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SCRAP METAL MANAGEMENT PRACTICES IN THE KUMASI SUAME MAGAZINE INDUSTRIAL AREA OF THE ASHANTI REGION OF GHANA: CHALLENGES AND PROSPECTS

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AUGUST, 2017

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BY

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AUGUST, 2017

DECLARATION

STUDENT'S DECLARATION

I, FORKOR NANJO PETER, declare that this project work, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: ....………………………………………………………

DATE: …………………...

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of project work as laid down by the University of Education, Winneba.

SIGNATURE: ....……………………………………………………….

DATE :…………………...

NAME OF SUPERVISOR: MR. C. K. NWORU

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I wish to express my profound appreciation to God Almighty for giving me life, strength and good health to undergo this study. I also want to thank my project supervisor Mr. Chibuzo Kenneth Nworu for his patience, useful suggestions and corrections to positively shape this work. I am deeply grateful to my family, friends and colleagues for being there for me and supporting me in my studies.

DEDICATION

I dedicate this work to my family especially my late grandmother Kapiri Bawine, my mother Ajaro Bawine, my sister in-law Damata Yakubu, my wife Mrs Muniratu Yakubu Bawine and my lovely sons Ziyad Nanjo Banwine and Nazir Nanjo Bawire.

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ABSTRACT

This study was conducted in the Kumasi Metropolis to assess the scrap metal management practices in the Suame Magazine industrial area. Today with increasing public awareness and research into the many environmental implications, metals recycling is now of paramount importance due to a number of reasons. The study sought to determine the economic profitability of scrap metal trade in the Metropolis, assess the challenges faced by scrap metal dealers in the collection, sorting and smelter of scrap metals in their operations and determine the innovative ways of managing scrap metal in the Kumasi Metropolis. The study employed the descriptive research design in the form of a survey. The population for the study consisted of all scrap metal collectors (SMCs) and all scrap dealers (SDs) in the Suame Magazine industrial area. A total of 25 participants were sampled for the study using snowballing technique. The main instrument used for data collection was questionnaire. From the data analysis it was revealed that even though the activity of scrap metal dealing was beneficial, it was not mechanically useful to those engaged in it, especially the scrap metal collectors. It became evident that challenges such as lack of access to funding, no government regulations, no specialised equipment to help in sorting and separating scrap, the risk of injury during collection of scrap and the inherently tedious nature of scrap collection and separation plagued the scrap metal trade. Additionally, in order to improve the scrap metal business, stakeholders should provide safety equipment for scrap metal collectors, employ technology and modern equipment in the collection and separation of scrap, form associations to fight for their interests and government support, and provide education and technical know-how for SMC and SD to improve their trade. The study recommends that a holistic approach should be put in place where all stakeholders will help to streamline and standardise the scrap metal trade.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Metals are uniquely useful materials by virtue of their fracture toughness, thermal and electrical conductivity, and performance at high temperatures, among other properties. For these reasons, they are used in a wide range of applications in areas such as machinery, energy, transportation, building and construction, information technology, and appliances (Graedel, Allwood, Birat, Buchert & Hageluken, 2011). Additionally, of the various resources seeing wide use in modern technology, metals are different from other materials in that they are inherently recyclable. This means that, in theory, they can be used over and over again, which minimizes the need to mine and process virgin materials and thus saves substantial amounts of energy and water while limiting environmental degradation in the process (Sibley, 2004).

Scrap metals originate both in business and residential environments. Typically, a ‘scrapper’ will advertise their services to conveniently remove scrap metal from people who don’t need it. Scrap is often taken to a wrecking yard, also known as a scrapyard, junkyard or breaker’s yard, where it is processed for later melting into new products (Dubreuil, et al., 2010). Scrap consists of recyclable materials left over from product manufacturing and consumption such as parts of vehicles, building supplies and surplus materials. Unlike waste, scrap has monetary value, especially recovered metals. The recycling of metals is widely viewed as a fruitful sustainability strategy, but little information is available on the degree to which recycling is actually taking place (Graedel, *et al.*, 2011).

According to Reck and Gordon, (2008), scrap can be defined as residue or leftover material after the preparation or manufacturing process. It can also be defined as the waste, used or surplus materials or parts arising out of the manufacturing process or other activities. For example, steel, nonferrous turnips, after scrap metal, rejected components and obsolete machinery, among others.

The occurrence of scrap in the manufacturing industry and usage due to breakdown is inevitable and for that matter, there is the need for a concerted effort to pay attention to the management of scrap (Sibley & Butterman, 1995). It is rather unfortunate that many people do not realise that revenue can be generated from scraps if they are managed properly. The general perception is that scraps are waste materials which are of no practical use. For this reason, when scraps occur, they are usually thrown away or given out for free.

The scrap industry was valued at more than $90 billion in 2012, up from $54 billion in 2009 balance of trade, exporting $28 billion in scrap commodities in the US alone (Waughray, 2014). Since 2010, the industry has added more than 15,000 jobs, and supports 463,000 workers, both directly and indirectly. In addition, it generates more than $10 billion in revenue for federal, state, and local governments. Scrap recycling also helps reduce greenhouse gas emissions and conserves energy and natural resources. For example, scrap recycling diverts 135 million short tons (121,000,000 long tons; 122,000,000 t) of materials away from landfills. Recycled scrap is a raw material feedstock for nearly 60% of steel made in the US, for almost 50% of the copper and copper alloys produced in the US, for more than 75% of the US paper industry's needs, and for 50% of US aluminium. Recycled scrap helps keep air and water cleaner by removing potentially hazardous materials and keeping them out of landfills (Chancerel & Rotter, 2009).

Among the economic advantages of dealing with scrap metals, scrap metals can create jobs. It can also be reused and recycled as resource recovery measure in a circular economic model. Scrap metal management and recycling is also a key concern of environmental protection agencies around the world and has become increasingly acute in recent years. In particular, the recycling of scrap iron, steel and aluminium is not only an environmental issue but also raises issues as to the economic independence as regards the extracting of new raw materials. In Ghana, the scrap metal industry in Kumasi generally serves the Ghanaian market even though fractions of scraps collected are exported due to the relatively higher revenue obtained compared to selling locally (Price and Nance, 2009). The exportation of scrap metal generates revenue for the country. However, this practice affects the tonnage of raw material supplied to the local steel companies. Recently the government of Ghana placed a ban on the export of ferrous scraps because of the threat it poses to local steel industries which require scrap metals as raw materials (The Ghanaian Chronicle, 2012).

To have a truly successful recycling operation, the backing and participation of the general public, industry and the government is required. The scrap metal industry gathers waste scrap metals to ultimately produce a valuable raw material end product for use by the metal manufacturing industries. If the scrap metal industry did not exist then there would be vast quantities of waste polluting our environment as well as an increased burden on primary sources (Emery *et al.*, 2000; Javaid and Essadiqi, 2003; Muchová and Eder, 2010)

1.2 Statement of the Problem

The threat of scrap metals being considered as waste in this country is alarming considering the fact that many consumers are now purchasing new machines due to technological advancement and abandoning the old ones. As a result, many households throw such equipment and machines away considering them as waste. These equipment may have valuable metals in them which could be salvaged as scrap for recycling thereby reducing the amount of energy required to extract and process new metals from their ores. What many people do not know is that, most scrap metal can be recycled for cash payments at local scrap yards around the country.

A feedback from scrap collectors suggests that the scrap metal industry is a lucrative business. Nonetheless, there is no proper documentation regarding the activities and practices in this business.

It has become necessary for scrap dealers to intensify their efforts in scrap collection and management to mitigate the environmental effects and also generate income. To this end, the researcher sought to find out how scrap dealers in the Suame Magazine area of Kumasi Metropolis procure their scrap and the methods which they employ to put them to valuable use.

1.3 Objectives of the Study

The main objective of the study is to evaluate the challenges and prospects in the management of scrap in the Kumasi Metropolis, with specific reference to the Suame Magazine Industrial Organisation. The specific objectives for the study are to:

i. determine the economic profitability of scrap metal trade in the Kumasi Metropolis.

ii. assess the challenges faced by scrap metal dealers in the collection, sorting and smelter of scrap metals in their operations.

iii. determine the innovative and sustainable ways of managing scrap metal in the Kumasi Metropolis to increase profitability and environmental safety.

1.4 Research Questions

The research questions to guide the study are as follows:

i. What is the profitability level of scrap dealings in the Kumasi Metropolis?

ii. What are the challenges faced by scrap dealers in the collection and housing of scraps?

iii. In what ways can the management and recycling of scrap metals in Kumasi Metropolis be sustained and boosted?

1.5 Significance of the Study

The study will be significant to stakeholders in the following respects:

- The study will provide information to government, the metal industry, metal users and the recycling industry on the usefulness of recycling scrap metals and its benefits to stakeholders.
- Provide information for research on improving recycling efficiency of scrap metals
- Stimulate informed scrap metal recycling policies.

1.6 Limitations of the Study

Most interviewees were unfriendly towards the administration of questionnaires to them because they felt their job security was threatened. Many people declined from allowing pictures to be taken on their activities and answering any questions even though it was explained to them as being for academic purposes only. Another challenge was the language barrier. Many of them originated from the northern part of the country and were thus not fluent in the Twi dialect which is the commonly spoken language in the area.

1.7 Scope of the Study

The study is generally confined by space and conceptual dimension. The study is therefore primarily limited within the boundary of the Kumasi Metropolis. The conceptual dimension brings to the fore the involvement of industries which may not necessarily be in Kumasi but are stakeholders in the scrap metal trade. Selected steel industries were interviewed.

