# NEEDED IMPROVEMENT IN THE COMPETENCY OF FOUNDRY CRAFTSMEN IN THE RECYCLING OF METAL SCRAPS IN MINNA TOWN, NIGER STATE

**BY**


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**MATRIC No. 2007/27293BT**

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**FEDERAL UNIVERSITY OF TECHNOLOGY MINNA,**

**NIGER STATE**


**OCTOBER, 2012**

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**A RESEARCH PROJECT SUBMITTED TO THE**

**DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION,**

**SCHOOL OF SCIENCE AND SCIENCE EDUCATION,**

**FEDERAL UNIVERSITY OF TECHNOLOGY MINNA,**

**NIGER STATE**

**IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE AWARD OF BACHELOR OF TECHNOLOGY (B.TECH) IN INDUSTRIAL AND TECHNOLOGY EDUCATION**

**OCTOBER, 2012**

## CERTIFICATION

I Ike,Tochukwu Ifeanyi, Matric No 2007/1/27293BT,an undergraduate student of the department of Industrial and Technology Education certify that the work embodied in this project is original and has not been submitted in part or full for any other diploma or degree of this or any other University.

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Name Signature

# APPROVAL PAGE

This project has been read and approved as meeting the requirements for the award of B.Tech degree in Industrial and Technology Education of the Department of Industrial and Technology Education, School of Science and Science Education, Federal University of Technology, Minna.

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Supervisor Sign-Date

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HOD Sign-Date

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External Examiner Sign-Date

## DEDICATION

The project is dedicated to God almighty for his immeasurable care, love, abundant provision and protection for the programme.

To my mother for bringing me up in an atmosphere out of ignorance. And also to my beloved sister, relatives, friends, well-wishers and the needy and oppressed who suffer the inhumanity of man.

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I also acknowledge Mall. A. B. Kagara for his contributions and guidance towards the realization of this project. My gratitude also goes to Mr. I. K.Kalat towards the success completion of this project.

My appreciation also goes to my father Mr. Samuel Agbapu for his assistance throughout my life and my programme in the university. I express profound gratitude and appreciation to my mother Madam Eunice Agbapu for her support throughout my life so far. Mummy you have been the back bone of my existence and have given greatly even at the expense of your life to ensure my success in life. I love you all but God loves you most. May God Almighty never forget you in all your endeavours. Thanks to God that you see this day.

My sincere acknowledgement goes to Mr. Fidelis and his family members for ensuring my entrance into the university and guidance throughout my programme as an undergraduate. I say may the Almighty God bless you and your family abundantly, Amen.

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# ABSTRACT

The study was designed to determine the needed improvement in the competency of foundry craftsmen in the recycling of metal scraps in Minna town, Niger state. The study was designed to determine the needed improvements in the competency of foundry craftsmen in the recycling of metal scraps, to determine the possible challenges faced by foundry craftsmen to recycle metal scraps, to determine the strategies that can enhance effective recycling of these metal scraps. Three (3) research questions and two (2) null hypotheses were formulated to guide the conduct of the study. A survey research design was adopted for the study. A total of forty (40) respondents consisting of fifteen (15) master craftsmen and twenty five (25) technical teachers were used as a population for the study. A forty one (41) items questionnaire developed by the researcher and validated by three (3) experts from Industrial and Technology Education Department was used for the data collected for the study. Data collected was analyzed using mean, standard deviation and t-test statistic.The null hypothesis was tested at 0.05 level of significance and 38 degree of freedom. The finding revealed that there is no enough training for the craftsmanship and that many craftsmen don't have standard machine tools for recycling of metal scraps. Based on the findings, it was recommended among others that regular practical workshop training should be organized by the Government for local foundry craftsmen and the National Directorate for Employment (NDE) and Youth Employment Scheme (YES) should provide more training, certification and soft loans for local craftsmen.

# CHAPTER I

# INTRODUCTION

## Background of the Study

From the creation of man to this point in time, there has being improvement in the standard of living which includes kinds of foods and how they are prepared, means of transportation and communication, style of dressing, kinds of shelter, and even energy. These improvements were achieved due to the invention of technology. Before now, materials used technologically in the improvement of standard of living are being wasted when faults are noticed in them.

Technology has really helped man in minimizing these wastage of materials for example, technology brought about means of food preservation like the use of refrigerator, technology also brought about the recycling of metal scraps which could be faulty metallic plates, spoons, pots, used tins and cans, defaulted automobile parts, electrical parts and engine parts generally. Mdurwa, (1993) stressed that with time even the highest quality product becomes a scrap as a result of wear and tear or damage following the natural cycle of growths bloom and decline. In our everyday life we use metals in one way or the other, at a time these metals gets defaulted, which would make it useless to us, but technology brought about the recycling of these metals. Historically, waste was not viewed as a social problem. Prior to the 1890s, it was often seen as a potential source for the future, as the junk could be sold, given away, or used as spare parts.

An increased population brought about the demand for urban land, which was needed for factories and for housing the new workers who migrated to the cities seeking jobs. Thus, population densities increased, with people living closer to one another than ever before. In essence, this created a “friction of space.” The “backyard” virtually disappeared. People found their neighbours’ wastes less acceptable. People's wastes could not be segregated from the living spaces of others, nor were they as easily segregated from people's own living spaces (Oyinlola 1994). Apart from that, the disposal of these materials have not only disturbed man’s settlement or search for land, it has also caused pollution to the environment and the ozone layer as a whole. According to the 3Rs of saving the environment – Reduce, Reuse and Recycle, man has tried to reduce the use of unnecessary metal, tried to reuse it as scrap and the main one to be accepted is recycling. The question what is recycling then comes to play in the mind.

Recycling is processing used materials (waste) into new products to prevent waste of potentially useful materials, reduce the consumption of fresh raw materials, reduce energy usage, reduce air pollution (from incineration) and water pollution (from landfilling) by reducing the need for “conventional” waste disposal, and lower greenhouse gas emissions as compared to virgin production. (Wikipedia)

**Steps to Recycling a Product**

Recycling includes collecting recyclable materials that would otherwise be considered waste, sorting and processing recyclables into raw materials such as fibres, manufacturing raw materials into new products, and purchasing recycled products. Collecting and processing secondary materials, manufacturing recycled-content products, and then buying recycled products creates a cycle or loop that ensures the overall success and value of recycling.

- Collecting recyclables varies from community to community, regardless of the method used to collect the recyclables. Recyclables are sent to a materials recovery facility to be sorted and prepared into marketable commodities for manufacturing. Recyclables are bought and sold just like any other commodity, and prices for the materials change and fluctuate with the market.

- Once cleaned and separated, the recyclables are ready to undergo the second part of the recycling loop. More and more of today's products are being manufactured with total or partial recycled content. Common household items that contain recycled materials include newspapers and paper towels, aluminium, plastic, glass, and steel cans. Recycled materials are also used in innovative applications such as recovered glass in roadway asphalt or recovered plastic in carpeting, park benches.
- Purchasing recycled products completes the recycling loop. By "buying recycled products," governments, as well as businesses and individual consumers, each play an important role in making the recycling process a success. As consumers demand more environmentally sound products, manufacturers will continue to meet that demand by producing high-quality recycled products (U.S. environmental protection agency 1992).

These defaulted objects made from metals when they are no more useful are referred to as metal scraps. Metal scrap is any metal object or remnant that has been rendered as waste because of age or a variety of other factors.

For every work done, there is always a place where the work piece is prepared which is the workshop. This brings us to where these metal scraps are being recycled which is the foundry and specialists in the field are called the foundry craftsmen. Therefore foundry is an industrial plant where metals are cast and shaped for use as everyday products, such as bathtubs, cooking pans and automobile parts. There are several methods for casting metal, and several types of foundry workers are involved in the process. Many foundry workers work for independent foundries, while others find on-site work within industries like automobile manufacturing. Metals are cast into shapes by melting them into a liquid, pouring the metal in a mould, and removing the mould material or casting after the metal has solidified as it cools. The most common metals processed are aluminium and cast iron. However, other metals, such as bronze, steel, magnesium, copper, tin, and zinc, are also used to produce castings in foundries. (Kohser, 2003).

**Statement of the Problem**

A lot of engineering material wastes such as obsolete equipment, light and heavy vehicles or their components end up abandoned and left to deteriorate on our major roads. Eleke, (2001) lamented that apart from environmental abuse and eye sore caused by these products, many ghastly motor accidents that have terminated the lifes of Nigerians have occurred as a result of these vehicles abandoned on our roads. Importantly disposed industrial waste is not only an eye sore, but leads to the environment getting chemically polluted as a result of oxidation processes taking place especially on the metallic scraps.

A small proportion of metallic scraps are recovered by scavengers from dump sites. These are sold to artisans, who either reshape them into simple tools and implements or refurbish them for sales. Some of these craftsmen scavenge for beverage and food tins and cans. They recycle these products into domestic products such as local lamps, and flour sieves. In as much as the efforts of these men be commended, it is important to state that in most cases the refurbished components fail shortly after being refitted into use or at best only dismal performance can be expected from it. The reason for this is not far-fetched as these craftsmen are not in any way trained (Atsumbe, 2004).

