UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

ENVIRONMENTAL EFFECTS OF SMALLSCALE SAWMILLS WOODWASTE DISPOSAL IN THE KUMASI METROPOLIS

EVANS BREFO

DECEMBER, 2018

UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

ENVIRONMENTAL EFFECTS OF SMALLSCALE SAWMILLS WOODWASTE DISPOSAL IN THE KUMASI METROPOLIS

EVANS BREFO

7161230007

A Dissertation in the DEPARTMENT OF WOOD AND CONSTRUCTION TECHNOLOGY EDUCATION, Faculty of TECHNICAL EDUCATION, submitted to the School of Graduate Studies, University of Education, Winneba, in partial fulfillment of the Requirement for the award of the Master of Technology Education (Wood) degree

DECEMBER, 2018

DECLARATION

STUDENT'S DECLARATION

I, BREFO EVANS, declare that, this Dissertation with the exception of quotations and references contained in published works which have all been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE:……

DATE:……

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of the Dissertation were supervised in accordance with the guidelines on supervision of Dissertation laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: PROF. STEPHEN JOBSON MITCHUAL

SIGNATURE:…….

DATE:…….

ACKNOWLEDGEMENT

The researcher first acknowledges the efforts of all individuals who made available information for this study. I also acknowledge my supervisor Prof. Stephen Jobson Mitchual for the supervision of this study. I again acknowledge all the lecturers at the Wood and Construction Technology Education Department for their support throughout my entire programme. I finally acknowledge Dr. Rogarson Anokye for his guidance and support during the programme.

DEDICATION

I dedicate this work to the Late Mr. Emmanuel Oppong Peprah.

TABLE OF CONTENTS

CONTENT **PAGE**

LIST OF TABLES

TABLE **PAGE**

LIST OF FIGURES

FIGURE **PAGE**

LIST OF PLATES

PLATE **PAGE**

ABSTRACT

This research assessed how small scale sawmills wood waste disposal affect the environment in Kumasi metropolis. The study was conducted at selected local timber mills in Kumasi in the Ashanti region of Ghana. The study was a descriptive social survey design which sought to portray an accurate profile of persons, events and situations. To harness the needed information, a triangulation method comprising of questionnaire, interview and observation/photography methods were employed in gathering data. Purposive random sampling method was used in selection of two hundred and thirty eight (238) respondents from population comprising of wood processors, carpenters and timber sellers from the areas under survey. The study showed sawing and planning as the highest waste generation sources whiles majority of sawmill collect the waste generated by manual clearing. These wastes affect the environment by reducing its aesthetic, produce offensive odours during the rains and pollute the air with smoke when the wastes are burnt uncontrollably. Improper wood waste disposal cause hazard to human. The study recommended measures for dealing with the situation of waste disposal at these saw mills.

CHARPTER ONE

INTRODUCTION

1.1 Background of the Study

Waste generation is a concomitant aspect of living; it cannot be banished but can only be managed. The problems posed by these wastes are many: they degrade the urban environment, reduce its aesthetic value, produce offensive odours during the rains and pollute the air with smoke when the wastes are burnt uncontrollably. They also constitute health hazards in themselves if they are not timely disposed; they become breeding places for worms and insects (Dosunmu and Ajayi, 2002).

Disposal of solid waste is the ultimate step in a management system. In advanced technologies, disposal is preceded by some engineering activities such as sorting and quantity reduction (White et al., 1997). This is done in order to sort out materials that can be turned into some economic value. Several method of disposal waste exists. The choice of any method depends on a number of factors. These factors according to Eerd (1997) include: characteristics of the solid waste to be disposed, cost consideration (i.e. how much is available and how much the method could cost), availability of disposal site (cost of land for example) and cost of labour and technical implication of the methods. Any community whether in the advanced or less developed countries is open to choose among the following options of solid waste disposal methods: converting/ recycling, sorting and salvaging, open dump, controlled tipping/sanitary and landfill/daily burying.

Others include: composting, incinerating and disposal into sea (Oluwande, 1974; Rushbrook and Pugh, 1999).

The 'open dump' method of solid waste disposal is considered as both naïve and dangerous (Rushbrook and Pugh, 1999). This is because there is no control on the leachate (the contaminated liquid draining from waste) generated and constitutes a direct risk to human health. Though, open dump is initially thought to be cheap and easy it is in the long run the costliest (Eerd, 1997). Johnnessen and Boyer (1999) observed that it remains the predominant means in developing countries.

Logging, wood processing and storage generate a considerable amount of waste. These bring the natural forest which is the main source of raw material for the wood industry under threat. Using wood carefully with minimum waste is also 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 burden-some disposal problem (FAO, 1990). However, the materials have potential to become 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. Dost (1966) also defined wood residue as the remnant of the original raw material after the economic value has been removed. Gyimah and Adu-Gyamfi (2009) reported a lumber yield of about 28-64%. This means, more than half of the raw materials sent to the timber industries come out as waste.

1.2 Statement of Problem

Waste generation is a concomitant aspect of living; it cannot be eliminated but can only be managed, the problems posed by these wastes are many. They degrade the urban environment, reduce its aesthetic value, produce offensive odours during the rains and pollute the air with smoke when the wastes are burnt uncontrollably. They also constitute health hazards when they are not timely disposed. They become breeding places for worms and insects. They also pose bad working environment for those working in the area, due to accumulation of wastes over a period of time most especially during raining season (Odewumi 2001, Akinbode & Olujimi, 2014).

