

# Sawdust Waste Management in Enugu Timber Market

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## Abstract

This study sought to grasp how sawmill wastes are managed and disposed-off in the study area. The research was carried out at the Enugu Timber Market in Kenyatta, in Nigeria's eastern region. The study used a descriptive, qualitative, and quantitative ex-post facto survey design to create an accurate profile of people, events, and situations. To obtain the required data, a triangulation method comprised of questionnaire, interview, and observation/photography methods was used. For primary data collection, stratified random sampling method was used to select a realised sample of 250 respondents from a finite population (of 1970 timber market workers) comprising of wood processors, carpenters, timber sellers, dealers on wood accessories, food sellers and fabricated cart haulers from the areas under survey. The survey results show that sawdust is the most common type of wood waste generated, accounting for 28.4 percent of total wood waste generated, and is closely followed by offcuts. The study also reveals that open dumping and burning are perhaps the most prevalence method of disposing of wood wastes in the study area, with only a small quantity recycled or reused. Improper disposal of wood waste has negative effects on the environment because it affects both aquatic and terrestrial ecosystems. Burning waste wood also emits greenhouse gases into the atmosphere, causing a range of health problems. These wood wastes can be best utilised recycling and reusing them to help lessen the impact on and the environment caused by improper disposal.

## Keywords

Sawdust, Waste management, Timber market, Pollution, recycling.

## 1. Introduction

One of the most pressing urban challenges is the disposal of municipal solid waste. The development of integrated solid waste management facilities is required in order to avoid, recycle, and manage solid waste in ways that safeguard human health and the environment most efficiently (Duran et al., 2017). Nigeria is a country with a warm equatorial climate that is blessed with huge natural resources of all types to support its citizens' social and economic goals (Momodu, 2013; Akpan and Chuku, 2014). After being processed into a finished product, these resources generate a large volume of waste. Empirical statistics ranks Nigeria as one of the countries in the world that produces high quantities of solid wastes (Nnaji, 2015; Nwachukwu, 2010; Babayemi and Dauda, 2009). This trend is projected based on her ever-increasing population, as well as her urban population's refinement in taste and need for domestic and industrial commodities, including energy. The unregulated generation and disposal of these wastes has deteriorated our otherwise desirable urban environment, and as a result, almost all Nigerian towns are characterised by piles or mountains of solid waste (Orhorhoro and Oghoghorie, 2019). In this context, the notion of waste creation and its potential consequences on health, environmental quality, and the urban landscape has become a contentious issue in Nigeria today (Ike et al., 2018).

Managing timber waste may be a big challenge, especially given that most wood industries thrive and strive to earn profits at the lowest feasible cost, with waste extraction and disposal being one of those expenditures (El-Haggar, 2007). The industry's traditional techniques and machinery are not only labour demanding and costly, but they are also unsustainable owing to fast changes in technology, which ultimately undermines the industry's competitiveness, necessitating new, economical, and sustainable waste management approaches (Joshi et al., 2015). The disposal of sawdust in an economical and ecologically acceptable manner offers more space and a safe working environment for a healthy and motivated workforce, which may translate to increased productivity, quality, and efficiency, resulting in a much-needed decrease in product costs.

## 1.1 Objectives

It becomes critical to conduct this research in order to provide best management approaches in handling sawdust wastes generated from the Enugu timber market. In achieving this, the following specific objectives were set:

- To investigate the options for managing waste in Enugu timber market.
- Rate of wood waste generation in Enugu timber market
- Types and sources of wood waste generation in Enugu timber market
- To investigate the problems associated with the management of waste in Enugu Timber market

## 2. Literature Review

Presently, Nigeria and other African nations such as Ghana is confronted with a number of serious environmental challenges resulting from poor waste management practices especially from the production and manufacturing sectors (Agwu, 2012). The issue of solid waste management has become a major problem at global, regional and local levels and one of the difficult issues for local authorities in urban centres in third world nations (Joshi and Ahmed, 2016; Chaves et al., 2014; Zhang et al., 2012). As a nation, the net effect of waste borders on concerns such as health, sustainable development, climate change and environmental protection. Industrial activities and urbanisation for a developing country like Nigeria has gradually led to the deterioration and contamination of the natural environment in modern years. As the demand for wood and its products increase, the volume of wastes generated increases correspondingly (Dosunmu and Ajayi, 2002). One of the utmost environmental problems is how to dispose properly the waste being generated daily by the ever increasing activities of the sawmill, furniture, plywood and particle-board industries in the forest sector (Top, 2015). The forest sector is challenged with low recovery rate leading to waste.

