

# ENGINEER'S VIEW ON SCRAP METAL RECYCLING IN NIGERIA

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## ABSTRACT

This study describes the secondary refining process in scrap metal recycling and investigates factors affecting Nigerians from establishing a scrap metal recycling industry, being the brain/muscle behind the growth of existing recycling industries, and their confidence level in handling scrap metal recycling company. A survey questionnaire was used to navigate throughout the research and a total of one-hundred-and-seventy-nine (179) members of staff and workers were randomly sampled for the study. The data obtained were analyzed using percentages. The study distills that factors such as poor government planning, poor education and inadequate exposure of Nigerian metallurgists, amongst others are the major retardants to the growth of Nigerians handling the recycling industry when investors are willing to invest. The findings revealed that Nigerians working in the recycling industry are the brain and muscle behind the industry's growth. Despite their contributions, peanuts are been given as accolades. Amongst other things, there is a need for a strong magnetic pole to attract investors in the scrap metal recycling industry. Base on my findings, it was recommended that the federal government should create an enabling environment that will encourage investors to support Nigerians in growing their scrap metal recycling industry.

**Keywords:** confidence, engineers, investor, scrap metal recycling, secondary refining

## **1.0 TITLE: ENGINEER'S VIEW ON SCRAP METAL RECYCLING IN NIGERIA**

### **2.0 SCOPE**

This study focuses on scrap metal recycling companies in Nigeria and the recycling of ferrous-metal scrap to obtain steel. Also, the survey used was carried out amongst others, in Ogijo, Shagamu local government area, Ogun State and Odogunyan, in Lagos State, Nigeria. This study will not focus on the metallurgical thermodynamics and kinetics involved in the heating and refining of scrap to obtain steel. The study utilized a survey questionnaire to obtain data from staff and workers of different scrap metal recycling company in Ogijo, Odogunyan, amongst others. From the data obtained researchers can understand the major factors affecting Nigerians from taking hold of scrap metal recycling companies independent of foreigners and whether Nigerians working in the industry have gained enough knowledge to start-up theirs.

### **3.0 BACKGROUND**

Steel which is an alloy of iron, carbon not more than 2 percent and other desired elements in small quantity, is an essential engineering material—a pivotal to global industrialization—it is the vehicle through which industrialization takes place. Steel holds all the aces in its applicability: it is a versatile engineering material used virtually in everything; in the earth and space. Steel is used for building construction, transportation, household equipment, domestic appliances, aviation, etc.

Steel can be obtained from the recycling of scrap ferrous metal. Ohimain (2013a) study unveiled that scrap metals are important components of the municipal solid wastes in Nigeria accounting for 1.8 percent in the South West, 10.8 percent in the South East, and 3 – 20 percent in the North West. More so, “United States Environmental Protection Agency (EPA) reported that for every

tonne of steel produced from scrap steel saves 1.115 kg of iron ore, 625 kg of coal and 53 kg of limestone, using recycled steel saves 75 percent of energy, 90 percent raw materials, reduces air pollution by 86 percent, water use by 40 percent, water pollution by 76 percent and mining wastes by 97 percent.” Steel recycling rate amounts to 95 percent in automobile, 88 percent in appliances, 70 percent in steel packaging, (Steel Recycling Institute, nd). Research has revealed that unlike plastics, metals, especially steel, have deathless atoms which make it possible to be recycled repeatedly: the iron atoms in steel can be re-melted repeatedly without being destroyed.

Recycling scrap metal can be done in various ways; but, some techniques offer a plethora of challenges that could arise as a result of the production process used or the scrap metal initial composition. Scrap metal recycling processes involve scrap collection, scrap pre-treatment/sorting, melting, refining the chemistry, and casting of the molten metal to obtain a cast. Primary steelmaking process involves the direct movement of molten steel from the furnace to the caster but studies have shown that secondary refining (indirectly treating of molten metal in a ladle or vessel) used in steel production offers a myriad of opportunities, amongst others includes proper control of temperature and steel grades/chemistry. These permit high production of vast steel grades with proper utilization of alloying compounds and/or elements. Figure 1 below illustrates a process chart for scrap metal recycling using a secondary refining process.