Sawmill by its nature generates a lot of wastes such as; saw dusts, wood off cuts, wood barks, plain shavings, wood rejects, etc. As the demands for wood and its products increase, the volume of wastes being generated cannot but increase in the absence of proper disposal methods, these wastes are burnt in the open air, or spilled into the water bodies, sometimes blocking the drainages and canals. The blockages of canals and drainages also cause flooding where sawmills are situated in (especially Anloga junction) the city of Kumasi and in the hinterland during raining season. Sometimes sawdust is used to fill a pot hole which is not the appropriate material to these fill pot holes which degrade the aesthetic of the city. The problems facing the small scale mills today is how to properly dispose the waste generated daily by the ever increasing number of the smallscale sawmills.

1.3 Purpose of the study

The purpose of this study is to assess how small scale sawmills in Kumasi wood waste disposal effect the environment.

1.4 Objective of the Study

1. To determine the process of collection wood waste by smallscale sawmills.
2. To examine the methods of disposal by smallscale sawmills.
3. To assess wood waste disposal implication on the environment.
4. To evaluate health hazards on the workers coursed by wood waste dispose around sawmills

1.5 Research Questions

- What mechanisms (system) are used for collection of wood waste generated at the smallscale sawmills?
- How does wood processing shop (smallscale sawmills) dispose waste generated?
- Where the smallscale does sawmills dispose waste generated?
- To what extend does wood waste disposal affect the environment?

1.6 Significance of the Study

The study would provide an insight into the effect of improper wood waste disposal on environment and health of human and other living organism. The study would help the authorities to be conscious on the effect of improper wood waste disposal.

My findings would also serve as baseline information on which policy makers can resort in designing course of action or inaction to improve wood waste disposal management.

The study would serve as a literature to any other future researcher, organizations and the government who might take up similar projects.

Finally, the study would be of help to me, as a researcher by means of broadening my scope of analyzing, understanding and evaluating the effect of improper wood waste disposal.

1.7 Scope of the Study

This study focused only on small scale sawmills (wood processing shops) selected from Kumasi metropolis in the Ashanti Region.

It also focused on the effects of improper wood waste disposal of solid waste on the environment and the health of people in Kumasi. This will include looking at the processes of collecting waste, how the waste are disposed, the effect on the environment as well as the health of workers in the timber industries and suggestions in addressing and improving of solid wood waste management related issues in the metropolis.

1.8 Delimitation

This study focused only on small scale sawmills (wood processing shops) selected from Kumasi.

1.9 Organization of the Study

This research constitutes the following chapters; chapter one constitutes General introduction, problem statement, significant of the study, scope and limitations of the study, among others. Chapter two constitute Literature Review, Chapter three constitute Research methodology, Chapter four constitute Result and findings ,Chapter five constitute

Discussion and chapter six constitute summary of Finding Recommendation and Conclusion.

CHARPTER TWO

REVIEW OF RELATED LITERATURE

2.1 History of Waste Management

In ancient cities, wastes were thrown onto unpaved streets and roadways, where they were left to accumulate. It was not until 320 BCE in Athens that the first known law forbidding this practice was established. At that time a system for waste removal began to evolve in Greece and in the Greek-dominated cities of the eastern Mediterranean. In ancient Rome, property owners were responsible for cleaning the streets fronting their property. But organized waste collection was associated only with state-sponsored events such as parades. Disposal methods were very crude, involving open pits located just outside the city walls. As populations increased, efforts were made to transport waste farther out from the cities (Nathanson, 2014).

After the fall of Rome, waste collection and municipal sanitation began a decline that lasted throughout the Middle Ages. Near the end of the 14th century, scavengers were given the task of carting waste to dumps outside city walls. But this was not the case in smaller towns, where most people still threw waste onto the streets. It was not until 1714 that every city in England was required to have an official scavenger. Toward the end of the 18th century in America, municipal collection of garbage was begun in Boston, New York City, and Philadelphia. Waste disposal methods were still very crude, however. Garbage collected in Philadelphia, for example, was simply dumped into the Delaware River downstream from the city (Nathanson, 2014).

A technological approach to solid-waste management began to develop in the latter part of the 19th century. Watertight garbage cans were first introduced in the United States, and sturdier vehicles were used to collect and transport wastes. A significant development in solid-waste treatment and disposal practices was marked by the construction of the first refuse incinerator in England in 1874. By the beginning of the 20th century, 15 percent of major American cities were incinerating solid waste. Even then, however, most of the largest cities were still using primitive disposal methods such as open dumping on land or in water (Nathanson, 2014).

Technological advances continued during the first half of the 20th century, including the development of garbage grinders, compaction trucks, and pneumatic collection systems. By mid- century, however, it had become evident that open dumping and improper incineration of solid waste were causing problems of pollution and jeopardizing public health. As a result, sanitary landfills were developed to replace the practice of open dumping and to reduce the reliance on waste incineration. In many countries waste was divided into two categories, hazardous and nonhazardous, and separate regulations were developed for their disposal. Landfills were designed and operated in a manner that minimized risks to public health and the environment. New refuse incinerators were designed to recover heat energy from the waste and were provided with extensive air pollution control devices to satisfy stringent standards of air quality. Modern --solid-waste management plants in most developed countries now emphasize the practice of recycling and waste reduction at the source rather than incineration and land disposal (Nathanson, 2014).

Solid waste management has over the years been an albatross around the neck of city authorities in Ghana. Particularly in Kumasi, where over 2,000tons of solid waste is generated daily, waste management departments still grapple with the collection of this huge amount of solid waste. Undoubtedly, the capacity of authorities has been greatly overwhelmed by the ever-increasing amounts of waste at urban centres.