Nigeria is endowed with a plethora of forest reserves, the most of which are situated in the country's south. The number of sawmills in this part of the country has increased significantly, with Oyo, Ogun, Ondo, and Enugu States having the most (Okedere et al., 2017). This is due to the necessity to meet the increasing demand for wood for building and other construction activities. These forest products come in a variety of species. Forest trees are processed at sawmills to produce construction, building, and furniture materials. Timber is one of the most versatile products, with several applications for building and construction, carvings and sculpting, aquarium construction, musical instrument production, and so on, all of which are sold on a regular basis in both local and international markets. Timber processing and furniture manufacturing involves several phases, including ripping huge blocks of raw wood to standard and movable sizes, cutting to desired components, shaping, mortising, and lastly polishing and assembling. At each of these phases, a significant amount of waste is generated, ranging in grade from large off-cuts and chips to extremely fine sawdust (Nyemba et al., 2018). After these ostensibly valuable products have been taken, a lot of sawdust is left behind. In most sawmills, the timber recovery factor is between 45 and 50 percent (Kehinde et al., 2009). This implies that approximately 50 to 55 percent of log inputs into sawmills are left as wood residues, accounting for 5.2 million metric tonnes of wood waste generated annually across Nigeria (Ohimain, 2012; Francescato et al. 2008), with a significant portion of these coming from the country's southern region. Enugu's timber industry alone is responsible for a significant quantity of wood waste, including sawdust, chippings, planar shavings, sander dust, and so on, with sawdust accounting for more than 70% of total waste. They use traditional machineries and manual techniques to process timber and produce furniture, therefore the amount of sawdust generated is often considerably larger than in the developed world, where precise machinery and advanced manufacturing processes are used (Shigehisa et al., 2014). The vast volumes of sawdust waste generated necessitate efficient and dependable methods of extraction and disposal with little impact on the environment and the operators while maintaining a safe working environment free of health dangers. As a result, both the government and environmental organisations in Enugu have devised a variety of solutions to the problem.

## 3. Methods

The study was conducted at Enugu Timber Shed located in Kenyatta market, Asata in Enugu South LGA of Enugu State. Enugu Timber Shed is located in the Savanna zone of the nation's vegetation belt. It is 1.92km from the

University of Nigeria Enugu Campus (UNEC) and 3.99km from the Enugu State University of Technology (ESUTH) Campus II or the Institute of Management and Technology, Enugu. It is between latitude 6.414°N and longitude 7.504°E.

A qualitative, quantitative and descriptive research design was chosen for this study in order to give a detailed description of both the management practice of sawdust in timber markets and its disposal options (Robson, 2002; Jupp, 2006). The descriptive research answers the questions who, what, where, when and how (Saunders et al., 2009).

A stratified random sampling procedure was used for selecting the participants in this study. This technique was employed to ensure a fairly equal representation of the variables for the study. The stratification was based on the arrangement pattern of the market (the market has six partitions normally referred to as lines). Within each section, selection of staff was by simple random sampling. The flow process for the study is summarised below;

For the data obtained, descriptive statistics were generated and used to obtain the percentage occurrence and use of each recycling option as well as the disposal practices. Some close-ended questions and responses were coded and entered in the computer using Microsoft Excel software. Required analysis was done with the aid of Statistical Package for Social Sciences 20.0 Version. The open-ended questions gotten from the interview sessions were categorised by hand by the researcher. The findings are discussed and the data obtained from all the sources were evaluated using content analysis, descriptive statistics and graph in the results and discussion section.

#### 4. Data Collection

All of workers of Enugu-timber market made up the target population. This is because all the shops generate sawdust waste. There are 970 workers registered with Enugu Timber Union and 1000 unregistered workers. In addition to the timber market workers, the respondents chosen included residents from rural areas around Enugu state metropolis such as Abakpa-Nike, Orba, Tinker, etc. This is because they were most likely to utilise the wood waste-sawdust as a major source of fuel for cooking compared to homes in urban areas such as Independence Layout, New Heaven, Okpara Avenue, etc.