Experience has shown that the recycling of these metals is done by foundry craftsmen whereby the quality of their products is determined by their competency. Competency from the oxford learned dictionary sixth edition is defined as the ability to do something well. Logically you can’t do something well if you can’t overcome or face possible challenges in doing that thing. So with the knowledge of this, competency can be defined as the ability to face possible challenges or problems in doing something well.

**Purpose of the Study**

The general purpose of this study is to identify the competency of foundry craftsmen and the improvement needed for a better output to be achieved in the recycling of metal scraps in Minna town Niger state. Specifically this study is to:-

1. Determine the needed improvement in the competency of foundry craftsmen in the recycling of metal scraps.
2. Determine the possible challenges faced by foundry craftsmen to recycle metal scraps.
3. Determine the strategies that can enhance effective recycling of these metal scraps

**Significance of the Study**

This study when successfully completed will be a guide to local craftsmen particularly in the competency of recycling metal scraps and also widening their awareness of their major problems in the process of recycling.

Having such waste products in any form and shapes everywhere in the street, around the homes, within the industrial premises, and even dumped in the rivers and canals which causes serious hazard and resulting in getting the environment chemically polluted as a result of oxidation process taking place especially on the metallic scraps which are washed off and contaminating surface and underground water, with devastating effects on plants, animals and even human lives. When waste products are effectively utilized will reduce to the bearest minimum and the problems of environmental deterioration and the reward goes to the society.

The study is also of benefits to the government as it helps in the regulation of waste disposal and also in the reduction of importation of these products while the same standard imported can be produced in the country. It will at the same time educate the general public and the government about the usefulness of metal waste.

The study will also help in the employment opportunities which is one of the social problem facing Nigeria as a whole and Minna in particular

The result of these findings will also encourage the further research of more ways to better the performance of foundry men just as mans’ standard of living increases by the day.

**Scope of the Study**

This study is delimiting to the competency of foundry craftsmen in the recycling of metal scraps and the needed improvements in Minna town of Niger state. This study will not cover an assessment of other places where metals are being recycled apart from Minna town Niger state.

**Research Questions**

The following question guides this research project:-

1. What are the needed improvements in the competency of foundry craftsmen in the recycling of metal scraps?
2. What are the possible challenges faced by foundry craftsmen to recycle metal scraps?
3. What are the strategies that can enhance effective recycling of these metal scraps?

**Hypotheses**

The following hypotheses were formulated and tested at a 0.05 level of significance.

Ho1: There is no significant difference between the mean responses of technical teachers and the foundry master craftsmen on the competency and challenges of foundry craftsmen in the recycling of metal scraps in Minna town, Niger state.

Ho2: There is no significant difference between the mean responses of technical teachers and the foundry master craftsmen on the needed improvement in the competency of foundry craftsmen and the strategies to enhance effective recycling of metal scraps in Minna town, Niger state.

**Assumption of the Study**

The following assumptions were made in carrying out the study

1. The foundry craftsmen in charge of the recycling of metal scraps were sincere enough to respond objectively to the items on the instrument administered to them.
2. Responses from the respondents provided valid information for realistic decision about the competency of foundry craftsmen and whether there is any needed improvement

# CHAPTER II

## REVIEW OF RELATED LITERATURE

The review of the related literature is organised under the following sub-headings.

- Early history of metal casting in Nigeria.
- Concept of foundry operation.
- Competency of foundry craftsmen.
- Possible challenges in recycling metallic scraps.
- Strategies for development of local foundry craftsmen.
- Summary of the review.

**Early history of metal casting in Nigeria**

The early history of metal casting in Nigeria, could be described as somehow an accidental discoveries, which brought to light by a great deal of ancient cultural heritage of the people of Nigeria. Literature review on the issue clearly showed that the artistic and scientific creativity of these cultures make the people of this subcontinent the proud owners of this historical discovery (Mannir, 1997).

Another history stated that, the famous Nok coupled with the societies of Igbo-Ukwu and Hausa, made the cultural discoveries and archaeological findings that clearly demonstrated the people of Nigeria are associated with the earliest iron smelting in Africa. Ife and Benin developed centralized institutions that supported the development of art, especially in terracotta, brass, bronze and iron castings. The west of the Jos Plateau between the rivers, Niger and Benue, in the northern part of Nigeria, lays the Nok valley. The first discoveries of the Nok came accidentally during tin mining of this area according to Shaw. Open cast mining methods were employed to extract tin from gravels. During the course of these operations in the Nok valley before and during World War II, a number of recognizable archaeological objects had been turned out (Thurston, 1998). Some of these objects included the terra-cottas, the alluvial deposits, perforated quartz beads, tin beads, places of iron smelting furnaces, iron slag, clay draught pipes of furnaces, and quantities of foundry tools.

It is well known from the literature, that the people south of the Sahara were the earliest iron smelters due to the pieces that were discovered. The various furnaces and iron slag, including the tuyeres, clay nozzle for bellows, clearly demonstrated that they were very advanced in this technology. A radiocarbon date of 500 B.C. is claimed for the Nok, and they may have started as early as 900 B.C (Thurston, 1992). The Igbo-Ukwu is a town south of Onitsha in Anambra State of Nigeria. Like most major archaeological discoveries of Igbo-Ukwu, it was accidental. In 1938, a man named Isaiah Anozie was digging a pit to use for collecting rainwater at the back of his house. In so doing, he comes across a series of bronzes that were lying about two feet below the ground. Further excavation on the compound of Isaiah's brothers, Jonah and Richard Anozie, produced different and more sophisticated bronze works (Thurston, 1992). All the objects recovered were intricately designed and made with a complete mastery of lost wax casting (Shirley, 1999).

The actual of where and how the Igbo-Ukwu bronzes and technique to make them entered this society could not be proved by the history, and is one of the enigmas of Nigeria art history. Bronze is an alloy of copper and contains a much smaller quantity of tin. Brass is an alloy of copper and zinc. The 1gbo-Ukwu castings are of bronze, with an admixture of lead, while the objects not cast by the lost wax process, but made by smelting and chasing are of almost pure copper. This can only show that the ancient craftsmen of Igbo-Ukwu had significant knowledge of metallurgy to know that leaded bronze is more ductile than copper and is better for casting, while copper can be more easily hammered, twisted and engraved than bronze. The 1gbo-Ukwu bronze castings have been dated to the ninth century A.D., but there is evidence which suggests that it might have been in the 15th century.

In addition to these, the lfe discoveries, or more properly, Ile-Ife, have been important to city for the Yorubas, Western part of Nigeria. The first attention to the cultures in this part of the country was in 1910 - 1911, when the Gennan ethnographer, Leo Frobenius, discovered evidence of an ancient art tradition in terra-cotta and bronzes (Daudal, 2002).

The early discoveries of these terra-cotta and bronze heads were of a remarkable naturalistic style showing a high standard of creativity of the people. Nearly 40 years after this discovery, lfe built a modern foundry, made by a sand mould technique and not lost wax as in the case of Igbo-Ukwu. It is not known exactly when lfe art began to develop, but radiocarbon dates for the fully developed art range between the 11th and 15th centuries. The Benin works of art now reside in a famous city in Bendel state of Nigeria (Thurston, 1998). The Benin bronzes and brass are better known than those of either lfe or 1gbo-Ukwu. Evidence of this is that an ancient Benin bronze cast mask was the symbol for the 1977 World Black Festival of the Art that took place in Nigeria in 1977. Their popularity is both because they are more numerous and because they have been known to the world outside Nigeria for a longer time and can be seen in mediums both in Europe and America.

The people of Benin works of art and stylish castings have been very remarkable and much has been written about them by Europeans who were intimately connected with the history of the ancient Benin City. Whether this founding art of Benin actually vanished from Ife to Benin is not yet known, but there is no significant bronze industry in Ife today. This is in contrast with the situation in Benin were craftsmen continue to produce bronze and brass sculpture for the tourist industry (Thurston, 1998). However, excavations at Owo between Ife and Benin have revealed the contemporaneous presence there of an art showing both the Ife and Benin style, in time range radiocarbon dated to the 14-15th centuries. Thus it can be seen that there is an Ife-Benin connection in art and casting.

Also in the coast of the Niger River, west of the Benue Plateau, there exist some significant bronze discoveries. Certain iconology graphic motifs shared by the Benin and the Tada bronze may indicate influences exercised on the Benin bronze during the 16th century by some, as yet unidentified, northern industry. Similarities in the technique employed between Ife bronze and Tada bronze, such as the unification of the core and mould to achieve stability during casting, would seem to indicate a connection (Thurston, 1978).

Concerning this historical background review of the ancient foundry men in Niger state Nigeria, may have to believe that with the significant iron smelting of Nok culture, and the highly creative brass, bronze castings of Igbo, Ife and Benin, etc., the Niger State Nigerian ancient craftsmen had developed sophisticated articles obtained by the people of this sub-continent.

Metal Casting work or foundry, is basically the easiest way to shape metal with practically no limitations, simply melting it in a furnace and pouring the liquid metal into prepared moulds where it solidifies into the cast shape required (Samin, 2005). Metal casting is needed for vital basic industries which would utilize the available raw materials and by-products in the country for the manufacturing processes, and hence form the basis for further industrial development.

A survey literature of the Economic Conditions in Nigeria's Minerals production has revealed that the country is endowed with vast mineral resources that could form a solid framework for gigantic metal industries that are needed in the country (Abraham, 2007).