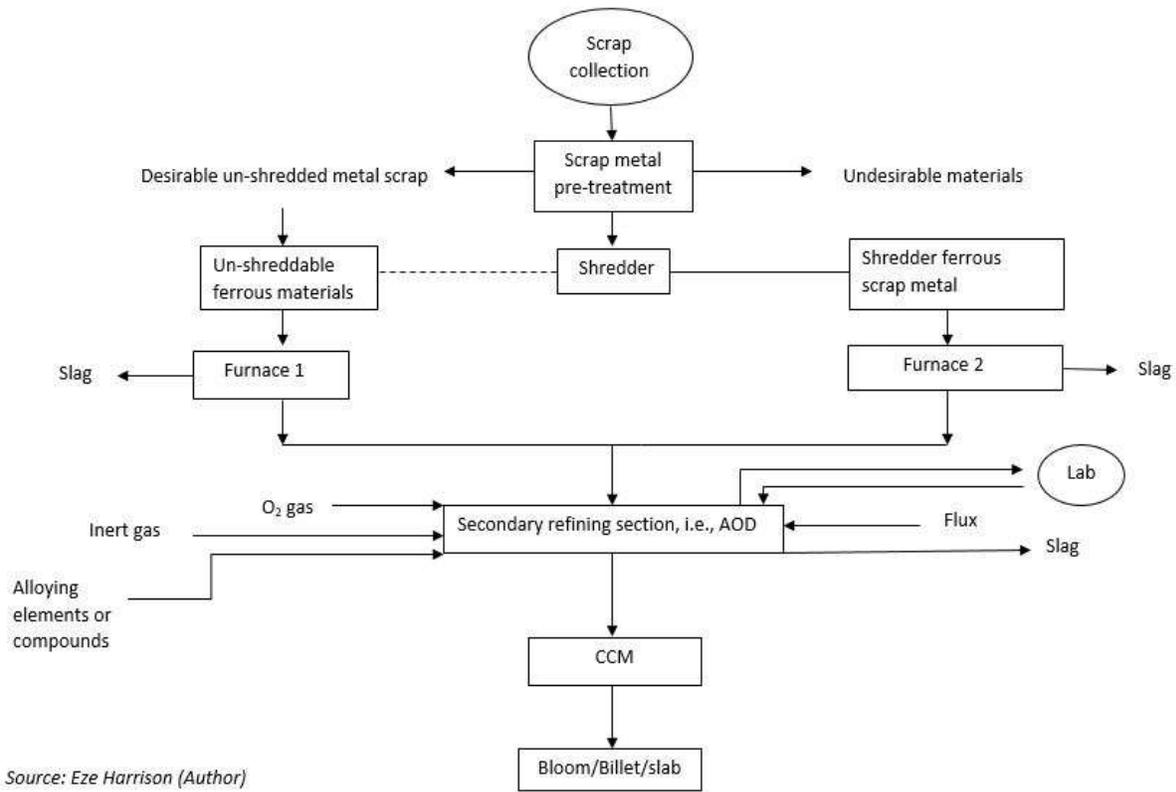


Figure 1. Process chart for secondary refining of ferrous scrap metal

### 3.1. Description of scrap metal recycling using Argon Oxygen Decarburization (AOD) refining process

3.1.1 Scrap collection: scrap can be gotten from scrap broker or peddlers in bulk. It can also be obtained from scrap scavengers. Scrap can be of different types such as internally generated scraps that come as a result of erroneous processing or faulty machine and worn-out scraps that have served its purpose.

3.1.2 Scrap metal pre-treatment: scrap pre-treatment means the segregation of scrap to obtain the desired composition that will increase the yield of the final metal produced. This is done to remove any unwanted materials found in the scrap such as radioactive materials.

This section is essential because what goes into the furnace can affect its lining life, alloys used, energy cost, and the total time required for processing the liquid steel. The scrap properties and application is majorly used in the segregation process. For instance, engine blocks for vehicles are mainly cast; car body parts are made from low carbon steel; colour, weight, and magnetic property are employed during the segregation of aluminum from steel. Not all scrap material can be shredded; thus, un-shreddable materials that meet the required composition are channelled to the furnace.

3.1.3 Shredder: this helps to reduce the volume and size of metal scrap materials and also improve the quality of materials to be charged in the furnace. Scrap materials that meet its requirements are channelled to the shredder. The shredding process provides ferrous shredded/smaller sized materials that are charged into the furnace. Metal scrap that cannot be shredded is called un-shreddable, examples include heavy cast iron, and special scrap (ship/aircraft engine parts). Shreddable materials are crushed/shredded; a magnetic drum separates ferrous from non-ferrous materials. The shredded ferrous metal is conveyed to the furnace, for instance, to furnace 2 while the unshreddable ferrous metal scrap is charged in furnace 1.

3.1.4 Furnace: different furnaces such as electric induction furnace, electric arc furnace, copula, and crucible can be used; but, in this case, electric induction furnaces are used because of its ergonomics: well-controlled melting process and nonreactive nature with scrap metal—no heating fuel is required. The flow process chart is designed in such a way that furnace 1 and furnace 2 have approximate processing time. This can be achieved by varying their capacity, the kinds of refractory lining employed, the temperature of operation, amongst other things. The slag obtained here depends on the nature of scrap

charged; during de-slagging, the slag phase may contain majorly  $\text{SiO}_2$ . The furnace is tilted and the molten metal is discharged into a transfer ladle where it is conveyed to the secondary refining section.