1.8 Organisation of the Study

This research paper is organized into chapters, with the chapters being organized as below: Chapter One focused on the introductory aspects of the research topic and gave a general introduction to the research. The chapter is made up of the following, the background of the study, the statement of the problem, purpose of the study, the objectives of the study, the significance of the study, the research questions, the scope of the study, and the limitation of the study. Chapter Two which presents the literature review dwells on the related literature on the scrap management and challenges. The researcher considered theoretical literature available on the subject matter. Chapter Three deals with methodology of the research. That is the research design and approach the researcher adopted in carrying out the research. This chapter includes the sources of the data, primary and or secondary, the sampling techniques used and the reasons for employing such techniques. Chapter Four is concerned with the discussion of data, analysis of data and the interpretation of the data collected. That is, how the data was processed, presented and arranged to bring out the meaning in them so to help achieve the objectives of the study. The chapter is made of absolute figures, bar charts and pie charts in analysing the data collected. Chapter Five deals with presentation of findings, making conclusions from the findings of the study. In addition, it presents recommendations and suggestions based on the findings of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Interest in metals recycling is not a new phenomenon that has just been thought about in the 20th century. Mankind has always recycled metal in one form or another. For example, early Bronze Age man would have recycled old damaged or redundant metal rather than discard this precious resource. The industrial revolution (traditionally dated around 1730 to 1850), which saw the emergence of large metallurgical industries, was commonly regarded as the period when large scale metal recycling truly commenced (Emery *et al*., 2000; Javaid and Essadiqi, 2003).

2.2 Scrap Metal Recycling

Today with increasing public awareness and research into the many environmental implications, metals recycling is now of paramount importance due to a number of reasons. For instance, incineration and landfilling of metals result in contamination of air and groundwater. Additionally, recycling is extremely energy efficient; the production of one tonne of copper from its ore consumes about 116 GJ of energy whereas from scrap copper this is substantially reduced to about 19 GJ per tonne (Emery *et al.,* 2000; Javaid and Essadiqi, 2003). Muchová and Eder (2010) also reported similar energy reduction for aluminium where the production of one tonne of aluminium from scrap requires only 7% of the energy for primary production excluding bauxite production. Recycling also cuts down on the need for mining raw materials and hence saves large scale destruction of the natural environment.

These benefits as well as the economics of the scrap metal industry have established a great deal of collaboration between developed and developing countries which includes Ghana through exports (Tsikata *et al.*, 2008).

The metal recycling industry encompasses a wide range of metals. The more frequently recycled metals are scrap steel, iron, lead, aluminium, copper, stainless steel and zinc. There are two main categories of metals: ferrous and non-ferrous. Metals which contain iron in them are known as *ferrous* where metals without iron are *non-ferrous*.

- Common non-ferrous metals are copper, brass, aluminum, zinc, magnesium, tin, nickel, and lead.

Non-ferrous metals also include precious and exotic metals.

- Precious metals are metals with a high market value in any form, such as gold, silver, and platinum group metals.
- Exotic metals contain rare elements such as cobalt, mercury, titanium, tungsten, arsenic, beryllium, bismuth, cerium, cadmium, niobium, indium, gallium, germanium, lithium, selenium, tantalum, tellurium, vanadium, and zirconium. Some types of metals are radioactive. These may be "naturally-occurring" or may be formed as by-products of nuclear reactions. Metals that have been exposed to radioactive sources may also become radioactive in settings such as medical environments, research laboratories, or nuclear power plants (Castro, et al., 2004).

2.2.1 Scrap Types and Types of Recycling

The ever expanding human population has brought about an increased demand for industrial and consumer goods, which in turn leads to higher production and the use of more energy. A well thought out economic/environmental model should be able to utilise the advances in modern technology, maximising energy conservation and minimising harmful pollutants.

Metal recycling is one proven area where energy and environmental savings can be and are presently made. Many different types and grades of metals at present fall in the category where recovery is extremely economic with high levels of metals being recovered (Emery *et al.,* 2000).

Recycling basically occurs on three recognised levels. First is manufacturing or pre-sales scrap, in which this operation is normally well organised and often occurs in-house, incorporated into the production of primary metal in many cases. Secondly, the industrial or post-sales scrap and residues, and finally household scrap collected by a local scrap merchant or local authority via a local municipal solid waste (MSW) refuse collection (Emery *et al.,* 2000).

The different types of recycling are related to the type of scrap and its treatment:

- Home scrap is material generated during material production or during fabrication or manufacturing that can be directly reinserted in the process that generated it. Home scrap recycling is generally economically beneficial and easy to accomplish. It is excluded from recycling statistics and not further discussed here.
- New (or preconsumer) scrap (sometimes termed “prompt scrap”) also originates from a fabrication or manufacturing process. As opposed to home scrap, it is not recycled within the same facility but rather is transferred to the scrap market. Because of its known properties, high purity, and value, its recycling is generally economically beneficial and easy to accomplish, although recycling becomes more difficult the closer one gets to finished products (e.g., rejected printed circuit boards). New scrap is typically included in recycling statistics.

- Old (or postconsumer) scrap is metal in products that have reached their end of life (EOL). Their recycling requires more effort, particularly when the metal is a small part of a complex product.
- Functional recycling is that portion of EOL recycling in which the metal in a discarded product is separated and sorted to obtain recyclates that are returned to raw material production processes that generate a metal or metal alloy. Often it is not the specific alloy that is remelted to make the same alloy but any alloys within a certain class of alloys that are remelted to make one or more specific alloys. For example, a mixture of austenitic stainless steel alloys might be remelted and the resulting composition adjusted by addition of reagents or virgin metal to make a specific stainless steel grade.
- Non-functional recycling is that portion of EOL recycling in which the metal is collected as old metal scrap and incorporated in an associated large-magnitude material stream as a "tramp" or impurity elements. This prevents dissipation into the environment but represents the loss of the metal's function, as it is generally impossible to recover it from the large-magnitude stream.

Although non-functional recycling is here termed a type of recycling, it leads to an open metal life cycle, as discussed above. Examples are small amounts of copper in iron recyclates that are incorporated into recycled carbon steel.

Losses occur when metal is not completely captured through any of the recycling streams mentioned above. Losses also result from in-use dissipation, as in the corrosion of sacrificial zinc coatings on steel, loss of the metallic contents of vehicle brake linings, and unrecovered metal in mine tailings and refinery slags. Dissipation, tailings, and slag losses are not reflected in any of the recycling rate statistics in the present work (Castro *et al*., 2004).

2.3 Types of Scrap Metals

The metal industry is divided into ferrous and non-ferrous metals (Turkish Metal Industry Report, 2010). The scrap metal industry is also classified along these two kinds of metals.

2.3.1 Ferrous Scraps

Ferrous scraps comprise metals containing iron. Iron and steel scrap play an important role in the processing and final production of new ferrous products. Recycling of ferrous scraps prevent the environmental burden of large accumulations of scrap building up in landfill sites and other disposal areas. Recycling is also energy efficient. It is estimated that every tonne of steel that is recycled saves approximately 1,000,000 kg of iron ore, 600 kg of coal and 54 kg of limestone (Emery *et al.,* 2000). This results in reduced mining activities for the raw materials, again reducing the environmental burdens. Other environmental benefits occur in the form of 86% less air pollution, 76% less water pollution, 40% reduction in water used, and a 1.28 tonne reduction in the generation of solid wastes (Emery *et al.,* 2000).

Sources of ferrous scraps for recycling can be broadly classified into three (Fenton, 1998; Javaid and Essadiqi, 2003):

1. Internal Arising Scrap - these include reject materials from casting, rolling mill and other manufacturing processes. With more efficient steel production, these scrap quantities have fallen over recent years.
2. Prompt Industrial Scrap - scrap is produced from normal machining, tamping and other fabrication operations, normally of a fairly high quality. In a large number of cases, manufacturers sell directly to steel makers.
3. Obsolete or Capital Scrap - when a product has served its useful life and is then discarded. Large scale examples are decommissioned power stations, shipping fleets

down to small-scale examples such as cars and domestic appliances. With the restructuring of the developed world's base towards a lighter industry the main resource has now shrunk considerably.

Domestic appliances are a valuable source of scrap for recycling but firstly need other nonferrous elements to be removed, such as tin and copper. These elements can be detrimental to the steel, altering the strength and surface quality. More than one million tonnes of electrical goods are produced each year with many having a life cycle of 10 years or less (The Ends Report, 2000). Plastics also now play a great part in the manufacture of domestic appliances and cars with the gauge of steel being ever decreased. Structural steel is also being reduced in thickness in the construction industry all adding to reduced quantities of scrap.

2.3.2 Non – Ferrous Scraps

Non-ferrous scrap comprises metals that do not contain iron. New changes in modern technology have reduced quite substantially the amounts of non-ferrous scrap generated as products are being made from thinner gauge metal and also with the increased use of other materials such as plastics for products including drink cans and plumbing. The most common non-ferrous metals that are recycled and are traditionally found and segregated in domestic waste in sufficiently large quantities are aluminium, copper, lead and brass. Aluminium is the most abundant metal (by volume) found in domestic waste, consisting mainly of drink cans (Emery *et al*., 2000). Sources of non-ferrous scraps can also be grouped into three, similar to that of ferrous metals. Source of aluminium scraps include vehicle and transportation, construction and building sites, aluminium packaging waste, cable wire and electronic equipment from homes (Emery *et al*., 2000; Muchová and Eder, 2010).