Among the mineral potentials mentioned are bauxite, diamond, and iron ore, all of which are deposited at Kebbi with an estimated reserve of two billion metric tons. Other, smaller deposits of these minerals are found between Enugu and Nsukka. In addition, lead and zinc are found in the Abakalike area, and about five to eight billion metric tons of limestone is located in Kankara Katsina State (Ziya, 2008).

Other equally important minerals for the metal industry that are available include kaolinite with an estimated reserve of 250 million cubic meters, fire clays with an estimated 800 million cubic meters, and natural gas oil reserve with approximately two billion tons. These deposits and figures are based on the 1987-1991 survey of economic condition in Nigeria (FMMP, 1991).

A United Nation's special study publication on iron and steel demand in Nigeria revealed that, as a result of the rapid increase in reinforced concrete used in building construction, growth of steel imports for building rose from 13,000 tons in 1987 to about 60,000 tons in 1997.

Galvanized steel sheets of iron and steel, used to make household utensils and metal furniture and fixtures, are imported in very large quantities (UNIDO, 1999). This UNIDO publication concluded that the increasing volumes of imported iron and steel components and materials raised the possibility of a national iron and steel project to produce some of these items. The different iron and steel complexes in Ajakuta and Warri, and the steel rolling mills of Katsina and Jos, are remarkable worthwhile industrial programs. Also, it has been shown that the main burden of industrial development in Nigeria remains with the private sector, which has not had the financial resources in the past years. According to a publication by Davis on Nigeria's option for long-term development, it is very important that the local manufacturers are industrialized (Davis, 1990).

**Concept of foundry (casting) operation**

There are various method of casting metal which are the sand casting, die casting, lost-foam casting, investment casting, plaster casting, v-process casting and the billet (ingot) casting. This study shall be treating the sand casting process which is the common casting process practiced.

The sand casting process is the oldest method of making an intricately shaped component in metal, yet still extensively used today, often proving to be the cheapest method of production.

Basically a sand casting is produced by pouring molten metal into a non-permanent sand mould prepared with the aid of a suitable pattern. When the metal cools and solidifies, the casting is extracted by breaking away the mould; hence a new mould is required for each casting. Sand castings can be made from a variety of materials; the most commonly used include cast iron, brass and other copper alloys, aluminium and magnesium alloys. Castings in steel are very limited because of their high melting temperatures and related contraction problems.

During recent years many sand foundries have been fully mechanised, transforming what was previously a crude art into a controlled science. Despite this, however, the basic principles of the process remain unchanged.

1. Pattern making
2. Mould making
3. Melting
4. Pouring
5. Shakeout

6. De-gating
7. De-gassing
8. Surface cleaning
9. Finishing

**Patterns making**

Patterns for small repetition work are frequently made in metal, but the bulk of patterns are made in wood which although not as durable as metal is relatively cheap, of light weight, more easily worked, and easier to modify if this should be required. Other materials used in making the patterns are wax and plastic.

The two types of wood used for making patterns are yellow pine and mahogany, the latter being more expensive but are more durable. These patterns make only a limited number of castings, possibly fifty to a hundred, after which they need repair or replacement.

The pattern is a replica of the required casting, but all its dimensions are made slightly larger than those of the casting to allow for the contraction which takes place when the hot metal solidifies in the mould. Accordingly the pattern maker employs a special rule known as a contraction rule, but since the contraction allowance varies with different materials, he will select the rule appropriate for the material from which the casting is to be made. The normal contraction allowances are cast iron 8mm per metre, brass 15mm per metre, aluminium 13mm per metre. Simple designs can be made in a single piece of solid pattern; more complex designs are made in two parts called split patterns. A split pattern has a top or upper section called a cope and the bottom or lower section called a drag. Both solid and split patterns can have cores inserted to complete the final part shape. Where the cope and drag separates, is called parting lines.

Machining allowances must also be incorporated in the pattern dimensions on all surfaces which will require subsequent machining. It is essential that the pattern be constructed in such a manner that it can be withdrawn without causing damage to the mould impression, therefore a slight taper or ‘draught’ is provided on pattern faces where necessary. Many pattern arcs made in sections with additional loose pieces for bosses, etc. dowel pins register the various sections.

**Mould making**

There are various kinds of mould making, which are the;

1. Open sand moulds
2. Closed sand moulds
3. Green sand moulds
4. Dry sand moulds

1. Open sand moulds: An open sand mould is the simplest form of mould. Merely a depression formed in a level bed of sand in the foundry floor into which molten metal is poured and allowed to solidify. Open sand moulds are only used for making very simple castings requiring no great accuracy on the upper face, as this will be quite rough. Typical examples might include castings for manhole covers or drain grids.
2. Closed sand moulds: Most sand moulds are made in metal moulding boxes or flaxes. The bottom box is known as the drag, and the top box as the cope. These two boxes are registered by locating pins which fit into lugs on each side of the box. During the

actual pouring the two boxes are locked together by means of keys which are driven into slots in the locating pins. The large boxes have transverse webs or ribs which strengthen the box, and also help to 'key' the stand of the mould.

3. Green sand moulds: green sand mould is the name given to a mould which is made from sand in its natural or 'green' state, i.e. damp, still containing moisture. Green sand moulds are commonly used for small and medium-sized ferrous and non-ferrous castings.

4. Dry sand moulds: Dry sand mould refers to a mould which is artificially dried before the molten metal is poured into it. The small moulds may be dried in an oven, while the large moulds made on the shop floor are skin-dried by coke braziers or by gas torches. These moulds are much stronger than green sand moulds and are generally used for the larger and more complicated castings. Less steam is given off during pouring so reducing the possibility of blowholes in the final casting.

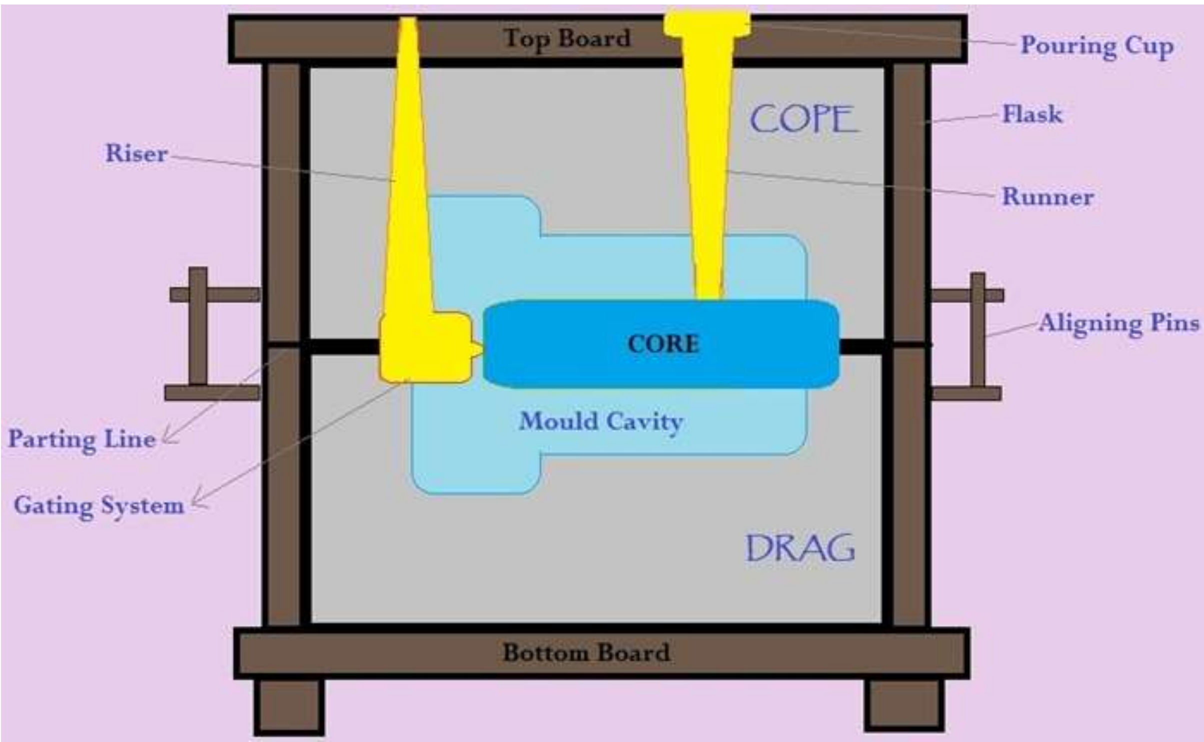


Fig 1

**Melting**

Melting is performed in a furnace. Virgin material, external scrap, and alloying elements are used to charge the furnace. The process includes melting the charge, refining the melt, adjusting the melt chemistry and tapping into a transport vessel. Refining is done to remove deleterious gases and elements from the molten metal.

**Pouring**

In a foundry, molten metal is poured into moulds. Pouring can be accomplished with gravity, or it may be assisted with a vacuum or pressurized gas. Many modern foundries use robots or automatic pouring machines for pouring molten metal. Traditionally, moulds were poured by hand using ladles.

**Shakeout**

The solidified metal component is then removed from its mould. Where the mould is sand based, this can be done by shaking or tumbling. This frees the casting from the sand which is still attached to the metal runners and gates which are the channels through which the molten metal travelled to reach the component itself.