The sample of the population of this study stood at 263 timber market workers and 50 residents in rural areas; this gave a total of 313 respondents. The corrected sample of population was determined using the statistical formula below

$$\text{Required sample size } n_r = \frac{z^2 pq}{d^2} \quad (1)$$

$n_r$  = required sample size

Z = 1.645 (from the gradation curve is the standard normal deviation set with an approximate 90% confidence level)

P = proportion of the population having a given characteristic. For this case, it is taken to be 65% because most of the workers' carryout the same task and as such their responses are more likely to conform.

q = proportion of the population not having a given characteristic; q = 1-p = 1 -0.65 = 0.35 = 35%

d = degree of precision or confidence level = ±5%

$$\text{Therefore, } n_r = \frac{1.645^2 \times 0.65 \times 0.35}{0.05^2} = 270.60$$

Minimum sample size = **271**

Applying the principles of [8] since this proportion is more than 5% of the population size (1970 timber market workers). We therefore apply the finite population correction factor formula;

$$n_a = \frac{n_r}{1 + \left(\frac{n_r - 1}{N}\right)} \quad (2)$$

$n_a$  = adjusted sample size

$n_r$  = the original required sample size

N = population size = 1970 timber market workers

$$\text{Thus, } n_a = \frac{271}{1 + \left(\frac{271 - 1}{1970}\right)} = 238.3$$

Sample size = **239** timber market workers.

Thus, in order to achieve adequacy of the data obtained as well as results computed, the obtained sample size was increased by 10%. As such, the sample size was set at 263 timber market workers.