Consequently, heaps of solid wastes are not uncommon sights in our cities mostly near residential and low income areas. This presents a host of problems as these huge piles of waste pose grave risk to human life and the environment as well. Although, numerous researchers have attributed this principally to lack of resources and weak institutional capacities, there seems to be some disregarded factors that also contribute substantially to the status quo.

There are various products that can be derived from wood wastes and yet still wood residues are often spilled on open spaces, sometimes occupying lands for development. Likewise, they also constitute bad working environment for those working in the area, due to accumulation of wastes over a period of time most especially during raining season. Wood residue leachate contains high concentrations of natural organic material which can mobilize metals such as iron from soils. Threats to forests due to adverse effect of climate change could be effectively tackled by increasing the use of wood residues. The situations of waste disposal in Ghana are similar to those of her fellow developing countries within the tropical climates. In Ghana, majority of landfills are open dumps, even though these are strongly discouraged in the national sanitation policy. Ghana's first sanitary landfill facilities were commissioned in Accra, Kumasi, Sekondi-Takoradi and Tamale between

2003 and 2004. In Ghana, the issue of collection, management and disposal of solid waste continues to feature prominently across the country. It is clear that the inability of state authorities to systematically manage waste and especially wood residues is presenting challenges such as the contamination of water bodies leading to the spread of water-borne diseases, health hazards from the stench emanating from uncollected and decaying garbage, air contamination, garbage- chocked drains and gutters, irresponsible disposal of refuse at our industrial areas and others. Recently, the problem of sanitation has assumed increased prominence as a political issue especially in urban areas leading to the introduction of a by- monthly national sanitation day. Saw dust is a major air pollutant as well as a source of smoke from burnt wood waste.

2.2 Waste

Waste is more easily recognized than defined. Something can become waste when it is no longer useful to the owner or it is used and fails to fulfill its purpose Freduah (2004). There are basically two types of waste namely liquid and solid waste Puopiel, (2010).

2.3 Solid Waste

According to Tchobanoglous (1993), solid waste is any material that arises from human and animal activities that are normally discarded as useless or unwanted. Furthermore, Zerbock (2003) also defined solid waste to include non-hazardous industrial, commercial and domestic waste including household organic trash, street sweepings, and institutional garbage and construction wastes. Solid waste can therefore be said that, it is any products in solid state that is useless or unwanted which is generated from the activities of and discarded by society.

2.4 Sources and Types of Solid Waste

According to Tchobanoglous et al (1993), solid waste is classified into types in terms of sources and generation facilities, activities or locations. The table below shows where wastes are

Table 2.1: Sources and Types of Solid Waste

Source	Typical location	Types of solid waste
Residential	Single-family and multifamily dwellings, low-medium, and high-rise apartments.	Food wastes, rubbish ashes, special wastes
Commercial/Municipal	Stores, restaurants, markets, office buildings, hotels, motels, print shops, auto repair shops, medical facilities and institutions	Food wastes, rubbish, ashes, demolition and construction
Industrial	Construction, fabrication, light and heavy manufacturing, refineries, chemical plants, lumbering, mining, demolition	Food wastes, rubbish, ashes, demolition and construction wastes, special wastes, occasionally hazardous wastes
Open areas	Streets, alleys, parks, vacant plots, playgrounds, beaches, highway and recreational areas.	Special wastes, rubbish
Treatment plant site	Water, wastes water, and industrial treatment processes.	Treatment plant wastes, principally composed of residual sludge
Agricultural	Field and row crops, orchards, vineyards, dairies, feedlots and farms	Spoiled food wastes, agricultural wastes, rubbish, hazardous wastes

Source: Tchobanoglous et al 1993 p.522.7

2.5 Solid Waste Management

Solid waste management systems in developing countries must deal with many difficulties, including low technical experience and low financial resources which often cover only collection and transfer costs, leaving no resources for safe final disposal (Collivignarelli et al., 2004). According to Tchobanoglous et al (1993: 7), solid waste management is "that discipline associated with the control of generation, storage, collection, transfer and

transport, processing and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations and that is also responsive to public attitudes".

Kumah (2007) also defines solid waste management as "the administration of activities that provide for the collection, source separation, storage, transportation, transfer, processing, treatment, and disposal of waste". For a healthy environment, there is the need for solid waste management by systematically controlling generation, collection, storage, transport, source separation, processing, treatment, recovery, and disposal of solid waste. The figure below show simplified process for solid waste management.

2.6 Sawmill

Sawmill is defined according to Encyclopedia Britannica as machine or plant with power-driven machines for sawing logs into rough-squared sections or into planks and boards. A sawmill may be equipped with planing, molding, tenoning, and other machines for finishing processes. Sawmill can be classified into three in Ghana, the classification of the industry as large ,medium or small scale depends on the rate of production and the number of employees.

2.6.1 Small-scale sawmill

An industry with a low rate of production and fewer employees less than fifty (50) is a small-scale industry. Smallscale sawmill require little starting and operating capital. They require cheap labor that is easily found and their target market is the host community. Such companies also realize a small annual turnover and, as a result, pay fewer taxes. The

industries help in alleviating poverty through provision of employment and other products. Small-scale sawmill are easy to start and manage given the minimal scale of production. They are set up to cater for the basic needs of the people within their locality. The number of employees is only a small portion of maximum fifty (50) people. Such enterprises are usually privately owned sole proprietorships and partnership. Most governments implement policies that strengthen the small-scale industry sector because of the role the industries play in economic development.