**De-gating**

De-gating is the removal of the heads, runners, gates and risers from the casting. Runners, gates, and risers may be removed using cutting torches, band saws or ceramic cut-off blades. For some metal types, and with some getting system designs, the spur, runners and gates can be removed by breaking them away from the casting with a hammer or specially designed knockout machinery.

## Degassing

In the case of aluminium alloys, a degassing step is usually necessary to reduce the amount of hydrogen in the liquid metal. If the hydrogen concentration in the melts is too high, the resulting casting will contain gas porosity that will deteriorate its mechanical properties.

## Surface cleaning

After de-gating, sand or other moulding media may adhere to the casting. To remove this, the surface is cleaned using a blasting process. This means a granular media will be propelled against the surface of the casting to mechanically knock away the adhering sand. The media may be blown with compressed air, or may be hurled using a shot wheel. The media strokes the casting surface at a high velocity to dislodge the moulding media (e.g. sand, slag) from the casting surface. Numerous materials may be used as media including steel, iron, other metal alloys, aluminium oxides, glass beads, walnut shells, baking powder among others. The blasting media is selected to develop the colour and reflectance of the cast surface.

## Finishing

The final step in the process usually involves grinding, sanding, or machining the component in order to achieve the desired dimensional accuracies, physical shape and surface finish. Removing the remaining gate material called a gate stub is usually done using a grinder or sander. These processes are used because their material removal rates are slow enough to control the amount of material removed. These steps are done prior to any final machining.

Types of sand

1. Facing sand
2. Parting sand
3. Moulding sand

1. Facing sand

   Facing sand is a find grade of sand consistent for grain size, highly refractory, and specially mixed for the purpose of withstanding the action of the molten metal. This type of sand is used against the face of the pattern, and will therefore form the surface of the mould and finally govern the surface finish of the casting.

2. Parting sand

   Parting sand is used to preserve the joint face between the cope and the drag and prevents the two lots of sand from adhering to each other. It consists of a mixture of burnt sand and bone dust which does not become damp or sticky.

3. Moulding sand

   The moulding sand or 'floor sand' is the main body of sand which is used to fill in the mould at the back of the thin facing layer. The two types of moulding sand are:-

   a) Natural sand, i.e. sand containing the silica grains and clay bond as found therefore varying in grain size and clay content. Main sources of supply are Erith, Mansfield, Belfast, and Clyde.
   b) Synthetic sand, i.e. sand composed of washed and graded silica grains, with the desired type and amount of clay bond added.

Good moulding sand must be:-

i. Cohesive, i.e. ability to retain shape of impression after the removal of the pattern and during pouring and solidifying.
ii. Refractory, i.e. withstand the heat of the molten metal without fusing.
iii. Permeable, i.e. porous enough to allow gases evolved during pouring to escape.
iv. Strong, i.e. strong enough to support the weight of hot metal and necessary sand cores.

The important qualities in the sand are:-

a) Size and shape of the silica grains; this affects the porosity of the mould.
b) Moisture content; adequate moisture is necessary to give a good bond. But excess moisture lowers porosity, and blowholes in the casting may result. Too little moisture makes the mould liable to crumble and thus difficult to finish. Moisture content should be about 4-8%.
c) Amount and type of clay bond; an average figure being between 2 and 6%. The clay should be fine particle clay, e.g. colloidal clay or fuller's earth.

**Making a two-part mould (solid casting)**

Casting could be conveniently made by the following sequence of operation:-

1. The flat face of the pattern is placed on a turnover board and a suitable size moulding box (drag) is placed over it. Smooth facing sand is sprinkled over the pattern; a quantity of moulding sand is then added and is rammed tightly around it the pattern. Additional moulding sand is added and the ramming repeated until the drag is full. The surface of the sand is then trimmed off (stickled) level with the edges of the box.

This ramming operation requires both skill and experience; if the sand is too loose a bad impression is obtained; if too tight the gases generated when the metal is poured cannot escape, resulting in a defective casting.

2. The drag is inverted and the joint surface is sprinkled with parting sand. The top box (cope) is placed in position above the drag and the two boxes are registered by locating pins. The cope is now rammed with moulding sand. Two conical wooden plugs form the down-gate and the riser channels. After ramming the cope, it should be vented to allow an escape for the hot gases. Vents are made by pushing a small diameter wire down through the sand until it nearly reaches the pattern.
3. The two boxes are separated and the pattern loosened in the impression by rapping. To assist rapping, a metal spike may be stuck into the pattern or a screwed rod inserted in the special bush provided in the face of the pattern. After rapping, the pattern is carefully withdrawn from the mould. A feed-gate is cut by hand in the joint face of the drag. If molten metal were fed directly into the mould cavity, its surface would be damaged. The mould is now painted with blackwash or dusted with lumbago to protect the mould surface and to give a smooth skin on the casting. The conical wooden plugs are removed from the cope, which is replaced in position on the drag and firmly secured by the locating pins. A pouring bush is placed over the down-gate channel and the completed mould is now ready to receive the molten metal.
4. The molten metal is poured into the mould and allowed to solidify. When cool, the two boxes are separated and the casting. The casting is now fettled before inspection; if satisfactory, it is sent to the machine shop.

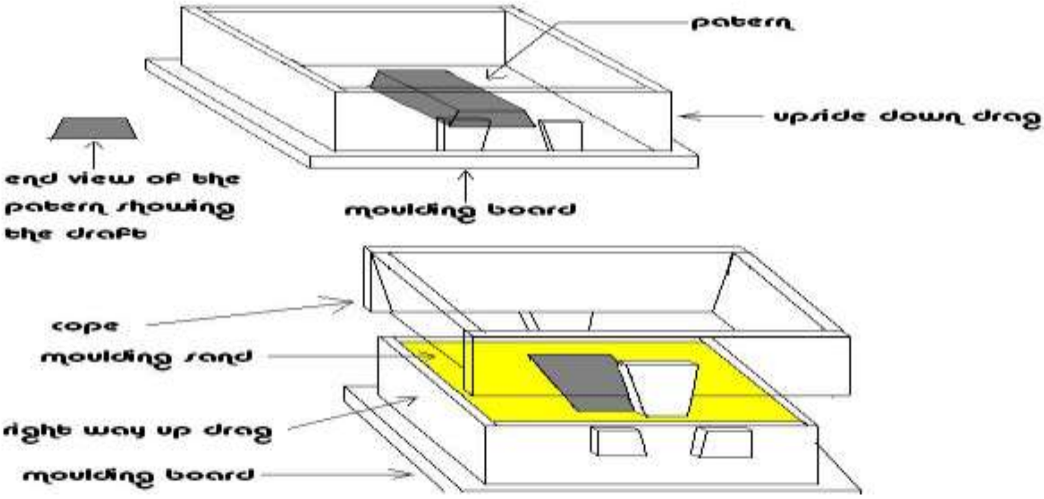


Fig 2

**Competency of foundry craftsmen**

Pots and pans, bathtubs, and automobile engine blocks are among the many kinds of products made by casting metals in foundries. There are several methods of shaping metals. The method used depends on the kind of metal and the intended use of the finished product. Casting is a relatively simple and inexpensive method that can produce intricate shapes and that can be easily adapted to the techniques of mass production. Metal is cast by heating it until it is a liquid and then pouring it into a specially prepared mould. As the metal cools, it becomes solid and takes on the shape of the mould.

Many workers in this industry are employed by independent foundries that make and sell castings to other manufacturing companies. Manufacturing companies that makes finished products also employ foundry workers. For example, automobile manufacturers have their own foundries that make engine blocks, crankshafts, and other parts for motor vehicles.

There are several ways to cast metal. The most popular method is sand moulding. Workers using this method pack special sand around a pattern in a box called a flask. The flask is usually made in two parts, one for each half of the finished product. The pattern is removed, and molten metal is poured into the hollow made by the pattern in the sand. The hardened metal is removed once it has cooled. If the product is made in two parts, they are joined together using specials pins and bushings. Other methods of casting use metal or ceramic moulds or shells made of sand and resin. Sometimes metal is cast dies or by spinning it at high speeds.

Several kinds of foundry workers are involved in the casting process. Once a casting has been designed and a blueprint has been drawn up, highly skilled patternmakers prepare a wood or metal pattern in the exact shape of the casting. Most patternmakers prepare metal pattern using a variety of hand tools and metalworking machines. A few patterns are still made from wood. Wood patternmakers use hand and machine tools, glue, screws, and nails.

Next, sand mixers prepare special sand, which the pattern moulders pack around the pattern to make a mould. Machine moulders or hand moulders pack the sand. Bench moulders are hand moulders who make moulds for small castings. Floor moulders are hand moulders who make moulds for large, bulky castings. Moulders form the largest group of workers in the foundry industry.

Core makers fill patterns with sand to make cores. Cores are solid forms that shape the hollow inside castings. Like moulders, core makers work either by hand or with machinery. Core makers who work by hand may be known as bench core makers or floor core makers, depending on the size of the cores that they make. More and more cores are being made by machine. Operators of these machines are known as machine core makers. Most cores are baked in ovens by core oven tenders. Baking hardens and strengthens the sand cores. The cores are then placed in moulds by moulders or by workers called core setters. Furnace operators control furnaces that heat and melt the metal that is to be cast. Pourers regulate the flow of the metal into the sand moulds.

