants: Steel works discharge large volumes of water to lakes, rivers and streams, with additional volumes being vaporized while cooling coke or steel. Waste water retained in unsealed or leaking holding ponds can seep through and may contaminate the local water table and underground streams. These may also be contaminated by the leaching of rainwater through piles of raw materials or accumulations of solid wastes. According to (Andriesse, 2004). Contaminants include suspended solids, heavy metals and oils and greases. Temperature changes in natural waters due to discharge of higher temperature process water (70% of steel-making process water is used for cooling) may affect the ecosystems of these waters. Consequently, cooling treatment prior to discharge is essential and can be achieved through application of available technology.

Suspended Solids: Suspended solids (SS) are the main waterborne pollutants discharged during steel production. They comprise mainly iron oxides from scale formation during processing; coal, biological sludge, metallic hydroxides and other solids may also be present. These are largely non-toxic in aqueous environments at normal discharge levels. Their presence at higher levels may lead to discoloration of streams, de-oxygenation and silting.

Heavy Metals: Steel-making process water may contain high levels of zinc and manganese, while discharges from cold-rolling and coatings areas may contain zinc, cadmium, aluminum, copper and chromium. These metals are naturally present in the aquatic environment; it is their presence at higher than usual concentrations that create concern about potential effects on humans and the ecosystems (Haugen 2007). These concerns are increased by the fact that, unlike many organic pollutants, these heavy metals do not biodegrade to harmless end products and may become concentrated in sediments and in the tissues of fish and other aquatic life. Further, by being combined with other contaminants (e.g., ammonia, organic compounds, oils, cyanides, alkalis, solvents and acids), their potential toxicity may be increased.

Oils and Greases: Oils and greases may be present in waste water in both soluble and insoluble forms. Most heavy oils and greases are insoluble and are relatively easily removed. They may become emulsified, however, by contact with detergents or alkalis or by being agitated. Emulsified oils are routinely used as part of the process in cold mills. Except for causing discolouration of the water surface, small quantities of most aliphatic oil compounds are innocuous. Monohydric aromatic oil compounds, however, may be toxic. Further, oil components may contain such toxicants as PCBs, lead and other heavy metals (Albert, 2009). In addition to the question of toxicity, the biological and chemical oxygen demand (BOD and COD) of oils and other organic compounds can decrease the oxygen content of the water, thus affecting the viability of aquatic life.

Solid Wastes: Much of the solid waste produced in steel making is reusable. The process of producing coke, for example, gives rise to coal derivatives which are important raw materials for the chemical industry. Many by-products (e.g., coke dust) can be fed back into the production processes. Slag produced when the impurities present in coal and iron ore melt and combine with the lime used as a flux in smelting can be used in a number of ways: land fill for reclamation projects, in road building and as raw material for sintering plants that supply blast furnaces. Steel, regardless of grade, size, use or length of time in service, is completely recyclable and can be recycled repeatedly without any degradation of its mechanical, physical or metallurgical properties. The recycling rate is estimated to be 90%.

There are different types of pollutions in which the workers in iron and steel production are exposed to during the process of production in the working environment (OSHA, 1996). In iron and steel production, there are various units that perform different operations but are still working together to achieve production of iron and steel.

Pollution Management

Management is the organizational process that includes strategic planning, setting, objectives managing resources, deploying the human and financial assets needed to achieve some set objectives and managing result. According to Drucker (1972), this basic task of management includes marketing, innovation, accidents or injuries prevention in any production sector or organization.

The organization and coordination of the activities of a business in order to achieve define objective. Management is often included as a factor of production along with machine, material and money. According to Drucker (1909-2005), the basic tasks of management include both marketing innovation. Practice of modern management originate from the 16th century study of law efficiency failure of certain enterprises conducted by the English statement sir Thomas more (1478) management consist of interlocking function of creating cooperate policy and organizing, planning, controlling and directing an organization's resources in order to achieve the objective of that policy. This policy may be restricted to the workers in the organization alone or policy that will base on the rules and regulation established to check some fundamental bases being prevention of hazard or accident and injuries, the regulatory policy maker will also ensure quality assurance and quality standard of any production industry through good management. An example of this policy maker is the Environmental Management and Pollution Control Act

(EMPCA) established in 1994 to check some fundamental bases being the prevention, reduction and remediation of environmental harm. The clear focus of the Act is on preventing environmental harm from pollution and waste.

Safety and Health Measures in Iron and Steel Production

Safety Organization: Safety organization is of prime importance in the iron and steel production, where safety depends so much on workers' reaction to potential hazards and pollutions. The first responsibility for management is to provide the safest possible physical conditions, but it is usually necessary to obtain everyone's cooperation in safety programs. Accident-prevention committees, workers' safety delegates, safety incentives, competitions, suggestion schemes, slogans and warning notices can all play an important part in safety programmes. Involving all persons in site pollutions and hazard assessments, behaviour observation and feedback exercises can promote positive safety attitudes and focus work groups working to prevent injuries and illnesses. Accident statistics reveal danger areas and the need for additional physical protection as well as greater stress on housekeeping. The value of different types of protective clothing can be evaluated and the advantages can be communicated to the workers concerned (OSHA, 1997).

Training: Training should include information about pollutions and hazards, safe methods of work, avoidance of risks and the wearing of PPE. When new methods or processes are introduced, it may be necessary to retrain even those workers with long experience on older types of furnaces. According to Health and Safety Executive (HSE, 1995) Training and refresher courses for all levels of personnel are particularly valuable. They should familiarize personnel with safe working methods, unsafe acts to be proscribed, safety rules and the chief legal provisions associated with accident prevention. Training should be conducted by experts and should make use of effective audio-visual aids. Safety meetings or contacts should be held regularly for all persons to reinforce safety training and awareness.