3.1.5 Secondary refining: this can be achieved using different techniques such as ladle reheating furnace, vacuum degasser, Ruhrstahl-Heraeus process, and argon oxygen decarburization. The refining process here is carried out in an AOD vessel. The AOD vessel has a pear-like shape with an opening at the top and bottom/side. Currently, AOD is used for refining steel, it was originally designed for refining stainless steel; because, stainless steel required no or negligible carbon content and it also prevents the oxidation of some elements such as chromium. Oxygen enters from the top while inert gas such as argon and nitrogen enters from the tuyeres at the bottom/side of the vessel. A stream of high-speed oxygen gas from a lancing pipe impinges on the molten metal causing proper dilution and homogenization of temperature and composition. Reactions that occur in this section are mostly oxidation; thus, poses a strong exothermic effect which increases the temperature of the bath. In other words, no other energy source is needed. During the refining process, a sample is taken to the lab for analysis of the liquid metal composition. The outcome serves as a guide for the next line of action. Gases and flux are added, alloying elements/compounds are also added to adjust the slag viscosity and final steel composition, deoxidize, dephosphorize, and desulphurize.  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{MgO}$ ,  $\text{MnO}$ ,  $\text{CaO}$ , and  $\text{Fe}_2\text{O}_3$  slag phases may be obtained during de-slagging. The proper analysis of the metallurgical thermodynamics and kinetics carried out in the secondary refining process is beyond the scope of this work. Full knowledge of thermodynamics is required for easier understanding, design, and control of steel chemistry.

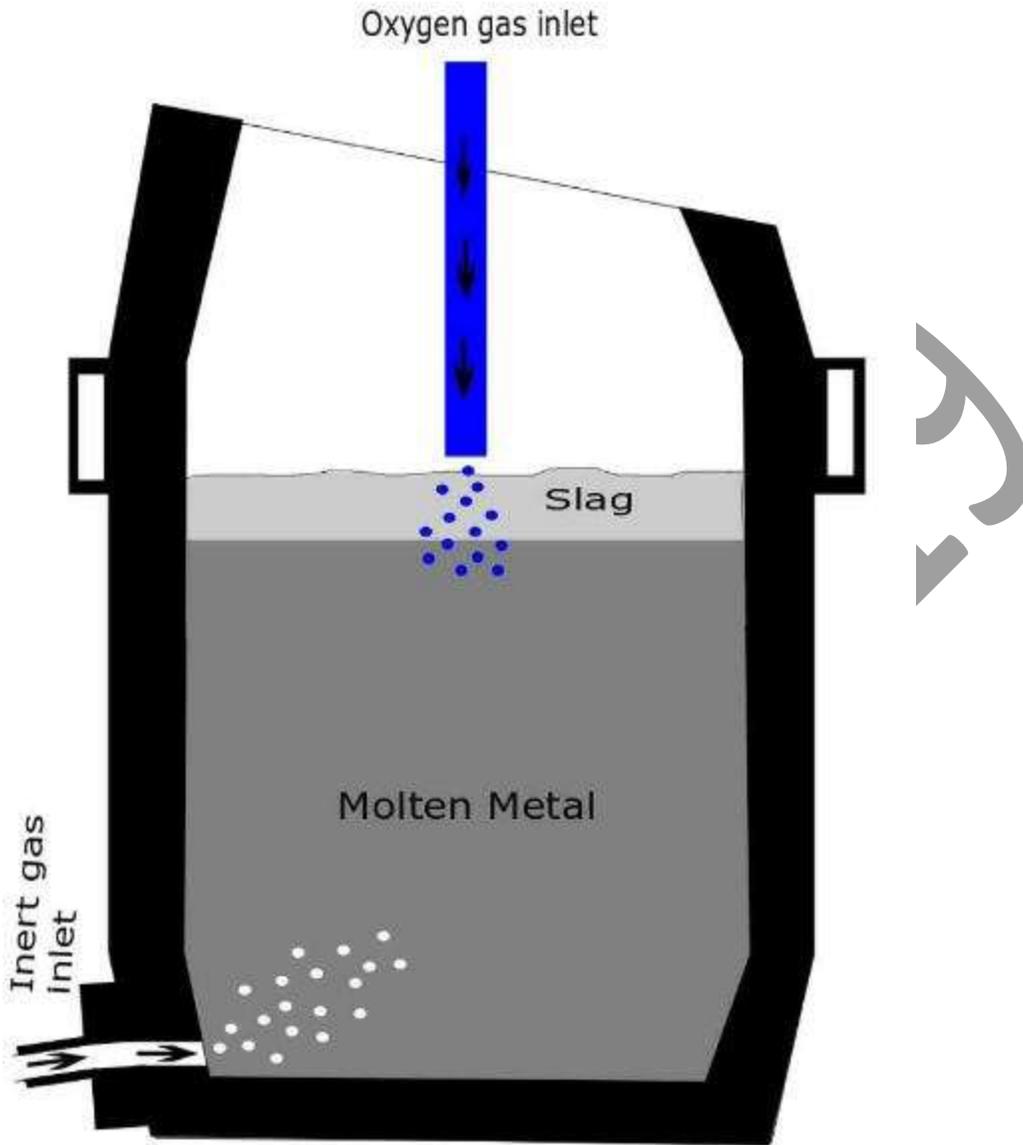


Figure 2. Argon Oxygen Decarburization vessel

3.1.6 Continuous casting machine (CCM): a bottom pouring ladle is used to transfer refined molten metal from the secondary refining section to the continuous casting machine section where it is subsequently cast into bloom/billet/slab. During continuous casting, molten metal is poured from a bottom pouring ladle—placed on a ladle turret—into a tundish through the mould to the withdrawal unit. This process causes some further

temperature drop and oxidation of some elements. Thus, reasonable tolerance for temperature, heat, and composition should be considered before tapping.

