

COMPETENCY NEEDS OF FOUNDRY WORKERS IN RECYCLING USED METAL FOR PRODUCTION OF WOODWORKING MACHINE PARTS IN MINNA METROPOLIS, NIGER STATE, NIGERIA

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Abstract

The research determined the Competency needs of foundry workers in recycling used metal for production of woodworking machine parts in Minna metropolis, Niger state. The major purpose of this study was to determine the competency needs of foundry workers in recycling of metal scrap for producing woodworking machine parts. Two null hypotheses were formulated to guide the study. The researcher designed a questionnaire to solicit information from the respondents. The targeted population was 40 which consisted of 15 foundry masters and 25 foundry workers. The research design used in carrying out the study was the descriptive survey research. Data obtained were analysed using mean and z-test statistics was used to test the two null hypotheses that were formulated and tested at 0.05 level of significance. The findings of the study were as follows: determine the correct type of metal scrap in compliance with the job specification and de-gas the molten metal for a perfect casting. Based on the findings of the study, it was recommended that there is a need for inexperience foundry workers to collaborate with other experience foundry workers to improve their craftsmanship and foundry workers should improve their finishing skill by always using files and sand paper.

Keywords: Competency needs, Foundry, metal, Recycling, Woodworking machine part

Introduction

Foundry involves the casting of molten metal into a mould. According to Hornby (2000), foundry is a factory where metal is melted and moulded into various shapes or objects while foundry operation involves the process of pouring liquid metal into a mould for the purpose of making parts in a desired shape. This process has existed for many centuries but is continually being advanced with different metal alloys; different mould types and different operation parameters within every foundry operation. The importance of foundry products in the society today is indicated by how societies depend extensively upon metal products. Many useful metal products are obtained from casting. Without the casting, there would be no metal and if there were no metals, there would be virtually no useful objects such as motor vehicles and woodworking machines and so on. It is difficult to plan, mortise, groove or cut wood when done manually and it takes a lot of time. Many woodworking machines are not functional due to lack of spare parts and quality furniture items cannot be produced when the machines are not functional. Furthermore, the convenience enjoyed in modern homes depends largely on woodworking machines and foundry works. Examples of this include castings which are found in form of hardware, faucets, parts of machines and other household items (Emamodeeni, 2001). It is important to emphasis on casting of machine parts that are lacking rather than importing. Constant producing of the above items or casting new machine parts using scrap metals improves competency of foundry workers as practice makes one to be perfect.

Hornby (2000) defined competency as the ability to do something well. Competency is also

known as the capability to apply or use a set of related knowledge, skills, and abilities required to successfully perform tasks in a defined work setting. Competencies often serve as the basis for skill standards that specify the level of knowledge, skills and abilities required for success in the workplace as well as potential measurement criteria for assessing competency attainment. However, competency plays a lot of role in engineering firm, without consistency and hard work the process of appropriate service will never be guaranteed, and there would not be any competent work done with reference to foundry work in recycling metal for producing items such as woodworking machine parts.

Woodworking machines are those machines use for processing wood into different forms or shapes. For instance, cutting, planing, moulding, turning, grooving, rebating and so on. These machines include jointer, thicknesser, spindle moulder, bandsaw machine, wood lathe among others. Woodworking machine parts include in feed and out feed table in a surface planer, cutting knives in the circular saw, fence in the circular saw and band saw machine, tool rest in the wood lathe, arbor in the planing machine, and protective guards in the band saw machine, sprocket and pulleys in woodworking machines and so on. According to Okwori et.al (2006), woodworking machine is very essential to woodworkers as it assists greatly in reducing human labour. Work that can be done manually in three days is usually done in a day using woodworking machines. Many woodworking machines have been rendered useless due to lack of spare parts. The parts that have worn out are in the workshops or on the road. It is obvious that woodworking machine parts are difficult to get in the country due to high exchange rate so it can be fabricated or casted using foundry workers to make the machine functional. Therefore, the study examines the competency needs of foundry workers in recycling used metal for production of woodworking machine parts in Minna metropolis, Niger state, Nigeria.