Engineering and Administrative Measures: All dangerous parts of machinery and equipment, including lifts, conveyors, long travel shafts and gearing on overhead cranes, should be securely guarded. A regular system of inspection, examination and maintenance is necessary for all machinery and equipment of the plant, particularly for cranes, lifting tackle, chains and hooks. An effective lockout/tagout programme should be in operation for maintenance and repair. Defective tackle should be scrapped. Safe working loads should be clearly marked, and tackle not in use should be stored neatly. Means of access to overhead cranes should, where possible, be by stairway. If a vertical ladder must be used, it should be hooped at intervals. Effective arrangements should be made to limit the travel of overhead cranes when persons are at work in the vicinity. It may be necessary, as required by law in certain countries, to install appropriate switchgear on overhead cranes to prevent collisions if two or more cranes travel on the same runway. Locomotives, rails, wagons, buggies and couplings should be of good design and maintained in good repair, and an effective system of signalling and warning should be in operation. Riding on couplings or passing between wagons should be prohibited. No operation should be carried on in the track of rail equipment unless measures have been taken to restrict access or movement of equipment. Great care is needed in storing oxygen. Supplies to different parts of the works should be piped and clearly identified (Ohimain, 2013). All lances should be kept clean. There is a never-ending need for good housekeeping. Falls and stumbles caused by obstructed floors or implements and tools left lying carelessly can cause injury in themselves but can also throw a person against hot or molten material. All materials should be carefully stacked, and storage racks should be conveniently placed for tools. Spills of grease or oil should be immediately cleaned. Lighting of all parts of the shops and machine guards should be of a high standard.

Industrial Hygiene: Good general ventilation throughout the plant and local exhaust ventilation (LEV) wherever substantial quantities of dust and fumes are generated or gas may escape are necessary, together with the highest possible standards of cleanliness and housekeeping. Gas equipment must be regularly inspected and well maintained so as to prevent any gas leakage. Whenever any work is to be done in an environment likely to contain gas, carbon monoxide gas detectors should be used to ensure safety. When work in a dangerous area is unavoidable, self-contained or supplied-air respirators should be worn. Breathing-air cylinders should always be kept in readiness, and the operatives should be thoroughly trained in methods of operating them. With a view to improving the work environment, induced ventilation should be installed to supply cool air. Local blowers may be located to give individual relief, especially in hot working places. Heat protection can be provided by installing heat shields between workers and radiant heat sources, such as furnaces or hot metal, by installing water screens or air curtains in front of furnaces or by installing heat-proof wire screens. A suit and hood of heat-resistant material with air-line breathing apparatus gives the best protection to furnace workers. As work in the furnaces is extremely hot, cool-air lines may also be led into the suit. Fixed arrangements to allow cooling time before entry into the furnaces are also essential. Acclimatization leads to natural adjustment in the salt content of body sweat. The incidence of heat affections may be much lessened by adjustments of the workload and by well-spaced rest periods, especially if these are spent in a cool room, air- conditioned if necessary. As palliatives, a plentiful supply of water and other suitable beverages should be provided and there should be facilities for taking light meals (Salvi, 2006).

The temperature of cool drinks should not be too low and workers should be trained not to swallow too much cool liquid at a time; light meals are to be preferred during working hours. Salt replacement is needed for jobs involving profuse sweating and is best achieved by increasing salt intake with regular meals. In cold climates, care is required to prevent the ill-effects of prolonged exposure to cold or sudden and violent changes of temperature. Canteen, washing and sanitary facilities should preferably be close at hand. Washing facilities should include showers; changing rooms and lockers should be provided and maintained in a clean and sanitary condition. Wherever possible, sources of noise should be isolated. Remote central panels remove some operatives from the noisy areas; hearing protection should be required in the worst areas. In addition to enclosing noisy machinery with sound-absorbing material or protecting, the workers with sound-proofed shelters, hearing protection programs have been found to be effective means of controlling noise-induced hearing loss (svenson, 1991).

Personal Protective Equipment: All parts of the body are at risk in most operations, but the type of protective wear required will vary according to the location. Those working at furnaces need clothing that protects against burns-overalls of fire-resisting material, spats, boots, gloves, helmets with face shields or goggles against flying sparks and also against glare. Safety boots, safety glasses and hard hats are imperative in almost all occupations and gloves are widely necessary. The protective clothing needs to take account of the risks to health and comfort from excessive heat; for example a fire-resisting hood with wire mesh visor gives good protection against sparks and is resistant to heat; various synthetic fibres have also proved efficient in heat resistance (Miles, 2006). Strict supervision and continuous propaganda are necessary to ensure that personal protective equipment is worn and correctly maintained.

Ergonomics: The ergonomic approach (i.e. investigation of the worker-machine-environment relationship) is of particular importance at certain operations in the iron and steel industry. An appropriate ergonomic study is necessary not only to investigate conditions while a worker is carrying out various operations, but also to explore the impact of the environment on the worker and the functional design of the machinery used.

Medical Supervision: Pre-placement medical examinations are of great importance in selecting persons suitable for the arduous work in iron and steel making. For most work, a good physique is required: hypertension, heart diseases, obesity and chronic gastroenteritis disqualify individuals from work in hot surroundings. According to (Sklet, 2006) Special care is needed in the selection of crane drivers, both for physical and mental capacities. Medical supervision should pay particular attention to those exposed to heat stress; periodic chest examinations should be provided for those exposed to dust, and audiometric examinations for those exposed to noise; mobile equipment operator's should also receive periodic medical examinations to ensure their continued fitness for the job. Constant supervision of all resuscitative appliances is necessary, as is training of workers in first-aid revival procedure. A central first-aid station with the requisite medical equipment for emergency assistance should also be provided. If possible, there should be an ambulance for the transport of severely injured persons to the nearest hospital under the care of a qualified ambulance attendant. In larger plants first-aid stations or boxes should be located at several central points.