#### **4.0 STATEMENT OF PROBLEM**

In light of the conundrum that besmirches the steel sector, engineers must ensure that scrap metal recycling sustains the steel sector. According to Ohimain (2013a), “Nigerian steel industry is being sustained through recycling of scrap steel obtained from municipal solid wastes.” But, factors are limiting Nigerian engineers from taking hold of the steel sector.

“Ajaokuta Steel Company project appears too massive for a nation (Nigeria) without any previous experience in steelmaking,” Ohimain (2013b). This claim echoes loudly that the Ajaokuta Steel Company project failed because, amongst other things, Nigerian engineers were not exposed enough. Studies have not particularly shown if Nigerian engineers, particularly metallurgists, can harness the scrap metal recycling industry. The purpose of this study include:

- a. To describe metal recycling using AOD secondary refining process.
- b. To find out why Nigerians are not harnessing scrap metal recycling industry amidst the moribund state of the Nigerian steel sector.
- c. To find out if Nigerians are the *brain* and/or *muscle* behind the growth of scrap metal recycling companies in Nigeria.
- d. To know if what was/is being taught in Nigerian schools would be enough for an engineer to start-up a scrap metal recycling industry, irrespective of the capital and support involved.

- e. To know if Nigerians working in a scrap metal recycling industry have gained vast exposure and understanding about engineering; if their exposure is enough for them to set up a scrap metal recycling industry.

## 5.0 RESEARCH QUESTIONS

As engineers, having known that Ajaokuta Steel Company, Delta Steel Company, etc., are moribund, how can we sustain the steel sector through recycling of metal scrap? Are Nigerian metallurgist exposed enough to handle a scrap metal recycling firm? Can investors trust our engineers, independent of foreign officials for their technical know-how?

The *brain* means, “Having *deep knowledge/insight* about the design/principle of operation and the right maintenance practice of the tools/plant/equipment/machine used—you can design the system” while, the *muscle*, on the other hand, means that you *only know how to use* the machine/plant/equipment—you followed laid down principles, and by experience and strength the job is done. The following research questions were asked to steer this study:

- a. Why are Nigerians not harnessing the scrap metal recycling industry?
- b. Are Nigerians the brain and/or muscle behind the growth of existing scrap metal recycling industries in Nigeria and what is their reaction towards their salary/wage/incentive?
- c. What is the confidence level of Nigerian engineers working in a scrap recycling industry?  
If capital and support are certain, can they start-up a recycling firm from scratch.

## 6.0 LITERATURE REVIEW

According to Ohimain (2013a), scrap iron recycling in Delta Steel Company is achieved by collecting scraps then sorting it, and a magnetic separator separates the ferrous metal scrap from non-ferrous. The ferrous metal is further separated manually into high carbon and low carbon iron. The high carbon requires a longer time and thus, produces more slag while that of low carbon iron is charged into the second furnace that operates at a relatively low temperature and time. In addition to this, Delta Steel Company produces iron from basic raw materials and recycles scrap iron to new products for reuse, the plant was designed to run on 80 percent direct reduced iron and 20 percent scrap.

In a comprehensive review of Agbu (1992) study, it distils that the myriad of factors limiting iron and steel industry in Nigeria including inadequate funding, poor planning and implementation, and political consideration rather than that of economic and technical considerations that influenced the location of the government-owned iron and steel companies. He holds a view that the factors affecting the iron and steel sector are more political than technical.

(Ocheri, C., et al., 2017, pp. 3), "Nigeria possesses the skilled manpower and technical know-how to run the steel industry efficiently. Also, thousands of professionals have been trained both locally and internationally in anticipation of the take-off of the steel company (Ajaokuta Steel Company)." Works in this phase reveals some intriguing facts: how can those knowledge, obtained during the course of their training be transferred to the younger generation of engineers, because in light of the challenges affecting iron and steel industry in Nigeria, most of the trained Nigerians are ageing/retiring/dying without sharing or utilizing the knowledge.

## **7.0 RESEARCH METHODOLOGY**

The study adopted a descriptive survey research design. It was conducted in Ogun and Lagos State, Nigeria. The entire population sample of one-hundred-and-seventy-nine (179) respondents was adopted for the study. Respondents were drawn from Ogijo, Odogunyan, etc., all in Nigeria.