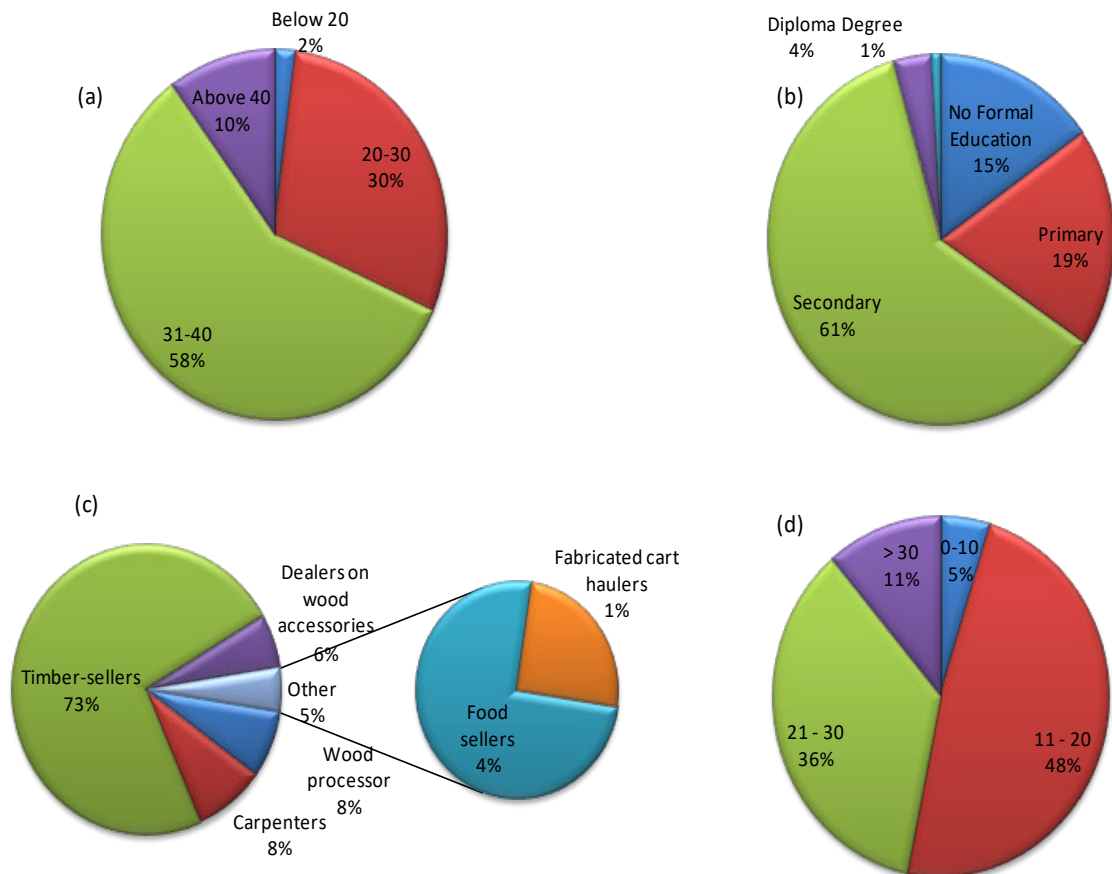
#### 5. Results and Discussion

##### 5.1 Workers' Demographics

Data obtained from the demographic section yielded information about respondent's demographic characteristics (Figure 1). Majority of the respondents were males (96.4%) while others (3.6%) were females. This implies that a reasonable number of wood workers are males. Therefore, it could be hypothesised that the male folks could withstand much stress and carryout strenuous jobs efficiently more than the females. The female sect captured herein were those selling wood work accessories as well as those selling food. Majority of the respondents were

between 20 to 30 years (29.6%) and 31- 40 years (58%) respectively. Invariably, that may be why many of the respondents were timber sellers (73.2%) because it is less tasking.

Finally, those with no formal qualification constitute 15.2%, 19.2% had primary education, 61.2% had secondary education, 3.6% had their diploma and 0.8% had a degree. This indicates that the workers of Enugu- Timber market in Enugu state, the Eastern part of Nigeria is dominated by those with post-primary level of education. It could also be inferred that this kind of job is neglected by graduates. This is because it received a low patronage from degree holders (0.8%) and diploma holders (3.6%). Therefore, it is not a current trend for Nigerian graduates to go into such profession.



**Figure 1.** Particulars of respondent workers

## 5.2 Waste Generation

In order to determine the volume of wastes generated in the entire market, the researcher selected the sample of population in such a way that it included all the shops having at least a wood working machine which obviously generates wastes. By doing so, the total volume of waste generated in the timber market was accounted for. The wastes were measured in batches using a 25kg spring balance. The spring balance graduated in kilograms (kg) and pounds (lbs) was suspended above ground level and thereafter, the waste collected in a sack was hung across its hook. The waste dangled on the hook but was left to be still after which the volume was recorded. This procedure was carried out successively across those shops having a wood working machine and thereafter the average volume was computed. From the results obtained, the average volume of sawdust generated in the market on a daily basis was 195.9kg.

Figures 2 and Figure 3 shows the type of wood wastes that are generated by the respondents. Sawdust was the highest waste generated. This was closely followed by offcuts as the second type of waste generated. With frequencies of 19.6% and 10.4%, planar shavings and chippings were the next forms of waste generated respectively. Sanding powder (9.6%) and bark (4.8%) were the least form of waste generated according to the findings of the study. These proportions were obtained by successively weighing these wastes using a spring

balance. A 25kg spring balance was suspended above ground level and the waste collected in a sack was hung around its hook. Thus, the above proportions are best regarded as proportions by weight.

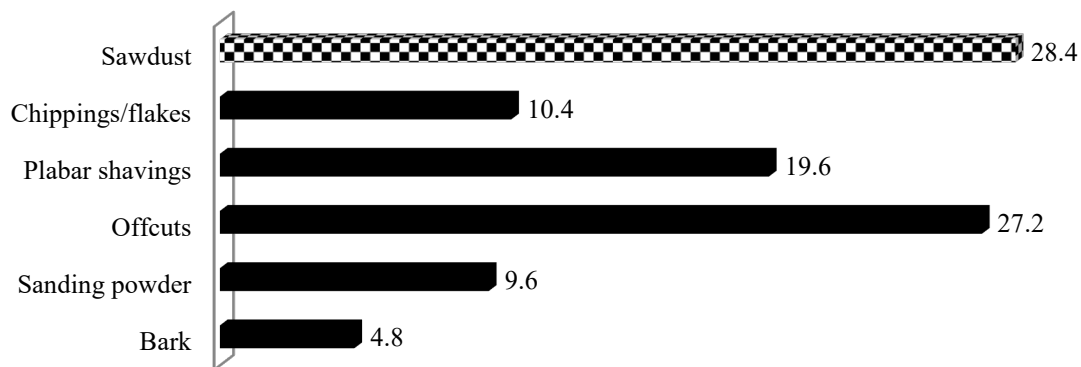


Figure 2. Types of Wood Waste Generated (percent)