2.4 Scrap Metal Recycling Steps

The scrap metal procedure goes through several processes before the scrap can effectively be said to have been recycled. The various steps in the scrap metal recycling are enunciated below as depicted in the diagram:

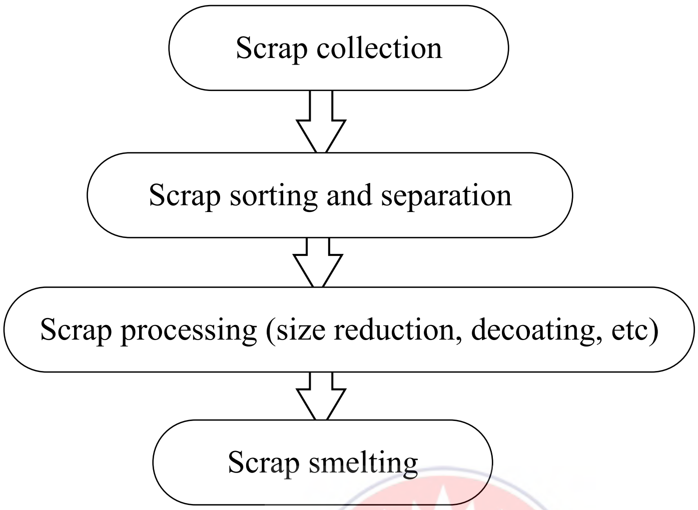

Figure 2.1 Scrap metal recycling steps

2.4.1 Scrap Collection

Scrap collection is the first step in recycling of metals. Scrap metal collection is largely performed by young men in their teens and twenties. Collection usually spans from early hours of the morning to late in the afternoon lasting about eight hours daily. Scrap metal collectors may usually go as individuals or in groups of two. The method of scrap collection varies from the use of simple technological tools to the use of the hands. Scrap metals are usually collected from the land surface with the hand and stored in the houses after collection for sale later depending on the situation in the local area (Moyes, 2005). Simple tools like metal detectors are often used for metals hidden underneath the land surface. The use of magnetic detector is paramount in the collection of scraps in that the collectors are able to differentiate between ferrous and non-ferrous scraps. Ferrous scraps are attracted to the magnetic detector when passed over a stockpile of scraps.

2.4.2 Scrap Processing

Scrap processing is the second step in recycling of metals. Scraps come from a variety of sources in many different forms and must be processed to facilitate efficient use. The primary roles of the scrap processor are to collect, sort, grade, prepare, market and distribute scrap (Moyes, 2008).

Sorting is carried out following identification of the scrap. Sorting of scraps is done at the point of sale to the scrap dealers (European Commission Joint Research Centre Institute for Prospective Technological Studies, 2008). Scraps are usually sorted based on the metal types. However, the sorting of scraps is done, a lot of the time, by visual inspection and not with any special devices. This requires a lot of skill and expertise especially in cases where the metals have degraded beyond recognition. In some cases, chemical processes are used in a wide range of metal scrap recycling industries as a means to separate scrap into its component metals. The chemical processes clean the scraps prior to using physical processes and also remove contaminants (such as paint) from scrap material. It also extracts selected metals from a batch of scrap containing many metal types. Chemical processes may include high-temperature chlorination, electro-refining, plating, leaching, chemical separation, dissolution, reduction, or galvanizing (Foulke, 2008).

The type and size of equipment they use depend on the types and volume of scrap available in the area and the requirements of their customers (Foulke, 2008). The largest and most expensive piece of equipment is the shredder. The shredder can fragment vehicles and other discarded steel objects into fist-size pieces of various metals, glass, rubber, and plastic. These materials are segregated before shipment by using fans, magnets, air ducts, hand pickers, and flotation equipment. Hydraulic shears, which have cutting knives of chromium-nickelmolybdenum alloy steel for hardness, slice heavy pieces of ship plate, railroad car sides, and structural steel into chargeable pieces are also used. Baling presses are used to compact scrap into manageable bundles thereby reducing scrap volume and shipping costs. Ferrous scrap metals are magnetic and are often collected in scrap yards by a large electromagnet attached to a crane, sweeping across piles of scrap to grab magnetic objects (Foulke, 2008).

2.4.3 Scrap Smelting

Scrap processing is followed by scrap smelting. Smelting is done in a furnace at high temperatures. Smelting is done to fit manufactured metals to specifications of the industry. scrap metal of lower grade, which may be contaminated or in a form that is not easily used, tends to be brought and used as feed by primary metal producers (and possibly transported to large smelters located near or at mining operations), where they pay a much lower price per unit of metal than for high grade materials (Global e-Sustainability Initiative & Electronic Industry Citizenship Coalition, 2008). The amount of scrap metal smelted is dependent on end-of-life (old) scrap recovery which is hampered in two ways:

- Products become physically distributed regionally and globally, making collection costly.
- There may be many different metals embedded in a single product, wherein a specific type of metal may be dispersed or mixed throughout a single product, making separation and cleaning difficulty.

Cost-effective, efficient, end-of-life product recovery represents the limiting factor for increasing metal recovery and hence metal smelting (Global e-Sustainability Initiative & Electronic Industry Citizenship Coalition, 2008).

2.5 Scrap Sorting and Preparation Techniques

The numerous sources and forms of ferrous scrap require the use of numerous scrap sorting and preparation techniques to remove the contaminants and/or recover other valuable materials (i.e. non-ferrous metals) prior to entering the steel-making process.

2.5.1 Manual Sorting and Preparation

Large items such as ships, automobiles, appliances, railroad cars and structural steel must be cut to allow them to be charged into a furnace. This can be done using shears, hand-held cutting torches, crushers or shredders. Manual sorting obviously involves the removal of components from the scrap by hand. It is most suitable when miscellaneous attachments have to be removed from the scrap (i.e. radiators from scrap cars, plastic end tanks from radiators) or when manual off-loading is unavoidable. The separation of metallics from non-metallics is also often accomplished manually.

2.5.2 Scrap Size Reduction Processes

A wide range of equipment is used to reduce the size of large scrap material into pieces small enough to enable consolidation, shipment and subsequent feeding into furnaces. The equipment used to accomplish this includes shears, flatteners, and torch-cutting and turning crusher. This equipment is usually operated by dealers and processors who prepare the scrap to be fed into the steel mills.

<u>Baling Press:</u>

Loose scrap that has a high surface area and low density (i.e. lathe turnings) must be compacted by baling or briquetting. A baling press is a heavy piece of processing equipment that uses up to three hydraulic rams to compress the scrap that requires greater density before remelting. With 600 horsepower, the largest baling press can take three flattened autos without engines and in less than two minutes produce a 5400 lbs bale that is 36 in. by 24 in. by 60 in.[4] At 100% efficiency, this machine will process just over 40 lbs of scrap per hour.

Briquetter: In a briquetter, small scrap is compacted into packets as it passes between two counter rotating drums, compaction can be assisted with heat depending on the material.

Shear: The hydraulic guillotine shear slices heavy pieces of metal including I-beams, ship plate, pipe and railroad car sides. Shears vary in size from 300 tons to more than 2000 tons of head force.

2.5.3 Shredding

Shredders or fragmentizers can reduce old automobile hulks into fist-sized pieces using massive hammer-mills. A medium-size shredder uses 36 hammers weighing 250 lbs each to pound auto hulks to pieces[4]. Although the predominant raw material for the shredder is automobile hulks, "white goods" (household appliances such as stoves, washers, dryers, and refrigerators) and other large items can also be shredded. Depending on its size, a shredder can process from 1500 to more than 20 000 tons of scrap per month. The shredding process produces three types of material: ferrous metal (iron and steel), shredder residue (light fraction) and shredder residue (heavy fraction). The two residue fractions, either singularly or collectively, are frequently referred to as automotive shredder residue (ASR). "Shredder fluff" is the term given to the low density or light materials, which are collected during the shredding process for cyclone air separation. Each ton of steel that is recovered produces about 300 kg of ASR, comprised of plastics, rubber, glass, foam and textiles, contaminated by oil and other fluids[5]. The ferrous metals are recovered by the shredder operator using magnetic separation and sold to steel mills. The ASR heavy fraction contains primarily aluminum, stainless steel, copper, zinc and lead. The non-ferrous and ferrous metals are recovered from the ASR heavy fraction, either by the shredder operator or by non-ferrous metal separators who purchase the ASR from the shredding industry. Heavy media separation and eddy current separation are the technologies primarily used to recover the metallic material from the ASR heavy fraction.

2.5.4 Magnetic Separation

Magnetic separation is used when a large quantity of ferrous scrap must be separated from other materials. Permanent magnets and electromagnets are used in this process. The latter can be turned on and off to pick-up and drop items. Magnetic separation can be of either the belt-type or the drum-type. In the drum, a permanent magnet is located inside a rotating shell. Material passes under the drum on a belt. A belt separator is similar except that the magnet is located between pulleys around which a continuous belt travels.

Magnetic separation has some limitations. It cannot separate iron and steel from nickel and magnetic stainless steels. Also, composite parts containing iron will be collected and could contaminate the melt. Hand sorting may be used in conjunction with magnetic separation to avoid these occurrences.

2.5.5 Eddy Current Separation

Eddy current separators are used to separate non-ferrous metals from waste and ASR. The process generally follows the primary magnetic separation process, and it exploits the electrical conductivity of non-magnetic metals. This is achieved by passing a magnetic current through the feed stream and using repulsive forces interacting between the magnetic field and the eddy currents in the metals.

The simplest application of the process is the inclined ramp separator. This uses a series of magnets on a sloped plate covered with a non-magnetic sliding surface such as stainless steel.

When a feed of mixed materials is fed down the ramp, non-metallic items slide straight down, while metals are deflected sideways by the interaction of the magnetic field with the induced eddy current. The two streams are then collected separately. Variations of the eddy current separator include the rotating disc separator, in which magnets are arranged around a rotating axis. Yet another system uses a conveyor with a head pulley fitted with magnets. Both systems rely on the varying trajectories of materials either affected or unaffected by magnetic fields, to make the separation.

2.5.6 Heavy-Media Separation

Recovery of recyclable materials is often achieved using a heavy-medium separation (HMS) to recover non-ferrous metals from ASR. This process utilizes a medium normally consisting of finely ground magnetite or ferrosilicon and water. By varying the relative proportions of the solids, the relative density (or specific gravity) of the medium can be adjusted. The specific gravity of the medium is typically half way between the densities of the two materials being separated. Once separated, the products/materials are allowed to drain, and the medium recovered is then returned to the process. Any medium still adhering to the product/material is removed by a water spray. The resultant solution is passed through magnetic separators to recover the medium. The effluent is then reused as spray water. HMS separations can be conducted in an open bath to achieve a separating force equal to the force of gravity. For smaller particles, the forces of medium viscosity tend to work against the separating force. In these cases, cyclonic separators are employed which effect a separation at several times the force of gravity.

