ASSESSMENT OF WOOD WASTE UTILISATION FOR WEALTH CREATION IN MINNA METROPOLIS, NIGER STATE

BY

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DECLARATION

I, AGBIDI, Elias Ejelikwu with Matriculation Number: 2013/1/46146BT 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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SIGNATURE & DATE

CERTIFICATION

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

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DEDICATION

This project is specially dedicated to God Almighty, My Parent and all well-wishers.

ACKNOLEDGEMENTS

The researcher expresses special thanks to Almighty God for his divine protection, provision, mercy, wisdom and guidance throughout the course of study in FUT Minna. I pray that God almighty will continue to bless him and his family My gratitude also goes to the project coordinator and my able and understanding supervisor Dr. A. M. Hassan for is support and care for me. My sincere gratitude goes to the Head of Department Dr. I. Y. Umar and the entire lecturers of the department of Industrial and Technology Education who have in one way or the other contributed to my life. God bless you all. I own a special thanks to my lovely parent Mr. AGBIDI Matthew who through the years have been supportive financially, morally and above all spiritually My sincere thank goes to my sister Dr. Alice Akwonya Osuji for her assistant and financial support throughout my years in school I pray God will continue to bless you all and your family Finally, my sincere appreciation goes to my family members and all well-wishers Thank you and God bless you all (Amen).

ABSTRACT

This study was designed to identify assessable wood waste in Minna and how it can be utilised to create wealth. The purpose of the study was to identify the wood waste available in Minna. Identify the sources of wood waste generated, identify the uses of the wood waste generated and identify the benefits of the utilization of the wood waste generated in Minna. A review of literature was carried out on utilization of the assessable wood waste for wealth creation in Minna metropolis. The research questions was formulated to guide the study and the research was restricted to cover utilization of the assessable wood waste for wealth creation in Minna metropolis, there for questionnaire items for the instrument was drawn based on fifteen (15) carpenters. Five (5) Niger state environmental pollution agency (NISEPA) staffs and ten (10) technical staffs of wood processing industries (timber sheds and sawmills). Results of the findings revealed that the wood waste available in Minna include; barks, branches, planer shavings, sawdust, veneer clippings, panel trims, chips and furniture (whole and piece) , the sources of the wood waste generated in Minna include; forests, sawmills, timber sheds, carpentry shops, homes, industries and work areas, the uses of the wood waste generated in Minna include; papers, MDFs, HDFs, furniture, extracting manure, fuel and general energy, the method of utilizing wood waste for wealth creation in Minna include; creating awareness, introduction of recycling method, management of wood waste expert, creation of assessable waste, advertisement, increasing of the quantity of waste, encouragement of craftsmen, reduction of government policies on waste, training of craftsmen, and quality control.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Wood waste generation in Nigeria is constantly on the increase as a result of low average percentage timber recovery both in the forests and wood processing industries and increased demand for wood and its products in the country (Gyimah*et al.*, 2009). Being perceived as mere useless materials to be discarded, wood waste has become a menace to public health and the environment in Nigeria due to its indiscriminate disposal practices.

Nigeria's climate varies from tropical rain forest in the south, to savannah in the middle belt andarid/semi-arid in the north (USAID, 2008). The huge volume of rainfall annually enables forest reserves to thrive throughout the country. Around 11million hectares of forest and about 5.5million hectares of other wooded land are available in Nigeria (FAO, 2005). Round woods in Nigeria are mostly from the southern region; Cross Rivers, Delta, Ogun, Edo, Ekiti, Ondo, Oyo and Osun states, as a result of high annual rainfall in the region (FAO, 2005). These woods are processed in the various wood processing industries; sawmill industries, plywood mills, furniture industries, pulp and paper industries and particleboard mills (Mijinyawa*et al.*, 2010), in the country. The activities at these forests, wooded lands and wood processing industries generate huge volume of wood wastes that could be harnessed to produce value added products and can also be used to create wealth for the nation.

Wood waste generally include branches, scrap lumber, saw dust, broken wooden pallets, mixed soil and rocks generated as waste materials from log dock and milling facilities, inert construction and demolition waste. Any part of wood which is left considering it of no use is recommended as wood waste (Arimoro*et al.,* 2007). It can also be ash from burning of wood from a site, wood fired boiler, kiln dryer and burners.

Sawmills account for over 93% of the entire wood processing industries in Nigeria (Ogunwusi, 2014). The activities at these sawmills have led to the generation of huge quantity of wood wastes. Having obtained logs of wood from the forest, the saw millers process them into lumbers of various forms and sizes in their mills. Several wood wastes including sawdust, slabs, bark, split wood, etc. are generated during this process. Although sawmills are the largest sector of wood processing in Nigeria, wood wastes are also generated from other wood processing industries, like the furniture industries, plywood mills and particleboard mills. Wood wastes are also generated from municipal and industrial activities.

Sambo (2009) estimated the amount of sawdustgenerated per annum in Nigeria to be about 1.8million tonnes, while (Francescato, Antonini, Bergomi, Metschina, Schnedl, Krajnc, Koscik, Gradziuk, Nocentini, Stranieri, 2008) reported a figure for wood residues to be about 5.2million tonnes per year. Due to poor management methods these vast amount of wood residues are often discarded as useless materials, usually untreated, into the environment where they cause adverse effects. Disposal methods such as heaping at industrial sites, dumping on road sides, drainages or water bodies and open air burning are common practices. Some of these industries situated close to banks of rivers often dump their residues into the rivers. These indiscriminate disposal practices results in untoward environmental and human impacts; unsightly look of the environment, air pollution, respiratory tract infection, eye problems, contamination of rivers and ground waters, distortion of water eco-systems and contribution to climate change (Arimoro*et al.,* 2007; Nwankwo, 1998; Wihersaari, 2005). These wastes disposal practices contradict sustainable solid waste management which entails various activities that encourage the efficient utilization of material resources to reduce the amount of waste produced and the management of wastegenerated in such a way that the economic, social and environmental goals of sustainable development arelargely achieved (Pianosi, 2012). According to (IISD, 2016), sustainable development is a development that satisfies the needs of the present generation without jeopardizing the ability of future generations to meet their own needs. Most countries are enacting policies that encourage waste reduction and promote effective waste utilization.

Quantity of wood waste generated in Nigeria is constantly on the increase. This is adduced to low average percentage of timber recovery both in the forest and wood processing industries, due to the useof obsolete equipment and production processes, coupled with increased demand for wood and its products in the country (Ogunwusi, 2014). To ensureproper and economic management of these wood wastes, they must no longer be regarded as mere useless materials to be discarded but as useful resources of economic value from which energy, fuel and other by-products can be harnessed. This paper aims to highlight the potentials of wood waste as a viable resource for economic growth and sustainable development with the view to pique the people's interest in the proper management and harnessing of wood waste.

1.2 Statement of Problem

The Timber Research and Development Association (TRADA 2007) has stated that it is very difficult to obtain reliable information on wood waste arising partly due to quantitative data on wood waste not being available at the company level. Many companies do not collate exact figures on volumes of residues generated, but rather base estimates on containers used such as bins, skips, trucks. With vast quantities of timber products being consumed in Nigeria, considerable volumes of both wood residue and wood waste is produced through processing and end of life products. In most cases less than half the feedstock timber ends up in the end product, the greater portion that end up as waste needs to be used for wealth creation (however new advances in technology and the development of alternative markets are creating greater opportunities to further utilise this valuable resource).The recovery of value from wood waste simultaneously can reduce the impacts of wood waste 'disposal' while adding value to society in the form of additional material and energy flows, and increased economic activity. It is not enough to recycle wood in order to be sustainable, instead we must strive to find the most appropriate and highest valued applications of the material to extend its 'life' as much as is practical, and to offer the greatest net return on the material in terms of wealth creation.This study therefore access the utilization of wood waste in Minna metropolis and to highlight the potentials of wood waste as a viable resource for economic growth and sustainable development and thereby pique the people's interest in the proper management and harnessing of wood waste for wealth creation.

1.3 Purpose of the Study

The purpose of this study is to assess wood waste utilization for wealth creation in Minna. Specifically, this study seeks to address the following objectives:

- Identify the wood waste that are generated in Minna metropolis.
- Identify the sources of the wood waste generation.
- Identify the uses of wood waste generated.
- Identifying the benefit and market profit?

1.4 Significance of the Study

The findings from this study will be beneficial to the following categories of people: wood work students, wood work teachers, technical staff in wood processing industries, and the society at large.

The environmental benefits attributable to wood waste utilization depend on the method of recovery. The major direct environmental benefits appear to be most noteworthy andquantifiable when wood waste is used to displace coal for electricity or steam generation.When wood is used to displace high sulfur bituminous coal, sulfur emissions can be reducedby more than 80%. Using wood waste frees up landfill space, contributes to sequestering of carbon, reduces carbon dioxide emissions from processing virgin material, and contributes tosustainable use of natural resources. Environmental issues accompany the environmentalbenefits of recycling wood waste, especially demolition wood waste. For example, in the caseof waterborne wood preservatives, there is a concern about chemical leaching (if the wood isused as mulch) or concentration in the ash (if the processed wood is used as boiler fuel).These environmental issues are currently being researched.

Recovering and recycling wood from the waste stream result in the conservation of naturalresources. For example, more than 1 billion pallets are put into circulation each year, 50% of these pallets are designed for a single-use trip. The pallet market is an important outlet forlumber mills that serve the high-quality furniture industry. By developing new markets forwood waste, forest owners have more opportunities to offset the costs of sustainable forest management and improve the overall health of the forests.

The findings of this study are of great significance to residents of Minna as it unveils to the people how wood waste can be accessed within Minna metropolis. Also this study’s findings will highlight possible use of wood waste for creation of wealth in Minna, Niger state. It would improve wood waste disposal and reduce the harmful effect on public health in Nigeria.