2.6.2 Medium Scale Sawmill

The category of medium scale sawmill is made up of enterprise which employ fewer than 250 persons. These enterprises emerge from the slow and steady growth of successful small sawmills. As a company earns more revenue, it starts keeping aside the capital required for buildings, equipment and recruitment of more employees. This eventually creates a bridge between small business and large scale sawmills.

2.6.3 Large Scale Sawmill

To generalize in a broad way, large scale sawmills have significant quantities of capital and employ greater than or equal to 250 employees. They also have a broad geographic reach or generate substantial volumes of revenue. They use sophisticated equipment to carry out their activities.

2.7 Solid Waste Management Process

For proper solid wood waste management system, there should be an effective control of the production of waste, its storage, collection, transportation, as well as proper disposal system. Waste should be disposed in a manner that will not have an effect on the environment and humans. According to Tchobanoglaus et al, 1993, managing solid waste must be accomplished in an efficient and systematic manner hence the fundamental aspects and relationships accompanied with it need to be identified and tackled diligently.

Just like most natural resources used by man, timber and timber products generate lots of unwanted, or used products (waste), from tree cut-offs, sawdust, tree bark etc. and this waste (wood waste) has become prominent due to the high demand for timber and its derived products, forests are being cleared and these residues are left unattended to. Wood industries produce large volumes of residues which must be manage or properly disposed of.

2.8 Definition of Wood Waste

Warnken (2008) defines wood waste as the end-of-life products, failed products, off-cuts, shavings and sawdust from all timber products. This excludes both forest residues (often referred to as primary wood waste) and garden organics including branches, bushes and tree stumps. Wood waste was also defined as “sawdust, timber offcuts, wooden crates, wooden packaging, wooden pallets, wood shavings and similar materials, and includes any mixture of those materials, but does not include wood treated with chemicals such as copper chrome arsenate (CCA), high temperature creosote (HTC), pigmented emulsified

creosote (PEC) and light organic solvent preservative (LOSP)" in the 1997 NSW Protection of the Environment Operations Act (POEO). The Californian Integrated Waste Management Board (CIWMB) defined urban wood waste as "the portion of the wood waste stream that can include sawn lumber, pruned branches, stumps and whole trees"

2.9 Attributes of Wood Waste

Waste could be described as any material which has been used and is no longer wanted because the valuable or useful part of it has been removed. Wastes in the wood industry could be in solid form while others are in soluble or solvent state. Waste is the left-over materials generated -during the manufacturing process considered to be unusable and useful again and discarded. Wood wastes consists of wood pieces and particles generated from the industrial or small scale processing of wood, construction and demolition activities and broken- down wood products. -Common wood wastes includes bark, scrap lumber, sawdust, construction and demolition wastes, offcuts, ash from the burning of wood wastes, and broken furniture (Keene & Smythe, 2009).

2.10 Sources of Wood Wastes

Wood waste is generated in various sectors of the wood industry during processing. This includes wood waste generated from sawmills, furniture companies and plywood industries as -they are directly involved with the usage and conversion of timber into its derived products for consumer use. In the sawmill industry, the wood has to be converted into various sizes to maximize profit and also satisfy the demands of the people. The sawmilling industry originated in Ghana with the establishment of the first pit-sawing. Since then,

more sawmills have been established as the demand for lumber (sawn wood) continues to increase. Sawmills generate a lot of wood wastes due to the intensity of wood processing. Saw dusts, wood off cuts, wood backs, plain shavings, wood rejects are all wastes generated during wood processing in sawmills. Wastes such as off-cuts, sander dusts, wood shavings and wood chips are produced in the furniture or carpentry shops (companies). The plywood industries mainly generate wood waste from bark, peeler cores, veneer wastes and panel trims while the wastes from particle board industries is very negligible but comes from chip wastes from panel trimmings and dust from sanding machines.

Depending on the nature of the material and how deeply imbedded in the wood, it may be difficult to automate this process, resulting in additional labour cost. Shavings of wood can range in size and can also include splinters. Sawdust particles are also highly variable and range from coarse particles to flour that can present a health and/or an explosion hazard.

'Off-cuts' refers to the pieces of wood created in manufacturing that are superfluous to requirements either due to irregularity of form or unsuitability for reuse. The collection, transportation and storage of this type of wood waste occupies a large volume due to the irregularity and lack of uniformity in shape or structure of the recovered material.

Some forms of wood waste, such as shavings and sawdust, have a tendency to absorb moisture from the air due to the relatively high surface area of the individual particles, potentially complicating their reprocessing. Stockpiles of these materials can also be subject to wind dispersal and so must be covered or contained in some way.

The inherent challenges of dealing with wood waste in all of its various physical forms means that innovative solutions are required to recover maximum value from this resource. Solutions may be technical in nature and involve significant amounts of capital. However, there are opportunities for synergistic utilization of wood wastes, either on-site (for example co-generation of heat and power) or nearby in co-operation with partners (for example as inputs for added-value products) that may only require improved planning related to the design of the manufacturing process or storage site itself.

2.11 Classification of Wood Waste

Wood waste can be categorized based on condition and category based on grade condition: Clean Wood Waste could be scrap lumber, sawmill ends, plywood, wood used in concrete with less than 2 inch diameter residual chunks of concrete on it. Clean wood may contain nails, bolts or screws in fair quantities. Clean wood waste should not have paint, oil or Styrofoam, telephone poles, treated wood, wood with tar are not considered clean wood waste. Note: wood waste that has paint or other contaminants can be recycled as construction and demolition waste. Contaminated wood waste is wood painted or coated, wood from construction, furniture, roofing planks and generally treated wood. Category based on grade: Grade A: contains wood with very few contaminants such as paint or other coverings. Mixed Grade: wood wastes with considerable amounts contaminants such as concrete and nails in relatively low quantity. Low Grade: contaminated wood containing tar and other chemicals industry. Characterization is the way in which something is described or defined.