2.5.7 Color, Density, Magnetic, Spark, Chemical and Spectroscopic Testing

Scrap materials are typically identified by skilled sorters using a limited number of physical and chemical tests. These tests rely on object recognition, color, apparent density, magnetic properties, and nature of spark pattern when ground on an abrasive wheel, chemical reaction to reagents, chemical analysis and spectrographic analysis.

Physical properties such as color, density and relative hardness can be used to quickly separate certain classes of materials. For example, copper and brass can be identified by color, while lead can be recognized by both its density and relative softness. Differentiating between alloys of similar grades and compositions can be more difficult; in these cases, magnetic testing, spark testing, and chemical and spectroscopic analysis can be used. Magnetic testing can also be used as iron, nickel and cobalt are ferromagnetic, as are low-alloy stainless steels. Therefore, while magnetic testing cannot be used to differentiate between alloys, it can classify alloys into their series. Spark testing involves grinding an alloy on an abrasive wheel. The color and length of the spark can be used to identify the alloy.

There is a spectrometer that analyzes the spectra given off from the spark and compares it with standards to identify the alloy, but this unit is not truly portable and is therefore not widely used. Various optical and X-ray spectrometers can be used to identify the composition of alloys. Thermoelectric testing involves using the Seebeck effect to identify materials. These thermoelectric devices contain two probes made of the same metal, one heated and one at ambient temperature. When they contact the scrap, a potential difference is generated that is characteristic of the metal being tested. Chemical spot tests are also used whereby reagents such as acids are dropped on the metal and the reaction is observed. Quantitative chemical analysis can be used to confirm the exact composition of the alloy.

2.5.8 Decoating Techniques

There are currently a number of processes used in industry for decoating scrap metal.

Dezincing

Any zinc-bearing scrap included in the charge will result in discharge of zinc oxide in the flue dust. The main source of zinc is galvanised steel sheet scrap. The removal of zinc using thermal methods can be accomplished using various techniques.

1. The galvanised parts are heated to a high temperature (>900^{0}C) at which the zinc evaporates.
2. The galvanised parts are heated to a temperature sufficient to embrittle the coating which is then removed by abrasion.
3. Heating and subsequent removal of the coating is accomplished by shot blasting.

Zinc removal can also be carried out by using chemical techniques in which ammonia leach or caustic soda is used to dissolve the zinc coating from galvanised scrap.

Detinning

Tin-bearing scrap (i.e. food containers and auto bearings) in steel recycling affects the surface quality of the steel products because tin segregates to the grain boundaries and causes surface scabs during working. Some of the processes being used for detinning the tin-plate scrap include electrolytic and alkaline detinning.

Incineration

Some scrap processors use incineration to remove combustible materials including oil, grease, paints, lubricants and adhesives.

2.6 Scrap Metal Industry Structure

The scrap industry is characterised by many independent actors involved at different points in the supply and demand of scraps. According to Wernick and Themalis (1998), the actors of the industry are scrap dealers, brokers, dismantlers and smelters. Three actors were however identified by Moyes (2005) as scrap metal collectors, brokers and scrap metal processors. The structure of the recycling industry, from collectors until using the scrap in steelworks and foundries, could be described as a pyramid structure shown in Figure 2.1. Most of the stakeholders are small collecting companies which are supplying the larger companies for the processing, treatment and trading. These larger companies are delivering scrap to the steelworks or foundries.

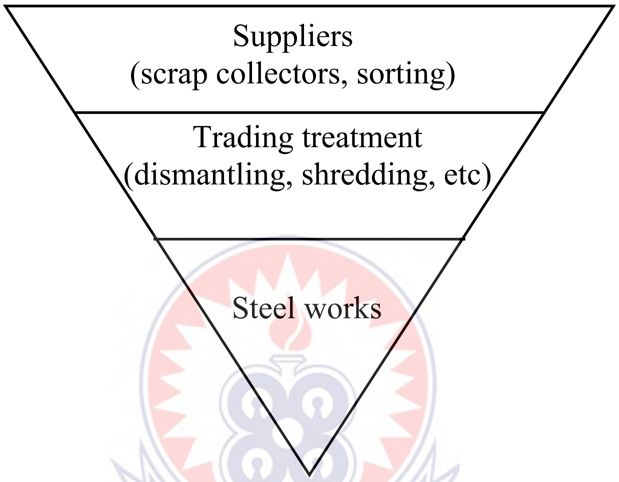

Figure 2.2 The pyramid structure of the scrap metal trade (Muchova and Eder, 2010).

The collection system can vary depending on the type of product and the country. Large sized scrap metals and in high quantities, such as those from construction and demolition sites, are usually transported directly to the scrap yard or to scrap treatment plants. Small products such as packaging materials are collected by the scrap metal collectors within the municipalities, where sorting is done and baled for transportation to treatment plants or refineries (Muchová and Eder, 2010).

2.6.1 Export and Import of Scraps

Export and import of scrap metals to and from other countries has been established for decades. For instance, within the EU it is difficult to estimate the total quantity of the scrap being shipped. The largest scrap buyer from the EU is Turkey with its scrap requirement increasing by over 20 %, to 7 million tonnes during the first half of 2008 (Muchová and Eder, 2010). The key supplier to the EU is Russia. The main grades of the scrap which were imported in EU-27 during 2008 included cast iron (2%), new scrap (3%), turnings (13%), stainless steel scrap (19%), shredded scrap (18%), and old scrap (45%). The exported scraps included cast iron (4%), new scrap (4%), stainless steel scrap (7%), shredded scrap (33%), and old scrap (52%). The majority of the imported and exported scrap was old scrap followed by shredded scrap and stainless steel scrap (Muchová and Eder, 2010).

Ghana exports its scraps to mainly the developed countries including China where aluminium alloy, aluminium waste and scrap as well as copper waste and scrap are exported (Tsikata *et al*., 2008). However, at the time of this research, there was no proper documentation as to the quantity and type of scrap exported or imported.

2.6.2 Quality of Scrap in Trade

Quality of scraps is reflected in the direction of exports of scraps in developed and developing countries. Quality is a major concern for environmental reasons mainly because of the potential pollutants that could be released into the atmosphere during smelting and the possibility of hazardous material being mixed in the shipment containers of scraps from exporting countries (Yoshida *et al*., 2005). Tighter environmental regulations in scrap importing countries help importers obtain a higher quality of scrap separation (Yoshida *et al*., 2005). At the time of this research, there was no proper documentation as to how the quality of scraps for smelting or export is being monitored in Ghana.

2.6.3 Economy of Trade

In a free-market economy, scrap prices react quickly to changes in supply and demand (Fenton, 1998). When demand for steel mill and foundry products is low, demand for scrap is low, and prices fall. Dealers cannot influence sales of scrap if mills and foundries do not need it to charge their furnaces. Although prices of scrap depend upon the market conditions for new products, the scrap industry uses inventory to absorb price differentials; that is, inventories increase as scrap prices decrease (Fenton, 1998). Prices are also influenced by technological changes in mills, processing of scrap, the use of scrap substitutes, environmental controls and other Government regulations, and export demand.

Metal demand has been driven by development in China and other emerging economies. In China, the world's largest miner of tin, domestic consumption now exceeds production, resulting in increased imports of metal and ore concentrate (Moyes, 2005; Global e-Sustainability Initiative & Electronic Industry Citizenship Coalition, 2008). The industry continues to be susceptible to economic swings, as demand and prices are affected by increased production in end-use sectors like manufacturing, construction and telecommunications. In general, prices at the local level are linked to prices at the global or international level (Moyes, 2008). For instance, in the second half of 2008, with the onset of the global financial and economic crisis, falling output among many metal processing companies resulted in low levels of demand for scrap (Muchová and Eder, 2010). Export restrictions on the raw materials used in the steel industry for instance can raise the prices of steel in the global market. These raw materials are iron ore, coke and steel scraps. China is the leading producer of these inputs and so restrictions on these exports can have huge impacts on the availability of these resources (Price and Nance, 2009).

2.7 Legislation and Regulation in Scrap Metal Trade

The scrap metal trade is characterised by legislation and regulation both at the local and international level. At the local level, legislations and regulations center on protecting individual country interests such as ensuring the security of employment in the scrap metal industry from possible threat of exports. For instance, many countries have placed a ban on steel scrap exports including Ghana. Ghana has banned the exportation of ferrous scraps since 2004 by the Ministry of Trade and Industry, Ghana (The Ghanaian Chronicle, 2012).

The reason for this ban is to ensure that the local steel industry has the required quantity of ferrous scraps to meet the capacity of its operations. Other countries like China have placed taxes on steel scraps making it unprofitable to export and encouraging recycling within their country (Price and Nance, 2009).

At the international level, however, legislation and regulations on scrap metal trade are geared towards sound environmental management or sustainability. For instance, Kopsick *et al.*, (2005) have reported the importance of laying down an approach for monitoring radioactively contaminated scrap metal due to its implications both on the environment and the health of workers at recycling plants. This consensus towards an approach for monitoring radioactively contaminated scraps came not because individual countries were not checking for it. On the contrary, they do have such systems in place. However, there is no central point for information on various protocols currently in use to monitor radioactively contaminated scraps. In the EU, the management of waste scrap metal is currently under the waste regulations, e.g. the Waste Framework Directive and EU Waste Shipment Regulation. Scrap treatment plants (e.g. shredders, dismantlers, media separation plants) as well as scrap collectors and sorting plants are operated under a permit for waste treatment, although the details of their permits vary across member states. The production of secondary metal at steelworks and the associated treatment of scrap metal on site are subject to the Integrated Pollution Prevention and Control (IPPC) Directive (Muchová and Eder, 2010).