Effective implementation of the findings and the recommendations of this study will significantly improve the financial and economic power of the town.

1.5 Scope of the Study

This study focused only on the wood waste from the wood processing industries (sawmill, timber shed and furniture workshop) and Niger state environmental pollution agency (NISEPA). It did not consider forest residues produced in the process of logging or land clearing.

It contributes to land degradation, salinity and declining water quality, damage to coastal marine zones, species extinctions and greenhouse emissions.

Land clearing leads to habitat loss and habitat fragmentation, exposing what's left to fire and invasive pests such as weeds.

1.6 Research Questions

This study is set out to addressed the following research questions:

1. What are the wood wastes generated in Minna metropolis?
2. What are the sources of the wood waste generated in Minna?
3. What are the uses of the wood waste generated in Minna?
4. What are the strategies for the utilization of wood waste for wealth creation in Minna?

1.7 Research Hypotheses

HO1: There is no significant difference in the mean responses of Niger state Environmental pollution agency(NISEPA) workers and technical staff of wood processing industries on the wood waste generated in Minna metropolis.

HO2: There is be no significant difference in the mean responses of Niger state Environmental pollution agency (NISEPA) workers and technical staff of wood processing industries on the sources of the wood waste generated in Minna metropolis.

HO3: There will be no significant difference in the mean responses of Niger state Environmental pollution agency (NISEPA) workers and technical staff of wood processing industries on the uses of the wood waste generated in Minna metropolis

HO4: There will be no significant difference in the mean responses of Niger state environmental pollution agency (NISEPA) workers and technical staff of wood processing industries on the strategies for the utilization of wood waste for wealth creation in Minna metropolis?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Frame Work

The literature for the study will be reviewed under the following subheadings;

The concept of wood waste.

Wood waste and market value.

Wood waste to the rescue.

Factor militating against industrial waste utilization.

Current method of wood waste handling in Nigeria prospects for optimising wood waste utilization in Nigeria.

2.2 The Conceptual frame Work

Any part of wood which is left considering it of no use is recommended as wood waste. For example branches, stumps, sawdust, slabs etc.

In general: Some activities that can generate wood waste in a sawmill in Nigeria is shown in the picture below

a. Log in mill yard **b. Log in conversion process**

c. Sawdust **d. Ripping**

Plate 2.1 a-d : Activities that generate wood waste in a typical Nigerian sawmill

Source: Babayemi (2010)

Types of wood residue

Mainly there are two types of residues.
Logging residues

Industrial waste

Logging residues include buttress, cross cutting residues, crown, branches, logs left in forest, stem off cuts, stump.

Industrial waste is again divided into

Logging transporting residues

Logs left or rejected at loading station, waterway transportation.

Primary processing waste

Bark, core, slab, sawdust, shorts, trimming, veneer waste, defective pieces caused by processing.

Secondary processing waste

Mould woods, sawdust, shavings, old construction roofs and stakes etc.

Wood Waste Classification:

Wood wastes have been broadly classified into two:

Unavoidable Waste

Unavoidable wastes are those wood wastes that cannot be avoided or prevented even where the saw's kerf is minimal and the mill workers are efficient. These include sawdust, inconvertible slabs and strips.

Avoidable Waste

Avoidable wastes, on the other hand, is caused by lack of

Pre-inspection of trees and logs

Adequate saw maintenance

Poor harvesting techniques

Which result in residues in the forest in the form of branches, tree crowns, off cuts, twigs, stumps, small diameter sized timbers, substandard lumbers which are inaccurately processed or converted.

Source of Wood Waste:

All types and sources of wood waste are mainly organized in three major categories:

Forest biomass

Wood processing residual by-products

Urban wood waste

Within these three major categories, the following eight supply sources were identified:

Forest Biomass

Commercial logging and forest fuel management

Range improvement contractors

Wood Processing Residual By-Products

Primary wood products manufacturing business

Secondary wood products manufacturing business

Urban Wood Waste

Municipal waste disposal facilities

Tree care- private business

Tree care- city governments

Utility companies

Forest Biomass:

Commercial Logging: Forest biomass generated by commercial timber harvest represents a significant source of wood waste supply. The available amount of this type of wood waste is ultimately dependent upon timber harvest levels. The four phases of timber harvest include:

Tree logging

Log processing

Loading

Hauling

The log processing involves cutting the tree into appropriate sizes for loading and hauling, and, the removal of limbs, tops and other un-merchantable portions of the tree. The wood waste generated as a result of log processing is commonly known as logging slash or forest residue.

Fuel Management and Range Improvement Contractors: In some forests, softwood trees are managed in order to reduce forest fuels. Management activities to achieve fuel reduction generate various kind of waste in terms of cones, needles, branches etc. Similarly to improve range condition certain tree species are removed which have lethal effect on forage condition and livestock. Management activities include tree thinning and tree removal.

Wood Processing Residual By-Products:

Primary Processors:

Primary wood processors are businesses that manufacture wood products using logs or other round wood as raw material. Manufactured wood products include lumber, veneer, logs, firewood, shavings and wooden fencing materials (posts, poles, and rails). The primary bio products are bark, sawdust, chips and shavings. In many situations tree bark is removed prior to initial processing, which results in the generation of bark as a by-product. The wood products manufacturing by-product sawdust is produced during the initial log break down phase and as lumber is edged and trimmed. Slabs produced during the initial log breakdown phase and can be further processed into chips and/or wood mulch. Shavings are produced by planning lumber to produce a smooth surface.

The residues generated from the forest products industry may be divided into two parts; that which results from harvesting and extracting logs from the forest, and generally considered of no economic use for further processing, and that which is generated by the forest industries themselves during the process of manufacturing timber, plywood, particleboard and the like namely:

Table 2.1.1: types of residues and their sources

Source	Type of residue
Wood processing	Sawmill, timber shed and furniture workshop leaves, stumps, roots, low grade and decayed wood and sawdust
Sawmilling	Bark, sawdust, trimmings, split wood, planer shavings, sander dust
Plywood production	Bark, core, sawdust, lillypads, clippings and waste, panel trim, sander dust
Particleboard production	Bark, screening fines, panel trim, sawdust, sander dust

Source: Tairiq (2013)

The actual production of residues, or waste, generated from the manufacture of wood products, differs from plant to plant and depends on several factors, from the properties of the wood to the type, operation and maintenance of the processing plant. However, mean averages apply to each type of industry, which is summarized in Table

Table 2.1.2: Proportion of residues generated in selected forest products industries

	Sawmilling	Plywood Manu.	Particleboard Manu.	Integrated Operations
	%	%	%	%
Finished product (range)	45-55	40-50	85-90	65-70
Finished product (average)	50	47	90	68
Residues/Fuel	43	45	5	24
Losses	7	8	5	8
Total	100	100	100	100

Source: Tairiq (2013)

Secondary Processors:

Secondary wood processors are defined as businesses that manufacture wood products from lumber, partially manufactured logs, or residue from primary wood products manufacturing. Secondary products include cabinets, shipping pallets, construction stakes, roof and floor trusses, interior doors, picture frames, hardwood molding and trophy plaques.

Secondary processes primarily produce sawdust and shavings-chips and barks are not a common by-product of secondary processing.

Urban wood waste:

Municipal Waste Disposal Facilities:

The category known as municipal waste consists of everyday household and business garbage, construction and demolition waste and also includes other wood waste generated as a result of lawn maintenance and urban forest management activities. The study defined suitable urban wood waste as the portion of the municipal waste stream that includes pruned branches, stumps, and whole trees from street and park maintenance, wooden shipping pallets and woody material from land clearing activities. While unsuitable urban wood waste is that generated from construction and demolition activities and commonly contain wood preservation chemicals, paint and adhesives.

Tree Care Service and Utility Companies:

The disposal of whole trees, tree branches and other wood waste generated as a result of urban forest management represents a potential future supply of bio-energy feedstock.

In general, it may be said that of a typical tree, less than two-thirds is taken from the forest for further processing, the remainder being either left, burnt or collected as fuelwood by the local inhabitants. After processing, only 28 percent of the original tree becomes lumber, the remainder being residues, as indicated in Table.

Table 2.1.3: Division of a typical tree harvested for sawn timber

Tree part or product	Portion (%)
Left in the forest:	
Top, branches and foliage	23.0
Stump (excluding roots)	10.0
Sawdust	5.0
Sawmilling:	
Slabs, edgings and off-cuts	17.0
Sawdust and fines	7.5
Various losses	4.0
Bark	5.5
Sawn timber	28.0
Total	100.0

Source: Tairiq (2013)

2.2.1 Wood Waste and Market Values

Historically wood waste has been processed as feedstock for the board manufacturing industry, however in recent years alternative markets have slowly been developing. End markets now range from animal bedding to specialist composite materials.

The end markets available to each source of material will ultimately depend on the quality of the material. Depending on the level of contamination, varying degrees of processing may be required which can influence the cost-effectiveness of the process. The recycled fibre will often have to compete with virgin materials and as such should be produced to the highest specification possible for wealth creation. The recovery of value from wood waste simultaneously can reduce the impacts of wood waste 'disposal' while adding value to society in the form of additional material and energy flows, and increased economic activity. It is not enough to recycle wood in order to be sustainable, instead we must strive to find the most appropriate and highest value applications of the material to extend its ‘life’ as much as is practical, and to offer the greatest net return on the material.

Regarding the waste management in the Nigerian wood industry, serious problems have come up recently caused by numerous conflicts. In the Nigerian society of wood industry it is an accepted fact that the incineration is not the best way for wood waste utilization or management because in many cases it can be considered as a by-product and may be recycled in several production processes as a secondary raw material for creation of wealth in the nation. Therefore, the distinguishing of waste and non-waste materials arising during the production or any other level utilisation process, and their utilization method should be assessed and decided from an economical and ecological point of view for wealth creation.