Once the metal has cooled into solid castings, shakeouts workers take the castings out of the sand. The rough castings are sent to the cleaning and finishing department. Workers use several different processes to clean and smooth the castings. Shot blasters, or shot blast equipment operators, run machines that blast large castings with a mixture of air and metal shot or grit. Tumbler operators place smaller castings in revolving barrels with sand or a similar rough material. Chippers and grinders use hand tools and power chisels, files, and saws to remove excess metal and finish the castings. Many castings are also heat-treated to give them strength. Workers known as heat treaters, or annealers, run the furnaces in which the castings are heated. Finally, the castings are checked by casting inspectors, who make sure they meet the foundry's standards. Sometimes inspectors x-ray the metal castings to check for defects.

Safety rules in a foundry shop

When casting, the following precautionary measures should be strictly adhered to:

1. Hand gloves must be worn when carrying the crucible out of the furnace through the use of thong.
2. Do not be close to the furnace when working because the heat can be hazardous.
3. Leather apron should be put on in case there might be a splash when carrying or pouring a molten metal.
4. Ensure adequate cooling and solidification before removal of the cast.
5. Ensure that die is properly set before pouring the hot metal.
6. Take extra care when carrying and pouring the molten metal into the mould as it is very dangerous. i.e. can burn the skin very rapidly.
7. Only the operator and the helper should be near at hand when a pour is being made.
8. Adequate ventilation must be provided to carry away fumes.

9. The casting apparatus, furnace and moulds should stand on a tray of dry sand in order to catch any spills.
10. Make sure the sand is not too moist to disallow blowback which is also dangerous.
11. Pouring must be done at the floor level.
12. Cope and drag should be fastened together or weighted down to prevent the flasks from separating during pouring of molten metal.
13. Goggles, spats and gauntlets should also be worn in addition to apron to prevent other parts of the body from burns or splash.
14. Tools used must be brushed over with a refractory wash to prevent the metals from contamination.
15. Preheat the furnace and crucible to avoid cracking the refractory linings.

**Possible challenges in recycling metallic scraps**

Metallic scrap can be divided into three major categories: home, prompt industrial and obsolete all of which are discards, (Jordan, 1993). Home scrap and prompt industrial scrap are involuntary by-product of manufacturing processes. Obsolete scrap arises when a product made of metals has served its useful life and is discarded. The largest single source of obsolete scrap is old automobiles. Other example of obsolete scrap are items that are discarded from demolition projects, manhole covers, old water pipes, kitchen sinks, etc. as well as household discards such as toys, lawn mowers, lawn furniture, pots and pans, tins/cans etc.

Crawford, (1993) observed that the importance of recycling metal scrap not only is producing other useful items from scrap efficient, it obviously keeps obsolete metal items from making their way into landfills, which alleviates an environment problem. Producing steel from scrap is also desirable in terms of energy conservation. Jordan, (1993), relates that it takes much less energy to make steel from scrap than iron ore. Estimates are that it takes four times more energy to produce steel from ore than from scrap.

The activities involved in the recycling process discard, collection, processing, melting, fabrication, and return to customer use; and eventual discard once again. If one of these key elements is missing then recycling has not occurred.

All recycling effort has been directed into areas (Igbax and Audu, 2000), in plant and at specialized plants. For in plant closed-loop recycling, scrap material from the industrial process and in-plant waste are utilized for the production of parts or for energy. This includes on one hand, feeding back the scrap in the appropriate form into the appropriate stage of the production process. For example, moulded plastic spur can be ground into granules, cast metal spurs and runners are broken up into pieces. On the other hand, oil can be recycled into machine or lubricating oil, casting sand to reclaimed sand, furnace ash to asphalt sheet, and so on.

However, most of the post-use product (junk) constituting the majority of material scraps is initially recycled at specialized plants where they are shredded into first-sized hunks and passed through magnetic separators and air classifiers. Here, ferrous scraps are separated from non-ferrous scrap. Non-ferrous metals are recovered by heavy media separation, allowing aluminium and magnesium to float while zinc, copper and other heavier metal sink.

Oyilola, (1994), pointed out some of the problems in metal recycling. He observed that car hulks and domestics appliance are categorized as fragmental scraps. It is difficult and costly form of scrap to recycle because of its awkward physical shape and contamination by non-ferrous metals. This may hinder the process of the successful recovery of steel from the scrap.

**Steps to Recycling a Product**

Recycling includes collecting recyclable materials that would otherwise be considered waste, sorting and processing recyclables into raw materials such as fibres, manufacturing raw materials into new products, and purchasing recycled products. Collecting and processing secondary materials, manufacturing recycled-content products, and then buying recycled products creates a cycle or loop that ensures the overall success and value of recycling.

In Nigeria, Niger state, Minna to be précised, steps of recycling is not different from what we discussed in chapter I, but in this location it is done in a more local way.

Step 1

Metal scraps are collected from house to house; here you will find the scavengers (popularly known as “Baban bola”) going from doors to doors carrying objects mostly made of plastic like buckets, bowls, plates, etc., in a barrow or in a manually pushed truck in exchange for house hold metal scraps which may be electronics, damaged generators, stoves, pots, etc. The Baban bolas makes noise on the streets by hitting a metallic object or sometimes they make use of their voice in making noise so that people in their houses will know that they are around. They continue like that from street to street collecting metal scraps exchanging them with the plastic items they are carrying until they exhaust the plastic objects in their possession. Another set of the Baban bolas storm refuse dumps, they move from one neighbourhood to another, going to refuse dumps to pick metal scraps. These scraps collected from the ground and refuse dumps are usually dirty, but they are collected and put in a bag which they hang on their back. Sometimes, some people may think they (Baban bolas) are mad people, but really they are not. Some of the collectors go to automobile workshops to buy automobile parts and body that are scraps in large quantities. After all this scraps have been collected, they are transported to the foundry.

Step 2

After these scraps have been collected, they are cleaned where necessary (especially for those that are picked up from the ground and refuse dumps). Some of the scraps have sand stock on their surface, so sometimes the processors use knife and other hard materials to scrape off the sand that are seen from the surface of these scraps so as to reduce the rate of impurities during the actual recycling process. Materials made from rubber, plastic, etc. are sometimes attached to the metal scraps from mostly household items; they are manually separated with hand and for those that can't be done with the hand will be left because they get burnt during the actual recycling process.

These scraps are then recycled following foundry procedures as stated earlier. Refined products are gotten from the recycled scraps according to the intended design. Sometimes they make cooking utensils (pots, spoons, plates, stoves, etc.), engine parts (pistons, etc.), and many other items according to the demand of the market.

Step 3

These products are now ready to be sold. They are transported to the market where the consumers who demanded for the products before they are produced, after which the remaining of the products are taken to the open market where any interested consumers can come and purchase them. This is the last stage which completes the recycling loop or cycle.

**Strategies for development of local foundry craftsmen**

The craft process can produce a beautiful and complicated object that could be mistaken for the work of highly skilled designer, (jones, 1986). He added that the surprising things to us is that the beautifully organized complexity of (farm wagon, home utensils), the rowing boat, the violin and the axe, should be achieved without the help of trained designers and also without managers, salesmen, production engineers and the many other specialist upon whom modern industry depends.

It is equally surprising that an illiterate craftsman, with only his simple tools to help him, appears to govern an evolutionary process without any equivalent of genetic coding from which to derive the complete forms that he produces.

Beyond the traditional apprenticeship system, practical skills development programmes in Nigeria are a rarity. This runs contrary to the provision of the National Policy on Education that a vocational centre will be established in each local government area of the Federation to cater for the practical skill training needs of all shades of persons. Tola, (2002) showed that only an insignificant number of local Government areas have complied with this provision. Even then, the services of these vocational centres have not been extended to rural adults who have long fallen out of the formal school system.

The first task before the Government therefore is to urgently establish many formal vocational education centres in rural areas to cater for the skill development need of the people. Vocational education centres and practical skill programmes may be available and yet rural people would not participate effectively in the activities. Such a situation might have arisen, probably, from many oversights such as inadequate publicity about the objectives, advantages, training and other aspects of the dissemination of information concerning the practical skill-training programmes available.

**Summary of the Review**

In Nigeria, foundry has been in existence before the period of the war as the Yorubas are the first to smith iron and thus, they built foundries from where they also produced agricultural implements to boost food production. Even to this present time, foundry has been a career which people practice for a living. Pots and pans, bathtubs, and automobile engine blocks are among the many kinds of products made by casting metals in foundries. Several kinds of foundry workers are involved in the casting process ranging from the pattern makers, sand mixers and the core makers etc. The training required for a career in the foundry depends on the kind of job you want. Many skilled foundry jobs require a high school education before you can start the training program needed to learn the trade, as education, funds and tools are the back born of any recycling industry, The sand casting process is the oldest method of making an intricately shaped component in metal, yet still extensively used today which is very cost effective than the other method of casting which are the die casting, lost-foam casting, investment casting, plaster casting, v-process casting and the billet (ingot) casting. Basically a sand casting is produced by pouring molten metal into a non-permanent sand mould prepared with the aid of a suitable pattern. When the metal cools and solidifies, the casting is extracted by breaking away the mould; hence a new mould is required for each casting.