The survey questionnaire titled, “scrap metal recycling survey questionnaire.” The questionnaire used was a combination of both open and closed-ended survey question; it was sectioned into three parts to obtain information on why Nigerians are not harnessing the scrap metal recycling industry; being the brain and/or the muscle, and their level of confidence. The closed-ended survey used a five-point scale ranging from strongly agree (SA), Agree (A), neutral (N), disagree (D), and strongly disagree (SD) while the open-ended provided a box for more detailed explanations of responses to the closed questions. Stringent details were observed as to who will participate in the survey: a total of one-hundred-and-twenty-nine (129) members of staff (64 metallurgists; 61 engineers of other disciplines; and 4 non-engineers) and fifty (50) contract workers of different scrap metal recycling companies were surveyed. Fifty contract workers were randomly picked from different companies in Ogun State and Lagos State, to obtain the average amount being paid per hour. Section A, B, and C adopted thirteen (13), four (4) and three (3) item statements, respectively. Data obtained from section A was further divided into two views, namely: metallurgist view and non-metallurgist view. The non-metallurgist view is dominated by sixty-one (61) engineers of other engineering disciplines and four (4) non-engineers (working in a metal recycling firm) while the metallurgist view consists of metallurgists (15 females and 49 males). I tagged the open-ended section data obtained from different respondents.

## 8.0 DATA PRESENTATION AND DISCUSSION

Chart 1 and 2 (below the references) contain the analysis of the information obtained from metallurgists and non-metallurgist working in a scrap metal recycling industry, respectively. The data shows the respondents in percentage on why Nigerians are not harnessing the scrap metal recycling industry. Data obtained from different contract workers show that their payment ranges from seven-hundred naira (N700) to one-thousand naira (N1,000) for an assumed maximum working time of twelve (12) hours. Chart 3 (below the references) shows the data obtained in section B on, are Nigerians the *brain* or *muscle* behind the growth of scrap metal recycling company in Nigeria. The data obtained in section C is shown in chart 4 below.

In the open-ended section, the questionnaire I tagged Q8, a respondent (5-years experienced metallurgist) opines that Nigerians cannot handle a scrap metal recycling company because they are not allowed to take full control of some machines they are using to work. Q1 distills that inadequate modern engineering facilities in Nigerian universities especially in the area of metallurgy have created a wider gap between modern recycling methods and obsolete recycling methods. From Q7, a 4-years experienced metallurgist revealed (in consonance with data obtained from section c) that Nigerian efforts and contributions in scrap metal recycling companies are given fewer recognitions and yet they are basically the *muscles* at the shop floor and *brains* generating the ideas which are converted and implemented by most of the departmental foreign heads, who takes the credit afterwards.

A striking revelation from a respondent (10-years experienced non-metallurgist) says, “Foreign recycling companies in Nigeria have successfully limited and restricted the further competence of Nigerians to a state where they can only remain servants and not owners. They make you the *muscle* and restrict your *brains*, through incomes, positions, and exposure. Nigerians cannot

fully run a scrap metal recycling company without an expatriate's support. But, when they get trained and return to the country, they can challenge the foreign coy," excerpt from Q4. Q3 revealed that Nigerian educational institutions have failed to provide basic skills, machines and industrial exposure for Nigerians.

## **9.0 FINDINGS AND RECOMMENDATIONS**

The findings as captured in chart 1 and 2 of this study reveal that poor government planning and implementation, inadequate funding from government, unfavourable government/political policies, inadequate exposure of metallurgist, high competition from foreign steel company, poor investment culture, and lack of infrastructure are the major retardants to Nigerians growing their recycling company.

Results from chart 3 show that the majority of the respondents hold the view that Nigerians are the *brain* and *muscle* behind the growth of scrap metal recycling companies in Nigeria. Also, their salary/wage/incentive do not worth their contribution to the firm. An average contract worker's pay per hour is seventy-naira-eighty-three-kobo (N70.83), this is too poor compared to the risk involved in the recycling company and other country's wages per hour.

Chart 4 revealed that Nigerians working in the scrap industry can start-up their recycling company irrespective of the size and capital involved. Besides, the Nigerian educational system is not equipped enough to provide the required skill needed for establishing a scrap recycling industry. It is too far from reality. Thus, rapid attention should be placed on advanced technology and teaching patterns to bridge the huge gap between theory and practice. This would provide enough exposure for engineers and engineering aspirants. Therefore, there is a need to focus the beam of industrialization on the aisle of Nigerian engineers. The following should never be

placed on the back burner if Nigerians would successfully engage in or take the lead in scrap metal recycling in Nigeria.

- a. The legislative arms of the government should put policies in place that will create an enabling environment for the growth of indigenous steel/recycling companies and level the field for competition with the already established companies run and owned by foreigners. The government can improve the plight of the poor masses by proper reviewing of outdated policies/laws causing barriers.
- b. Educational/teaching and research institutions should provide a pragmatic system of training engineers such that it bridges the huge gap between theory and practice. Research hub and engineering incubation centres should be encouraged, this will aid in extracting and utilizing the untapped potentials of Nigerians.
- c. Human capital development remains weak due to under-investment. Investors should support Nigerian engineers in actualizing their dreams. Investors and fellow Nigerians lack confidence in Nigerian engineers, even the engineers themselves lack confidence in their abilities, this is because of inadequate exposure. The confidence level of those engineers within the marrow of engineering firms is relatively higher because of their level of exposure. The government and investors should support institutions and ensure proper monitoring and implementation of policies that provides broad base technical training of engineers and scientists. There is nothing special about the *whites*, they saw a need to invest in their bright minds. Nigerians can do the same, however small or significant, efforts might be perceived. Human capital investment is fundamental to any nation's development.