### 5.2.1 Rate of waste generation

From Figure 2 above, it could be deduced that in Enugu timber market, sawdust happens to be the most generated wood waste since it accounts for the greatest proportion (28.7%) of the wood waste generated. This is because all the wood working operation directly or indirectly produces this biomass waste. This is closely followed by wood offcuts and rejects (27.2%) and lastly by barks (4.8%). The table below clearly portrays the rate of wood waste generated in the study area. Ekhuemelo and Atondo (2015) and Akhator et al., (2017) discovered that Nigeria generates between 16 and 35 percent of sawdust, equating to around 8.6 million cubic metres per year. In Mexico, 35 percent is produced, whereas Zambia produces between 10 percent and 25 percent (Guzman and Munno, 2015; Ncube and Phiri, 2015). In the southwestern states of Nigeria, Okedere et al., (2017b) discovered that the total volume of sawdust produced in the region is around 526,650 metric tonnes (526650000 kg) every year. Furthermore, Veeyee et al. (2020) highlighted in their research that sawdust, offcuts, and bark are the most common forms of wood waste created in Yaounde towns.










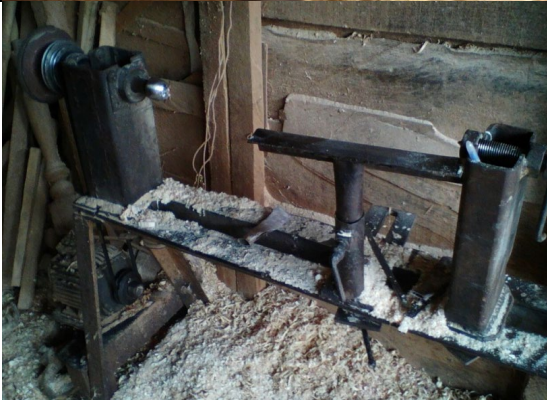

Figure 3. Wood waste at the study site  
(Field Survey 2016)

### 5.2.2 Waste Generation Sources

Wood waste residue is generated from a variety of sources and production processes, including sawing, planing, mortising, sanding and so on. Table 1 (Source: [field survey]) gives a comprehensive list of the waste generation sources within the study area as well as their functions. It also provides detailed information on the statistics of wood working machines.

Table 1. Waste Generation Sources

Sources	No.	Pictorial view Description/ function	Types of waste generated
<b><u>Curving machine.</u></b> Just like the name implies, it is a simple mechanically operated machine used for designing (aesthetics) lumber. It has a vertical blade attached to an arbor for rigidity. The to-be designed pattern is first printed on the timber using a lead pencil or an ink and thereafter, it is carefully moved along the blade which cuts off undesired fragments from the lumber.	13		Sawdust Off cuts Chippings
<b><u>Mortising machine</u></b> It is a specialised wood working machine used to cut square or rectangular holes in a piece of lumber. It has a drilling bit of variable diameter installed on it which mechanically rotates in an anticlockwise direction. The size of the hole is first imprinted on the lumber after which it is moved across the drilling bit until the desired hole size is achieved.	11		Chipping Sawdust Off cuts
<b><u>Hand feed surface planers</u></b> It is used for planing (smoothing) the face side of a given lumber. It has a long surfacing table which supports the timber as it is passed from the in feed table over the circular cutter block to the out feed table	23		Planar shavings Chippings Sawdust