2.8 Specification and Standards in Scrap Metal Trade

The worldwide scrap metal recycling industry has developed sets of specifications and grading systems to ensure consistent quality of source scrap material for a given grade of metal scrap. The three most widely-used specifications are the Scrap Specifications Circular (U.S. Institute of Scrap Recycling Industries, Inc.), the European Classification for Non-Ferrous Scrap Metals, and the Standard Classification for Non-Ferrous Scrap Metals (U.S. National Association of Secondary Materials Industries, Inc.). These specifications generally set minimum and maximum content of certain metal impurities, and restrict levels of certain hazardous metals and other hazardous substances (Foulke, 2008).

Specifications and standard classifications for ferrous metal scrap exist at all levels: International, European, National, as well as between individual parties. It is clear that for the reason of marketing and trading, standards and specifications are needed not only to set the price but also to be used as reference for classification and quality control (Muchová and Eder, 2010). Traded scrap metal is classified according to many properties: chemical composition of metals, level of impurity elements, physical shape and size and finally homogeneity, that is, the variation within the given specification (Muchová and Eder, 2010).

2.9 Benefits of Scrap Metal Trade

The benefits of the scrap metal trade are many and are generally grouped under economic, social and environmental benefits.

2.9.1 Economic Benefits

The economic benefit of the scrap metal trade at the international level is great. In 2010, the United States alone earned more than $30 billion from exports of products manufactured from scraps (Wiener, 2011). Metal scrap that is collected for recycling is material that does not have to be managed as a waste reducing the overall cost of waste management. It is a valuable resource that is converted into value-added commodities (Global e-Sustainability Initiative & Electronic Industry Citizenship Coalition, 2008).

Furthermore, the relatively high value of recycled metal helps to sustain the economics of today's automotive and municipal recycling schemes (Martchek, 2000). Production of metal products from inexpensive raw materials like metal scraps is economically advantageous due to the reduction in labour costs as compared to the cost of importing the raw material for example (Hyde, 1995). Recycling scraps goes through stages such as collection, separation, cleaning, processing etc. At every stage a little value is added to the raw material and this goes a long way to increase the profit margin when the product is finished, making more productive use of urban waste (Furedy, 1984).

The economic benefit of scrap metal in the Ghanaian economy is somewhat substantial. According to Nkansah *et al,* (2015), the most common types of metals found in Ghana are aluminium, copper, iron, lead and steel. Table 2.1 shows the metal types and their volumes, weight and costs of purchase. From the table, the total amount for the metals amounts to about GH¢ 141,584. This has huge economic significance for the nation, if appropriate measures are taken to promote scrap business with good tax incentives.

Table 2.1 Types of scrap metals and their economic value

Metal	Vol (m^2)	Mass (kg)	Cost in GH¢/kg	Total Cost (GH¢)
Lead	1.7	19,278	1.50	28,917
Copper	1.2	10,716	7.0	75,012
Steel	1.8	14,040	1.03	14,461.20
Iron	1.8	14,040	1.03	14,461.20
Aluminium	3.5	9,492	0.92	8,732.64
Total Cost (GH¢)				141,584.04

GH¢ = Ghanaian cedi (currency)

Source: Nkansah *et al*., (2015)

Table 2.1 indicates that the relative abundance of the various types of scraps in terms of volume. This is important because metals are incompressible and therefore only certain volume and weight could be taken at any given time by the scrap transports. This has implication for profit margins. In terms of the available volume, aluminium is the leading scrap metal taking up to 35% of volume while copper has the least percentage of the volume. Thus aluminium is by far the most common metal in the municipality. This may be due to the fact that aluminium is processed in Ghana, and therefore is abundant in the country (Husband *et al*., 2009). Most of the aluminium scraps were obtained from cans which are obtained from various drinks manufacturers. The relatively few presence of the other metals is an indication of relatively weak industrialization status of the municipality and the country. Aluminium production from the raw sources is highly energy dependent and Ghana uses much of her energy production for harnessing aluminium (Husband *et al*., 2009), therefore reuse and recycling of aluminium is going to save Ghana energy as well as virgin resources. Thus policy makers and authorities in Ghana should help intensify aluminium reuse and recycling.

2.9.2 Social Benefits

In the United States alone, more than 450,000 people are employed directly or indirectly by the scrap industry (Wiener, 2011). Recycling provides social benefits related to minimising waste landfills, which reduces competition of urban lands for different uses and generates employment for collection and recycling activities (Martchek, 2000). The economic potential of the scrap metal trade makes it an effective tool for improving the lives of local people who may be involved as scrap metal collectors. Another component of the scrap metal industry is the limited skills required to be a player in the industry. From collectors of scrap metals to dealers who supply steel companies with scrap metals the level of technical know-how is still low. This makes it possible for new persons to be employed (Martchek, 2000; Wiener, 2011).

2.9.3 Environmental Benefits

Scrap recycling reduces greenhouse gas emissions by requiring significantly less energy to manufacture products from recyclables than virgin materials and by avoiding landfilling (Wiener, 2011). Energy saved using recycled materials is up to 92% for aluminium, 90% for copper, 56% for steel (Wiener, 2011). Beyond the energy conservation benefits, there are additional environmental benefits, such as reduced land disturbance, water use, air emissions and waste generation (Global e-Sustainability Initiative & Electronic Industry Citizenship Coalition, 2008). Recycling is one of the best risk management tools available, as it allows reducing and even eliminating any risk that may be eventually generated by the disposal of products at their end-of-life (Martchek, 2000). Recycling also contributes to the conservation of natural resources and environmental improvement as metals can be recycled repeatedly without substantial degradation in quality by avoiding fresh raw material exploitation (Senfuka, 2011).

2.10 Negative Repercussion of the Scrap Metal Trade

In spite of the benefits associated with recycling scrap metals, some negative repercussions also pertain at different stages in the industry. Heavy metals may be released into the environment from metal smelting and refining industries, scrap metal, and from burning of waste containing these elements (Kimani, 2007). Employees in facilities that recycle metal scrap are exposed to a range of safety hazards associated with material handling methods, metals themselves (as dust or fumes), and with the hazardous substances used to process or recover these metals (Foulke, 2008). During loading and unloading of scraps, employees or workers are exposed to many health hazards which can be prevented by using the appropriate combination of personal protective equipment (PPE) such as hard hats, sturdy boots, gloves, thick clothing, and respirators (if the operation generates hazardous dust) to be adequately protected from safety and health hazards (Foulke, 2008).

Size-reduction of metal scrap is a necessary step in recycling scrap metals. Basic metal breaking processes often involve heavy manual labour to break up large or complex assemblies of scrap metal, or to cut or break the pieces into sizes that can be fed into a furnace. Employees involved in activities of this type may be exposed to metal fumes, smoke, hot environments, and hot material when working near furnaces, and may come in contact with metals that present hazards through both skin contact and inhalation (Foulke, 2008). Handling sharp or pointed pieces of scrap metal poses cut or abrasion hazards to hands or bodies (Foulke, 2008). One of the most common tools used to break apart large metal pieces is the gas cutting torch. Thermal (gas) torches expose employees to sprays of sparks and metal dust particles, high temperatures, bright light that could damage eyes (light both inside and outside of the visible spectrum), and various gases (Foulke, 2008). Compressed gas cylinders can also present explosion hazards due to excessive heat or physical damage (ibid).

Dust and air emissions from scrap processing are generally at low levels. However, emissions of hazardous air pollutants may be generated by the secondary metal production in a furnace, e.g. dioxins and furans and metals/metal oxides such as lead and zinc (Muchova and Eder, 2010).

A rise in prices of scraps, especially the non-ferrous metals, has the potential to incite an upsurge in metal theft from the built environment. For instance, the demand for copper has fuelled a conspicuous rise in the pillaging of the built environment around the world (Bennett, 2008). There is also the issue of child labour in the scrap metal trade (Moyes, 2005) in most developing countries.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents a discussion on the methods and methodology employed by the researcher in the conduct of this study. The methodology or framework used and the methods employed in data collection are the primary focus of this section. The chapter further talks about how data was collected, the population, sample and sampling procedure, data collection instruments and data analysis.

3.2 Research Design

According to Yin, (2003) the selection of a research strategy depends on the type of research questions, extent of control the researcher has over behavioural events and the degree of focus on issues. This study is intended to explore the scrap management practices, challenges and prospects of the scrap industry in the Suame Magazine Industrial Development Organisation (SMIDO) at Kumasi. In undertaking this research the researcher adopted the descriptive survey technique in examining the problems associated with collection, handling and recycling of scrap metal in the Kumasi Metropolis. This gave the researcher the opportunity collect data from various scrap dealers and collectors. Both qualitative and quantitative data were utilised through survey techniques and field observations.

3.3 The Study Area

Kumasi is the capital of the Ashanti Region of Ghana. It is Ghana's second largest city, after Accra the capital with a population of about 2 million (Ghana Statistical Service, 2010). The city of Kumasi is located 300 km Northwest of Accra (Cofie, 2003). It is located on latitude 6°35'N – 6°40'N and longitude 1°30'W – 1°35'W.

The city has an approximate land area of 254 km² and falls within the plateau of the south-west physiological region which ranges from 250 – 300 m above sea level. Kumasi lies in the humid forest zone, and experiences much higher rainfall than northern Ghana. In Kumasi, there are two rainy seasons: from mid-March to mid-July, and from mid-September to mid-November. December to February is the driest period of the year. Temperatures range from 20.7 to 33.6 degrees Celsius. This influences the time for the crop harvest, which in turn means an increased waste generation during this period (Bostrom, 2009).