Collecting and processing secondary materials, manufacturing recycled-content products, and then buying recycled products creates a cycle or loop that ensures the overall success and value of recycling. There are advantages of recycling to production from fresh raw material, it conserves energy, conserves raw material and reduces pollution. Recycling also creates job opportunities.

Beyond the traditional apprenticeship system, practical skills development programmes in Nigeria are a rarity. So the first task before the Government therefore is to urgently establish many formal vocational education centres in rural areas to cater for the skill development need of the people.

# CHAPTER III

# RESEARCH METHODOLOGY

This chapter describes the Research design, Area of study, Population of the study, Instrument for data collection, Validation of the instrument, Administration of the instrument, Method of data analysis and Decision rule.

## Research Design

The research design used in carrying out this study was the survey research design where questionnaires were used to source for opinions of respondents on the issue of competency of foundry craftsmen in the recycling of metal scraps in Minna town, Niger state. The survey research design was chosen as an appropriate method for the research as it seeks the view of people about a particular issue that concerns them, give room for research to study the group of people and items to source for information from the respondents.

## Area of the Study

The study covered all local foundry shops in Minna town, Niger state.

## Population of the Study

The targeted population for this study is 40 respondents consisting of 15 master craftsmen and 25 technical teachers. The entire population was used for the study, therefore no need for sampling.

## Instrument for Data Collection

The questionnaire was the main instrument used by the researcher for the data collected for the study. It consists of three sections as follows:

Section I: This section contains 19 items dealing with what are the needed competencies of foundry craftsmen in the recycling of metal scraps in Minna town, Niger state.

Section II: This section contains 10 items dealing with the possible challenges faced by foundry craftsmen to recycle metal scraps in Minna town, Niger state.

Section III: This section contains 10 items dealing with the strategies that can enhance effective recycling of metal scraps in Minna town, Niger state.

**Validation of the Instrument**

The instrument was validated by three (3) lecturers in the Department of Industrial and Technology Education, Federal University of Technology Minna. The validation suggestions were incorporated in the final draft of the instrument with appropriate modification based on the suggestions and corrections. This was to ensure that the instrument was capable of eliciting necessary information for the data needed for the study.

**Administration of the Instrument**

The questionnaire was personally administered by the researcher to the respondents (foundry master craftsmen and technical teachers) and the completed questionnaires were also collected by the researcher. The questionnaire was interpreted to those craftsmen who cannot read and understand the questionnaire by a research assistant.

**Method of Data Analysis**

The data collected was analysed using mean, standard deviation and t-test. A four points rating scale was used to analyse the data collected for the study as shown below.

| | | | |
|---|---|---|---|
| Strongly Agree | (SA) = 4 | Highly Needed | (HN) = 4 |
| Agree | (A) = 3 | Moderately Needed | (MN) = 3 |

| | | | |
|---|---|---|---|
| Disagree | (D) = 2 | Not Needed | (NN) = 2 |
| Strongly Disagree (SD) = 1 | | Highly Not Needed (HNN) = 1 | |

**Decision Rule**

In order to determine the level of acceptance or rejection of any item, a mean score of 2.50 was used. Therefore any item with a mean response of 2.50 and above was accepted and any item with a mean response of 2.49 and below was rejected. The hypothesis was tested at 0.05 level of significance and 38 degree of freedom.

# CHAPTER IV

## PRESENTATION AND DATA ANALYSIS

This chapter deals with the presentation and analysis of data with respect to the research questions formulated for this study, the result of this data analysis for the research questions are presented as follows.

**Research Question 1**

What are the needed improvements in the competencies of foundry craftsmen in the recycling of metal scraps?

**Table 1: Mean responses of master craftsmen and technical teachers on the needed improvement in the competencies of foundry craftsmen in the recycling of metal scraps**

$N_1$=25, $N_2$=15

| S/N | ITEMS | $X_1$ | $X_2$ | $X_t$ | Remarks |
|---|---|---|---|---|---|
| 1 | Identification and monitoring of hazards in work area | 3.72 | 3.60 | 3.66 | HN |
| 2 | Identify and inspecting of tools and materials to satisfy work plan in compliance with job specifications | 3.60 | 2.93 | 3.27 | HN |
| 3 | Determine correct type of scraps in compliance with job specification | 3.56 | 3.00 | 3.28 | HN |
| 4 | Prepare sand adequately for making moulds in accordance with work requirements | 3.56 | 3.53 | 3.55 | HN |
| 5 | Prepare furnace accurately to melt scraps | 3.44 | 3.27 | 3.36 | HN |
| 6 | In making pattern using wood in accordance with job specification | 3.04 | 3.07 | 3.06 | HN |
| 7 | Adequately use metal to make pattern in compliance with job specification | 3.00 | 2.87 | 2.94 | HN |
| 8 | Perfectly melt metal scraps | 3.28 | 3.40 | 3.34 | HN |
| 9 | Handle the drag and cope perfectly | 3.40 | 3.20 | 3.30 | HN |
| 10 | Adequately differentiate between facing sand and parting sand | 3.04 | 3.07 | 3.06 | HN |
| 11 | Make moulds accurately in compliance with job specification | 3.04 | 2.93 | 2.99 | HN |
| 12 | Can remove impurities totally from molten metal in the crucible | 3.60 | 3.27 | 3.44 | HN |
| 13 | Good at Pouring molten metal in the moulds | 3.32 | 3.00 | 3.16 | HN |
| 14 | Fettle after casting using files and sanders accurately | 3.20 | 2.93 | 3.07 | HN |
| 15 | De-gating accurately using cutting torches | 2.36 | 2.27 | 2.32 | NN |
| 16 | De-gate using hammer accurately | 3.00 | 2.80 | 2.90 | HN |
| 17 | Perfectly clean the surface of recycled products using baking powder | 3.00 | 2.53 | 2.77 | HN |
| 18 | Good at using rags to clean the surface of recycled products after casting | 3.16 | 3.20 | 3.18 | HN |
| 19 | Have adequate finishing skills using files, sand papers/emery cloths | 2.84 | 2.80 | 2.82 | HN |

**Key**

Xt = Average mean of technical teachers and master craftsmen

The data presented in Table one revealed that the respondents highly competent with all the items with mean score ranging between 2.77-3.66 and incompetent with the items on 15 with mean score of 2.32.

**Research Question 2**

What are the possible challenges faced by foundry craftsmen to recycle metal scraps?

**Table 2: the mean responses of the master craftsmen on the possible challenges faced by foundry craftsmen to recycle metal scraps**

| S/N | ITEMS | $X_1$ | $X_2$ | $X_t$ | Remarks |
|---|---|---|---|---|---|
| 20 | Lack of basic education affects their activities | 3.72 | 3.27 | 3.50 | Agreed |
| 21 | No enough fund to purchase raw materials | 3.40 | 3.60 | 3.50 | Agreed |
| 22 | Lack of adequate tools in the workshop | 3.64 | 3.20 | 3.42 | Agreed |
| 23 | The tools being used are not standard | 3.76 | 3.27 | 3.52 | Agreed |
| 24 | There is no machine tool for the production of the products | 3.76 | 3.53 | 3.65 | Agreed |
| 25 | The materials used are not easily obtained | 3.28 | 3.13 | 3.21 | Agreed |
| 26 | There is no enough training for the craftsmanship | 2.72 | 3.00 | 2.86 | Agreed |
| 27 | Lack of enough and sufficient space in the workshop | 3.56 | 3.40 | 3.48 | Agreed |
| 28 | Lack of encouragement from the Government | 3.40 | 3.53 | 3.47 | Agreed |
| 29 | Lack of sharing ideas amongst local craftsmen in recycling metal scraps | 3.12 | 3.27 | 3.20 | Agreed |

The data presented in table two revealed that the respondents agreed with all the items with mean score ranging between 2.86-3.65

**Research Question 3**

What are the strategies that can enhance effective recycling of these metal scraps?

**Table 3: the mean responses of master craftsmen and technical teachers on the strategies that can enhance effective recycling of these metal scraps.**

| S/N | ITEMS | $X_1$ | $X_2$ | $X_t$ | Remarks |
|---|---|---|---|---|---|
| 30 | Receiving further training from other foundry workshop | 3.68 | 3.73 | 3.71 | Agreed |
| 31 | Short term course conducted in the local language can be used to up-date the master craftsmen's knowledge | 3.64 | 3.67 | 3.66 | Agreed |
| 32 | There should be induction programme for local craftsmen | 3.20 | 3.40 | 3.30 | Agreed |
| 33 | Need to be registered with either local or state Government so that they can be assisted easily | 3.60 | 3.67 | 3.64 | Agreed |
| 34 | Receiving loan from Government organizations or voluntary organization | 3.72 | 3.80 | 3.76 | Agreed |
| 35 | The local craftsmen should be taught basic technical theories once in a month | 3.24 | 3.20 | 3.22 | Agreed |
| 36 | Each local craftsman should have a minimum of Federal Labour Trade Test III before being allowed to practice | 3.40 | 3.33 | 3.37 | Agreed |
| 37 | Inviting resource persons from Polytechnics and Universities for part time training | 3.20 | 3.60 | 3.40 | Agreed |
| 38 | The National Directorate for Employment (NDE) should be organizing qualifying examination for the local craftsmen | 3.28 | 3.13 | 3.21 | Agreed |
| 39 | Local craftsmen should be certified before they establish their workshop | 3.40 | 3.20 | 3.30 | Agreed |
| 40 | Regular practical workshop training should be organized for the local craftsmen | 3.36 | 3.33 | 3.35 | Agreed |
| 41 | State Ministry of Works should regulate and supervise the activities of the local craftsmen | 3.16 | 3.07 | 3.12 | Agreed |

The data presented in table three revealed that the respondents agreed with all the items with mean score ranging between 3.12-3.76

**Hypothesis 1**

There is no significant difference between the mean responses of technical teachers and the foundry master craftsmen on the needed improvement in the competency of foundry craftsmen in the recycling of metal scraps in Minna town, Niger state.