Waste characterization involves analysing different waste stream compositions and is an important part in any management of waste. New waste technology developers must take into consideration the rudiments that waste streams consist of in order to fully treat the waste (Ghani et al., 2013). Wood waste is usually composed of: Saw dust: produced during wood processing, wood offcuts. Wood barks: bark is the outer most layer of wood plants, wood bark overlays the wood. Plain shavings: are wood wastes that result from smoothing or planning of wood. Wood rejects: are wood/timber that have being rejected either due to degradation or pest infestation (e.g beetles and fungi). Wood chips: are medium sized solid materials made by cutting, or chipping, large pieces of wood (Christersson et al., 2005).

2.12 Collection of Wood Waste from Sawmills

Collection of wood waste is a big problem for the smallscale sawmills (wood processing) shops waste in Ghana. The process in collecting solid wood waste from shops (sawmills) is done manually by bear hands or wheel barrow without any safety gadgets. This makes it difficult to properly gather waste generated in a day production processes. Alternatively waste may be heaped or bagged for weeks or month before track or tractor will be hired to dispose the waste. The use of dust or extractors for collection of waste is absent in Ghanaian smallscale sawmills. Workers that regularly inhale dust (wood dust) could be in danger of respiratory infection. With irritation of the respiratory tract, flu-like symptoms may occur as a result of inhaled wood dust.

2.13 Health Challenges of Wood Waste

Burning of waste wood is the most common management practice in Ghanaian smallscale sawmills. The burning is done in the open place, 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. Some chemicals in wood smoke such as polycyclic aromatic hydrocarbons (PAHs) and dioxin are suspected to be carcinogens. Wood smoke increases risk of lower respiratory infections and interferes with normal lung development in children. It can also depress the immune system and make it difficult to breathe.

Workers who regularly inhale dust (wood dust) are inflammable, and if ignited can lead to fire could be in danger of respiratory infection. With irritation of the respiratory tract, flu-like symptoms may occur as a result of inhaled wood dust. Prolonged exposure may lead to more serious health conditions such as asthma and emphysema. Employers must, therefore, control exposure to dust from wood. Chemicals used to treat wood if present in wood dust can cause dermatitis red, dry, itchy skin which may develop blisters. Repeated exposures of a worker can cause severe skin reaction. Wood dust is carcinogenic, according to the International Agency for Research on Cancer (IARC). A study carried out in Canada, showed workers exposed to wood dust developed adenocarcinoma (a rare form of nasal cancer), further studies showed that workers in logging, sawmills, furniture and cabinet making, and carpentry are at an increased risk of developing adenocarcinoma (Vallières et al., 2015).

2.14 Environmental Challenges of Wood Waste

A common practice by smallscale sawmills is dumping wood waste in open areas nearby mills. Unattended over a period of time the wood waste starts decomposing, and methane gas is emitted which is a harmful greenhouse gas. Living things must generate waste, it's associated with living; it cannot be stopped but must be managed (Odebunmi, 2001). Wastes pose many problems: environmental degradation, loss of aesthetic value, produce unpleasant odours and smoke pollutes air during improper incineration of wastes. If not properly disposed these could be hazardous to health; inappropriately disposed of wastes become breeding grounds for pests and vectors of diseases. Dumping of refuse (e.g. sawdust) into water bodies could block drainage and cause flooding during the rainy season, which can lead to lose of lives and properties (FAO, 1991; Elijah & Elegbede, 2015). An environment such as a water body contaminated by organic pollutant (wood waste) has low diversity and low species of aquatic organisms (e.g. fish) in the water body. Wood wastes dumped in rivers and other water bodies are toxic and clog fish gills and incidentally light penetration is reduced which limits productivity of aquatic plants. Aquatic organisms are vulnerable due to pollution of their environment, as a result of wood and other industries discharging wastes into water bodies. In developed countries, wood waste management practices are more elaborate than in a developing country such as Ghana. Wood wastes are collected from various points or locations (households, factories, construction sites etc.); either directly by the process or by the individual/ groups taking it (wood waste) to the processor themselves. These wood wastes are stored (if not used immediately), processed and transformed into new usable materials sometimes to

traditional healers or given away free of charge while slabs are disposed by selling them as firewood in bread bakers.

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. To minimize this risk, dust may be removed by manual means, or preferably, gathering by local exhaust ventilation systems and collected in bags or cyclones. The waste generated by a vertical band saw is sucked into the dust collection hood like a vacuum cleaner. This reduces the sawdust in the air and generates a suction pressure that sucks dust (sawdust) from the air in the mills.

CHAPTER THREE

METHODOLOGY

3.1 Research Design

Research designs are concerned with turning the research question into a testing project. The best design depends on the research questions. The research design has been considered as a "blueprint" for research, dealing with at least four problems: what questions

to study, what data are relevant, what data to collect, and how to analyse the results (Creswell, 1994). The research design chosen for the study is qualitative research design. Qualitative research is a method of inquiry employed in many different academic disciplines, traditionally in the social sciences, but also in market research and further contexts. Qualitative researchers aim at gathering in-depth understanding of human behaviour and the reasons that govern such behaviour. The qualitative method investigates the why and how of decision making, not just what, where, when. Hence, smaller but focused samples are more often needed, rather than large samples (Marshall, & Rossman, 1989). Furthermore, it involves an interpretive, naturalistic approach to its subject matter and gives priority to what the data contribute to important research questions or existing information (Marshall, & Rossman, 1989). From the explanations above, characteristics of qualitative research method made it suitable to be employed in the study.