Large volumes of the logs that come into most timber industries are not efficiently utilized leading to high rates of residue generated from logging, wood processing and storage processes (Magin, 2001). The production of high volumes of residue brings the natural forest which is the main source of raw material for the wood industry under threat. Using wood carefully with minimum waste is a vital component of sustainable timber use, but this has been less of a focus to date (Magin, 2001). Wood residues like sawdust, trimmings and edgings are typically viewed as a burdensome disposal problem (FAO, 1990), however, the material has a potential to become a usable resource. Ghana is in a position to take up this advantage since the timber industries have average yield of about 28-64% (Gyimah and Adu-Gyamfi, 2009), with majority of the wood resources going to waste.

To take advantage of the market opportunities that exist for wood residues and waste for wealth creation, information is needed on their availability, quantity and production rates, types of wood residues/waste being produced, current markets and current disposal practices (Alderman, 1998).

Wood residue from waste could be decomposed in the soil to improve soil structure and fertility for food crops to enhance food security. Thus, there will be no need to clear more hectares of land for same quantity of food, hence forest maintained. Also, plantation crops could be fertilized with bio char which is a carbonaceous material produced by thermal decomposition of wood with limited supply of oxygen and a relatively low temperature (<700^{o}C). Bio char is produced specifically for the application to soil as part of agronomic or environmental management (Lehmann and Joseph, 2009). Bio char is very stable hence the carbon remains sequestered in the soil for a long time and contributes to the mitigation of climate change (Lehmann, 2007a).

For a more efficient wood waste utilization and the environment load reduction,the Nigerian Union has launched several research and technological programmes, among which we have some dedicated to the wood recycling. The members met regularly and the new research results were shared, the development of the individual participants on this field was introduced.

Most of the accessible and known wood wastes were are listed below:

packing waste

demolition wood

wood waste from the building industry

Fractions of used wood from public, industrial and commercial activities.

Based on the common research activity, the most important utilization methods are (in hierarchical order) as follow:

reuse
recycling
energy generation
Disposal.

Base on the above utilization methods only few can be used to generate wealth for nation, and these are also under-utilized for a developing country like Nigeria. In Nigeria, in many cases the conflict is between recycling and energy generation since the determination of the appropriate ratio can be difficult (for instance: wood chips should be used for particle board production or as energy source for heating systems?). It is clear that the third possibility, the disposal is the worst solution from the aspect of greenhouse effect. In this case, the wood is considered as waste or as compost material, possibly it is burned without using as an energy source – so it leaves the carbon CO2- cycle. It cannot be used further on, and if it is handled as waste, significant amount of methane and other greenhouse gases will be released. Consequently, reduction of GHG-emission may be realized in this way – moreover valuable secondary raw material can be saved. Recycling and energetic utilization have a big market, but there are restricting factors. For example, the utilization of timbers treated with dangerous chemicals is difficult because of the content of preservatives inthem (copper, arsenic, chrome, etc.).

It is of primary importance that the carbon bounded in wood should be preserved as long as possible and released back to the atmosphere as the last possibility, from where the trees (perhaps the sea, polar ice caps etc.) can absorb it again.

The process is important not only from the viewpoint of environmental protection. From economic and social aspect, it can be stated that the cost of material collection and recycling is smaller than that of gathering and storage (eg. the timber dissolves in a waste yard it without providing energy but CO2 releases in the same way). Naturally, recycling is economic for a company only if the derived secondary raw material is cheaper than the primary.

Wood residue result as a by-product of tree felling and timber processing and can be used by industry to produce energy for their activities and operations. Wood residue can be collected and used from in forest cut over, log landing or wood process. Most of New Zealand's wood residue arises from the 1.7 million hectares of pine plantation forests currently spread through the country (EECA 2018). Wood residue comes in various forms, for example, wood chips which are made from wood off cuts and are fairly regular in size ones screened, hogged wood which has been mechanically damaged and is usually low quality, saw dust and shavings in very small sized wood particles. Wood residues can be gotten from in-forest cut over sites, log landing sites and wood processing sites. Wood residue is considered as wood waste.

Wood waste generally include branches, scrap lumber, saw dust, broken wooden pallets, mixed soil and rocks generated as waste materials from log dock and milling facilities, inert construction and demolition waste. Any part of wood which is left considering it of no use is recommended as wood waste. It can also be ash from burning of wood from a site, wood fired boiler, kiln dryer and burners. Nigeria has a total of around 11.1 million hectares of forest and 5.5 million hectares of other wooded land. As such, wood waste from these huge landmasses could be explored as fuel for power generation purposes. The country's landscape is varied, as is the climate, from humid and sub-humid in the south, to semi-arid in the north. The considerably high annual volume of rainfall allows the government-controlled forest reserves to thrive extensively throughout the country.

2.3 Review of Related Empirical Studies

Realizing the economic potential of these wood wastes, there is needed to conduct a concomitant study to determine the ratio of waste generated in different techniques of processing these logs in order to obtain expected monetary returns from them(NISER, 2004, Steel, 2006, Jamieson 1977). This invariably means that waste should be reduced as much as possible to enhance lumber recovery. Wood industries produce large volume of residues which must be utilized, marketed or disposed-off. Heaps of wood residues are common features in the saw millthroughout the year, and to be precise in Nigeria as a whole, it is generally regarded as waste and this has led to open burning practices as a method of residuedisposal. There are two categories of wood wastes,these are: those generated in the forest during logging process and those generated within the wood-based plants during conversion processes. There are several causes of wood wastes. Most of these depend on factors such as the logging methods employed during timber extraction, the debarking process employed; type of sawing machinery used during timber conversion and the skill of the band saw operators. As a result of these factors, quantities of wood residues generated at any particular time vary from sawmill to sawmill (Smith and Joe, 2006, Hindle, 2009, Ayarkwa J.A and Addae – Menash A., 1999). Realizing the extent of exploitation of forest land, there is need to conduct a study to determine the ratio of lumber recovery with respect to factor influencing it, so as to be able to identify the factors that affect the recovery ratio of these logs. This study therefore focused on the assessment of machines used in the conversion of logs, experience of operators, number of machines involved in the operation, number of personnel; log input volume and the lumber recovery that impact on the conversion efficiency obtained during log processing.

A cardinal implement to achieving a more sustainable socioeconomic development in Ghana is energy. The importance of energy in the socioeconomic development of Ghana is echoes in an era where the country continues to battle with a reliable energy source in powering its industries, households, and the entire nation. Salient economic variables such as poverty reduction, employment opportunities, education, and demographic transitions do have a linear relationship with the availability of energy, as espoused by the International Atomic Energy Agency. In view of this, for Ghana to successfully transition from a predominantly agrarian economy to an industrialized one, sufficient and affordable energy supplies remain a keystone.

Undoubtedly, the underlying catalysts for the immerse growth, development, and the subsequent maintenance of all economies in the world are energy. Its influential and sensitive effects have been largely witnessed in the developed and giant economies such as the United States, Japan, United Kingdom, Germany, and China. At the onset of Ghana's independence, the Akosombo Dam, a hydro-powered dam, generated enough energy capable of sustaining the developmental agenda of young and emerging economy of Ghana.At the onset of Ghana's independence, the Akosombo Dam, a hydro-powered dam, generated enough energy capable of sustaining the developmental agenda of young and emerging economy of Ghana. So much was the energy that Ghana exported its energy to neighbouring countries. However, with the passage of time, the overdependence on hydropower for the socioeconomic development of the country currently has proven to be dangerous, especially at a time when the population is increasing at a rate of 2.39% as at 2016 and economic activities are booming. This has been experienced in the recent power outages in the country where several small-scale industries collapsed and/or were crippled, with the heavy industries retrenching over 1000 of its labourers. Even though power plants were imported into the country to supplement energy generation from the Akosombo Dam, a hydro-powered dam, generated enough energy capable of sustaining the developmental agenda of young and emerging economy of Ghana. So much was the energy that Ghana exported its energy to neighbouring countries. However, with the passage of time, the overdependence on hydropower for the socioeconomic development of the country currently has proven to be dangerous, especially at a time when the population is increasing at a rate of 2.39% as at 2016 and economic activities are booming. This has been experienced in the recent power outages in the country where several small-scale industries collapsed and/or were crippled, with the heavy industries retrenching over 1000 of its labourers. Even though power plants were imported into the country to supplement energy generation from the Akosombo Dam, the initiative contributed to increasing cost of energy due to the thermal component of the said plants which operated on diesel or petrol.

As a remedy, more sustainable and appropriate energy sources have been suggested and paramount among the alternatives is energy from waste. Using waste to produce energy which is more sustainable and environmentally friendly is not a new idea but the needed interest, priority, and attention has not been given to the concept in Ghana although Zoomlion Ghana Limited adopted the concept recently in its new facility in the Abokobi Landfill site in Accra. The worry and surprising aspect to the low patronage of waste-to-energy facilities in Ghana is predicated on the amount of solid waste generated annually in the country, as well as the budgetary allocation towards making the cities clean. Nevertheless, converting waste to energy by employing appropriate technology has received tremendous embracement by other economies as Wiles espoused that 125 waste-to-energy facilities were in operation in the United State as at 1993. In the European Union more than 64% of facilities use waste materials as alternative fuels.

Globally, the degree of alternative fuel use differs depending on the country. Even though Netherland has the highest ratio (83%) of use of alternative fuel worldwide, Austria, Germany, and Norway have achieved significant replacement ratios of 60 to 63%, whereas that of Switzerland and Belgium was 47 to 49%. Although Italy and Spain have only achieved low replacement ratios, approximately 8.6% and 22.4%, respectively, as at 2004, these countries have increased their volume of alternative fuel from waste substitution in recent years. For instance, the use of alternative fuels from waste increased about 22% compared with the 2004 figure, when approximately 175,000 tons of waste materials were energetically recovery material in Spain. In the United States, many plants reportedly met 20 to 70% of their energy requirement from the use of alternative fuels from waste in 2009 according to the Portland Cement Association.