Pollution Control and Prevention: Where technically and economically feasible, direct reduction of iron ore for the manufacture of iron and steel is preferred because it does not require coke manufacturing and has fewer environmental impacts. Wherever feasible, pelletizing should be given preferences over sintering for the agglomeration of iron ore (Alafara, 2005). The following pollution prevention measures should be considered.

Pig Iron Manufacturing

Improve blast furnace efficiency by using coal and other fuels (such as oil or gas) for heating instead of coke, thereby minimizing air emissions.

Recover the thermal energy in the gas from the blast furnace before using it as a fuel. Increase fuel efficiency and reduce emissions by improving blast furnace charge distribution.

Improve productivity by screening the charge and using better tap hole practices.

Reduce dust emissions at furnaces by covering iron runners when tapping the blast furnace and by using nitrogen blankets during tapping.

Use pneumatic transport, enclosed conveyor belts, or self-closing conveyor belts, as well as wind barriers and other dust suppression measures, to reduce the formation of fugitive dust.

Use low- NO burners to reduce NOx emissions from burning fuel in ancillary operations.

Recycle iron-rich materials such as iron ore fines, pollution control dust, and scale in a sinter plant.

Recover energy from sinter coolers and exhaust gases.

Use dry SOx removal systems such as carbon absorption for sinter plants or lime spraying in flue gases.

Steel Manufacturing: According to (Williams 2002). Use dry dust collection and removal systems to avoid the generation of wastewater. Recycle collected dust.

Use BOF gas as fuel.

Use enclosures for BOF.

Use a continuous process for casting steel to reduce energy consumption.

Others

Use blast furnace slag in construction materials.

Slag containing free lime can be used in iron making.

Target Pollution Loads: The recommended pollution prevention and control measures can achieve the following target levels.

Liquid Effluents: Over 90% of the wastewater generated can be reused. Discharged wastewaters should in all cases be less than 5 m3/t of steel manufactured and preferably less than 1 m3/t.

Solid Wastes: Blast furnace slag should normally be generated at a rate of less than 320 kg/t of iron, with a target of 180 kg/t. The generation rate, however, depends on the impurities in the feed materials. Slag generation rates from the BOF should be between 50 and 120 kg/t of steel manufactured, but this will depend on the impurity content of feed materials. Zinc recovery may be feasible for collected dust (Ohimain, 2013).

Treatment Technologies

a. Air Emissions

Air emission control technologies for the removal of particulate matter include scrubbers (or semidry systems), bag houses, and electrostatic precipitators (ESPs). The latter two technologies can achieve 99.9% removal efficiencies for par Iron and Steel Manufacturing 329 particulate matter and the associated toxic metals: chromium (0.8 milligrams per normal cubic meter, mg/Nm3), cadmium (0.08 mg/Nm3), lead (0.02 mg/Nm3), and nickel (0.3 mg/Nm3). Sulfur oxides are removed in desulfurization plants, with a 90% or better removal efficiency. However, the use of low-sulfur fuels and ores may be more cost-effective. The acceptable levels of nitrogen oxides can be achieved by using low-NOx burners and other combustion modifications. For iron and steel manufacturing, the emissions levels presented in Table 1 should be achieved.

b. Wastewater Treatment

Wastewater treatment systems typically include sedimentation to remove suspended solids, physical or chemical treatment such as pH adjustment to precipitate heavy metals, and filtration. The target levels can be achieved for steel-making processes.

Solid Waste Treatment.

Solid wastes containing heavy metals may have to be stabilized, using chemical agents, before disposal.

c. Emissions Guidelines

Emissions levels for the design and operation of each project must be established through the environmental assessment (EA) process on the basis of country legislation and the Pollution Prevention and Abatement Handbook, as applied to local conditions. The emissions levels selected must be justified in the EA and acceptable to the production group Al-Shuibi, 1991).

Summary of Related Literature

The review of related literature revealed that effective management of pollution in iron and steel company with respect to iron and steel production, pollution in iron and steel production, pollution management, safety and health measure in iron and steel, pollution control and prevention in iron and steel production.

It was revealed that the production of steel at an integrated iron and steel plant is accomplished using several interrelated processes. The major operations are; coke production, sinter production, iron production, iron preparation, steel production, semi-finished product preparation, finished product preparation, heat and electricity supply. Pollution is typically referred to excessive amount of waste, much of which contain harmful poison that are released in to the environment air, water and soil which possess a level of threat to life, properties and environment. Management consist of interlocking function of creating cooperate policy and organizing, planning, controlling and directing an organization's resources in order to achieve the objective of that policy. This policy may be restricted to the workers in the organization alone or policy that will base on the rules and regulation established to check some fundamental bases being prevention of hazard or accident and injuries. Safety organization is of prime importance in the iron and steel production, where safety depends so much on workers' reaction to potential hazards and pollutions. The first responsibility for management is to provide the safest possible physical conditions. Pollution control and prevention is a systematic way to maximize or eliminate pollutions which can be achieve by given preferences to feasible and pelletizing or direct reduction of iron ore over sintering for the agglomeration of iron ore in iron and steel production.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

This chapter describes the methods adopted in carrying out the study. Thus; research design, area of the study, population, sample and sampling techniques, instrument for data collection, validation of instrument, administration of instrument, method of data analysis and decision rule.