## **10.0 CONCLUSION**

Nigerian engineers in the field can harness the scrap metal recycling firms from scratch to finish if the support and capital is assured. Besides, they are the brains and muscles behind the growth of established recycling firms and peanut is what they get in return. Thus, rapid attention should be channelled towards harnessing the crude untapped potentials of Nigerian engineers. When the government, investors, and engineers do their little bit collectively, a giant contribution will be achieved.

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Chart 1.

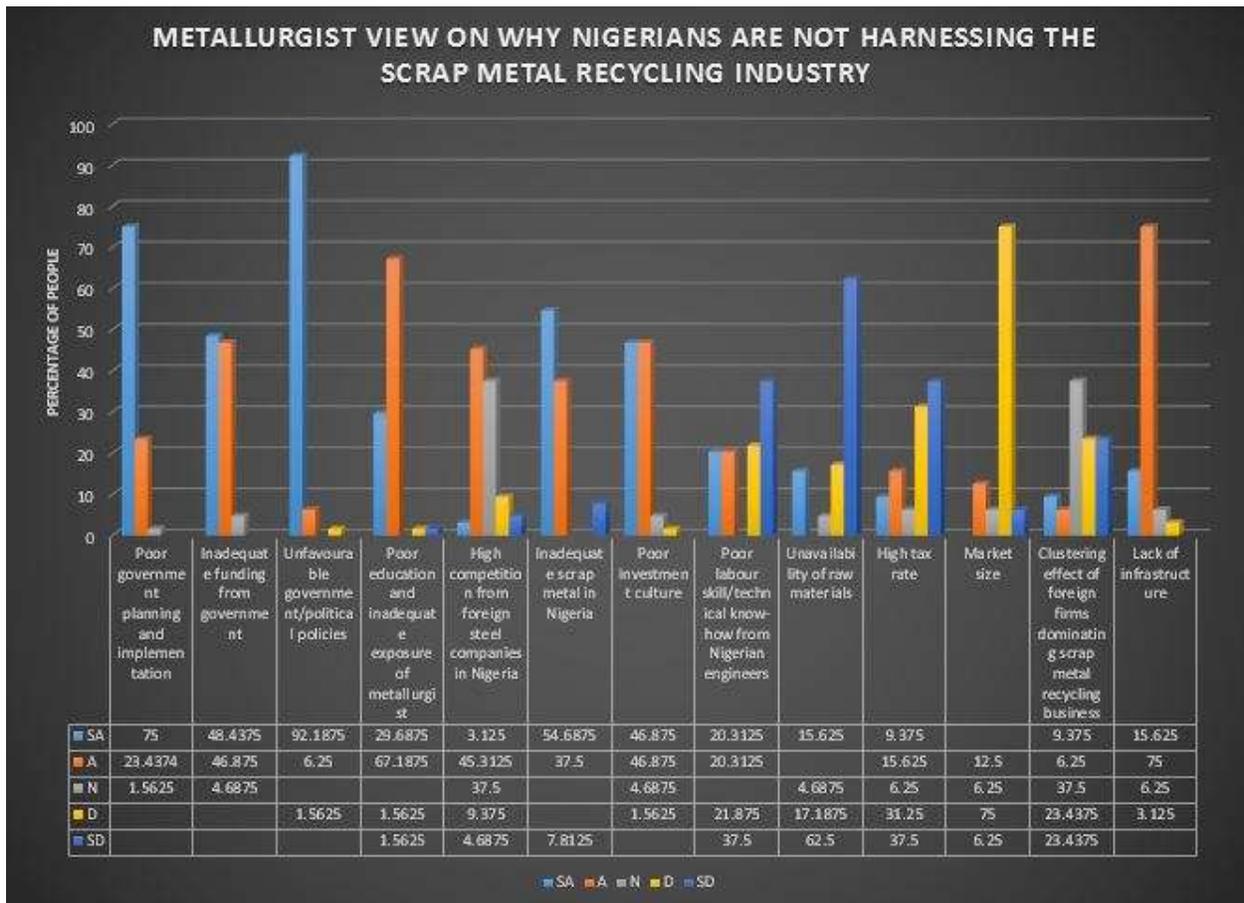


Chart 2

NEST

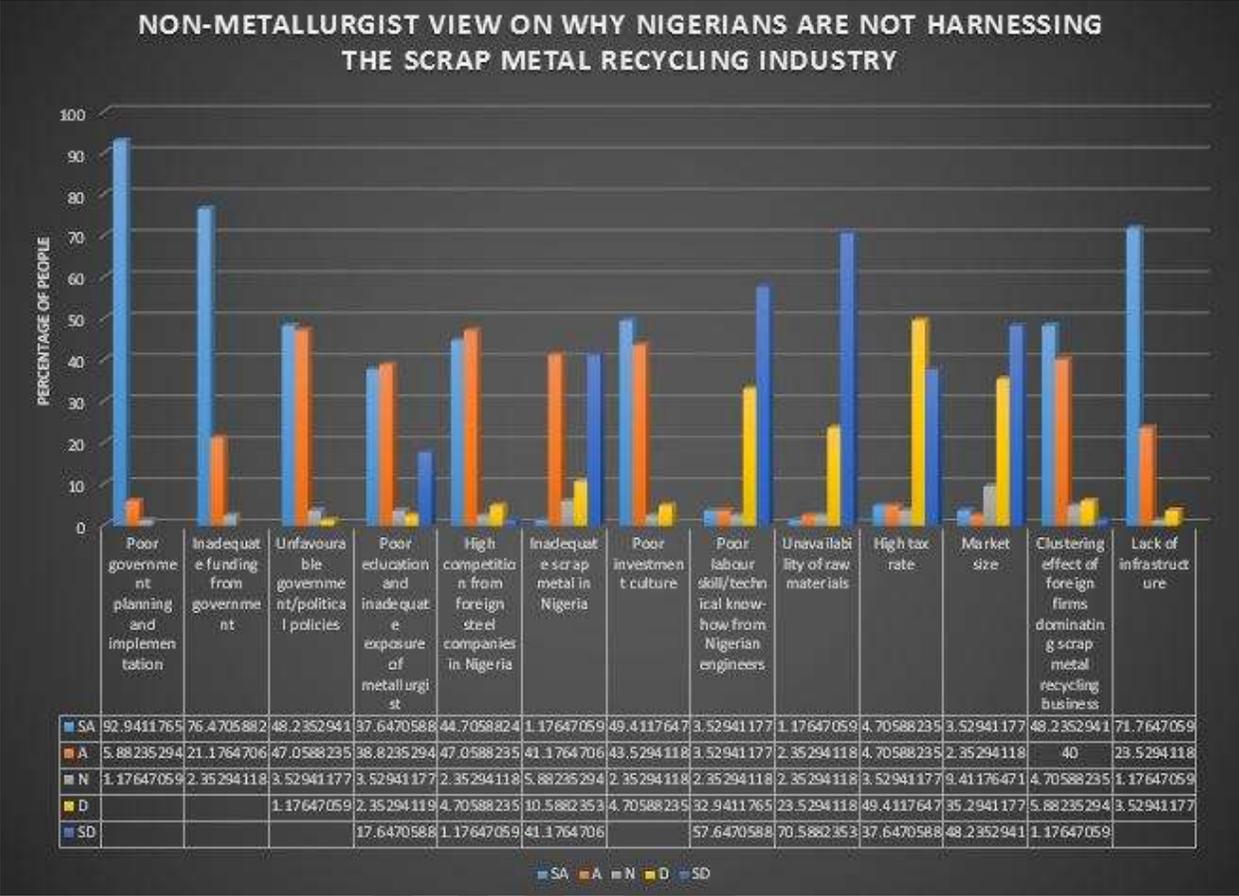


Chart 3

General view on being the *brain* and/or *muscle* in different scrap metal recycling companies in Shagamu local government, Ogun State.