Statement of problem

Many materials have been abandoned as a result of not being used, some wasted equipment were left to rot without making something out of them as such end up deteriorating on major roads while there are many woodworking machines lying waste due to lack of spare parts as a result of high exchange rate. This abandoned equipment can be recycled to produce woodworking machine parts and make it functional. Similarly, Emefiele (2015) pointed out that so many items can be produced in Nigeria if those involved can apply themselves sufficiently enough. He emphasized that the present situation of Nigeria enables individual to embrace self-sufficiency and reduce appetite for anything foreign to conserve the country's scarce foreign exchange and create jobs. Eleke (2001) Said that apart from environmental abuse and sore caused by these products, many ghastly motor accident that have terminated the lives of Nigerians occurred as a result of these abandoned vehicles and equipment on the roads.

Metal scraps are either reshaped into tools or refurbished for sale. They recycle these items into products and their efforts are appreciated by those that bought them.

The recycling of this metal is done by foundry workers whereby the quality of their products is determined by their competency. Therefore, identifying the competency skills needed by foundry workers could change the entire life of humans in terms of economy by making woodworking machine lying waste due to lack of spare parts become functional using scrap metal to produce these parts.

Purpose of the study

The purpose of this study is to identify the competency needs of foundry workers in recycling used metals for producing woodworking machine parts in Minna metropolis, Niger state, Nigeria. Specifically, this study is to:-

- (I) Determine the competency needs of foundry workers in the recycling metal scraps for producing woodworking machine parts.
- (ii) Determine the strategies that can enhance effective recycling of metal scraps for producing woodworking machine parts.

Research Questions

- (i) What are the competence needs of foundry workers in recycling scrap metals for producing woodworking machine parts?
- (ii) What are the strategies to be adopted in recycling scrap metal for producing woodworking machine parts?

Hypotheses

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

- Ho₁:** There is no significant difference in the mean responses of foundry master and foundry workers on the competency needs of foundry workers in metal recycling for producing woodworking machine parts.
- Ho₂:** There is no significant difference in the mean responses of foundry master and foundry workers on the strategies to be adopted in enhancing a better recycling of metal scrap for producing woodworking machine parts in Minna metropolis.

Literature Review

Metal casting consists of pouring molten metal into a mould and it has a variety of shapes. It enables the production of simple to complex parts that meet a variety of needs (Treyger, 2017). He also explained that casting are further processed by machining which entails smoothing surfaces, drilling holes, cutting threads for fasteners and other steps necessary for incorporation into an assembly. The other casting methods include sand casting, shell-mould casting; investment casting, lost-foam casting; permanent-mould casting; centrifugal casting and die casting (Treyger, 2017). Similarly, Narayanan (2017) disclosed that casting is one of the oldest manufacturing process. He said that the following factors should be considered for successful casting operation and these factors are:

- (i) Preparation of moulds
- (ii) Melting and pouring of liquefied metal into mould
- (iii) Solidification and further cooling to room temperature
- (iv) Defects and inspection

It is observed that many items can be produced in Nigeria through casing using foundry workers instead of importing them. Emefiele (2015) disclosed that Central Bank of Nigeria will no longer continue to promote importation when there is potential to produce the items locally. He further said that the bank will support investors ready to invest in local production in the country. Sharing the same view, Buhari (2015) stressed that with focus on job creation, the government was ready to do whatever it considered necessary to boost domestic manufacturing and industrialization. The researchers were of the opinion that embracing foundry works can promote domestic manufacturing which can reduce dependence on foreign goods.

Basic Principles of Foundry

During recent years many sand foundries have been fully mechanized, transforming what was previously a crude art into a controlled science. However, the basic principles of foundry explained by Wikipedia in Abu (2015) are: Pattern making, Mould making, Melting, Pouring, Shakeout, De-gassing, De-gating, Surface cleaning and finishing.