3.2 Descriptive Research

It is a research design that offers a detailed account of some social phenomena setting experience, group etc. (Ryane, 2005). William (2001) states that descriptive research depends on observation as a means of collecting data. He further says that observation examines situations in order to establish what the norm is and what can be predicted to happen again under the same circumstances. According to Asabere (2011), descriptive research is written for the purpose of providing the readers with complete detail of events and emotions as they happen. Another function of descriptive research is to make an effort to present events, emotions, sentiments or ideas and images to the reader as realistically as possible (Wiersma, 1995). It is further explained that, the author of a descriptive research

paper seeks to communicate to readers what they would see, hear, feel, think or even smell as if they were actually present in that environment. For this reason, a descriptive research makes use of strong and powerful adjectives which possess the ability to create pictures in the mind of the readers.

According to Knupfer and Mclellan (2001), descriptive research method also emerges following creative exploration, and serves to organize the findings in order to fit them with explanations, and then test or validate those explanations. Many research studies call for the description of natural or man-made phenomena such as their form, structure, activity, and change over time, relation to other phenomena and so on. The description often illuminates knowledge that might not otherwise be noticed or even encountered. This research method was employed to assist the researcher in the explorations and explanations of findings.

3.3 Population for the Study

Castillo (2009) defines research population generally as a large collection of individuals or objects that is the main focus of a scientific query. It is for the benefit of the population that researches are done. He further discusses that, a research population is also known as a well- defined collection of individuals or objects known to have similar characteristics. All individuals or objects within a certain Population usually have a common binding characteristic or trait. It may be finite if its members can presumably be counted or infinite if its members cannot be definitely known. In this research the population for the study was

people who deal with wood, wood products and residents around sawmill in Kumasi metropolis.

The target populations for this study comprises saw mill workers, sawmill managers or owners and residents around sawmills. The study area was the Ashanti region of Ghana, but due to the vastness of the region, the area of study was limited to Kumasi, the capital of Ashanti region.

3.4 Sampling

According to Frankel and Wallen (1996), a sample in a research study refers to any group on which information is obtained. Sampling is the process of selecting these groups or individuals. This source further explains that when it is possible, researchers prefer to study the entire population in which they are interested. Usually, however, this is difficult to do. Most populations of interest are large, diverse, and scattered over a large area. Finding, let alone contacting, all the members can be time-consuming and expensive, hence, sampling becomes very essential in research to select a manageable size of respondents from the parent population to be studied.

The importance of sampling in this study was to select appropriate sawmills and this was done using purposive random sampling technique. As stated by MacNealy (2005), simple random samples is selected by assigning a number to each member in the population list and then use a random number table to draw out the members of the sample. In simple random sampling researcher requires that each member of the population have an equal chance of being selected. Researchers who choose simple random sampling must be cognizant of the numbers that they choose. Researcher bias in regards to preferred numbers can be a problem for the end results in regards to sample selection Frey, et al.1999 This

random sampling technique was relevant to the study based on the number of residents and workers at various sawmill location. Therefore the researcher relied on purposive random sampling method to select convenient sample size of two hundred and thirty eight (238) from the population for the study. Therefore the researcher had a specific purpose of interviewing them, as they were chosen for specific information.

3.5 Data Collection Instruments

As a qualitative study, the data collection instruments used in this research was observation, interview and questionnaire. The interviews were conducted using structured interview guide. Therefore the researcher served as an observer of the research proceedings as well as a participant.

3.6 Observation

It involves collecting information around the world using all of one's senses especially the sense of sight and hearing in a systematic and purposeful way to learn about a phenomenon of interest (Sage encyclopedia, 2008). Ott (2001) states that direct observation is used in many surveys that do not involve measurements. Data collection through observation may be often more real and true than data collected by any other method (Asabere, 2011). Amoh (2009) explains that observation enables the researcher to gather data on: The physical setting (e.g. the physical environment and its organization); human setting (e.g. the organization of people, the characteristics of the groups or individuals being observed. for instance gender or class). The interactional setting (e.g. the interactions that are taking place, formal, informal, planned, unplanned, verbal non- verbal etc.); The programme setting (e.g. the resources and their organization, pedagogic styles, curricula and their

organization). The researcher observed how wood waste generated by the sawmills are disposed, how wood waste has destroyed the environment and he also observed the health hazards caused by poor wood waste disposal on the workers and residents around sawmill location.

3.7 Interviews

Interview refers to a personal exchange of information between an interviewer and an interviewee (Raune, 2006). Asabere (2010, p.9) defines interview as "a purposeful conversation in which one person asks prepared questions (interviewer) and another answers them (respondent)". According to Asabere, interview is a process by which information on a particular subject or area of research is gained thus, through conversation.

One could also define an interview as purposeful conversation with either one person or a group of people (interviewer/s) and an individual or a group of people to gather information on a particular topic. Interviewing may not also be confined to specially prepared questions. The process of interviewing may be either formal or informal so long as the information needed could be obtained. Interview guides were designed to guide the researcher as to the manner and kind of questions to be asked. The interview processes were conducted in structured manner. This was to aid the researcher to acquire more information. With the researcher's aim of getting specific questions answered, the nature of respondents and their environment had a bearing on the interview process.