A wide range of alternative fuels from waste are used, and these fuels can be classified into three basic groups, according to Mokrzycki and Uliasz-Bocheńczyk: gas (e.g., landfill gas, pyrolytic gas, and biogas), liquid (e.g., used oils and solvents), and solid (wood waste, plastics, municipal waste, and textiles). In 2010 alone, appreciable percentages were recorded across different countries worldwide; Austria achieved 70% recycling (including composting) alongside 30% waste which was incinerated; Germany achieved 62% recycling alongside 38% incineration, while Belgium achieved 62% recycling alongside 37% incineration. As an energy source, energy from waste has a number of potentials beyond its renewable content including energy security, nonintermittent nature, varieties of potential energy outputs, reducing overdependence on fossil fuel usage, greenhouse gas emissions, pollution, and landfill dumping.

The US Environmental Protection Authority (EPA) states that waste-to-energy facilities are a "clean, reliable, renewable source of energy" and waste-to-energy facilities produce energy with "less environmental impact than almost any other source of electricity." Waste can be converted into energy in a range of ways through diverse appropriate technologies. Energy from waste is not just about waste management practice but produces valuable domestic energy source contributing to energy security. However, incineration has been the most well-known practice among other methods according to the UK Department for Environmental and Rural Affairs.

In view of this, numerous conversion options exist but the conversion of waste (solid) into useable form of energy can be broadly undertaken with three main process technologies:

biochemical extraction, thermochemical extraction, and mechanical extraction. For the first process, biochemical conversion, enzymes in the bacterial and microorganisms are used to fragment biomass. As regards biomass, the US Department of Energy posits that “biomass is a term that includes all energy materials that emanate from biological sources, whether they are wood or wood wastes, residue of wood processing industries, food industry waste products, or municipal solid waste”. The biochemical extraction or conversion procedure is regarded by (Odlare et al. and Pant et al) as one of the handful procedures that provide environmentally friendly direction for obtaining useable energy fuel from waste particularly municipal solid waste. Its environmental friendliness rests on its use of microorganisms to perform the conversion process by using anaerobic digestion with what is called “CHHP” (Combined Heat Hydrogen and Power) systems and fermentation.

On the other hand, thermochemical conversion according to Hamad et al. forms one component in a number of integrated waste management solutions in multifarious schemes. Four main kinds of conversion technologies are used in this conversion process: combustion, gasification, pyrolysis, and liquefaction. Combustion is used over a wide range of commercial and industrial combustion plant outputs to convert the chemical energy stored in the solid waste into either heat or electricity.The process deals with the burning of biomass in air, by recycling the carbon fixed by photosynthesis in the growth phase. Though biomass can be used to generate constant planned amounts of energy “base load”, its constant supply in meeting demand peaks cannot be adequately ensured in the same way as gas due to the key role of waste management on a continuous basis. However, there is potential for energy from waste plants with a greater degree of flexibility that could be suitable for providing peak load electricity such as those that could provide biogas or pyrolysis oil, which could be stored and used when needed. In their 2001

Renewable Energy Annual report, the US Department of Energy intimated that waste-to-energy with 2750 megawatts represents 27% of the biomass category. Generally, any type of biomass can be burned in practice, but combustion is realizable only for biomass that has been pre-dried. In combustion, a number of process equipment items including boilers and turbines are needed.

Meanwhile, gasification conversion process involves treating a carbon-based material with either oxygen or steam to produce gaseous fuel which can be cleaned and burned in a gas engine or transformed chemically into methanol that can be further used as synthetic compound. Pyrolysis conversion on the other hand deals with the heating of biomass in an oxygen free environment to produce liquid which is often called biooil or biocrude in varying yield of solid and gaseous fragments. To ensure effectiveness, the pyrolysis depends on the heating rate, temperature level, particles size, and retention time to produce the required energy. Furthermore, liquefaction as the last waste-to-energy conversion process under the thermochemical conversion concerns low temperature cracking of biomass molecules to obtain liquid-diluted fuel as a result of high pressure. The process requires a temperature range of around 200 degrees Celsius to about 400 degrees Celsius. Lastly, mechanical extraction deals with the process of extracting oil from the seeds of waste. Targeted at producing biodiesel, the clamped down oil is made to react with alcohol through a process known as esterification. Mechanical extraction can moreover be broken down into three main classes: electricity generation, heat generation, and steam generation. All the processes under the thermochemical conversion of waste to useable form of energy generate large quantity needed for indigenous consumption when appropriately performed.

In Africa, for instance, the Cows to Kilowatts project in Ibadan became the first plant in the world to simultaneously treat abattoir waste and provide domestic energy and organic fertilizer.

The project generated the equivalent of 0.5 Megawatts (MW) of electricity daily. Similarly, the Thekwini Landfill Gas to Electricity project in Durban generated 7.5 MW of electricity from 2 landfill sites. All these facilities add to the national electricity grids in the respective countries were they exist, thus easing the pressure on the other sources of energy. Also, waste-to-energy contributes 32% of the entire US electricity generation. Conclusions could be drawn from these evidences that an innovative and sustainable energy alternatives exist in Ghana which can be tapped with the use of appropriate technologies. This energy can only be tapped into and increase energy generation in Ghana if it would focus its energies on converting waste to energy rather than dumping them in designated landfill sites. However, it must be noted that financing waste-to-energy facilities is difficult owing to its capital intensiveness but the gains from the facilities can offset the cost in the long run.

Waste management and an exploration of its economic potentials is at an infant stage in Africa, specifically, Ghana. Perhaps, this may be due to a confluence of factors like social norms and associated concerns, natural environmental issues, economic factors, regional and national legislation, technological developments, human resource deployment, and historical influences, among others. Waste generation is an invitation to income generation when considered from the periscope of waste management economics. Income from waste may be generated from the employment it creates and the cost it saves from waste collection and management. While other developed economies such as Australia, Singapore, and Sweden are profiting financially from the generation of solid waste, developing economies such as Ghana continue to regard all forms of solid waste to be fated for the landfill sites and see it as a burden as well as a problem to be addressed. The contributing factor to the perception of waste as a burden fated for the landfill sites could be attributed to the lack of segregation of waste from the source.

In Australia, businesses in the private and public trading sector received an income of $8.6b during the 2009-10 financial year, with waste services accounting for about $5.1 billion (59.9%) of the total income generated and sales of recyclable or recoverable material contributed 26% in 2009. For private and public trading sector businesses, income from the commercial and industrial stream contributed 61.4% of waste services income, followed by the domestic and municipal waste stream (27.3%) and the construction and demolition stream (10.5%). In 2010, nonhazardous waste contributed 82.9% of waste services income. Nonrecyclable waste services contributed the most to waste services income (83.8%), with recyclable waste services accounting for the remaining 16.2%. The government sector received $2.6 billion income in relation to waste activity. Rates, charges, levies, fines, and licenses from waste management activities contributed 77.1%, followed by waste services income (19.5%) and sales of recyclable or recoverable material (1.6%). The sources of waste services income for the general government sector were similar to the private and public trading sector, with nonrecyclable waste accounting for 84% of waste services income and recyclable waste accounting for 16%. The government sector organizations in New South Wales employed 2,311 people in activities related to waste management, contributing 39% of total government sector employment, followed by Western Australia (1,096 or 18.5%) and Queensland (1,036 or 17.5%). New South Wales contributed $971.8 million (37.4%) of total government sector income related to waste management activity, while Queensland contributed $548.2 million (21.1%). Moreover, expenditure related to waste management activity was highest for New South Wales at $826.1 million (38% of the Australian total), with Queensland contributing 418.1 million (19.2%) [34]. Meanwhile, with all these expenditure in other countries, Singapore has created an island from its solid waste, thus attracting tourists to the country and generating income for the whole country.

As espoused earlier in Section 2.1, the various ministries contract private companies to help in the management of MSW. Besides this, Ghana's Ministry of Sanitation and Water Resources in collaboration with Zoomlion Ghana Limited contracted about 45,320 youths under the Youth in Sanitation module under the Youth Employment Agency (YEA) to serve a dual purpose: as an employment avenue and also to rid the cities of filth. Huge sums of money are allocated to the management of MSW through the PPP besides other means of waste management practices such as the pay-as-you-dump policy in Ghana. Although these partnerships have been in existence for long, the effective and viable means of waste management employed can be summarizes as follows: generate, collect, and dispose of in landfill site (GCD). With the practice of GCD, the only proof available for its effectiveness or otherwise has been the continual mountain of filth witnessed across the length and breadth of the country. Of course, these initiatives have not proven effective considering the mountain of filth in the gutters, streets, and even landfill sites which is eventually driven by wind into surrounding communities. Instead of, perhaps, contributing to the socioeconomic development of Ghana, the myriad MSW within the towns and cities effectively contribute to the outbreak of sanitation-related diseases and a dispensation of money for waste management purposes.

Even though other countries are making huge gains from the generation of MSW by means of income generation, Ghana persists to spend on waste management than generating income from waste, despite the economic viabilities of waste generated in the country. Reportedly, the Accra Metropolitan Assembly spends about US$ 3.45 million each year (GH 6.7 million) on collection and transport of waste for disposal and GH 550,000.00 a month to pay waste contractors and landfill maintenance. Poor sanitation resulting from indiscriminate waste disposal alone is estimated to cost the country $290 million every year. This share of money represents 1.6% of the country's Gross Domestic Product. However, the inability to effectively tap the dividends from waste generation and management significantly by the country may stem from the low investment due to the negative mindset towards waste management, low infrastructure, and poor research implementation.