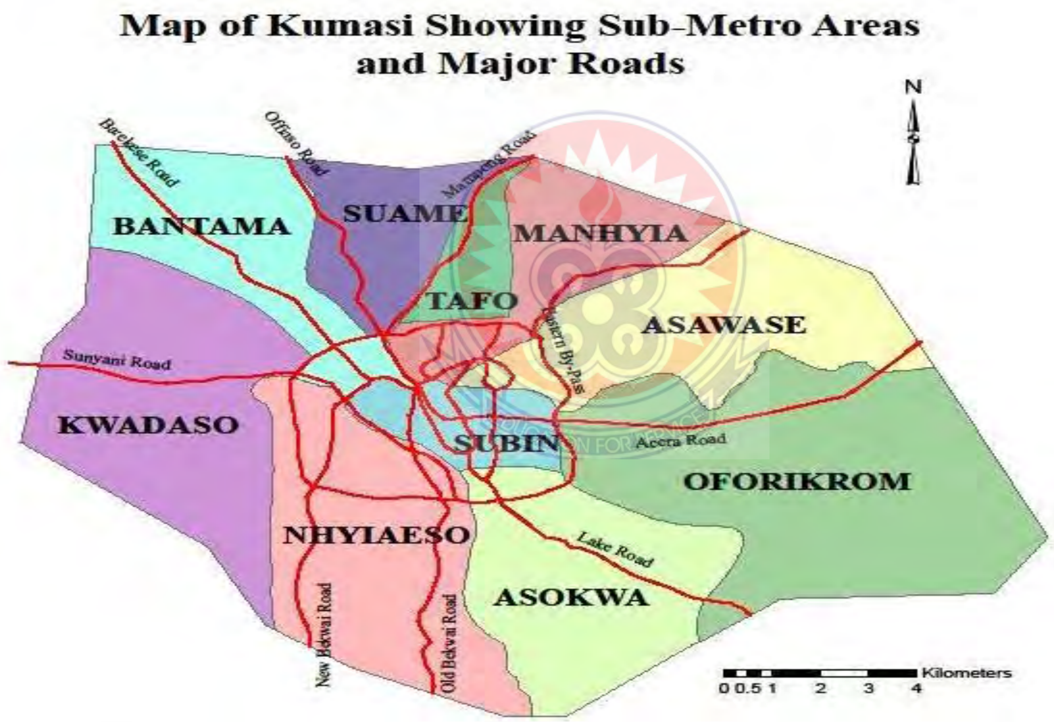

Figure 3.1 Map of Kumasi showing sub-metropolitan areas

Kumasi has ten sub-metropolitan areas as shown in Figure 3.1. Migration accounts for much of Kumasi's growth in recent years, and there is a significant migrant community. The city is an industrial centre with formal industries in timber, food processing (including beer brewing) and soap manufacturing, together with informal activities in woodworking, light engineering, vehicle repair, footwear, furniture manufacture and metal fabrication (Cofie, 2003). The service sector accounts for roughly 80% of the economic activity in Kumasi, and about 75% of employment in Kumasi comes from small informal businesses. Industry accounts for only 20% of the economy, and consists mainly of wood-working, sawmills, and breweries (though there are also factories that produce, for instance, foam products). Urban agriculture is an important source of food for the people living in Kumasi (King *et al*., 2001).

3.4 Population

The population for the study is composed of all scrap metal collectors (SMCs) in the local parlance called 'condemn buyers', scrap dealers (SDs) which typically include the scrap yards and the Suame Magazine Industrial Development Organisation (SMIDO) which is termed as the recyclers.

3.5 Sample and Sampling Technique

A total of 25 scrap metal collectors were selected for the study. The sampling technique used to select the scrap metal collectors was the snowballing technique. The researcher identified some of the scrap metal collectors who were going round the neighbourhood buying scrap and contacted them. They were briefed about the study and asked to provide information on their fellow scrap metal collectors. They also led the researcher to some of the scrap metal dealers or scrapyards in the metropolis aside Suame Magazine. Again, through the snowballing technique, five scrapyards were identified whose owners were contacted and selected for the study. They added up to the sample for the study making a total of 30.

3.6 Sources of Data

The data gathered for this study was from different sources to get a complete understanding of the issue under study. The researcher relied on two main data sources. Primary data was sought through interviews, questionnaire administration and field observation. This was done to get first-hand information on the practices, challenges and prospects of the scrap industry in Kumasi Metropolis. The primary data collection encompassed the use of structured questionnaires and interviews to obtain data from SMCs and SDs. This data provided information on the economics, social and environmental impact of the scrap metal trade in the Kumasi metropolis. Secondary data was obtained from journals, books, articles, newsletters and other useful materials on the internet. The secondary data assisted in reviewing existing information on the issue.

3.7 Data Collection Instruments

In the collection of primary data from respondents, the researcher employed interview for scrap collectors, questionnaire for scrapyard owners or scrap dealers and field observations at the scrap collection points and the scrap yards.

A semi-structured questionnaire consisting of open-ended and close-ended questions based on the research questions was administered by the researcher to the respondents. As a means to corroborate and acquire more data, the researcher conducted unstructured interviews for selected respondents. The interview was used for the purposes of providing a detailed information and establishing rapport with the respondents in order to assess the reliability of the responses received from the questionnaires. Information such as method of collection of scrap metals, industry structure, categorisation of scrap metals by dealers and utilisation of scraps collected were obtained.

3.8 Data Collection Procedure

In the process of collecting data for the study, personal contact was made with each of the sampled participants for the study. This was to avoid the possibility of the wrong person being administered questionnaire or interview. Whenever the researcher contacted a participant for the study, the participant was briefed about the significance of the study and then allowed to raise questions for clarifications. After that, the instrument was identified on a one-on-one basis.

3.9 Data Analysis

Copper and Schindler (2003) are of the view that, virtually all research involves some numerical data that usually could be quantified to help answer research questions and to meet objectives. Data collected need to be analysed and interpreted. Depending on the nature of study there are numerous statistical techniques for analysing data. Data obtained from the research instruments were edited, coded and categorized before analysis and interpretation of the result was done in relation to research questions in order to ensure content validity of the data.

To answer the research questions simple frequencies and percentages were applied to analyse the quantitative data using descriptive statistics. This gave the researcher the opportunity to present detailed information on nominal data and describes the results which is consistent with the focus of this study. Data obtained from the respondents through questionnaires and interviews were analysed in relation to the research questions.

3.10 Ethical Considerations

The study paid attention to the ethics of research. Before the study took off, the researcher wrote officially to the department to seek permission and a cover letter to start the study. The researcher also ensured that the information provided was used only for the purposes of the study. Again, in line with ethical principles in research, respondents' rights to self-determination, anonymity, confidentiality and informed consent were observed. The respondents were informed of their rights to voluntarily participate or decline in the study. They were informed about the purpose of the study and were assured of not reporting any aspect of the information they provided in a way that will identify them. They were assured that there were no potential risks involved in the process. Finally, plagiarism has become a thorn in the flesh of researchers these days. To this end, the researcher made references to works that are not the original work of the researcher. Such works were acknowledged for easy reference and also to make the study more credible.

CHAPTER FOUR

PRESENTATION OF RESULTS

4.1 Introduction

The scrap metal business is very important due to its environmental impacts. The scrap metal industry gathers waste scrap metals to ultimately produce a valuable raw material end product for use by the metal manufacturing industries. If the scrap metal industry did not exist, then there would be vast quantities of waste polluting our environment as well as an increased burden on primary resources. This study was conducted to assess the scrap metal management practices, with particular reference to the challenges and prospects of the trade.

This chapter of the study presents the discussion of results obtained from questionnaire administration. The discussion is done in accordance with the research objectives which consequently divides this section into four sub-sections. The first part talks about the demographic characteristics of the respondents of this study. The second part discusses the economic viability or profitability of the scrap metal trade in the study area whilst the third sub-section assesses the challenges faced by scrap metal dealers and collectors. The fourth and last part talks about the innovative and sustainable ways in which scrap metal can be managed to increase profitability and environmental safety.

4.2 Socio Demographic Background of Respondents

To gain a clearer understanding of the respondents' profile and their suitability for the study, the researcher collected demographic data on them. The demographic data collected was in terms of their gender, age, educational level, category of scrap dealing and number of years in the business. The demographic data also served as a basis for further discussions and subsequent recommendations.

Table 4.1: Demography of respondents

Variables	Frequency (*f*)	Percentage (%)
Gender		
Male	28	93.3%
Female	2	6.7%
Total	30	100%
Age (in years)		
Below 16 years	1	3.3%
16 – 20 years	3	10%
21 – 30 years	16	53.3%
31 – 40 years	8	26.7%
41 – 50 years	2	6.7%
Above 50 years	-	-
Total	30	100%
Educational Level		
No formal education	3	10%
Primary school education	5	16.7%
Junior high school education	19	63.3%
Senior high school education	2	6.7%
Tertiary school education	1	3.3%
Total	30	100%
Category of Scrap Dealing		
Scrap Metal Collector (SMC)	25	83.3%
Scrap Yard Owner/Dealer (SD)	5	16.7%
Total	30	100%
Number of years in the scrap business		
1 – 2 years	6	20%
3 – 5 years	7	23.3%
6 – 10 years	11	36.7%
11 – 15 years	4	13.3%
16 – 20 years	2	6.7%
Total	30	100%

Source: Field survey, 2017.

From the data presented in Table 4.1, the gender distribution of respondents reveals that 28 out of the 30 respondents representing 93.3% were males whilst only 2 representing 6.7% were females. This shows that the scrap metal trade is heavily dominated by males since it is considered a masculine job with heavy lifting and dangerous manoeuvers.

Similarly, from Table 4.1, the age information shows that only 3.3% with a corresponding frequency representation of 1 out of 30 respondents were below 16 years. Also, from the data, 3 respondents representing 10% wee aged 16 – 20 years whilst majority 16(53.3%) of respondents were reported to be in the age group of 21 – 30 years. Further, 8 respondents representing 26.7% were in the age group of 31 – 40 years with the remaining 2(6.7%) being aged between 41 and 50 years. No respondent was recorded to be above 50 years. This is an indication that, the respondents or scrap metal dealers are relatively youthful in age, probably due to the fact that the scrap metal business is tedious, dangerous and involves heavy lifting.

The educational level of respondents was sought which is presented as the third item in Table 4.1. From the data, 10% of respondents indicated that they had no formal education whilst 16.7% had primary school education. It is seen that, majority of respondents 63.3% had completed Junior high school education whilst 6.7% had senior high school education. Only one respondent representing 3.3% had tertiary school education. This information means that the educational level of respondents was relatively very low.