**Table 4: t- test analysis of master craftsmen and technical teachers regarding the competency and challenges of foundry craftsmen in the recycling of metal scraps in Minna town, Niger state.**

N1 = 25 N2 = 15

| S/N | ITEMS | $X_1$ | $X_2$ | $SD_1$ | $SD_2$ | t-cal | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | Identification and monitoring of hazards in work area | 3.72 | 3.60 | 0.45 | 0.61 | 0.66 | NS |
| 2 | Identify and inspecting of tools and materials to satisfy work plan in compliance with job specifications | 3.60 | 2.93 | 0.57 | 0.77 | 2.92 | S |
| 3 | Determine correct type of scraps in compliance with job specification | 3.56 | 3.00 | 0.70 | 0.89 | 2.08 | S |
| 4 | Prepare sand adequately for making moulds in accordance with work requirements | 3.56 | 3.53 | 0.50 | 0.62 | 0.16 | NS |
| 5 | Prepare furnace accurately to melt scraps | 3.44 | 3.27 | 0.50 | 0.57 | 0.96 | NS |
| 6 | In making pattern using wood in accordance with job specification | 3.04 | 3.07 | 0.87 | 0.85 | -0.11 | NS |
| 7 | Adequately use metal to make pattern in compliance with job specification | 3.00 | 2.87 | 1.10 | 1.02 | 0.38 | NS |
| 8 | Perfectly melt metal scraps | 3.28 | 3.40 | 0.96 | 0.71 | -0.45 | NS |
| 9 | Handle the drag and cope perfectly | 3.40 | 3.20 | 0.63 | 0.91 | 0.75 | NS |
| 10 | Adequately differentiate between facing | 3.04 | 3.07 | 0.77 | 0.85 | -0.11 | NS |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | sand and parting sand | | | | | | |
| 11 | Make moulds accurately in compliance with job specification | 3.04 | 2.93 | 0.82 | 1.00 | 0.36 | NS |
| 12 | Can remove impurities totally from molten metal in the crucible | 3.60 | 3.27 | 0.49 | 0.77 | 1.49 | NS |
| 13 | Good at Pouring molten metal in the moulds | 3.32 | 3.00 | 0.61 | 1.03 | 1.09 | NS |
| 14 | Fettle after casting using files and sanders accurately | 3.20 | 2.93 | 0.75 | 0.93 | 0.95 | NS |
| 15 | De-gating accurately using cutting torches | 2.36 | 2.27 | 0.97 | 1.12 | 0.26 | NS |
| 16 | De-gate using hammer accurately | 3.00 | 2.80 | 0.85 | 0.91 | 0.69 | NS |
| 17 | Perfectly clean the surface of recycled products using baking powder | 3.00 | 2.53 | 0.80 | 0.96 | 1.59 | NS |
| 18 | Good at using rags to clean the surface of recycled products after casting | 3.16 | 3.20 | 0.61 | 0.75 | -0.17 | NS |
| 19 | Have adequate finishing skills using files, sand papers/emery cloths | 2.84 | 2.80 | 0.97 | 1.05 | 0.12 | NS |

**Key**

N1 = Numbers of technical teachers

N2 = Numbers of master craftsmen

S.D1= standard deviation of technical teachers

S.D2 = standard deviation of master craftsmen

t= t-test value of technical teachers and master craftsmen

S= Significant.

NS= Not significant.

The analysis in this table 4: showed that the t-cal values of all the 19 items were below the t-cal except for two items, item 2 and 3. Therefore, the null hypothesis was rejected for each of the two items while it was accepted for each of the 17 items. Hence the opinion of the respondents differed in two items but did not differ in 17 items in relation to the needed improvement in the competency of foundry craftsmen in the recycling of metal scraps in Minna town, Niger state.

**Hypothesis 2**

There is no significant difference between the mean responses of technical teachers and the foundry master craftsmen on the needed improvement in the competency of foundry craftsmen and the strategies to enhance effective recycling of metal scraps in Minna town, Niger state.

**Table 5: t- test analysis of master craftsmen and technical teachers regarding the strategies to enhance effective recycling of metal scraps in Minna town, Niger state.**

N1 = 25 N2 = 15

| S/N | ITEMS | $X_1$ | $X_2$ | $SD_1$ | $SD_2$ | T-cal | Remarks |
|---|---|---|---|---|---|---|---|
| 30 | Receiving further training from other foundry workshop | 3.68 | 3.73 | 0.55 | 0.44 | -0.32 | NS |
| 31 | Short term course conducted in the local language can be used to up-date the master craftsmen's knowledge | 3.64 | 3.67 | 0.48 | 0.47 | -0.19 | NS |
| 32 | There should be induction programme for local craftsmen | 3.20 | 3.40 | 0.75 | 0.49 | -1.02 | NS |
| 33 | Need to be registered with either local or state Government so that they can be assisted easily | 3.60 | 3.67 | 0.49 | 0.60 | -0.38 | NS |
| 34 | Receiving loan from Government organizations or voluntary organization | 3.72 | 3.80 | 0.45 | 0.40 | -0.58 | NS |
| 35 | The local craftsmen should be taught basic technical theories once in a month | 3.24 | 3.20 | 0.81 | 0.65 | 0.17 | NS |
| 36 | Each local craftsman should have a minimum of Federal Labour Trade Test III before being allowed to practice | 3.40 | 3.33 | 0.69 | 0.60 | 0.34 | NS |
| 37 | Inviting resource persons from Polytechnics and Universities for part time training | 3.20 | 3.60 | 0.63 | 0.49 | -2.24 | S |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 38 | The National Directorate for Employment (NDE) should be organizing qualifying examination for the local craftsmen | 3.28 | 3.13 | 0.92 | 0.88 | 0.51 | NS |
| 39 | Local craftsmen should be certified before they establish their workshop | 3.40 | 3.20 | 0.57 | 0.65 | 0.99 | NS |
| 40 | Regular practical workshop training should be organized for the local craftsmen | 3.36 | 3.33 | 0.56 | 0.60 | 0.16 | NS |
| 41 | State Ministry of Works should regulate and supervise the activities of the local craftsmen | 3.16 | 3.07 | 0.78 | 0.93 | 0.31 | NS |

The analysis in this table 5: showed that the t-cal values of all the 12 items were below the t-cal which is ± 1.96. Therefore, the null hypothesis was accepted for each of the 12 items. This implies that there is no significant difference for the items accepted in the mean ratings of technical teachers and master craftsmen concerning the strategies to enhance effective recycling of metal scraps in Minna town, Niger state.

**Findings**

Based on the data collected and analysed, the following findings were made according to the research questions raised for the study. Below is the summary of findings form this study

1. There is a need to determine correct type of scraps in compliance with job specification.
2. There is a need for making pattern using wood in accordance with job specification.
3. Many craftsmen don’t have standard machine tools for recycling of metal scraps.

4. The craftsmen lack basic education needed to function effectively.
5. There should be the provision of regular practical workshop training should be organized for local craftsmen.
6. Regular practical skill training organized for the craftsmen at intervals is also a necessity.
7. A body should be established to certify the craftsmen before they are allowed to practice.
8. National Directorate of Employment should organize a practical qualifying examination for the craftsmen.

**Discussion of the findings**

The discussions of the findings are based on the research questions raised for the study.

Findings from table 1 showed that there is a need to determine correct type of scraps in compliance with job specifications. As observed by Jordan, 1993. Metallic scrap can be divided into three major categories: home, prompt industrial and obsolete all of which are discards, Home scrap and prompt industrial scraps are involuntary by-product of manufacturing processes. Obsolete scrap arises when a product made of metals has served its useful life and is discarded. The largest single source of obsolete scrap is old automobiles. Other example of obsolete scrap are items that are discarded from demolition projects, manhole covers, old water pipes, kitchen sinks, etc. as well as household discards such as toys, lawn mowers, lawn furniture, pots and pans, tins/cans etc. So the identification either ferrous or non-ferrous metal helps the craftsmen for better production of items in accordance with job specification.

Patterns for small repetition work are frequently made in metal, but the bulk of patterns are made in wood which although not as durable as metal is relatively cheap, of light weight, more easily worked, and easier to modify if this should be required. These help the craftsmen for better maximization of the available fund for the recycling of metal scraps.

Findings from table 2 indicated that lack of basic education affects their activities. . In as much as the efforts of these men are commended as they recycle these metal scraps into domestic products such as local lamps, and flour sieves, Atsumbe contributed that it is important to state that in most cases the refurbished components fail shortly after being refitted into use or at best only dismal performance can be expected from it. The reason for this is not far-fetched as these craftsmen are not in any way trained.