According to Zimmermann, "resources are not, they become; they are not static but expand and contract in response to human wants and actions". The earth is made up of raw materials (neutral stuff) which only become a resource when it is able to satisfy the wants of man. In view of this, for a neutral staff to qualify as a resource, it must possess two essentially related but different attributes: the capacity to take advantage of opportunities and the capacity to extricate one's self from difficulties. Thus, whereas waste may be considered a neutral stuff to one person, it could become a resource if one finds the need to take advantage of it when appropriate technology exists for its potential to be tapped to satisfy a want. For instance, just until recently in Ghana, empty sachet water bags were either dumped into gutters, wayside, and/or thrown into bins for eventual disposal at the landfill site without any use for.

Conventionally, raw materials for production in industries across the globe come from the utilization of neutral stuffs like clay, sand, stone, gravels, gold, diamond, manganese, timber, and steel, among others, which are tapped from the natural environment. Inherent in these neutral stuffs are the ability to cause harm to the environment with regard to their constant exploitation and/or be a blessing under the right environment and condition. As pointed out by Shah, waste may be generated during the extraction of raw materials for production which may be detrimental to the environment. To forfend the environment and at the same time conserve resources, efficient recycling of waste, particularly, and municipal solid waste for reuse is essential.

In view of this, experiences in some countries in both the developed and developing world indicate that several businesses and industries make use of waste as their raw materials to produce diverse goods. These are done to ensure environmental sustainability and management and promote cost saving in order to maximize profit. In India, the informal sector and secondary industries recycle up to 15–20% of solid wastes generated by the country in various building components. Also, Pappu et al.emphasized numerous examples on the availability of solid wastes of diverse forms from different sources, and how they have been transformed to derive different products for safe, sound, and substantial development in their country of production.

One important industry where waste materials are much needed for production is the cement industry. Solid wastes such as waste gypsum serve as important raw materials that are used as raw material substitutes in the clinker and the cement manufacturing process to provide significant savings in terms of natural resources. For example, about 38% replacement of limestone or 72% replacement of clay is from waste materials. The precalciner stage can process approximately 20–40% of the raw material before the kiln calcination step and, consequently, increase the energy efficiency of the kiln operation. In the final stage of cement production, the mixture that is obtained, called clinker, is cooled and grounded with gypsum afterwards (approximately 5%) and added to other substitute's materials from waste, such as slag, fly ash, and pozzolans to produce cement which is reground and packaged.

Interestingly, though hazardous solid wastes are characterized by negative perception because of their high concentration of poisonous elements and properties (ignitability, corrosivity, reactivity and toxicity) which are unsafe to use commercially and economically, as well as their adverse effect on the environment, humans, flora, and fauna, these can also be recycled and reused as a resource. Hazardous waste from metallurgical residues, galvanizing waste, and tannery waste can be converted into products including cement, bricks, tiles, ceramics, and boards. It is therefore evident from such studies that there are great potentials for recycling of solid wastes released from different sources including industrial processes, agricultural processes, mining processes, and medical processes. As a result, many companies in some countries such as India are making good use of waste to manufacture products such as cement, wall panels, and tiles.

In contrast, the recycling of waste to acquire materials for production has not gained strong root in Ghana. The country to a larger extent conceives waste management as discarding of waste with the aim of protecting the environment. Little attention is given to the reuse character inherent in waste generated in the country. Thus, these wastes, although are raw materials, continue to exist as neutral stuffs which pollute the environment and do contribute to the outbreak of sanitation-related diseases such as malaria, cholera, and typhoid. In their publication in May 1999, the Ministry of Local Government and Rural Development (MLGRD) outlined the basic principles of environmental sanitation, problems, and constraints. The role and responsibilities assigned to communities, ministries, departments, and agencies (MMDAs) and the private sector by the MLGRD impinge on environmental management and protection, legislation, and law enforcement and the criteria for specifying services and programmes, funding, equipment, and supplies, among others. Out of the National Sanitation Policy, the MLGRD has also developed a technical guideline document titled “The Expanded Sanitary Inspection and Compliance Enforcement (ESICOME) Programme guidelines”.

The programme guidelines which are implemented by the MMDA’s, routinely look at four broad areas, namely, effective environmental health inspections (Sanitary Inspections), dissemination of sanitary information (Hygiene Education), pests/vector control, and law enforcement. All MMDAs have developed waste management and environmental health plans to help solve the numerous sanitation problems. However, a critical assessment of the policy' achievements indicates that the policy has not lived up to it expectations as heaps of solid, liquid, radioactive, and hazardous waste continue to flood the streets of the country. This is evident from the worst ever cholera outbreak in 2012, besides the predicament in the 1980s. The management of plastic waste that resulted in a number of types of small-scale plastic waste recycling is still a neonate sector.

Some technologies that have been developed to assist recycling of waste have not worked to the mandate due to a multiplicity of factors including inadequate government financial support on recycling, lack of public awareness on the need to recycle waste, indifference of the public towards good waste management practices such as recycling, interinstitutional cooperation and collaboration, and low technical capacity. It must be emphasized that, with the current pace of natural resource exploitation in the country for production, recycling of recyclable waste as raw materials for production will serve a purpose of protecting the environment, conserving resource, and promoting the socioeconomic sustainable development of the country.

2.3.1 Factors Influencing the Utilisation of Wood Waste

The introduction of fiscal and regulatory drivers such as the Packaging Regulations and the Climate Change Levy are of increasing interest in recycling wood waste.

The majority of wood wastes have the potential to be recovered, reused or recycled; however, this potential depends largely on the quality and composition of the wood waste arising. Where there is a large degree of contamination which can often be the case with post-consumer waste, the material will often require some degree of sorting and or processing. The degree of contamination and condition of material can greatly influence processing costs.

Care must be taken to identify and remove potential contaminants where possible before the material is processed. If a contaminant is identified before processing then it can simply be removed from a load, however if this is discovered after processing it can lead to the whole load being rejected or downgraded.

Many sources of wood waste can prove uneconomical to collect at present due to high transportation costs or there simply not being enough material; however, this may be overcome where stockpiling or backhauling material is feasible.

Large commercial users of recycled woodchip will generally demand the material to be supplied at a consistent quantity and quality. Therefore, wood recyclers require a comprehensive quality control system.

Wood can be treated with a wide variety of performance enhancing treatments such as Creosote and Chromate Copper Arsenate (CCA) etc. With increasing use of performance enhancing treatments, the volume of treated wood waste arising in the UK is likely to rise **(**European Parliament and of the Council, 2010**)**. The European Union has determined that organo-treated timber waste is a hazardous material. It has subsequently classified preservative treated wood waste as a hazardous waste, which will require special treatment of the residues produced (wood and resources action program (WRAP) 2015;European parliament and the council(EPC) 2010).

The industry has generally accepted that the burning of chemically treated wood at temperatures above 800^{o}C is likely to produce emissions similar to untreated wood. However, Directive 2000/76/EC of the European Parliament on the incineration of waste, requires that hazardous wastes such as those which contain halogenated organic substances expressed as chlorine must be incinerated at least for 2 seconds at temperatures of 1100^{o}C (WRAP, 2015).

The principal problem associated with treated wood waste is in identifying the chemicals preservatives present in the load. There is no way to easily identify the composition or quantity of any chemicals present. Board manufacturers in the UK identify chemically treated wood as material they will not accept for use in their products, due to concerns with health and safety, product quality and processing.

Unless these barriers can be overcome or alternative markets developed which can handle treated wood, it will continue to be consigned to landfill as a hazardous waste.

There is considerable research currently being undertaken looking at the use and disposal of treated timber, which include particleboard, energy recovery, wood composites, dilution, biodegradation and bio-processing.

One such study is the work WRAP and the Timber Research and Development Association (TRADA 2007) who are currently investigating the rapid identification and sorting of preservative treated timber.

As competition for wood waste increases processors may have to develop ways to utilise more heavily contaminated material in order to increase their throughput of wood waste.

New markets are slowly emerging for waste wood. Each market requires a consistent supply of high quality material which is cost competitive with virgin material. The markets vary considerably in the quality of material they can utilise, however advances in technology and greater awareness are producing greater volumes of good quality recycled woodchip.

2.4 Wood Waste to the Rescue

Biomass resources such as municipal solid waste and animal waste, agricultural crops and residues, as well as forestry resources, are common in Nigeria. Given that they are available extensively, especially wood waste, there is a large potential for their use in producing bio fuel.

The use of biomass can, however, control the instability in the power sector. Table 2 provides an estimate of the amount of wood waste produced (tonne per day) in some cities situated in the southwest region of the country.

Table 2.4.1: Mass Flow of Wood Waste Generated in Southwest Nigeria.

City	Wood Residues (tonne/day)
Lagos	810
Abeokuta	1340
Ibadan	70
Ilorin	70
Ado-ekiti	20
Akure	10
Ile-ife	20
Total	**2300**

Source: Oluoti (2014)

Sawmills, by their very nature, generate much waste: sawdust, wood off-cuts, wood backs, plain shavings, wood rejects, etc. In the absence of proper disposal methods, these wastes are burnt in the open air, dumped along the bank of streams and rivers or left on any available space to rot (Popoola 2013). Sambo (2009) estimates that the amount of sawdust generated in Nigeria is about 1.8 million tonnes per annum, While Francescato et al. (2008) reports that the corresponding figure for wood waste is 5.2 million. As the demand for wood and its products increases, the volume of wastes being generated obviously increases too. Hence, one of the environmental problems facing cities and towns today is the proper disposal of the wastes being generated daily by the ever-increasing activities of the sawmills (Babayemi and Dauda, 2010).Odewunmi(2001) observed that waste generation is connected with everyday living: it cannot be avoided. With numerous attendant problems being caused by the lack of correct management of theses wastes, it is imperative that every effort be made not only to undertake proper management but also to put it into good use, as is the case in developed countries. On the part of the government, a workable policy should be formulated, implemented andfollowed to a logical conclusion. In the event of a system failure or a complete absence of genuine and efficient waste management, varieties of unpleasant situations become prevalent, and may include flooding as a result of drains and waterways being blocked during the raining season. They can also constitute impediments for wood workers due to unprecedented accumulation of wastes over a period of time, affecting work rate negatively and ultimately, leading to a reduced output. According to Bello and Mijinyawa (2010), wood disposal methods employed on mill sites include:

Agricultural uses, including material for animal bedding.