Pattern Making: From the design provided by an engineer or designer, a craftsman called a patternmaker produces the pattern for the object to be produced using wood, plastic or plaster. The patternmaker will also produce patterns from existing cast metal, particularly in the renovation of antique ironwork. As the metal to be casted will shrink within the time and it first solidified and the same time cools. The pattern must be made slightly larger than the finished product.

Mould Making: This is the process of producing a shape using a frame called matrix. It can be made using pattern or model of the final object. The mould is a hollowed-out block that is filled with a liquid or pliable material like plastic or ceramic raw material. The liquid harden or sets inside the mould to adopt its shape. A mould is the counterpart to a cast; the common moulding process uses two moulds, for each half of the object, piece-moulding uses a number of different moulds, each creating a section of complicated object. There are various types of mould making which are: Green sand moulds, Open sand moulds, Close sand moulds and Dry sand moulds.

Green Sand Moulds: The most common method used to make metal castings is green sand moulding. In this process, granular refractory sand is coated with a mixture of bentonite clay, water and in some cases other additives are added. The additives help to harden and hold the mould shape to withstand the pressures of the molten metal. The green sand mixture is compacted by hand or through mechanical force around a pattern to create a mould. The mechanical force can be induced by slinging, jolting, squeezing or by impulse.

Open Sand Moulds: is the form of mould merely a depressed 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 casting requiring no great accuracy on the upper face. Figure (1) below is an example of open moulds.

Close Sand Moulds: are made of moulding boxes. 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 each side of the box, during the actual pouring; the two boxes are locked together by keys which are driven into slots in the locating pins; the figure (2) below is an example of close moulds.

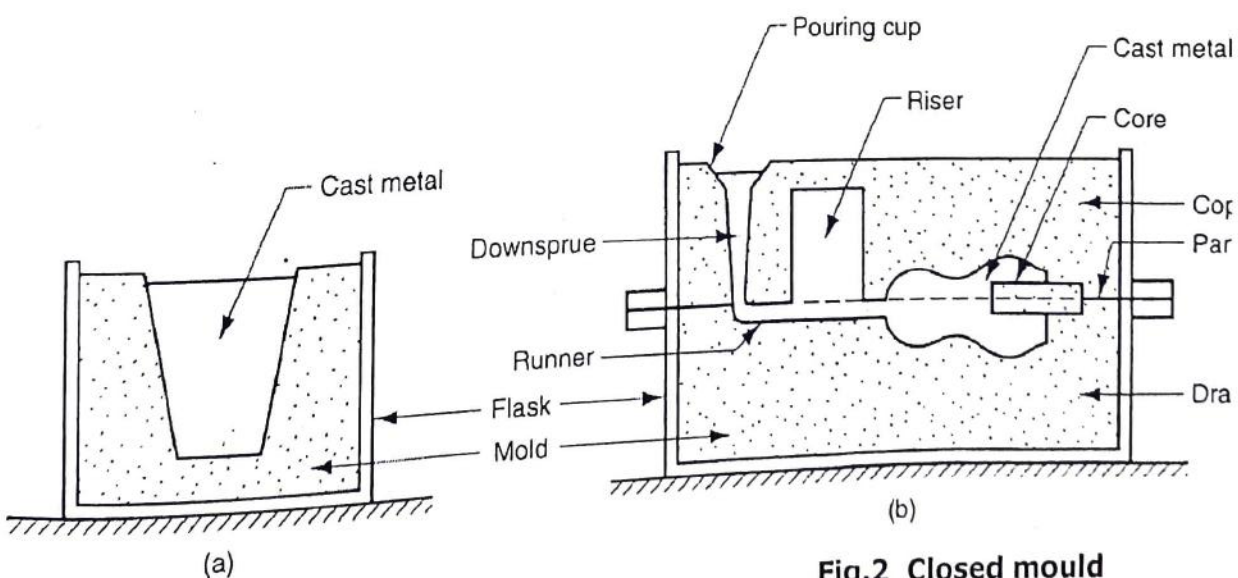


Fig.1 Open mould
Source: Wikipedia in Abu (2015)

Fig.2 Closed mould

Dry Sand Moulds it 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, which the large mould made on the shop floor are skin-dried by coke braziers or gas torches. These moulds are much stronger than green moulds and are generally used for the larger and more complicated casting. Less steam reduces the possibility of blowholes in the final casting.