3.1 Research Design

The study adopted survey research design; survey research design according to Nworgu (2006) is one in which a group of people or items are study by collecting and analyzing data through the use of questionnaire. The survey research design is considered appropriate according to Nworgu (2006) because the study involves the collection of data from group of respondents. This study sought the opinions of craftsmen and technicians for strategies for effective management of pollutions in Ajaokuta iron and steel company, Kogi State

3.2 Area of the Study

The study was carried out in Ajaokuta Iron and Steel Company, kogi state. The company was selected due to the production of iron and steel and of course it is a major iron and steel company in Nigeria.

3.3 Population of the Study

The population for this study comprises of craftsmen and technicians in the various units of Ajaokuta Iron and Steel Company. Due to the shifting arrangement of the workers, the available workers were used as respondents. The total population used for this study was 172 which consisted 97 craftsmen and 75 technicians.

3.5 Sample and Sampling Techniques

Due to the relatively small size population there was no need for sampling.

3.4 Instrument for data collection

Questionnaire was developed by the researcher based on the research question and purpose of study. The questionnaire was made of fifty (50) items divided in to three (3) sections. Each section sought for data to answer related research questions. These sections are:

Section "A" contains eighteen (18) items under the research question: What are the causes of pollution in iron and steel production?

Section "B" contains sixteen (16) items under the research question: What are the effects of pollution in iron and steel production?

Section "C" contains sixteen (16) items under the research question: What are the strategies to be adopted to increase health and safety awareness among workers and its environment in iron and steel production?

Four point rating scale was used as stated: Strongly Agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2, Strongly Disagree (SD) = 1.

3.5 Validation of the Instrument

The instrument was validated by three (3) experts in the department of Industrial and Technology Education, Federal University of Technology, Minna, and two industrial supervisor. The corrections and suggestions provided were effected on the final draft of the questionnaire.

3.6 Administration of Instrument

The instrument for this study was administered to the respondents by the researcher, and the craftsmen, technicians in the area of study were approached for assistance. This procedure assisted in the high percentage of the return rate of instruments.

3.7 Method of Data Analysis

During data analysis for this study, the researcher computes the mean, standard deviation of each items, and t – test were all used to test for the hypothesis at 0.05 level of significant. Mean was used to answer the research question item by item while z-test of individual items were obtained using mean, standard deviation and degree of freedom.

3.8 Decision Rule

To determine the acceptance a mean score of 2.50 was chosen as the decision point between agree and disagree. Any response or item with a mean of 2.50 and above was considered agree while response below 2.50 was considered disagree. Also an inferential statistic t– test was used to test the hypothesis at 0.05 level of significant to compare the mean response of the two group. A t– test value of ± 1.96 was based on the 170 degree of freedom at 0.05 level of significant. Therefore, any item with t–test value less than t– critical was regarded as accepted or not significant (NS). While any item with t – test calculated value greater than or equal to were regarded as rejected or significant (S).

CHAPTER FOUR

4.0 PRESENTATION AND ANALYSIS OF DATA

This chapter presents the analysis of data based on the three (3) research question and three (3) hypotheses that were formulated for the study.

Research Question 1

What are the causes of pollutions in iron and steel production?

Data answering this research question is presented in table 1.

Table 1:

Mean responses of respondents on the causes of pollutions in iron and steel production.

N_1= 97, N_2 = 75=172

S/N	ITEMS	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_t$	REMARK
1	excessive burning of fuel and gases	3.66	3.85	3.76	Agreed
2	Desulphurization between the blast furnace and the oxygen furnace	3.72	3.68	370	Agreed
3	Dust emission from sintering operation	3.86	3.60	3.73	Agreed
4	Lumping of iron ore using coke and limestone in the blast furnace	3.80	3.84	3.82	Agreed
5	Conversion of iron in to steel in the blast furnace composition	3.78	3.65	3.55	Agreed
6	Emission of chemical composition within the working environment	3.63	3.92	3.57	Agreed
7	Operation of heavy machine	3.72	3.79	3.76	Agreed
8	Excessive heat from the plants	3.56	3.53	3.55	Agreed
9	Poor management of waste during production	3.59	3.83	3.71	Agreed
10	Non- and compliance of environmental laws and regulation	3.65	3.51	3.58	Agreed
11	Emission of greenhouse gases	3.67	3.56	3.62	Agreed
12	Lack of proper safety orientation in iron and steel production	3.69	3.81	3.75	Agreed
13	Inadequate illumination and ventilation	3.65	3.49	3.40	Agreed
14	Unavailability of personal protective equipment	3.51	3.52	3.51	Agreed
15	Improper posture	3.52	3.53	3.52	Agreed
16	Lack of awareness of industrial safety among co- workers	3.53	3.49	3.51	Agreed
17	Lack of adequate supervision by industrial supervisor	3.47	3.75	3.61	Agreed
18	pig iron emission from blast furnace	3.56	3.48	3.51	Agreed

Key:

N_1= Number of Craftsmen

N_2 = Number of Technicians

$\bar{X}_1$ **=** means response of craftsmen

$\bar{X}_2$ = means response of technicians

$\bar{X}_t$ = Average mean of both craftsmen and technicians

d.f = Degree of freedom, thus $(N_1 + N_2) - 2$

Table 1 indicates that both respondents agreed with all items with mean above 2.50. While non-disagreed with mean score below 2.50.

Research Question 2

What are the effects of pollutions in iron and steel production?

Data answering this research question is presented in Table 2.

Table 2:
Mean responses of respondents on the effects of pollutions in iron and steel production.