Burning on dump sites and open spaces on a daily basis.

Fuel for use by food vendors and other individuals for cooking and other purposes.

Meanwhile, the huge volume of wood waste generated (by sawmills and other wood industries) in and around Nigerian cities and towns poses environmental and health challenges. Wood waste can however be utilized directly as fuel by public and private power facilities in dedicated power systems. Utilizing biomass waste as an energy source (fuel) converts environmentally detrimental materials (such as residues from agricultural lands, forests and wood processing industries) into fuel materials. Considering emerging global trends, the current desire for mitigating climatic changes, and the push to empower consumers in both developing and developed worlds magnify the need for a less-centralized generation, transmission and distribution of energy (Olesen and Kvetay, 2001). If developed well, studies and projections have shown that several Renewable Energy Technologies (RET) would be in a position to compete with fossil fuels by 2025. Moreover, a better and well-managed energy investment and local production of RET in developing countries, coupled with an enhanced focus on R & D for RET and energy efficiency are highly essential if this goal is to be achieved (Umar, 2004). In general terms, renewable energy resources, if fully harnessed, could serve as a means of reducing poverty significantly, as well as enhancing sustainable development, in Nigeria (Nnaji*et al.*, 2010).

2.5 Factors Militating Against Industrial Waste Utilization

One of the major problems limiting high level utilization of wood waste over the years in Nigeria was that no concrete effort made to incorporate fuel burners into the wood processing companies. As a result, many mills regard wood waste as a troublesome by-product, good only for domestic energy production and landfill. This occurs mostly as wood waste handling, processing and combustion may require higher capital outlay, considerable development in new and imported technology and plant design. Whilst it may be desirable to incorporate forest residues into the mainstream of wood waste for industrial use, transport cost has been a critical factor limiting its utilization. Also, the type of wood waste residues generated by wood processors differ from plant to plant and depends on factors such as properties of the wood, type of operation employed, and maintenance of processing plant. In general, the following factors militate against wood waste utilization in the country:

lack of bankable studies on economic returns from wood waste processing
lack of incentives for wood waste utilization

Inadequate enforcement of environmental regulations and absence of policy on wood waste management in the country.

Absence of technological knowhow on waste utilization and processing techniques.

Inadequate vertical and horizontal integration in business strategies

2.6 Current methods of wood waste handling in Nigeria

Currently, wood waste in Nigeria are mainly used for particleboard production. In most cases particleboard mills are integrated with sawmills for sustainable utilization of wood waste. In the 1970's to early 1990's, the Piedmont Plywood Ltd, Ologbo, Ondo State, has a bastion bahre machine and African Timber and Plywood has a Siempelkamp machine. Each has a single line making 3-layer particleboard. Both are built to utilize the residues of wood processing complexes with which they are integrated. While plans were on to expand production capacity through increased utilization of waste and veneer residues from independent sawmills, the mills went under as a result of the general economic climate and government privatisation policy of the 1990's. Despite the numerous potential uses of reconstituted panels in Nigeria, particles board production has declined considerably requiring an extensive program of investment incentives in the subsector (RMRDC, 2009; RMRDC, 2003;. GWV, 1994). As at present, the predominant method of wood waste disposal in the country is through open incineration. In order to promote industrial utilization of the waste, the Forestry Research Institute of Nigeria (FRIN), conducted research into wood waste utilization in the last twenty years (Ogunsanwo, 2001). This led to development of technology to manufacture floor tiles, wall tiles and ceiling boards on commercial basis (Badejo, 2000). The latest development in wood waste utilization at FRIN is the application of lamination techniques where saw dust –cement boards and veneers are bonded into bands called SP-panels (Owonubi and Badejo, 2001). The project, according to Ogunsanwo (2001), is an innovative way of recycling wood waste to produce value added wood products.

This enables optimal utilization of logs and provides a better wood waste management strategy in the country. In addition, wood waste, especially off cuts, shaving, edgings, slabs and trimmings of various wood species are usually arranged and glued together to form a variety of laminated products which could be used to produce products such as flower vases, bowls, etc. This use however consumes less than 5% of the total wood waste produced in the industry.

2.7 Prospects for Optimising Wood Waste Utilization in Nigeria

The 20th century's era of seemingly plentiful and cheap resources is coming to an end. Most economies are putting in place policy that will promote effective utilization of waste. The ability of any economy to adapt and become more climate change resilient, resource efficient and at the same time remain competitive depends on the high level of eco-innovation (EC,2014). It has become important to reduce resource use and its environmental impacts while increasing competitiveness. Using recycled content in products instead of new materials usually result in less Green House Gas (GHG) emissions over a products life cycle. Recycling more materials means less original resources are being used in the manufacturing process. More recycling means less waste would end up in landfills, thereby decreasing landfill emissions. As highlighted earlier, the high level of paper recycling in Nigeria saves GHG emissions that could have been generated from cutting and processing trees as well as allowing trees to continue to act as carbon sink. Closely allied with these, wood waste management has a number of advantages. It encourages total wood utilization, reduces cost of production and promotes a cleaner environment. It also prevents burning of wood waste and thus mitigate climate change. Various value added products has been produced from wood waste. These products have eliminated most of the negative implications posed by improper disposal and management of wood residues as mere waste. Some of the wood waste management methods that can be adopted to turn the country's wood industry into a sustainable industrial sector are subsequently discussed.

2.8 Summary of reviewed related literature

Waste is anything that has no use but wood waste has proven to be a different type of was as it is use in various aspect of economy ranging from wood industry, paper industry, agricultural sector and so on. Wood waste are gotten from forests, sawmills, timber sheds, wood industries and scraps from other industries, households and the environment. These wood waste includes saw dust, branches, lillypads, bark, panel trim, sanders dust, broken wooden furniture, broken pallets, split woods, trimmings e.t.c. this wood waste can be recycled into paper, particle boards, Medium density fibres (MDF), high density fibre (HDF), manure, waste furniture, fuel e.t.c, these materials can be sold in the market as it has been repackaged to meet market value and add value to the economy. The utilisation wood waste are influenced by some factors they include;

High rate of transporting the waste
Packaging regulations
Climate change levy
Wood contamination resulting to low quality of the wood waste
Carelessness of the craftman
Low quality control
If this factors are well tackled, wood waste will be properly utilised for wealth creation.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Research Design

Survey research design was used in carrying out this study. Olaitan and Nwoke (1999) defined a survey design as "a descriptive study in which the entire population or representative sample of the entire population is studied by collecting and analysing data from the group through the use of questionnaires". The use of questionnaire was employed for determination the opinions of the respondents under enquiry.

3.2 Area of Study and Respondents

The study was conducted within Minna metropolis in Niger state, which covers, saw mills, carpentry workshops, timber sheds, Niger state environmental pollution agency (NISEPA).

The saw mills and timber sheds will categorised as wood processing industries. Niger State is located on Latitude 10.2155388 and Longitude 5.3939551.

Population of the Study

The population that was accessible for this study include; large and small scale production Carpenters, technical staffs of wood processing industries and Niger state environmental pollution agency(NISEPA) staffs(waste collectors).

The accessible population for this study is 30, which comprises of 15 carpenters, 5 NISEPA staffs and 10 technical staffs of wood processing industries

3.4 Sample and Sampling Technique

The study adopted purposive sampling. All the 30 respondents was used for the study. The researcher purposively sampled 15 carpenters, 5 NISEPA staffs and 10 technical staffs of wood processing industries. Hence a total of 30 respondents (15 carpenters, 5 NISEPA staffs and 10 technical staffs of wood processing industries) was used.

3.5 Instrument for Data Collection

The instrument used for data collection is a structured questionnaire title "Questionnaire on the Assessment of Wood Waste Utilisation for Wealth Creation in Minna Metropolis, Niger State" was designed and developed by the researcher through the review of literature. The items on the questionnaire was organised in accordance with the researcher research questions formulated to guide the study. The instrument was structured to elicit information from the respondents. The structured questionnaire containing 36 items was divided into four sections: B, C, D and E. section A is designed to obtain personal data of the respondents, Section B contains 9 items and was designed to obtain information from respondents on the wood waste that can be generated in Minna metropolis. Section C contains 6 items and was designed to obtain information from respondents on what are the sources of the wood waste generated in Minna metropolis. Section D contains 7 items and was designed to obtain information from respondents on what are the uses of wood waste generated in Minna metropolis. Section E contain 14 items and was designed to obtain information from respondents on how wood waste generated in Minna could be used for wealth creation.

The questionnaire items were structured using FOUR-point rating scale with response options of: Strongly agreed (SA) rated 4 points, Agreed (A) rated 3 points, Disagreed (D) rated 2 points and Strongly Disagreed (SD) rated 1 point for research one, two, three and four in section B, C, D and E respectively.

3.6 Validation of Instrument

The Instrument was subjected to both face and content validation. Drafted copies of the questionnaire were given to Two (2) lecturers in the Department of Industrial and Technology Education, Federal University of Technology, Minna. All necessary corrections were effected in the items before administering the instrument to the respondents for pilot test.

3.7 Validity of the instrument

The Instrument was administered to the respondents by the researcher and two research assistants and the percentage of the administered questionnaires returned was recorded. The researcher gave the respondents 48 hours to respond to the questionnaires after which the researcher went back to collect the questionnaires. This is to give the respondents enough time for response of the items.

3.8 Method of Data Analysis

Data collected for this study were analysed using mean and analysis of variance (ANOVA). ANOVA was considered suitable because this research work involves three group of respondents. Items with mean score 0.5 – 1.49 was considered strongly Disagreed, 1.50 – 2.49 was considered Disagreed, 2.5 – 3.49 was considered Agreed, 3.50 – 4.49 was considered Moderately Agreed and 4.00 – 5.00 was considered Strongly Agreed. The reason for this number range is to determine the level of their acceptance. All statistical analysis were done using the Statistical Package for Social Sciences (SPSS).