3.8 Data Collection Procedure

Primary data were gathered through observation, questionnaires and interviews for the research with the aid of validated interview guide with respondents selected from workers of the various sawmills, owners or managers of sawmills, residents around the areas mills are established as well as community authorities.

Other data were gathered through the consult of relevant literary materials from books, journals, magazines and newspapers and the internet.

3.9 Data Analysis

This study used descriptive statistics to analyze and present primary data collected into charts and frequency table. It was done by grouping similar responses from samples and converting the outcome into percentages.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The result and discussion of finding of the study. The data collected was guided by the research questions put forward for the study to generate emerging themes to reflect the main objectives set out for the study. It is presented in three parts. The first part covers the socio-demographic data of respondents. The second part also covers wood waste disposal management in area of wood processing (sawmills), while the third part looks at the effect of wood waste disposal in the metropolis. Tables and figures are used to present the findings. These are further discussed below.

The study was conducted at smallscale sawmills or local timber markets in Kumasi metropolis in the Ashanti region of Ghana. Kumasi is located in the transitional forest zone and is about 270km north of Accra. It is between latitude 6.35^0-6.40^0 and longitude 1.30^0-1.35^0 and covers a total land area of $254km^2$ and has an elevation ranging between 250-300 meters above sea level. Precisely most of sawmills or wood market which was located at the outskirt of the Kumasi Metropolis has been encroach by residential buildings. This situation has made the mills in heart of communities in the metropolis. These conglomerated wood industry made up of micro, small, and medium-scale firms which produces all kinds of wood products ranging from household furniture to office furniture. The markets are run by small scale saw millers, timber merchant and artisans who obtained their wood stocks from sawmills and chainsaw operators. The main activities are sales of timber and secondary and tertiary processing of timber. The timber markets are communities that house wood related activities, carpenters and other woodworkers, with economic activities ranging from the sale of food, wood and wood products as well as accessories for wood work.

4.2 Socio Demographic Characteristics of the Respondents

This part shows the sex, ages, occupation and educational status of the respondents. Figure 4.1 shows the sex of the respondents.

4.2.1 Gender of respondents

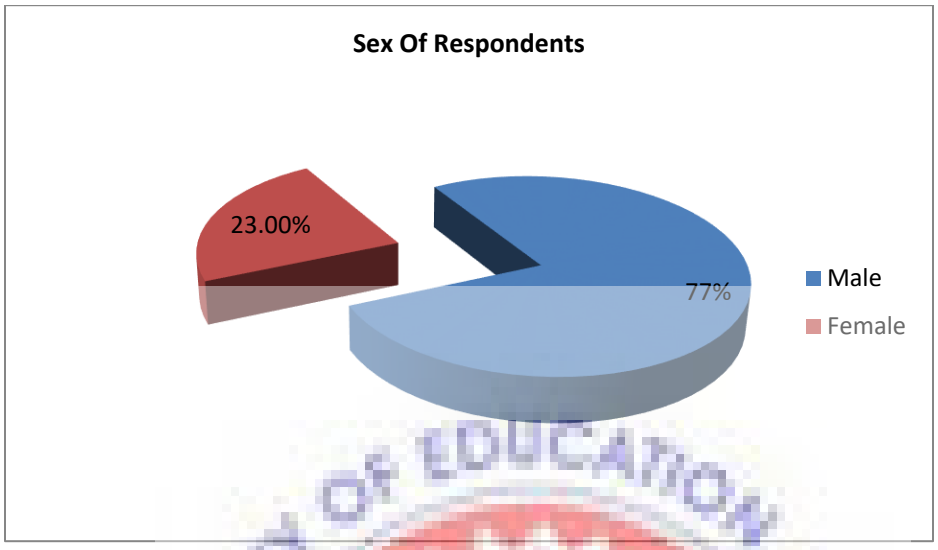

Figure 4.1: Shows sex of the respondents

Source: Field survey, 2018

The result indicates females constituted 23% which represent 82 out of the 238 respondent while 77% which represent 156 out of the 238 respondents were males. The women population in the industry confirms to women residents in sawmills, sites a study by Olawuni, & Okunola (2014) on socioeconomic impacts of sawmill industry on residents a case study of Ile-Ife, Nigeria which states that women represents 30.1% of residents in sawmill areas. This was due to the fact that, most men work and live near to wood processing areas. The women were found at the study area were petty traders, wood merchants, shop owners and residence nearer to sawmills. This implies that males are much involved in wood processing or sawmilling.

The sawmills are run by small scale saw millers, timber merchant and artisans. These activities require physical strength to carry out breakdown of beam or flitch of timber into

smaller pieces. This has made sawmill dominate of male than female as matter of fact most women fear of engaging in activities that are dangerous and also requires physical strength. The female found at sawmills are into sales of raw, secondary and tertiary processing timber, food as well as accessories for wood work.

4.2.2 Age of Respondents

From figure 4.2 below, the age group of the respondents shows, the study area dominated with youth representing 70% of the respondents was between the ages of 18 to 35 years. This support the work of Agu et al. (2016), that the most frequent age bracket of workers in sawmills is between 20-29 years. The data shows that sawmills are dominated of youthful age. Omole et al. (2018), stated that the mean age of sawmill workers is 29 years.

Figure 4.2: Age of respondent

Source: Field survey, 2018

In the analysis, it was realized that across a sample size of 238, majority of the respondents are males. In addition to this, majority of the respondents fell between the age group of 18

to 35 years. This shows that more of the respondents fall within a youthful age group therefore depicting a vibrant labour force.