$N_1 = 97, N_2 = 75 = 172$

S/N	ITEM	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_t$	REMARK
19	weakness of the body and fatigue	3.78	3.81	3.40	Agreed
	Global warming	3.68	3.64	3.66	Agreed
21.	Contamination of rain water through piles of raw materials or solid waste	3.49	3.42	3.46	Agreed
22	Infertile soil	3.42	3.49	3.46	Agreed
23	Environmental degradation	3.73	3.83	3.78	Agreed
24	Respiratory problems: asthma, lung and cancer disease	3.89	3.63	3.76	Agreed
25	Depletion of ozone layer	3.80	3.77	3.79	Agreed
26	Skin irritation and rashes	3.72	3.65	3.69	Agreed
27	Acid rain	3.82	3.75	3.79	Agreed
28	Mental confusion	3.77	3.57	3.67	Agreed
29	Ear problem	3.44	3.53	3.49	Agreed
30	Emotional instability and hearing damage	3.70	3.73	3.72	Agreed
31	Depression and blindness	3.68	3.76	3.72	Agreed
32	Loss of biodiversity	3.86	3.68	3.77	Agreed
33	Psychopathic and stress in job satisfaction	3.72	3.52	3.62	Agreed
34.	temperature changes in natural water due to discharge of higher temperature process water	3.69	3.72	3.71	Agreed

Table 2 indicates that both respondents agreed with all items with mean above 2.50. While non-disagreed with mean score below 2.50.

Research Question 3

What are the strategies to be adopted for increasing health and safety awareness among workers and its environment?

Data for answering this research question is presented in the Table 3.

Table 3
Mean responses of respondents on the strategies to be adopted for increasing health and safety awareness among workers and its environment

N_1 = 97, N_2 =75=172

S/N	ITEMS	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_t$	REMARK
35.	Adopt the use of material safety data sheet to prevent the workers from the effects of pollution	3.72	3.79	3.76	Agreed
36.	regular ergonomics study to explore the impact of working environment to the workers	3.72	3.63	3.67	Agreed
37.	Training of the workers on the effect of pollutions to life and the environment	3.80	3.77	3.79	Agreed
38.	The use of personal protective equipment to curb harm from pollution	3.68	3.71	3.69	Agreed
39	Provision of safest possible physical condition	3.59	3.59	3.59	Agreed
40	implementation and practice of environmental laws and regulation	3.81	3.85	3.83	Agreed
41	Proper planning and management of industrial materials	3.82	3.75	3.79	Agreed
42	Risk assessment and control iron and steel production	3.76	3.64	3.70	Agreed
43	Reduction and remediation of industrial harm	3.72	3.47	3.59	Agreed
44	Installation of sensitive radiation detector to screen all purchased steel scraps	3.59	3.49	3.54	Agreed
45	Pathway along which sound energy travel	3.59	3.72	3.65	Agreed
46.	Refuse bins with cover should be provided at strategic position in the iron and steel production	3.82	3.71	3.77	Agreed
47	recycling of waste industrial product	3.66	3.57	3.62	Agreed
48.	Adequate compliance monitoring should be given to the workers in the iron and steel production	3.70	3.71	3.70	Agreed
49.	standard iron and steel production company should be erected in an industrial area far from residential building	3.62	3.61	3.62	Agreed
50.	Safety poster with understandable code of pollution causes should be made available in iron and steel company	3.57	3.73	3.65	Agreed

Table 3 revealed that both respondents agreed with all items with the mean score above 2.50. While none disagreed with mean score below 2.50

Hypothesis 1

There is no significant difference between the mean responses of craftsmen and technicians on the causes of pollution in iron and steel production.

Table 4:

z-test Analysis of the respondents on the causes of pollutions in iron and steel production

N_1= 97, N_2 75=172

S/N	ITEMS	$\bar{X}_1$	$\bar{X}_2$	S.D₁	S.D₂	z-cal	REMARK
1	excessive burning of fuel and gases	3.66	3.85	0.48	0.35	-3.02	NS
2	Desulphurization between the blast furnace and the oxygen furnace	3.72	3.68	0.45	0.47	0.57	NS
3	Dust emission from sintering operation	3.86	3.60	0.35	0.49	0.90	NS
4	Lumping of iron ore using coke and limestone in the blast furnace	3.80	3.84	0.40	0.37	-0.67	NS
5	Conversion of iron in to steel in the blast furnace composition	3.78	3.65	0.41	0.48	1.87	NS
6	Emission of chemical composition within the working environment	3.63	3.92	0.49	0.50	1.43	NS
7	Operation of heavy machine	3.72	3.79	0.45	0.41	-1.06	NS
8	Excessive heat from the plants	3.56	3.53	0.50	0.50	0.30	NS
9	Poor management of waste during production	3.59	3.83	0.49	0.39	-3.59	NS
10	Non- and compliance of environmental laws and regulation	3.65	3.51	0.41	0.50	1.88	NS
11	Emission of greenhouse gases	3.67	3.56	0.47	0.50	1.47	NS
12	Lack of proper safety orientation in iron and steel production	3.69	3.81	0.47	0.50	-1.81	NS
13	Inadequate illumination and ventilation	3.65	3.49	0.49	0.49	0.28	NS
14	Unavailability of personal protective equipment	3.51	3.52	0.50	0.50	-0.19	NS
15	Improper posture	3.52	3.53	0.50	0.50	-0.23	NS

16	Lack of awareness of industrial safety among co-workers	3.53	3.49	0.50	0.50	0.55	NS
17	Lack of adequate supervision by industrial supervisor	3.47	3.75	0.50	0.44	-3.92	NS
18	pig iron emission from blast furnace	3.56	3.48	0.50	0.50	0.99	NS

Key:

N_1= Number of Craftsmen, N_2 = Number Technicians
SD_1 = Standard deviation of Craftsmen, SD_2 = Standard deviation of Technicians
NS = Not Significant, S = Significan
The result shown in the Table 4 indicates the comparism between the craftsmen and the technicians. Data revealed that all the items in this category has a calculated z- value less than the z-critical value of ($\pm$ 1.96), hence the null hypothesis for these items were upheld at 0.05 level of significance.