Respondents were asked what category of scrap dealing they were engaged in. In response to this, 25 respondents representing 83.3% were involved in scrap metal collection i.e. gathering waste scrap metal from the suburbs and homes which are subsequently sold to the scrap yard owners or scrap dealers. The remaining 5 respondents representing 16.7% were scrap yard owners who dealt with large scale buying, recycling or smelting of the scrap metals.

The number of years or experience of respondents in the scrap business was sought which is also presented in Table 4.1. From the table, 20% of respondents had been in the business for between 1 and 2 years whilst 23.3% had spent around 3 – 5 years in the scrap metal trade.

The majority of respondents, 36.7% had spent 6 – 10 years in the business whilst 13.3% had experience of 11 – 15 years. Further, only 6.7% had been in the business for about 16 – 20 years. It can be deduced from the above that respondents had moderate experience in the business of scrap metals and hence had a substantial amount of knowledge in the business.

4.3 Economic Profitability of Scrap Metal Trade in the Kumasi Metropolis

The scrap metal trade has a lot of benefits to the environment and also to the economy. In this regard, the researcher sought to find out the economic benefits that the scrap metal business offers those who are engaged in it, i.e. the scrap collectors and scrap yard owners or dealers. This information is presented in Tables 4.2 to 4.4 and are subsequently discussed.

Table 4.2: Sources of scrap

Responses	Frequency (*f*)	Percentage (%)
Homes	16	53.3%
Landfills/refuse dumps	2	6.7%
Industrial sites	3	10%
Streets	9	30%
Total	30	100%

Source: Field survey, 2017.

Table 4.2 sought to know the sources from which scrap dealers especially the collectors get their scrap for their business. The data shows that, 53.3% of respondents indicated that they get their scraps from homes. That is the metal parts of old and discarded equipment are sold to the scrap metal collectors or are sometimes just given them free of charge as a means of getting rid of the 'unwanted waste'. Also, 6.7% of respondents indicated that they get their scraps from landfill sites or refuse dumps where some of these old and discarded equipment with valuable metals still in them are disposed of. Further, 10% of respondents said they get their scraps from industrial sites with the remaining 30% indicating that their scrap sometimes comes from the streets where indiscriminate dumping of old machines and equipment are done. This is in consonance with Broni-Sefah (2012) who reports that homes are the major sources of scrap metals which can be salvaged by scrap metal collectors.

Table 4.3: Preferred scrap metal by collectors and dealers

		Responses		Percent of
		N	Percent	Cases
Type of scrap mostly preferred	Aluminium	19	22.6%	63.3%
	Copper	30	35.7%	100%
	Cast iron	3	3.6%	10%
	Steel	19	22.6%	63.3%
	Brass	9	10.7%	30%
	Lead	4	4.8%	13.3%
Total		84	100.0%	280%

Source: Field Survey, 2017

In Table 4.3, respondents were presented with a list of scrap metal options and were allowed to select all those that were applicable as being preferred most. In this case, one person could select more than one option. For instance, if a particular respondent preferred buying aluminium and copper, they were free to choose both options.

From the data in the table, the percentage of cases shows that all respondents 100% preferred to buy copper since it had the most value in terms of price followed by aluminium and steel each getting 63.3% of case responses. Lead scrap was also selected by 13.3% after which cast iron came next with 10% of respondents. This indicates that, the most valuable metals to scrap dealers were copper and aluminium followed by steel.

Table 4.4: Economic profitability of scrap business

Variables	Disagree		Agree		Mean
	f	%	*f*	%	($\bar{x}$)
I always get enough scrap metal for my activities	10	33.3%	20	66.7%	1.67
There are high financial rewards in the scrap metal business	19	63.3%	11	36.7%	1.37
The money I make from scrap dealings is enough to cater for myself and my dependents	22	73.3%	8	26.7%	1.27
People sell household scrap at exorbitant high prices	10	33.3%	20	66.7%	1.67
There are sometimes shortages of scrap metals reducing profitability	13	43.3%	17	56.7%	1.57
I will encourage my friend or family member to join me in the scrap metal business.	18	60%	12	40%	1.30

Source: Field survey, 2017.

In Table 4.4, respondents were asked how economically profitable the business was to them out of which responses are presented. From the table, 66.7% of respondents agreed that they get enough scrap metal for their activities with only 33.3% disagreeing. This indicates that there is enough supply of scrap metal for dealers and collectors to trade in.

As a follow up, respondents were asked whether there were high financial rewards in the scrap metal business. In response, it is seen that only 36.7% agreed to getting higher financial rewards whilst the majority of respondents, 63.3% disagreed. This is an indication that on the average, the financial returns that scrap metal dealers get from the business is not enough or encouraging at all.

Again, from the table 73.3% of respondents submitted that the money they make from scrap dealing is not enough to cater for themselves and their dependents whilst only 26.7% indicated otherwise.

On the issue of whether people sell their household scraps at high prices, only 33.3% disagreed whilst the remaining 66.7% agreed indicating that indeed, the scrap obtained from the homes are bought at expensive prices.

Further, respondents accepted that there are sometimes shortages of scrap metals reducing their profitability as 56.7% of them agreed to the assertion with the remaining 43.3% disagreeing.

Finally, in an attempt to find out whether respondents endorsed the business of scrap metal trade as lucrative or not, they were asked whether they would encourage friends or family members to join the scrap metal trade. To this question, 60% of respondents responded in the negative whilst 40% responded affirmatively. This goes to suggest that the scrap metal business is not all that profitable due to certain factors which can be considered as constraints, problems or challenges in the trade.

4.4 Challenges Faced by Scrap Metal Dealers and Collectors

As have been noted earlier in literature, the scrap metal business is faced with numerous challenges. As a result, the researcher asked from respondents the kind of challenges peculiar to their sector and has tabulated the responses in Table 4.5.

Table 4.5: Challenges faced by scrap metal dealers and collectors

Variables	**D**		**N**		**A**		**Mean**
	f	**%**	***f***	**%**	***f***	**%**	**($\bar{x}$)**
Transportation of scrap metals to scrapyards is expensive	7	23.3%	5	16.7%	18	60%	2.37
Collection and separation of scrap is tedious and risky	6	20%	5	16.7%	19	63.3%	2.43
No government regulations concerning scrap metal business	5	16.7%	2	6.7%	23	76.7%	2.60
Weighing of the scraps for sale are not always honest	6	20%	4	13.3%	20	66.7%	2.47
There is risk of injury (cuts, fractures) when dismantling equipment to retrieve metal parts	6	20%	2	6.7%	22	73.3%	2.53
Hazard of exposure to poisonous gases and corrosive substances	10	33.3%	4	13.3%	16	53.3%	2.20
There are no associations to fight for the interests of those engaged in the scrap business	11	36.7%	4	13.3%	15	50%	2.13
No specialized equipment to help in the sorting and separation of scrap to their constituent metals	6	20%	4	13.3%	20	66.7%	2.55
Lack of access to funding from banks	4	13.3%	5	16.7%	21	70%	2.57

Key: D = Disagree, N = Neutral, A = Agree
Source: Field survey, 2017.

The data presented in Table 4.5 is in the form of Likert scale with rating values of Disagree (D) = 1, Not sure or Neutral (N) = 2 and Agree (A) = 3. From the three point Likert Scale, mean values were computed a midpoint mean value of 2.0 selected (Cohen, Manion and Morrison, 2007). In this regards, variables with mean values less than 2.0 were regarded as rejected by respondents whereas variables with mean values greater than 2.0 were regarded as accepted by respondents.

The data from Table 4.5 indicates that respondents accepted all the variables presented to them as being limiting factors or challenges to the scrap metal business. For instance, regarding the transportation of scrap metals to the scrapyard centre, 60% of respondents agreed that it was expensive whilst 23.3% disagreed with 16.7% being unsure and hence remaining neutral. Further, 63.3% of respondents agreed that the collection and separation of scrap is tedious and risk whilst 20% disagreed. 16.7% respondents were however unsure.

On the issue of government regulations, as high as 76.7% of respondents agreed that there were no regulations concerning the scrap metal business with only 16.7% disagreeing and 6.7% were unsure.

Again, 66.7% of respondents agreed that weighing of the scraps for sale are not always hones coupled with unfair prices fixed by scrapyards and dealers. This was however disagreed by 20% of respondents whereas 13.3% were undecided.

Concerning the risk of injury (cuts, fractures, acid burns, etc), 73.3% of respondents agreed that there was a real threat of such injuries in the business whilst only 20% disagreed. In the same way, 53.3% agreed that there was the hazard of exposure to poisonous gases and corrosive substances in the scrap metal business with 33.3% disagreeing.

In the same vein, 50% of respondents opined that there were no associations to fight for the interests of those engaged in the scrap business especially the scrap collectors whilst 36.7% disagreed and 13.3% were not sure.

Another factor that was a constraint to the business of scrap metal dealing was the unavailability of specialised equipment to help in the sorting and separation of scrap into their constituent metals. This was accepted by 66.7% of respondents whilst 20% rejected this. Meanwhile, 13.3% were not sure of this assertion.

Respondents further agreed that there was the challenge of access to funds from the banks. This received an agreement percentage of 70% and disagreement of 13.3% whilst 16.7% were not sure regarding this matter.

It can be concluded from the foregoing discussion that the challenges of scrap metal dealers in the Kumasi Metro are many. Chief among them are the lack of access to funding, no government regulations, no specialised equipment to help in sorting and separating scrap, the risk of injury during collection of scrap and the inherently tedious nature of scrap collection and separation. Also, these challenges were accepted by respondents but on a lesser note; the high cost of transporting scrap metals to scrapyards, hazard of exposure to poisonous gases and corrosive substances, inexistence of associations to fight for the interests of stakeholders in the scrap business.