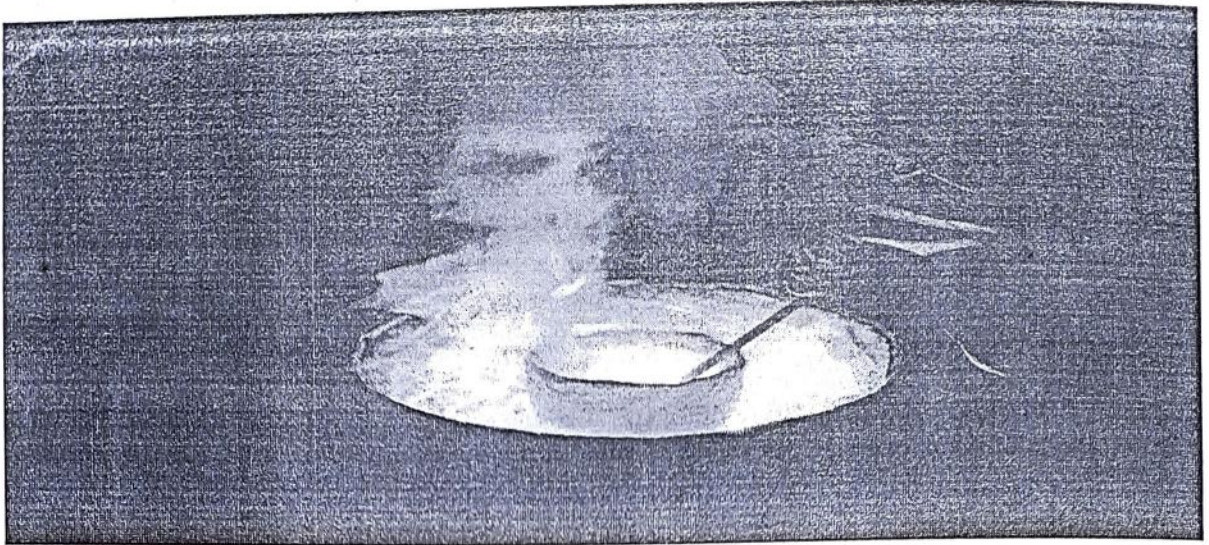
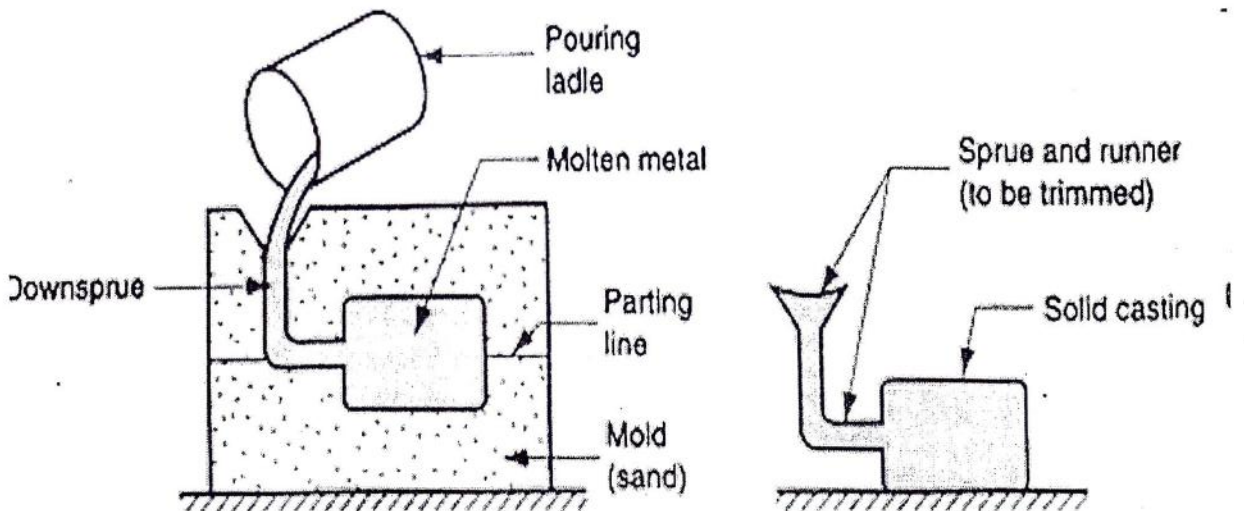