Hypothesis 2

There is no significant difference between the mean responses of craftsmen and technicians on the effects of pollution in iron and steel production.

Table 5:

z-test Analysis of the respondents on the effects of pollutions in iron and steel production.

N_1 = 97, N_2 = 75 =172

S/N	ITEMS	$\bar{X}_1$	$\bar{X}_2$	S.D₁	S.D₂	z-cal	REMARK
19	weakness of the body and fatigue	3.78	3.81	0.41	0.39	-0.48	NS
20	Global warming	3.68	3.64	0.47	0.48	0.55	NS
21.	Contamination of rain water through piles of raw materials or solid waste	3.49	3.42	0.50	0.49	0.89	NS
22	Infertile soil	3.42	3.49	0.50	0.50	-0.92	NS
23	Environmental degradation	3.73	3.83	0.45	0.38	-1.59	NS
24	Respiratory problems: asthma, lung and cancer disease	3.89	3.63	0.32	0.49	4.01	S
25	Depletion of ozone layer	3.80	3.77	0.40	0.24	0.49	NS
26	Skin irritation and rashes	3.72	3.65	0.45	0.50	0.95	NS
27	Acid rain	3.82	3.75	0.38	0.44	1.23	NS
28	Mental confusion	3.77	3.57	0.42	0.50	2.97	S
29	Ear problem	3.44	3.53	0.49	0.50	-1.17	NS
30	Emotional instability and hearing damage	3.70	3.73	0.46	0.45	-0.47	NS

31	Depression and blindness	3.68	3.76	0.47	0.43	-1.16	NS
32	Loss of biodiversity	3.86	3.68	0.35	0.47	2.70	S
33	Psychopathic and stress in job satisfaction	3.72	3.52	0.45	0.50	2.73	S
34.	temperature changes in natural water due to discharge of higher temperature process water	3.69	3.72	0.46	0.45	-0.42	NS

The result shown in the Table 5 indicates the comparism between the craftsmen and technicians. The analysis revealed that items 19, 20, 21, 22, 23, 25, 26, 27, 29, 30, 31 and 34 have a calculated t-value less than t-critical value ± 1.96, hence null hypothesis for these items were upheld at 0.05 level of significance. Except for items 24, 28, 32 and 33 that have a z-calculated value above the t-critical value ± 1.96, thus Ho_2 was rejected for this item.

Hypothesis 3

There is no significant difference between the mean responses of craftsmen and technicians on the strategies to be adopted for increasing safety awareness among workers and its environments.

Table 6
z-test Analysis of the respondents on the mean responses of respondents on the strategies to be adopted for increasing health and safety awareness among workers and its environment

N_1=97, N_2=75=172

S/N	ITEMS	$\bar{X}_1$	$\bar{X}_2$	$S.D_1$	$S.D_2$	z-cal	REMARK
35.	Adopt the use of material safety data sheet to prevent the workers from the effects of pollution	3.72	3.79	0.45	0.41	-1.06	NS
36.	regular ergonomics study to explore the impact of working environment to the workers	3.72	3.63	0.45	0.49	1.31	NS
37.	Training of the workers on the effect of pollutions to life and the environment	3.80	3.77	0.40	0.42	0.49	NS
38.	The use of personal protective equipment to curb harm from pollution	3.68	3.71	0.47	0.46	-0.37	NS
39	Provision of safest possible physical condition	3.59	3.59	0.50	0.56	0.01	NS
40	implementation and practice of environmental laws and regulation	3.81	3.85	0.40	0.36	-0.68	NS
41	Proper planning and management of industrial materials	3.82	3.75	0.38	0.44	1.23	NS
42	Risk assessment and control iron and steel	3.76	3.64	0.43	0.48	1.74	NS

	production						
43	Reduction and remediation of industrial harm	3.72	3.47	0.49	0.50	1.23	NS
44	Installation of sensitive radiation detector to screen all purchased steel scraps	3.59	3.49	0.46	0.43	-0.86	NS
45	Pathway along which sound energy travel	3.59	3.72	0.50	0.45	-1.83	NS
46.	Refuse bins with cover should be provided at strategic position in the iron and steel production	3.82	3.71	0.38	0.46	1.80	NS
47	recycling of waste industrial product	3.66	3.57	0.48	0.50	1.15	NS
48.	Adequate compliance monitoring should be given to the workers in the iron and steel production	3.70	3.71	0.46	0.46	-0.22	NS
49.	standard iron and steel production company should be erected in an industrial area far from residential building	3.62	3.61	0.49	0.49	0.07	NS
50.	Safety poster with understandable code of pollution causes should be made available in iron and steel company	3.57	3.73	0.50	0.45	-2.31	NS

The result shown in the Table 6 indicates the comparism between the craftsmen and the technicians. The analysis revealed that all the items in this category has a calculated z- value less than the t-critical value of ± 1.96, hence the null hypothesis for these items were upheld at 0.05 level of significance.

Findings of the study

The following were the findings of this study.

Findings related to the causes of pollutions in iron and steel production.