Further analysis shown in table 2 revealed that respondents agreed with the provision of enough fund to purchase raw materials. This is telling us that funds and are the back bone of any investment. If the craftsmen will be provided with funds to purchase raw materials, they will be encouraged and effectively recycle metal scraps.

Education is the foundation of any development; the result shows that lack of basic education seriously affects output of these local craftsmen. In support to this Salami, K.A., (2004) observed that without education no meaningful development can take place. Only educated people can understand the skills necessary for sustainable economic growth and for a better quality of life. This is really true because, from the response of the respondents the local craftsmen assumed their tools to be standard because they can serve the purpose in which they are expected to perform. An educated person has a positive self-image, and takes an active part in decision making relating to himself, his family and the community at large.

A waste recycling industry is a viable venture that needs the cooperation of the three arms of our Government in providing a new social and economic order, which can manage our natural resources fairly and logically while at the same time aiming for a high and equitable quality of life.

The study further showed on table 3 that the respondents attached great importance to the receiving further training from related workshops as one of the strategies that can enhance effective recycling of metal scraps. The technological institutions and technical training agencies such as National Directorate for Employment (NDE) should organize training programmes for local craftsmen both in theory and practical skills, since these people are not in any way trained (Atsumbe, 2004).

Because of the level of their understanding there is need for enlightenment campaign through radio, television and other media in order to make them aware of the importance of retraining in the use of metal scraps. Three steers of Government and voluntary organizations should make loans available for the local craftsmen.

Planning and organization, location of industry, collection and transportation of raw and finished materials and technological know-how are major contributing factors to a successful launching into full operation of any recycling industry. Accordingly, the setting up of recycling industry in Nigeria is therefore conclusively based on the aforementioned contributing factors (Oyinlola, 1994).

# CHAPTER V

# SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## Summary of the Study

The main focus of this research was to find out the needed improvement in the competency of foundry craftsmen and the challenges they face in the recycling of metal scraps in Minna town, Niger state.

The chapter 1 of the study discussed the background of the study, which examines the cause and steps to recycling. The statement of problem which was the reason for the research, purpose of the study, significance of the study, assumption of the study, the research questions and the hypothesis of the study were all stated clearly and discussed hypothetically for the conduct of this research.

The review of the related literature looked into the history of foundry in Nigeria. The processes of foundry were discussed thoroughly in detail. Recycling metal scraps, practical skill development for local craftsmen and foundry as a career are sub-headings that were also discussed with various views of different authors concerning the topic which was harmonized in a comprehensive literature review.

A survey approach was used to develop instrument for the study, the persons identified as the population of the study were the master craftsmen of foundry shops located in Minna town and technical teachers of metal work technology in Minna town, Niger state. A number of 40 questionnaires were administered, the instrument used were analyzed using mean scores and standard deviation. The research questions were discussed based on the findings from the responses and results of the instrument used. Some of the major findings includes, serious attention is needed for retraining the local craftsmen, provision of soft loans and machine tools for effective recycling of the scraps, regular practical training should be organized for the craftsmen at certain intervals etc.

Implications of the study and conclusions were also drawn from the findings and discussed. Recommendations and suggestions for further study were formulated and stated according to the findings of the study

**Implication of Findings**

The findings of this study have far reaching implications on the Government, the local foundry craftsmen and the public at large.

The findings of the study regarding the needed improvement in the competency of foundry craftsmen in the recycling of metal scraps shows that a sound practical skills and theory that can enhance effective recycling must be possessed by the local craftsmen. Therefore Government should provide means of retraining the craftsmen for the effective use and management of solid waste materials. The findings also confirmed that the effort of craftsmen in reshaping and recycling these metal scraps has to be encouraged and motivated. Therefore National Directorate for Employment (NDE), Youth Empowerment Scheme and other Voluntary Organizations should provide means of encouraging the local craftsmen by the training, certificating and provision of soft loans.

The implications of findings are also to the society that heaped up metal scraps seriously affects our environment and the public health. If metal scraps are effectively utilized, the nation’s economy is built up, social misconduct among the youths is reduced and the problems of unemployment are reduced.

The implications of findings is also to the craftsmen to engaged themselves in the enquiry of further training through related workshops and other sources alike.

## Conclusion

Based on the analysis of the findings and considering the competency of foundry craftsmen in the recycling of metal scraps, it is expected that in the improvement of these competencies for effective delivery, there are challenges that the craftsmen face. The findings of this study draw out the attention that the Government, private organizations and other bodies have a great role to play in other to help or improve the activities of the craftsmen which reduces the rate of unemployment and the excessive use of fresh raw material for the production of metallic items. It also reduces the amount of waste in the environment which leads to the reduction of pollution which might be air, water or land pollution which have adverse effects on our health.

## Recommendations

Based on the findings of the study the following recommendations were made:

1. Craftsmen should use wood in making patterns to conserve cost and effort in making adjustments when necessary.
2. The State Environmental Protection Agency must urgently review and formulate new waste dumping and recycling regulations and ensure strict enforcement.
3. Government should set up a centre where all recovered metal scraps are kept.
4. Government should encourage the setting up of recycling plants (foundry shops).
5. Manufacturing industries should provide a system of getting their scraps/equipment delivered back to them for recycling into identical or similar products.
6. Regular practical workshop training should be organized for local foundry craftsmen.
7. Short term courses in the local language should be used to up-date the master craftsmen's knowledge.

8. National Directorate for Employment (NDE) and Youth Empowerment Scheme (YES) should provide more training, certificating and soft loans for local craftsmen.

## Suggestions for Further Research

The following were made for further study:-

1. Strategies for improving indigenous technology
2. Strategies for improving cottage and small scale industries

# REFERENCES


Abraham, D. K. (2007). Technical and vocational curriculum and implementation. *Arts and culture forum*, 14-15.

Atsumbe, B.N. (2004) Strategies for improving the preparation of Master Craftsmen/Teacher of the non-formal and formal Apprenticeship programme. *Spectrum journal Kaduna polytechnic* 5; (2) 24-27.

Crawford (1993). *Science and civilization in developing countries*. London: Comb B. U. Publication London England.

Daudal. (2002). *Basic concepts of the human development.* System printers of South African Unity Publication.

Davis, M. (1990). *Economic report on Nigeria's optionfor long term development.* Onitsha, Nigeria: West African Publishers.

Eleke (2001). *Survey of economic condition in Nigerians minerals.* Lagos Nigeria: Government Printing Press.

FMMP, F. (1991). Survey of economic condition in Nigeria's minerals. Federal Minstry of Mines and Power, 23-26.

Igbax, P.I. and Abdul, A. (2000) Effective pollution and environmental management through recycling of industrial waste products: Presented at the 4th Annual National Engineering Conference. On the relevance of indigenous technology in the realization of vision 2010, April 10-13 Kaduna Polytechnic, Kaduna.

Jordan (1993). *Fundmental basic principles of metal casting design.* Massachusetts USA: A venture Works Press.

Kosher, A (2003) Values of foundry products for modern industries in the state and local government. Kaduna State: Nigerian Society of Engineers.

Mannir, S. N. (1997). *Instructional system for technology in Nigeria*. Zaria, Kaduna, Nigeria: Deowwon Printers.

Mduruwa, W.W. (1993) Engineering for profit from wastes materials. *Unpublished* HND project, Kaduna polytechnic. Kaduna.

Momoh, O.A. (2004) An Appraisal of Solid Waste Management in Kaduna metropolis: *Unpublished* work. Mechanical Engineering Department, Kaduna Polytechnic, Kaduna.

NER. (1999). Nigerian economical regional agency. Regional research agency development of West African Countries.

Npe, G. (2000). Extract on vocational and technical education. Government Printing Press Conference (pp. 14-16). Kaduna Nigeria: Government printing press.

Oyinlola, A.K. (1994) Solid metal waste pollution control by recycling: proceeding of National conference held in Kaduna Polytechnic. 1; (1) 77-82.

Salami K.A. (2004) A lecture note on Emergent problems in Nigerian Education: Department of Industrial and Technology Education, Federal University of Technology, Minna.

Samin, L. M. (2005). Process and technique for vocational curriculum in Katsina state Nigeria. Technical and Science Education, 16-18.

Shirley, F. A., (1999). Metal Design and Construction. Amersham, Houlton Educational Publications Ltd.

Tola, K.O (2002) Promoting skill and environmental development, through vocational education in rural Nigeria: 15th Annual conference, Nigerian Association of Teachers of Technology (NATT). Federal University of Technology, Minna.

Thurston, S. H. (1992). Nigeria's archaological and early history in the nation technological development. *Teaccher Journal of Art and Science,* 21-22.

Thurston, S. H. (1998). *Production and materials concepts in metal casting industries.* London: John Wiely & Sons.

UNIDO (1999). Production and materials concepts in metal casting industries. United Nation Industrial Development.

UNIDO, U. N. (2008). Special study into iron and steel development in Nigeria. United Nation Industrial Development, 23-25.

Yahaya, U. D. (1997). Indigenous education among the state's indigines of Katsina state. *Nigerian Apprentice Publication*, 31-33.

Ziya'ulhak, D. U. (2008, 02 12). Nigeria today and tomorrow as technology change. Commerce and Indutries, 11-12.