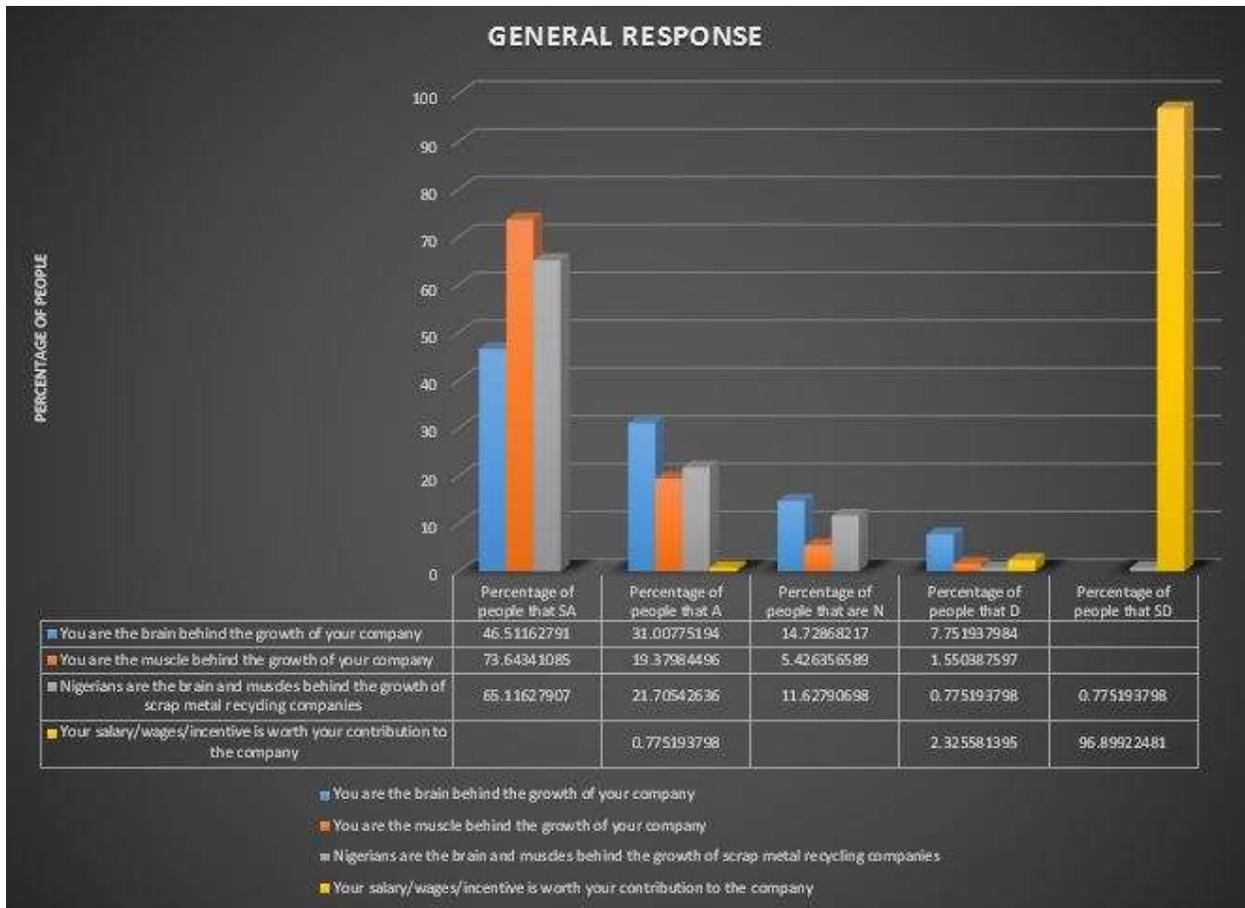
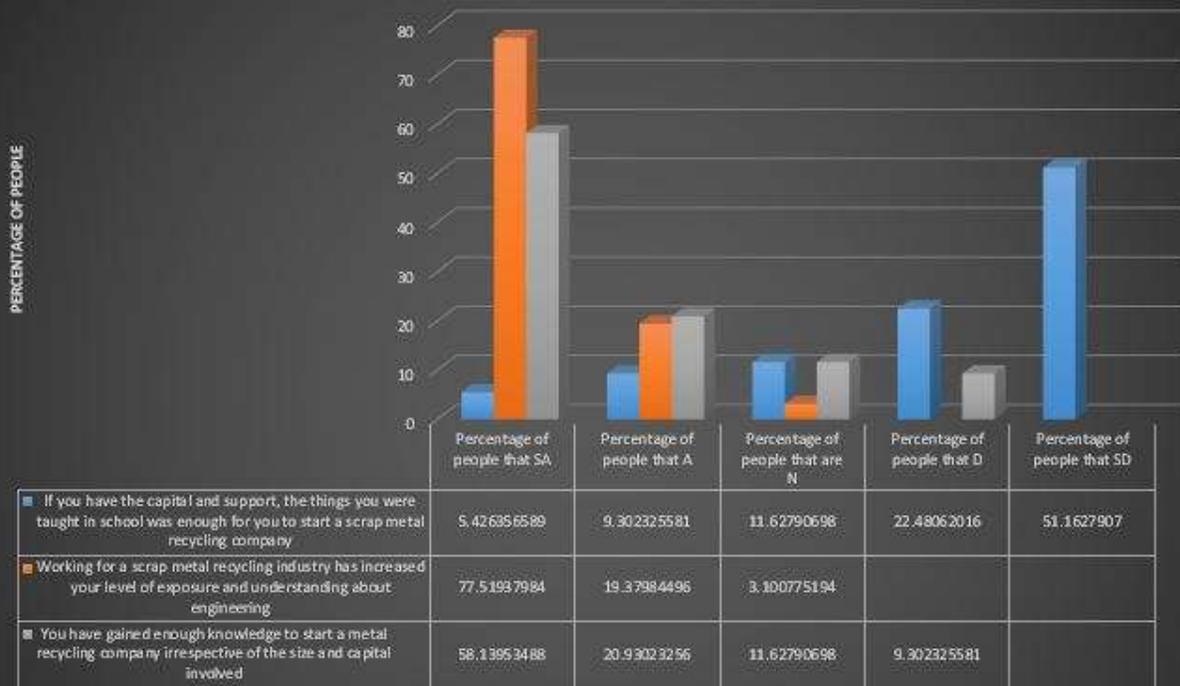


Chart 4

Data obtained from section C of the survey questionnaire.

## GENERAL RESPONSE



AXIS TITLE

- If you have the capital and support, the things you were taught in school was enough for you to start a scrap metal recycling company
- Working for a scrap metal recycling industry has increased your level of exposure and understanding about engineering
- You have gained enough knowledge to start a metal recycling company irrespective of the size and capital involved

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