4.5 Measures to Improve the Scrap Metal Trade

Owing to the existence of a myriad of problems for scrap dealers and scrap collectors in the business, it has become prudent for stakeholders to institute measures that would help to improve the scrap metal trade and better the lives of stakeholders. The researcher sought from respondents what measures they think would improve the scrap metal trade which have been presented in Table 4.6.

Table 4.6: Measures to improve the scrap metal business

Variables	D		N		A		Mean
	f	%	*f*	%	*f*	%	($\bar{x}$)
Forming associations to fight for government support and recognition	2	6.7%	5	16.6%	23	76.7%	2.70
Enacting laws and legislations to regulate the scrap metal trade	4	13.3%	4	13.3%	22	73.4	2.60
Employing technology and modern equipment in the scrap metal trade	-	-	5	16.7%	25	83.3%	2.83
Providing education and technical know-how in the form of workshops to SMC and SD to improve their trade	3	10%	4	13.3%	23	76.7%	2.67
Providing safety equipment like jackets, boots, nose masks, etc to scrap metal collectors to improve their health	-	-	2	6.7%	28	93.3%	2.93

Key: D = Disagree, N = Neutral, A = Agree
Source: Field survey, 2017.

From Table 4.6 respondents accepted the variables presented to them as measures that could be employed to improve the scrap metal business. From the data presented and in order of importance, the provision of safety equipment like jackets, boots, nose masks, etc to scrap metal collectors was accepted by respondents. With a mean value of 2.93, respondents placed high priority to this factor.

In a similar manner and with a mean value of 2.83, respondents agreed that employing technology and modern equipment in the scrap metal trade would enhance their activities in the business. To this statement, 83.3% agreed whilst only 16.7% were not sure with no respondent disagreeing.

Also, respondents were of the opinion that forming associations to fight for government support and recognition would go a long way to help sustain the scrap metal business. With a mean value of 2.70, 76.7% agreed to this statement whilst 6.7% disagreed and 16.6% were not sure and hence remained undecided.

Respondents further accepted that the provision of education and technical know-how in the form of workshops to scrap metal collectors and scrap dealers would improve their trade. This statement received a mean value of 2.67 and percentage agreement of 76.7% whilst 10% disagreed and 13.3% were unsure. Finally, respondents accepted that there should be the enactment of legislation to regulate the activities and business of scrap metal collectors and buyers. The government should set standards in the pricing policy of scrap metals in order for scrap metal collectors not to feel cheated for all their hard work.

The above discussion reveals that respondents accept that the following measures, in their respective order, when instituted would improve their business; Providing safety equipment for scrap metal collectors, employing technology and modern equipment in the collection and separation of scrap, formation of associations to fight for their interests and government support, and the provision of education and technical know-how for SMC and SD to improve their trade.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This study was conducted in the Suame Magazine industrial area in Kumasi, Ashanti Region of Ghana to assess the scrap management practices, the challenges and the prospects. This chapter of the study is dedicated to the summary of findings from the study, the conclusion of the study, recommendations from the study and suggestions for further studies.

5.2 Summary of Key Findings

From the analysis carried out in Chapter Four of this study, various findings have been arrived at. The findings are presented in accordance with the objectives of the study.

5.2.1 Economic Profitability of Scrap Metal Trade in the Suame Magazine Industrial Area

Arising out of the analysis, it was found that among the scrap metal types collected by recyclers, copper was the most valued followed by aluminium, lead and brass in that order. However, it was found that the financial rewards of the trade to those engaged in it were not that high and couldn't support themselves and their dependents. There were sometimes shortages of scrap metals reducing their profitability in which regards respondents said they would not encourage their friends or family to join the scrap business.

5.2.2 Challenges Faced by Scrap Metal Dealers in Their Operations

On the challenges affecting the effective conduct of scrap metal operations, it was revealed that lack of access to funding, no government regulations, no specialised equipment to help in sorting and separating scrap, the risk of injury during collection of scrap and the inherently tedious nature of scrap collection and separation constituted the major challenges Also, these challenges were accepted by respondents but on a lesser note; the high cost of transporting scrap metals to scrapyards, hazard of exposure to poisonous gases and corrosive substances, inexistence of associations to fight for the interests of stakeholders in the scrap business.

5.2.3 Measures to Improve the Scrap Metal business in Kumasi Metropolis

It became evident from the analysis that, in order to improve the scrap metal business, stakeholders should provide safety equipment for scrap metal collectors, employ technology and modern equipment in the collection and separation of scrap, form associations to fight for their interests and government support, and provide education and technical know-how for SMC and SD to improve their trade.

5.3 Conclusions

Judging from the results obtained from the findings of the study, the following conclusions were arrived at;

1. **Economic Benefits of Dealing in Scrap Metals**

The metal extraction industry is considered destructive which expends a lot of energy in its operation. Therefore, it is highly beneficial economic wise and environmentally to recycle old and 'waste' metals which are already in the system. This is made possible through the recycling of scrap metals which is the business of scrap metal dealers and collectors.

2. **Challenges encountered in the Dealing of Scrap Metal**

Notwithstanding the beneficial nature of the activities of scrap metal operators, the field is bedevilled with challenges which need addressing. It has also been found in the study that, the trade is not all that lucrative for the operators especially scrap metal collectors. The challenges such as lack of government support and regulation, lack of access to funding, no specialised equipment, hazardous nature of the job and inadequate technical know-how could be counteracted by instituting measures such as; forming associations to fight for government support and recognition, enacting legislation to regulate the trade, employing technology and modern equipment in the scrap business and providing education and technical know-how for those engaged in the business.

5.4 Recommendations

The activities of the stakeholders within the scrap metal trade in Kumasi could help in solving the unemployment problems in Ghana if policies and strategies are in place. In light of this, the following points have been listed as recommendations for the improvement of the scrap metal trade in Kumasi.

- SMCs should acquire employable skills which they could use should they run out of scraps.
- A holistic approach should be put in place where all stakeholders have a part to play in streamlining the scrap metal trade in Kumasi and ultimately standardise scrap metal pricing.
- The working conditions of all the stakeholders in the scrap metal business should be improved in order to make the business attractive.

5.5 Suggestions for Further Studies

For the consideration of future researchers in the field, it is suggested that studies be conducted to determine the social and environmental impacts of the scrap metal trade in the Kumasi Metropolis.

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QUESTIONNAIRE

QUESTIONNAIRE FOR SCRAP METAL COLLECTORS (SMC) AND SCRAP DEALERS (SD) IN THE SUAME MAGAZINE AREA

PREAMBLE

I am an M. Tech Mechanical Technology student from the University of Education, Winneba. I am conducting a study on the topic scrap metal management practices in the Suame Magazine area of the Ashanti Region. Your inputs to this questionnaire is vital to the success of this study. You are assured of absolute confidentiality since this study is only for academic purposes. Please tick (✓) in the appropriate box to indicate your answer to each question.

SECTION A: BIO DATA

1. Sex

   Male [ ]   Female [ ]

2. Age

   Below 16 years [ ]

   16 – 20 years [ ]

   21 – 30 years [ ]

   31 – 40 years [ ]

   41 – 50 years [ ]

   Above 50 years [ ]

3. Education level

   No formal education [ ]

   Primary school [ ]

   Junior high school [ ]

   Senior Secondary school [ ]

   Tertiary school [ ]

4. What category of scrap dealing are you engaged in?

   Scrap metal collector (SMC) [ ]

   Scrap yard owner/dealer (SD) [ ]

5. How long have you been in the scrap business?
   1-2 years [ ]
   3-5 years [ ]
   6-10 years [ ]
   11-15 years [ ]
   16-20 years [ ]
   Above 20 years [ ]

SECTION B: PROFITABILITY OF SCRAP DEALING

6. Where do you get your scraps from?
   Homes [ ]
   Landfills/refuse dumps [ ]
   Industrial sites [ ]
   Streets [ ]

7. What type of scrap metals do you prefer buying most? (tick as many as apply)
   Aluminium [ ]
   Copper [ ]
   Cast Iron [ ]
   Steel [ ]
   Brass [ ]
   Lead [ ]

Please tick (✓) in the appropriate box to indicate the extent to which you agree or disagree to the following statements of economic viability of scrap trade.
Key: D = Disagree, A = Agree

No.	Statement	D	A
8	I always get enough scrap metal for my activities		
9	There are high financial rewards in the scrap metal business		
10	The money I make from scrap dealings is enough to cater for myself and my dependents		
11	People sell household scrap at high prices		
12	There are sometimes shortages of scrap metals reducing profitability		
13	I will encourage my friends and family to join me in the scrap metal business		

SECTION C: CHALLENGES FACED BY SCRAP METAL DEALERS IN KUMASI METRO

Please tick (✓) in the appropriate box to indicate the extent to which you agree or disagree to the following statements as challenges in the scrap business

Key: D = Disagree, N = Not Sure, A = Agree

No.	Statement	D	N	A
14	Transportation of scrap metals to scrapyards is expensive			
15	Collection of scrap is tedious and risky			
15	No government regulations concerning scrap metal businesses			
17	Weighing of the scraps for sale are always not honest			
18	There is risk of injury (cuts, fractures, etc) when dismantling equipment to retrieve metal parts.			
19	Hazard of exposure to poisonous gases and corrosive substances			
20	There are no associations to fight for the interests of those engaged in this business			
21	No specialised equipment to help in the sorting of various metals			
22	Lack of access to funding from banks			

SECTION D: MEASURES OF IMPROVING THE SCRAP METAL BUSINESS

Please tick (✓) in the appropriate box to indicate the extent to which you agree or disagree to the following statements of economic viability of scrap trade.

Key: D = Disagree, N = Not Sure, A = Agree

No.	Statement	D	N	A
23	Forming associations to fight for government recognition and support			
24	Enacting laws and legislations to regulate the scrap metal businesses			
25	Employing technology and state of the art equipment in the business of scrap metals			
26	Providing education and technical know-how in the form of workshops to scrap metal dealers on how to improve their trade			
27	Providing safety equipment like jackets, boots, nose masks to scrap collectors to improve their health in the business.			