<p><b><u>Thicknesser</u></b> This is another type of the planning machine. This machine is used for the final part of the planning process that is, reducing timber to its finished size. It also has a long surfacing table that could be adjusted to the desired thickness hence its name thickneser. The timber is placed into the infeed end where it is engaged by a serrated roller which drives it below a cutter block.</p>	12		Planar shavings Chippings Sawdust
<p><b><u>Hand feed circular saw benches</u></b> This is a wood working tool consisting of a circular saw blade mounted on a mandrel (acting as its grip) that is driven by an electric motor (either directly, by belt, or by gears). The blade protrudes through the surface of the table, which provides support for the lumber.</p>	33		Sawdust Off cuts
<p><b><u>CNC wood lathe machine</u></b> It is primarily used for a wood working operation called wood turning. Wood turning is used to create wooden object on a lathe. In this case, the wood is moving while a stationary tool is used to cut and shape it.</p>	13		Chippings Sawdust
<p><b><u>Stenner machine</u></b> This is a mechanised wood working equipment used to split lumber. It is built with a feeder few meters away from the machine. The feeder is coupled with a mechanical roller used for moving the planks into the splitting chamber.</p>	15		Offcuts Sawdust Bark Chippings Planar shavings



### 5.3 Management of Sawdust Waste at Enugu Timber Market

To ascertain the means of collecting and transporting wastes to the disposal sites; an observation of the transport medium was done and the result presented in Figure 3 and Figure 4. Five ways of waste collection and transporting was predetermined before carrying out the research: bagging and, use of buckets, use of air extractors, use of wheel barrow or a cart and carriage by truck. Majority collected their waste by bagging and packaging with sacks which is subsequently hauled using either a wooden fabricated cart or wheel barrow to the disposal site. The use of buckets was ranked fourth. This may be as a result of its low capacity to accommodate the waste. Carriage by truck is also practiced, but by a minor fragment of the study sample (12.5%). The tractor is not used herein because the carriage way is reasonably small to accommodate its rotary movement. Traditional and manual ways of processing timber, including transportation and disposal, are used in Zimbabwe (Nyemba et al., 2018). The employment of these primitive techniques of transporting and disposal may be attributed to the fact that most dealers thrive and focus on generating a profit at the lowest feasible cost, with waste conveyance and disposal being one of those costs.

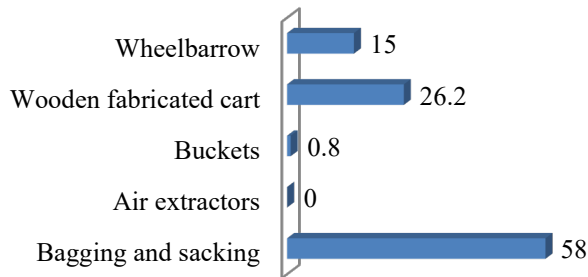


Figure 4a. Collection methods (%)

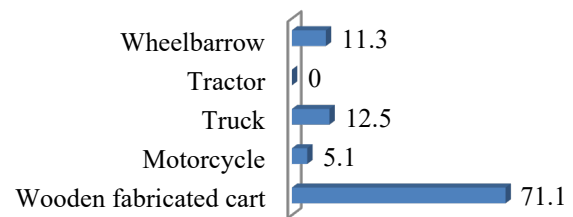


Figure 4b. Transportation methods (%)



Figure 5. Waste disposal practiced at the study sites

Figure 4 and Figure 5 are the results on the method of waste disposal practiced at the study sites. The collection by households was confirmed by 21.7% of the respondents. Collection by poultry farmers accounted for 10%. The highest response (76.7%) was practicing open dumping. Open pits and open burning also scored 0 and 71.7% respectively. There are some wood waste management practices aimed at reducing the impacts of sawmill wood wastes at the study sites (Figure 6). Some artisans have tried to reduce the volume of wood waste by on-site storage or disposals (Figure 7). Possible solid waste management practices include collection, recycling, solid waste disposal on land, treatments as well as incineration and open burning of waste. Lack of transportation to transport the waste from the site to designated safe dump site has led to opening burning just at the sites. These huge mountains of sawdust were observed been discarded indiscriminately in the area which has continue to pose solid waste management issues to the owners of sawmills who have settled for burning as the easiest way out. According to Ogunbode et al. (2013), around 96 percent of sawdust generated is disposed of by open burning, and up to



505,804 tonnes of sawdust are burnt in southwest Nigeria on an annual basis without regard for the environmental and air quality concerns that may arise. In Cameroon, 51% of total wood waste produced is gathered for cooking (used as refuse derived fuel), 34% for poultry farming, 8% for gardening, and 7% for other purposes such as cleaning ceramic tiles after placement (Nyemba et al., 2018).