Fig. 3: A furnace

Source: Wikipedia in Abu (2015)

Pouring: In casting work, when you're opening a furnace to remove any ferrous metal part from the crucible with your hook, then skim the slag from the molten alloy surface and throw it in a waiting iron receptacle. Pouring can be accomplished with gravity. Many modern foundry work are done by robots or automatic pouring machine for pouring molten. Though, traditionally, moulds were poured with hand using ladles.



Source: Wikipedia in Abu (2015)

Shakeout: This is where the solidified metal component is removed from the moulds by shaking or tumbling. This frees the casting from the sand which is still on the metal runners and gate that are directed through which molten metal travelled to the component.

De-gassing: In de-gassing, hydrogen gas moves from an area of high pressure to an area of low pressure. Hydrogen de-gassing of aluminum works on the principle that hydrogen gas will move from an area of high pressure to an area of low pressure. Hydrogen gas disperse in the

molten metal as it would if it were release in the air, as hydrogen gas moves, it will equalize its pressure throughout the melting.

De-gating: Is the removal of Runners, gates and riser using cutting torches, band saw or ceramic cut-off blade. For some metal types, with some system designs, runners and gates can be removed by breaking them away from the casting with a hammer or specially designed knockout machinery.

Cleaning Metal Surface: For all metal colouring and electroplating, a clean metal surface is essential. The cleaning process must remove mineral oils, organic oils and grease as well as traces. It must remove oxidation which might interfere with the metal coloration of plating adhesion and it should be able to activate or roughen the metal surface to better receive the treatment. Cleaning maybe accomplished using mechanical abrasive, chemical heating and solvents with acid and electrolytic means. Example of easily achieved clean surface includes sandblasted ones and ones scrubbed twice.

Finishing: Final step in the process usually involves grinding, sanding, or machining the component in order to achieve the desired dimensional accuracy, physical shape and surface finish. Removing the remaining gate material called a gate stub is usually done using a grinder or sander (UNIDO, 1999). These processes are used because their material removal rates are slow to control the amount of material removed. The metal objects are nice because of the finishing.

Methodology

Descriptive survey research design was chosen as it seeks the views of people about a particular issue that concerns them. It gives room for researcher to study the group of people and source for information from the respondents. Kothari and Garg (2014) explained descriptive research as those studies that are concerned with describing the characteristics of a particular individual or group.

The study covered all local foundry workers having foundry workshops in Minna metropolis, Niger state, Nigeria. The entire study was conducted among different categories of personnel in the major and minor foundry workshops, and they were mostly situated in Pantaker complex, Minna, Nigeria. The targeted Population for this study was 40 respondents which were registered members of Local Foundry Association in Minna, Niger state, Nigeria. It consisted of 15 Foundry Masters and 25 foundry workers. The entire Population was used for the study. Foundry masters and foundry workers were used for the study because they are the people involved in foundry work.

The questionnaire was the main instrument used by the researchers for data collected for the study. Section A contains 10 items and it deals with the needed competencies of foundry workers in recycling metal scraps in Minna metropolis. Section B contains 12 items which deal with the strategies that enhance effective recycling of metal scraps in Minna metropolis.