Data collected will beanalyzed using mean and ANOVA for the research questions. A four (4) point rating scale will be to analyze the data as shown below.

Strongly Agree	(SA)	=	4points
Agree	(A)	=	3points
Disagree	(D)	=	2points

Strongly Disagree (SD) = 1point

The formula below was used to calculate the mean.

Where;

= mean

Σ = sum of normal value (summation)

= weight of the response

F = frequency

N = number of respondents to the items

Therefore, the mean response was computed with the formula:

Where;

= mean

Σ = sum of normal value (summation)

Therefore, the mean value of the 5 point scale is:

= = 2.5

3.9 Decision Rule

The cut off point of the mean score of 2.5 was chosen as the agreed or disagreed point. This is interpreted relatively according to the rating point scale adopted for this study. Therefore, an item with response below 2.49 was regarded or considered as disagreed while an item with response at exactly 2.5 and above was regarded or considered as agreed. The null hypotheses were tested using ANOVA statistics at 0.05 level of significance in order to compare the mean responses of NISEPA workers, technical staffs of wood processing industries and carpenters. A critical value of ±1.960 was selected based on the degree of freedom at 0.05 level of significance. Therefore, every item with calculated values less than the critical value was regarded as not significant while every item with calculated value equal or greater than the critical value was regarded as significant.

CHAPTER FOUR

4.0 PRESENTATION AND ANALYSIS OF DATA

This chapter deals with the presentation and analysis of data with respect to the research questions and hypothesis formulated for the study.

Research Question I

What are the wood wastes generated in Minna metropolis?

Table 4.1: Mean responses of Niger state Environmental pollution agency(NISEPA) workers and technical staff of wood processing industries on the wood waste generated in Minna metropolis.

N_1 = 15, N_2 = 5, N_3= 15

S/NO	ITEMS	$_1$	$_2$	$_3$	$_t$	REMARK
1.	Sawmill, timber shed and furniture workshop	2.80	3.00	2.78	2.86	Agree
2.	Bark, split wood	2.66	2.71	2.88	2.75	Agree
3.	Core, Lilly pads	2.60	2.72	2.65	2.66	Agree
4.	Planer shaving	2.62	2.52	2.74	2.63	Agree
5.	Sawdust and sanders dust	2.67	2.81	2.78	2.75	Agree
6.	Veneer clipping	2.62	2.77	2.55	2.65	Agree
7.	Panel trim and broken wooden pallets	2.25	2.38	2.72	2.54	Agree
8.	Chips	2.28	2.44	2.50	2.41	Disagree
9.	Whole furniture and furniture pieces	2.73	2.58	2.68	2.66	Agree

Key: N_1 = Carpenters, N_2 = NISEPA staff, N_3 =wood work technical staff,
$_1$ = Mean of response of carpenters,$_2$ = Mean of response of NISEPA staff, $_3$ = Mean of response of wood work technical staff, $_t$ = Average mean of responses of wood waste generated in Minna metropolis

Research Question II
What are the sources of the wood waste generated in Minna?

Table 4.2: Mean responses of Niger state Environmental pollution agency (NISEPA) workers and technical staff of wood processing industries on the sources of the wood waste generated in Minna metropolis.

N_1 = 15, N_2 = 5, N_3= 15

S/NO	ITEMS	$_1$	$_2$	$_3$	$_t$	REMARK
1.	forest	2.77	2.85	2.78	2.80	Agree
2.	Sawmills	2.69	2.73	2.43	2.62	Agree
3.	Timber sheds	2.69	2.58	2.61	2.63	Agree
4.	Wood industries (carpentry workshop) that generate waste that can be utilised	2.50	2.84	1.83	2.39	Disagree
5.	Homes	2.51	2.54	2.30	2.45	Disagree
6.	Industries or work areas that generate wooden scrap like pallets, lockers etc	2.48	2.77	2.22	2.49	Disagree

Key: N_1 = Carpenters, N_2 = NISEPA staff, N_3 =wood work technical staff,
$_1$ = Mean of response of carpenters, $_2$ = Mean of response of NISEPA staff, $_3$ = Mean of response of wood work technical staff, $_t$ = Average mean of responses of sources of the wood waste generated in minna

Research Question III
What are the uses of the wood waste generated?

Table 4.3: Mean responses of Niger state Environmental pollution agency (NISEPA) workers and technical staff of wood processing industries on the uses of the wood waste generated in Minna metropolis

N_1 = 15, N_2 = 5, N_3= 15

S/NO	ITEMS	$_1$	$_2$	$_3$	$_t$	REMARK
	Papers	2.79	2.77	2.74	2.77	Agree
	high density fibre (HDF)	2.73	2.81	2.64	2.73	Agree
	medium density fibre (MDF)	2.53	2.54	2.43	2.50	Agree
	Furniture	2.30	2.23	2.43	2.32	Disagree
	manure in agricultural sector	2.45	2.50	2.53	2.49	Disagree
	fuel in homes and industry	2.55	2.54	2.30	2.46	Disagree
	generate energy	2.32	2.65	2.22	2.40	Disagree

Key: N_1 = Carpenters, N_2 = NISEPA staff, N_3 =wood work technical staff,
$_1$ = Mean of response of carpenters, $_2$ = Mean of response of NISEPA staff, $_3$ = Mean of response of wood work technical staff, $_t$ = Average mean of responses of uses of the wood waste generated

Research Question IV

What are the strategies for the utilization of wood waste for wealth creation?

Table 4.4: Mean responses of Niger state environmental pollution agency (NISEPA) workers and technical staff of wood processing industries on how wood waste generated in Minna can be used for wealth creation.

N_1 = 15, N_2= 5, N_3= 15

S/NO	ITEMS	$_1$	$_2$	$_3$	$_t$	REMARK
	Create awareness for the usefulness of wood waste.	2.68	2.84	2.68	2.73	Agree
	Introduction of waste recycling methods	2.56	2.38	2.65	2.53	Agree
	Management of wood waste requires experts	2.38	2.04	2.57	2.33	Disagree
	Creation of easy access to wood waste	2.44	2.85	2.65	2.65	Agree
	Adequate infrastructure for wood waste management	2.25	2.58	2.78	2.54	Agree
	By advertising wood waste recycled products	2.55	2.78	2.61	2.65	Agree
	Quantity of wood waste should be increased	2.83	2.88	2.70	2.80	Agree
	craftsmen should be encouraged	2.43	2.65	2.39	2.49	Disagree
	Government policy on waste management create problem	2.51	2.62	2.48	2.54	Agree
	Encouraging the utilization of wood waste refined products	2.74	2.42	2.57	2.58	Agree
	Creation of wood waste manipulating training for craftsmen	2.73	2.58	2.65	2.65	Agree
	Provision of sufficient funds agencies in charge of wood waste	2.40	2.26	2.35	2.34	Disagree
	Creation of wood waste monitoring team for proper management and wood waste quality control team	2.78	2.73	2.57	2.69	Agree
	Proper Creation of centralised area for waste management	2.71	2.44	2.30	2.48	Disagree

Key: N_1 = Carpenters, N_2 = NISEPA staff, N_3 =wood work technical staff,

$_1$ = Mean of response of carpenters, $_2$ = Mean of response of NISEPA staff, $_3$ = Mean of response of wood work technical staff, $_t$ = Average mean of responses of wood waste generated can be used for wealth creation

Hypothesis I

HO_1: There is no significant difference in the mean responses of Niger state Environmental pollution agency(NISEPA) workersand technical staff of wood processing industries on the wood waste generated in Minna metropolis.

Table 4.5: One- way Analysis of Variance of the mean responses of the respondents on the waste generated in Minna metropolis

Sources of variation	Df	Sum of Squares	Mean Sum of Squares	f- cal	f- critical	Significance	Decision
Between groups Within groups	2 36	0.0263 1.46	0.01315 0.041	0.321	3.26	NS	Accepted
Total	38	1.48683					

The hypothesis shows the f- calculated in Table 4.6, which is 0.321. Since the calculated f- ratio is below the f- critical of 3.36, the stated null hypothesis is accepted at 0.05 level of significant meaning there is no statistical significance difference in the mean responses of Niger state Environmental pollution agency(NISEPA) workersand technical staff of wood processing industries on the wood waste generated in Minna metropolis.

Hypothesis II

HO_2: There is no significant difference in the mean responses of Niger state Environmental pollution agency (NISEPA) workers and technical staff of wood processing industries on the sources of the wood waste generated in Minna metropolis.

Table 4.6: One- way Analysis of Variance of the mean responses of the respondents on sources of the wood waste generated in Minna.

Sources of variation	Df	Sum of Squares	Mean Sum of Squares	f- cal	f- critical	Significance	Decision
Between groups	2	0.0484	0.0242	0.773	3.35	NS	Accepted
Within groups	27	0.845	0.0313				
Total	29	0.893					

The hypothesis shows the f- calculated in Table 4.7 which is 0.773. Since the calculated f- ratio is below the f- critical of 3.35, the stated null hypothesis is accepted at 0.05 level of significant meaning there is no statistical significance difference in the mean responses of Niger state Environmental pollution agency (NISEPA) workers and technical staff of wood processing industries on the sources of the wood waste generated in Minna metropolis

4.1Findings of the study

The following are the findings of the study, based on the data collected and analyzed; they are highlighted based on the research questions posed on the study by the hypothesis.