Figure 6. Open dumping

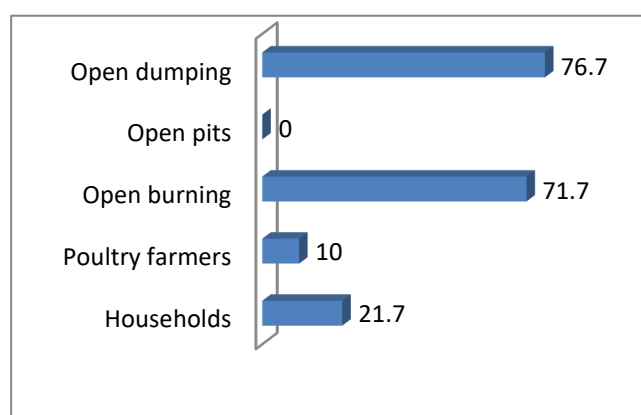


Figure 7. Waste Disposal Practices (%)

#### 5.4 Challenges Associated with Improper Management of Sawdust Waste

The most common management practice in Nigerian wood industries is the burning of waste wood. The burning is done in the open, releasing harmful (polluting) substances into the air such as carbon monoxide, sulphur dioxide, nitrogen oxides, and particulate matter. Burning waste wood indiscriminately pollutes the air, and the smoke contains fine particulate matter that can scar the lungs. Some wood smoke chemicals, such as polycyclic aromatic hydrocarbons (PAHs) and dioxin, are suspected carcinogens. Wood smoke raises the risk of acute respiratory infections and interferes with children's normal lung development. It can also weaken the immune system and make breathing difficult.

Another common practice of the Enugu wood timber market dealer is the disposal of wood waste in nearby open areas. When wood waste is left unchecked for an extended period of time, it begins to decompose and emits methane gas, a harmful greenhouse gas. Living things must generate waste; it is inextricably linked to life; it cannot be avoided, but it must be managed (Odebunmi, 2001). Waste causes numerous problems, including environmental degradation, loss of aesthetic value, the production of unpleasant odors, and smoke pollution of the air during improper waste incineration. If not properly disposed of, these can be hazardous to one's health; improperly disposed of wastes serve as breeding grounds for pests and disease vectors. However, dumping of sawdust into bodies of water can jam up drainage and cause flooding during the rainy season, resulting in the loss of lives and property (Elijah and Elegbede, 2015). A water body contaminated by organic pollutant (sawdust waste) has a low diversity and number of aquatic organisms (e.g., fish) in the water body. Wood waste dumped in rivers and lakes is toxic and clogs fish gills; additionally, light penetration is reduced, limiting aquatic plant productivity. Aquatic organisms are vulnerable due to pollution of their environment caused by sawdust waste discharged into water bodies by wood and other industries. Sawdust waste management practices in developed countries are more sophisticated than in developing countries such as Nigeria.

## 6. Conclusion and Recommendations

Wood waste is generated on a daily basis in Nigeria, as in most developing countries, due to a high demand for wood products for a variety of uses. These wood residues have a variety of environmental and health effects. Based on the study conducted, it is glaring that the amounts of wood waste generated by this sawmill (Enugu timber market) can always be managed without burning it and as such reducing the degree of carbon emission into the atmosphere. The treatment of wood waste in the study area and most sawmills is done by open burning. The burning of the wastes cannot be totally ruled out, because burning is often the easiest and cheapest means of disposal, therefore, it is necessary to recommend that:

- Only dried wastes should be subjected to burning because of their low moisture contents. Burning should be done in batches so that wastes do not smoulder and as such reducing the smoking effects. Also, it should not be done in the late afternoon or evening, as the air will be stable.
- More so, Government and relevant law making agencies should enforce the payment of carbon tax. This would go a long way in deterring the use of products with low carbon emission properties.

- Government can also encourage cottage industries that will utilise the wastes by establishing a sawdust bio-refinery. This will empower the people economically and create jobs as well.
- In addition to the aforementioned, the government and NGO's should synergise their efforts with that of the research institutes so as to effectively combat their present day challenges. This would go a long way in ensuring that almost all research solves a given problem.

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