The instrument was subjected to face and content validation by three lecturers in the Department of Industrial and Technology Education, Federal University of Technology, Minna, Nigeria. The validators' suggestions were incorporated in the final draft of the instrument to ensure that the instrument was capable of eliciting necessary information that were needed for the study. The questionnaire was administered by the researchers to the respondents (foundry Master and foundry Workers) and the completed questionnaire was also collected by the researchers. The questionnaire returned was 95 which mean 95% return.

The data collected were analyzed using mean and four point rating scale was used. 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 score of 2.50 and above was accepted and those below 2.50 were rejected. The z-test statistics was used to test the null hypotheses at 0.05 level of significance.

Result

Research Questions 1

What are the needed competencies of foundry workers in recycling metal scraps for producing woodworking machine parts in Minna metropolis?

Table 1: Mean responses of the respondents on the needed competencies of foundry workers in recycling metal scraps for producing woodworking machine parts in Minna metropolis

S/No	Items	X ₁	X ₂	X ₃	Remarks
1	Determine the correct type of scraps in compliance with the job specification.	3.27	3.60	3.44	Agreed
2	Preparing furnace accurately to melt scraps.	3.47	3.36	3.42	Agreed
3	Making pattern using wood in accordance with job description.	3.00	2.72	2.86	Agreed
4	Adequate use of the right metal to make pattern in compliance with the job specification.	2.80	2.96	2.88	Agreed
5	Perfectly melt the scrap metal.	2.87	2.88	2.88	Agreed
	Remove impurities from molten metal in the crucible.	2.93	2.80	2.87	Agreed
6	Remove impurities from molten metal in the crucible.	2.93	2.80	2.87	Agreed
7	Specialize in pouring molten metal in the moulds.	2.60	2.68	2.64	Agreed
8	Perfectly clean the surface of recycled products using baking powder.	2.73	2.72	2.73	Agreed
9	Have a good finishing skill using files and sand paper.	2.87	2.48	2.68	Agreed
10	De-gassing the molten metal for a perfect casting.	2.67	2.88	2.78	Agreed

Key: X_t = Average mean of foundry masters and Foundry workers

The results above revealed that the respondents agreed with all items with a mean score ranging between 2.50-3.44.

Research Question 2

What are the strategies that enhance effective recycling metal scraps for producing woodworking machine parts in Minna metropolis?

Table 2: Mean responses of the respondents on the strategies that enhance recycling metal scraps for producing woodworking machine parts in Minna metropolis

S/No	Items	X ₁	X ₂	X ₃	Remarks
1	Receiving loan from Government organization or voluntary organization.	3.47	3.80	3.64	Agreed
2	Receiving further training from other foundry experts.	3.47	3.00	3.24	Agreed
3	Courses conducted in local language can be used to up -date foundry worker's knowledge.	2.93	2.88	2.91	Agreed
4	Teaching foundry workers basically technical theories once in a month.	2.87	2.40	2.64	Agreed
5	Need to collaborate with other foundry workers in order to improve craftsmanship.	2.93	2.52	2.72	Agreed
6	Certifying foundry workers before allowing to establish workshop.	2.67	3.40	3.04	Agreed
7	Train graduates from polytechnics and universities on part time basis.	2.67	2.72	2.70	Agreed
8	Organising regular practical for the local foundry workers by NGOs	2.73	2.60	2.67	Agreed
9	Making sure each local foundry worker to have a minimum of labour trade test grade III before being allowed to practice.	2.67	2.64	2.66	Agreed
10	Have induction programme for local foundry workers.	3.13	2.52	2.83	Agreed
11	Involving Foundry workers in cooperative union in order to access credit from banks.	2.40	2.40	2.40	Disagreed
12	Enforcing government policy governing recycling process.	2.40	2.60	2.50	Agreed

The results revealed that the respondents agreed with the items with a mean score ranging from 2.50 -3.64 and disagreed with item 21 with mean score of 2.40

Ho₁: There is no significant difference in the mean responses of foundry master and foundry workers in the strategies to be adopted in enhancing a better recycling of metal scrap for producing woodworking machine parts in Minna metropolis.