The findings on the causes of pollution in iron and steel production between the craftsmen and technicians revealed that pollution in iron and steel production are caused by:

1. Excessive burning of fuel and gases, emits pollution

2. Emission of both chemical composition and greenhouse gases generates pollution
3. Poor management of waste during production emits pollution and Non- compliance with environmental laws and regulation
4. Lack of proper safety orientation and supervision in iron and steel production pose pollution threat to life and properties

Findings related to the effects of pollution in iron and steel production.

The findings on the effects of pollution in iron and steel production between the craftsmen and technicians revealed that pollution in iron and steel production are effected by:

1. Exposure to pollution result to skin irritation, rashes, emotional instability and hearing damage
2. Pollution led to mental confusion and blindness
3. Global warming and depletion of ozone layer is as a result of pollution
4. Pollution contaminates rain water through piles of raw materials and solid waste

Findings related to the strategies to be adopted for increasing health and safety awareness among workers and its environment.

The findings on strategies to be adopted for increasing health and safety awareness among workers and its environment in iron and steel production between the craftsmen and technicians revealed that health and safety of the workers and it environment can be achieve by:

1. Adoption of the use of material safety data sheet and Provision for recycling industrial waste product will minimize pollution threat to both workers and the environment.

2. Refuse bins with cover should be provided at strategic position in the iron and steel production
3. Adequate training and compliance monitoring should be given to workers in the production of iron and steel
4. Environmental laws and regulations should be implemented and practice

Discussion of findings

Findings on causes of pollution in iron and steel production indicate that one major causes of pollution is excessive burning of fuel and gas. This is in line with findings of Rawling jack (2005). Which revealed that decomposition of chemical and greenhouse gases emit radiation that result to pollution? Okoro (1993) pointed out that lack of safety orientation in production industry lead to industrial harm. He further said, the worker should be properly trained on pollution identification and management that can pose a level of threat to life and properties in the environment. In view of these there is no significant difference in the mean response of craftsmen and technicians on the causes of pollution in iron and steel production.

The findings of the study on effects of pollution in iron and steel production indicates that health and environmental effects cause by pollution are skin irritation and rashes, emotional instability and hearing damage, depression and blindness are all posed to workers during operation. It was also revealed that pollution results to global warming, depletion of ozone layer, and it contaminates rain water through pile of rain water and solid waste .

According to Albert (2009), exposure to pollution can be classified in to acute effect and chronic effects. The acute effect refers to those effects that occur immediately such as eye, nose, and throat irritation. While the chronic effects are those effects that take long time before it's appear on human health such as the respiratory tract. Exposure to chemical emission can result to emphysema effects that affect the lung resulting to abnormal breathing; Fact sheet No 1 (2002). There is no significant difference in the mean response of craftsmen and technicians on the effect of pollution in iron and steel production.

The findings on the strategies to be adopted for increasing health and safety awareness among workers and its environment indicated that health and safety awareness of the workers in iron and steel production can be increased by adopting safety data sheet to prevent workers from the danger of pollution. Regular ergonomics study to explore the impact of the working environment and provision of safest possible physical condition to the workers. It also revealed that refuse with cover should be provided at strategic position in iron and steel production.

Conclusively, the findings under this study revealed that implementation and practice of environmental laws and regulations as well as risk assessment and control in iron and steel production will reduce and curb the level of threat posed by pollution. Another strategic measure for increasing health and safety awareness is by erecting a standard iron and steel production industry far from residential building. There is no significant different between the main response of craftsmen and technicians on the strategies to be adopted for increasing health and safety awareness among workers and its environment.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 Summary of the Study

The purpose of this study is to determine the strategies for effective management of pollutions emitted during operation in iron and steel production, related literature were reviewed in the study under the following sub heading headings: impacts of iron and steel in the economy of a nation, pollutions in iron and steel production, causes and effects of pollutions as well as the symptoms illness developed from pollution; types of pollution that possess threat to life and the environment and the strategies to be adopted for ensuring health and safety awareness of workers and its environment in iron and steel production. Statistical tools such as mean, standard deviation and z-test were used to analyze the data of the respondents: craftsmen and technicians. Questionnaire of Fifty (50) items was used as instrument for data collection and was analyzed according to each of the research questions.

A survey research design was used in carrying out the study. Three research questions ware formulated for the specific purpose of guiding the study, while the hypotheses were tested at 0.05 level of significance. However, the study revealed that when expose to pollutions the eyes, nose, skin and throat will be affected and long-term exposure to pollutions can also result to cancer, kidney and lung problem. The study revealed that pollution contaminates water and destroy soil which also leads to depletion of ozone layer and environmental degradation.

The major contributing factors that cause pollution are excessive burning of fuel and gases, emission of radiation within the thermal infrared, exposing industrial waste product among other. However, some preventives measures have been discovered to curb or reduce its effects on life and the environment. The safety measures include: recycling of industrial waste product, use of personal protective equipment, providing refuse bins with covers at strategic position, installation of sensitive radiation detector and implementation and practices of environmental laws and regulations.

5.2 Implication of the Study

The findings of this study have a lot of implication for workers in iron and steel production, manufacturing industries, and the entire public by creating awareness to them on the threat that can result from exposure of pollutions. From these findings, it could be deduced that the possible ways of reducing pollution in iron and steel production ought to be adhered to, in order to provide as far as possible healthy and safe environment for all the workers. This implies that most of the harm and injuries that occur in iron and steel production are simply due to poor pollution management and once the pollution is identified and evaluates the rate of harm and injuries will be reducing to the minimum level. The findings will also benefits Occupational Safety and Health Act (OSHA), Environmental Protection Act (EPA), and other concerned bodies or institutions to perform their duty by circulating the information worldwide, through publications, GSM, poster and workshops.