1. The wood waste that are generated in Minna metropolis, Niger StateBranches, stumped roots and decayed wood, Bark, split wood and Core, Lilly pads, Planer shaving, Sawdust and sanders dust, Veneer clipping, Panel trim and broken wooden pallets, Chips and screening fines, whole furniture and furniture pieces
2. The sources of the wood waste generated in Minna metropolisForest, Sawmills and Timber sheds Wood industries (carpentry workshop) that generate wood waste that can be utilized

   Homes, Industries or work areas that generate wooden scrap like pallets, lockers etc

3. The uses of the wood waste generated in MinnaPapers, High Density fibre (Hdf), Medium Density fibre (Mdf), Furniture, Extract manure in Agricultural Sector, Fuel in homes and Industryand to generate Energy.

4. The strategies for the utilization of wood waste for wealth creation in MinnaCreate awareness for the usefulness of wood waste.

   Introduction of waste recycling methods, Management of wood waste requires experts

   Creation of easy access to wood waste, Adequate infrastructure for wood waste management, By advertising wood waste recycled products,Quantity of wood waste should be increased, craftsmen should be encouraged, Government policy on waste management create problem, Encouraging the utilization of wood waste refined products, Creation of wood waste manipulating training for craftsmen, Provision of sufficient funds agencies in charge of wood waste, Creation of wood waste monitoring team for proper management and wood waste quality control team,Proper Creation of centralized area for waste management

4.2Discussion of the findings

The findings revealed in table 1 shows the wood waste that are generated in Minna metropolis, Niger State the result of the findings shows that the respondents agree on the following items: branches, stumped roots and decayed wood are generated in Minna, bark, split wood and slashing are available in Minna, core, Lilly pads are available in Minna metropolis, planer shaving are generated in Minna, sawdust and sanders dust are generated in Minna, veneer clipping are available in Minna metropolis, panel trim and broken wooden pallets are available in Minna, whole furniture and furniture pieces are available in Minna, accessibility of wood waste in Minna metropolis require licensing, tools for accessing the wood waste is available, climatic condition is a determining factor of the quantity and quality of wood waste generated. The findings is in accordance with Ogunbode(2014) that tools for wood waste should be made properly and readily available for adequate treatment of wood waste.

The sources of the wood waste generated in Minna metropolis findings are reveal in table 2 which shows that the respondents agree with the following items: high availability of forest in Minna, sawmills are available in Minna, timber sheds are available in Minna. This means that there is availability of forest, sawmill, and timber shed in Minna. This is in line with Ogunbode (2014) that saw dust from sawmill are usually useful.

The findings from table 3 reveal the uses of the wood waste generated in Minna the table shows that the respondents agree with the following items Wood waste are used to make papers, Wood waste are used to make high density fibre (HDF), Wood waste are used to make medium density fibre (MDF). The shows that wood waste are use in generation of MDF, HDF and also in manufacturing of papers. This is in accordance with Daniel (2013) that the falling and conversion of wood for different purposes is gradually leading to depletion of the forests. Since a lot of the wood is still being used for firewood, this paper recommends that factories that would convert sawdust into briquettes so that it can be used as fuel for fire as it is being done in other countries should be built.

Table 4 reveals the findings on wood waste generated in Minna should be utilised for wealth creation the findings shows that the respondents agree with the following items:Create awareness for the usefulness of wood waste, Introduction of waste recycling methods, Creation of easy access to wood waste, Adequate infrastructure for wood waste management By advertising wood waste recycled products, Quantity of wood waste should be increased, Government policy on waste management create problem, Encouraging the utilization of wood waste refined products, Creation of wood waste manipulating training for craftsmen, Creation of wood waste monitoring team for proper management and wood waste quality control team. The findings are in line with Ogunbode (2013) that Government can help the industries by providing certain incentives. Since the volume of waste generated is enormous, and the industries are more concerned with their economic activities, the government can offer to cart away the wastes to land fill sites and incinerators at subsidized rates. Also Government can also encourage cottage industries that will utilize the wastes. This will empower the people economically and create jobs as well.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1Summary of the Study

The main focus of this research study was to assesswood waste utilisation for wealth creation in Minna metropolis, Niger state. Four research questions were developed to guide the study and four null hypotheses were formulated and test at 0.05 level of significance. The study adopt a survey research design, to accomplish this questionnaire containing 45 items was developed and used for data collection. The questionnaire was validated by three lecturers from the department of Industrial and Technology education. The total population of the study was 35, 35 questionnaires were administered to the respondents. The findings of the study show that sawdust are use for production of papers and also use for the manufacturing of MDF and HDF.

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

5.2Implication of study

Health challenges Sawdust and other process dusts present a fire and explosion risk in mills. Wood waste and dust are inflammable, and if ignited can lead to fire outbreak, such a fire may cause an explosion if the volume of dust contained in the area is high. Tominimize this risk, dust may be removed by manual means, or preferably, gathering by local exhaust ventilation systems and collected in bags or cyclones

Environmental challenges Burning of waste wood is the most common management practice in Nigerian wood industries. The burning is done in the open, releasing harmful (pollutants) substances like carbon monoxide, sulphur dioxide, nitrogen oxides, and ash into the air. Indiscriminate burning of waste wood pollutes the air, smoke contains fine particulate matter that can scar the lungs.

5.3 Contribution to Knowledge

The study contribute to the followings:

The increasing quantities of wood wastes from timber sheds, furniture industries and chainsaw millers posses a threat to thee sustainable management of forest resources and environmentally sustainability.

The wood waste utilization would also contribute to achieving the goals of Nigeria`s Renewable Energy Plan. The major that this contribute has enormously to the rapid depletion of the country's timber resources is wastage of wood during log processing

5.4Recommendations

Base on the findings of the study the following recommendation were made.

1. Government should encourage cottage industries that will utilize the wastes. This will empower the people economically and create jobs as well.
2. Short term courses in the local language should be used to up-date the master builders and structure engineer knowledge
3. National Directory for employment (NDE) and youth Empowerment Scheme (YES) should provide more training, certification and soft loans for industries.
4. Well-designed at this edgeshould be built inthe vicinity of these mills. This can serve as an incentive to entrepreneurs in the industry as well. Public enlightenment campaign will also sensitize all stakeholders in the community to the impending dangers of a badly managed environment.

5.5Suggestions for Further Research

The following suggestions were made for further study:-

Assessment of wood waste to improve power generation in Nigeria

Assessment of utilization of sawdust to enhance the production of modern wood materials

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APPENDIX A

QUESTIONAIRE

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION

QUESTIONNAIRE ON THE ASSESSMENT OF WOOD WASTE UTILISATION FOR WEALTH CREATION IN MINNA METROPOLIS, NIGER STATE

INSTRUCTION: Please complete this questionnaire as sincerely using 'a thick' to indicate the appropriate option that best represent your perception about each items that follows the questions. Your response will be used only for the purpose of this research.

SECTION A

PERSONAL DATA:

Please indicate below the group that best describe your job

NISEPA [ ]   Carpenter [ ]   technical staffs [ ]

Please indicate your opinion using the following rating as indicated in column and the rating options.

Rating Options

Strongly Agree	**=**	**(SA) (4Points)**
Agree	**=**	**(A) (3 Points)**
Disagree	**=**	**(D) (2 Points)**
Strongly Disagree	**=**	**(SD) (1 Points)**

SECTION B

What are the wood waste that are generated in Minna metropolis, Niger State?

S/N	ITEMS	SA 4	A 3	D 2	SD 1
1	Branches, stumped roots and decayed wood				
2	Bark, split wood and slashing				
3	Core, Lilly pads				
4	Planer shaving				
5	Sawdust and sanders dust				
6	Veneer clipping				
7	Panel trim and broken wooden pallets				
8	Chips and screening fines				
9	Whole furniture and furniture pieces				

SECTION C

What are the sources of the wood waste generated in Minna metropolis?

S/N	ITEMS	SA 4	A 3	D 2	SD 1
10	Forest				
11	Sawmills				
12	Timber sheds				
13	Wood industries (carpentry workshop) that generate waste that can be utilised				
14	Homes				
15	Industries or work areas that generate wooden scrap like pallets, lockers etc				

SECTION D

What are the uses of the wood waste generated in Minna?

S/N	ITEMS	SA 4	A 3	D 2	SD 1
16	Papers				
17	High density fibre (HDF)				
18	Medium density fibre (MDF)				
19	Furniture				
20	Extract Manure in Agricultural Sector				
21	Fuel in homes and industry				
22	Generate Energy				

SECTION E

What are the strategies for the utilization of wood waste for wealth creation in Minna metropolis?

S/N	ITEMS	SA 4	A 3	D 2	SD 1
23	Create awareness for the usefulness of wood waste.				
24	Introduction of waste recycling methods				
25	Management of wood waste requires experts				
26	Creation of easy access to wood waste				
27	Adequate infrastructure for wood waste management				
28	By advertising wood waste recycled products				
29	Quantity of wood waste should be increased				
30	craftsmen should be encouraged				
31	Government policy on waste management create problem				
32	Encouraging the utilization of wood waste refined products				
33	Creation of wood waste manipulating training for craftsmen				
34	Provision of sufficient funds agencies in charge of wood waste				
35	Creation of wood waste monitoring team for proper management and wood waste quality control team				
36	Proper Creation of centralised area for waste management				

APPENDIX B

Table 1.1 shows the proportion of wood waste from the various sources and the various wood waste types

Table 1.1: Wood Waste Proportion and Types Generated from Various Sources in Nigeria.

Source	Average wood waste Generated (%)	Type of Wood waste
Forest	50	Branches, leaves, needles, stumps, roots, low grade and decayed woodand sawdust
Sawmill	43	Bark, sawdust, trimmings, split wood, planer shavings, sander dust.
Plywood mill	45	Bark, core, sawdust, lillypads, veneer clippings and waste, panel trim, sander dust
Particleboard mill	5	Bark, screening fines, panel trim, sawdust, sander dust.
Furniture industry	40	Planer shavings, sawdust, panel trim, sander dust, chips
Municipal & industrialactivities	NA (Not available)	Pruned tree branches, stumps, whole trees, wooden pallets, wholefurniture, furniture pieces

Source: Ogunwusi 2014