Table 3: z-test analysis of respondents regarding the strategies to be adopted in enhancing a better recycling of metal scrap for producing woodworking machine parts in Minna

Respondents	Number	X	SD	df	z-cal	z-crit	Remark
Foundry masters	15	2.83	3.24	38	0.09	1.97	NS
Foundry workers	25	2.68	2.13				

Key: S = significant
NS = Not significance

The results disclosed that the z-cal value is less than the z-crit. Therefore, null hypothesis was accepted.

Ho₂: There is no significant difference in the mean responses of foundry master and foundry workers on the competence needs of foundry workers in metal recycling for producing woodworking machine parts.

Table 4: z-test analysis of respondents regarding the competence needs of foundry workers in metal recycling for producing woodworking machine parts

Respondents	Number	X	SD	df	z-cal	z-crit	Remark
Foundry masters	15	2.86	1.96	38	0.11	1.97	NS
Foundry workers	25	2.79	1.99				

Key: S = significant
 NS = Not significant

The analysis in table 5 disclosed that the z-cal value is less than the z-crit. Therefore, null hypothesis was accepted.

Discussion of Findings

The findings on the needed competencies of foundry workers in recycling metal scrap for producing woodworking machine parts show that the respondents agreed with all the items listed. It was also revealed that there is need to determine correct scraps in compliance with the job description. Jordan in Abu (2015) disclosed that metal scraps can be obtained from home and industries which are discarded. Home scrap arises when a product made of metals has serves its useful life and discarded. He added that this discarded metal scraps can be properly recycled when the foundry workers possess the necessary skills essential for carrying out this task.

The findings on the strategies that enhance effective recycling of metal scraps for producing woodworking machine parts show that receiving loan from government organization or voluntary organization, receiving further training from other foundry experts. The technological institutions and technical training agencies such as National Directorate for Employment (NDE) should organize training programmes for local foundry workers and this should involve both theory and practical since these people are not in any way trained (Atsumbe in Abu, 2015). Organizing training for local foundry workers will improve their skills which will boost local production of items. At a meeting with the Permanent Secretary, Federal Ministry of Industry, Trade and Investment, senior officers of the ministry and the Chief Executives of parastatals under the ministry, President Buhari stressed that with the focus on job creation, the government was ready to do whatever it considered necessary to boost domestic manufacturing and industrialization.

The findings on hypotheses 1 as revealed indicated that there is no significant difference in mean responses between foundry master and foundry workers on the competency needs of foundry workers in metal recycling. This shows that foundry workers accepted the competency needs for recycling metal scraps. The findings on hypotheses 2 indicated that there is no significant difference in mean responses between foundry master and foundry workers on the strategies to be adopted in enhancing a better recycling of metal scrap in Minna metropolis. This means the foundry workers accepted the strategies for enhancing better recycling of metal scraps.

Conclusion

Base on the analysis of the findings and considering the competency needed for recycling

metal scraps, it is expected that there is a need for improvement of these competencies for effective delivery. The findings of this study disclosed that government, private organizations and other bodies have a great role to play in order to help the activities of foundry workers with reference to use of scrap metals for the production of woodworking machine parts. There should be an engagement of foundry workers in transforming scrap metal into woodworking machine parts as it makes those machines rendered useless to become functional since it is difficult to import spare parts due to high currency exchange rate. Using this scrap metal also aids in reducing the amount of waste in the environment which reduces pollution which might be air, water or land.

Recommendations

The following recommendations are made;

- (i) National Directorate for Employment (NDE), Youth Empowerment Scheme and other Voluntary Organizations should provide means of encouraging the local foundry workers by training, certificating and providing soft loan to them.
- (ii) Short term course in local language should be used to up-date the foundry masters and foundry workers.
- (iii) There is a need for inexperienced foundry workers to collaborate with other experienced foundry workers to improve their craftsmanship.
- (iv) Foundry workers should improve their finishing skill by always using files and sand paper.
- (v) Ensure proper use of the right metal to make pattern in compliance with the job specification.

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