5.3 Contribution to Knowledge

The study contributed to knowledge by establishing the causes of pollution in iron and steel production. It also establishes the effects of pollution in iron and steel production. It also establishes the strategies to be adopted to increase health and safety awareness among workers and its environment in iron and steel production

5.4 Conclusion

Based on the findings of this study, it was discovered that lack of pollutions identification is one of the major causes of pollutions which also posed threat to life of workers in iron and steel production. It is clear and precise that human and the environment can be affected from exposure to pollutions by developing these short term effects: chest soreness, eye infection, nose, and skin and throat irritation. Long- term exposure can also pose hazardous threats that include kidney, cancer and lung disease. The findings also revealed some environmental effects caused by pollution such as global warming, ozone layer depletion and environmental degradation.

Conclusively, if pollution is identified and properly managed, there will be reduction on the toxic effects and threat posed to workers and the environment in Ajaokuta iron and steel company and the society at large.

5.5 Recommendations

Based on the findings of this study, it is recommended that:

1. The management of iron and steel production company should provide workers with personal protective equipment and installation of sensitive radiation detector to screen all necessary steel scrap and thermal infrared.
2. The industrial supervisor should ensure adequate compliance monitoring and regular Training of workers on the causes of pollution and the danger its pose on life and properties in the environment.
3. The government and the policy maker should ensure implementation and practice of environmental laws and regulation.

4. The regulatory body should ensure that standard iron and steel production company are erected in an industrial area far from residential building.
5. Recycling of industrial waste products to reduce accumulation of waste in the environment and provision for pathway along which sound energy travels.
6. The management of iron and steel production company should provide refuse bins with cover at strategic position.
7. The management should adopt the use of material data sheet to prevent the workers from the effect of pollution.

5.6 Suggestion for Further Study

The suggested further study for this research work can be earned out and should involve:

1. Strategies for effective implementation of safety law guiding iron and steel production industry in Nigeria.
2. Mechanism for effective management for pollutions in cement factories in Northern Nigeria.
3. Investigation in to the implementation of health and safety measures in production industries in Federal Capital Territory, Abuja.

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FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA. NIGER STATE

SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION

QUESTIONNAIRE ON EFFECTIVE MANAGEMENT OF POLLUTION IN IRON AND STEEL COMPANY, AJAOKUTA, KOGI STATE.

PART ONE

INTRODUCTION: please kindly complete this questionnaire by ticking (√) the column that best represent your perception about the items. The questionnaire is for research purpose and your view will be confidentially and strictly treated for the purpose of this research work only.

Respond options are: Strongly Agree = SA, Agree = A, Disagree =D, Strongly Disagree = SD

STATUS

CRAFTSMAN ☐

TECHNICIAN ☐

SECTION A

Research Question one

What are the causes of pollutions in iron and steel production?

S/N	ITEMS	SA	A	D	SD
1	Excessive burning of fuel and gases				
2	Desulphurization between the blast furnace and the basic oxygen furnace (BOF)				
3	Dust emission from sintering operation				
4	Lumping of iron ore using coke and limestone in a blast furnace				
5	Conversion of iron in to steel in the blast furnace composition				
6	Emission of chemical composition within working environment.				
7	Operation of heavy machines				
8	Excessive heat from the plants.				
9	Poor management of waste during production				
10	Non- compliance of environmental laws and regulations				
11	Emission of greenhouse gases.				
12	Lack of proper Safety orientation in iron steel production				

13	Inadequate illumination and ventilation.				
14	Unavailability of personal protective equipment.				
15	Improper posture when welding				
16	Lack of awareness of Industrial safety among co-workers.				
17	Lack of adequate supervision by the industrial supervisors.				
18	Pig iron emission from blast furnace				

SECTION B

Research Question Two

What are the effects of pollutions in iron and steel production?

S/N	ITEMS	SA	A	D	SD
19	Weakness of the body and fatigue				
20	Global warming				
21	Contamination of rain water through piles of raw materials or solid waste.				
22	Infertile soil				
23	Environmental degradation				
24	Respiratory problems: asthma, lung and cancer disease				
25	Depletion of ozone layer				

26	Skin irritation and rashes.				
27	Acid rain				
28	Mental confusion				
29	Ear problem				
30	Emotional instability and hearing damage				
31	Depression and blindness				
32	Loss of biodiversity				
33	Psychopathic distortion and stress in job satisfaction				
34	Temperature changes in natural waters due to discharge of higher temperature process water (70% of steel making process water is used for cooking) may affect the ecosystem of this water.				

SECTION C

Research Question Three

What are the strategies to be adopted for increasing health and safety awareness among workers and its environment in iron steel production

S/N	ITEMS	SA	A	D	SD
35	Adopt the use of material safety data sheet to prevent the workers from the effect of pollution				
36	Regular ergonomics study to explore the impact of the working environment to the workers.				
37	Training of the workers on the effect of pollution to life and the environment.				
38	The use of personal protective equipment to curb harm from pollution.				
39	Provision of safest possible physical condition.				
40	Implementation and practices of environmental laws and regulation.				
41	Proper planning and management of industrials materials				

42	Risk assessment and control in the iron and steel production				
43	Reduction and remediation of industrial harm.				
44	Installation of sensitive radiation detector to screen all purchased steel scrap.				
45	Pathway along which sound energy travels.				
46	Refuse bins with covers should be provided at strategic positions in the iron and steel production.				
47	Recycling of waste industrial product.				
48	Adequate compliance monitoring should be given to the workers in the iron and steel production.				
49	Standard iron and steel production company should be erected in an industrial area far from residential building.				
50	Safety poster with understandable code of pollution causes should be made available in the iron and steel company.				