4.2.3 Educational background of respondent

Table 4.1: The education level of respondents frequency and percentage

Education	Frequency	Percent (%)
Primary	87	34
Junior High School	57	24
Second High School	25	11
Tertiary	18	7.6
None	51	21.4
Total	**238**	**100**

Source: Field survey, 2018

The participant of the study who had no formal education was 51 which represent 21.4. 87 out of 238 respondents had their educational to primary level representing 34%, 57of respondent had their educational to Junior High School representing 24%, 25 of the respondents had their education to senior high school which represent 11%. Only 18 of the respondents had their educational to tertiary level represent 7.6%. This implies that most of the people in study the sites level of education is low. The study revealed that majority of respondents being 58% had basic level of education whiles 11% of responds had been to either Technical or Secondary school. This confirms to the work of Omole et al. (2018) that the education background of most sawmills workers in Nigeria is at secondary school. Few of respondents had tertiary education. There some people at study sites who has not been to school at all because they begin in the trade from childhood with the hope inheriting from parents.

4.2.4 Occupation of respondents

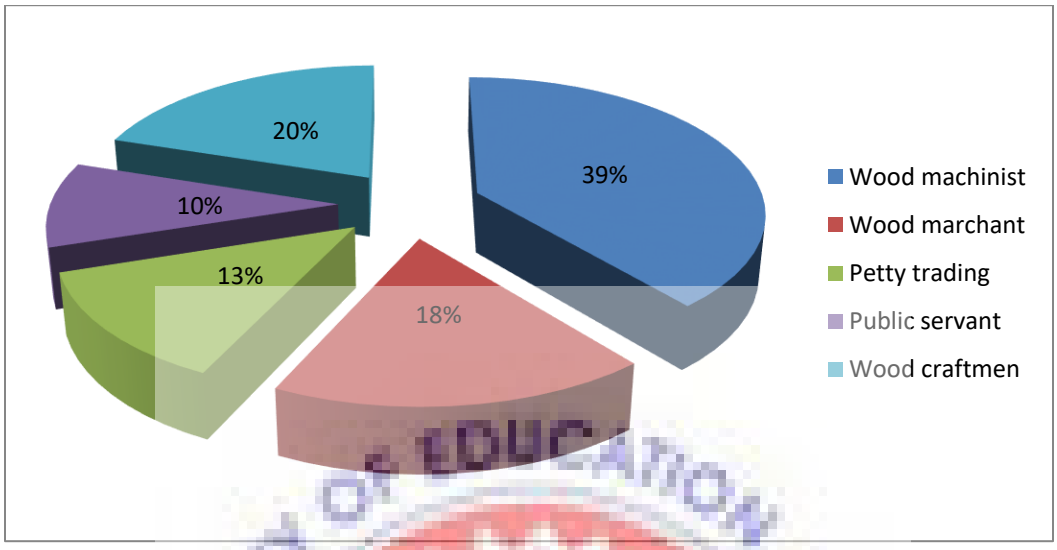

Figure 4.3: Occupation of respondents

Source: Field survey, 2018

The chart above indicates 39% respondents were wood machinist, 18% of respondents were wood merchants, 13% respondents were petty traders, wood craftsmen and 10% respondents were public servants. Omole et al. (2018), cited in their study that the socio economic status of people at sawmills is low. The occupational background of respondents includes wood machinist, wood merchants, petty traders, public servant and artisan (wood craftmen) this is due to this fact all the people found in and around sawmills are affected by indiscriminate dispose of wood waste. According to Effah et al (2015), the small scale saw millers are communities that house lumber brokers, carpenters and other woodworkers, with economic activities ranging from the sale of food, wood and wood products as well as accessories for wood work and financial institutions.

4.3 Method of Waste Collection

From the study by Effah et al. (2015) and Adu (2016) the composition of sawmill wastes generated in various sawmills in Kumasi are similar though, there are differences in quantities generated in each place. The wastes comprise sawdust, wood off-cuts and bark of log of woods. To ascertain the means by which the respondents collect their waste generated, six ways of waste collecting were put before the respondent to indicate the methods by which waste generated is collected or gathered from sawmills. This result is depicted on table 4.2 below. None of the respondents collect waste by mechanical means (air extraction). All respondents collect waste generated from their daily activities manually with shovel, broom and wheel barrow to clear the waste from mill (shop). Others bag wastes in sacks and convey them to dump site. Those who can afford to hire tractor, truck, or tricycle to collect waste generated none of mill visited use air extractor to collect waste generated. Ogunbode et al. (2013) support in their study which they observed that after a whole day's job, the various saw mills produce wastes of average 44 bags (50kg) of sawdust which is equivalent to 264 bags weekly respectively, depending on patronage and stability of power supply, this large quantity of wood wastes generated by the sawmill are sold to surrounding community as firewood for cooking and the sawdust used by poultry owners for Bedding and landfill.

Table 4.2: Method waste of collection

Process of collection waste	Frequency	Percentage(%)
Air extractor	0	0
Truck	34	14
Wheel barrow	48	20
Bagging	57	24
Manual clearing (shovel and broom)	81	34
Tractor	18	8
Total	**238**	**100**

Source: Field survey, 2018

During the study, it was observed that after a whole day's job, the various saw mills produce wastes of average of 50kg (45 bags) of sawdust.

Plate 4.1: Collection of saw dust from circular saw machine with shovel

Source: Field survey at Kwadaso Timber market, 2018

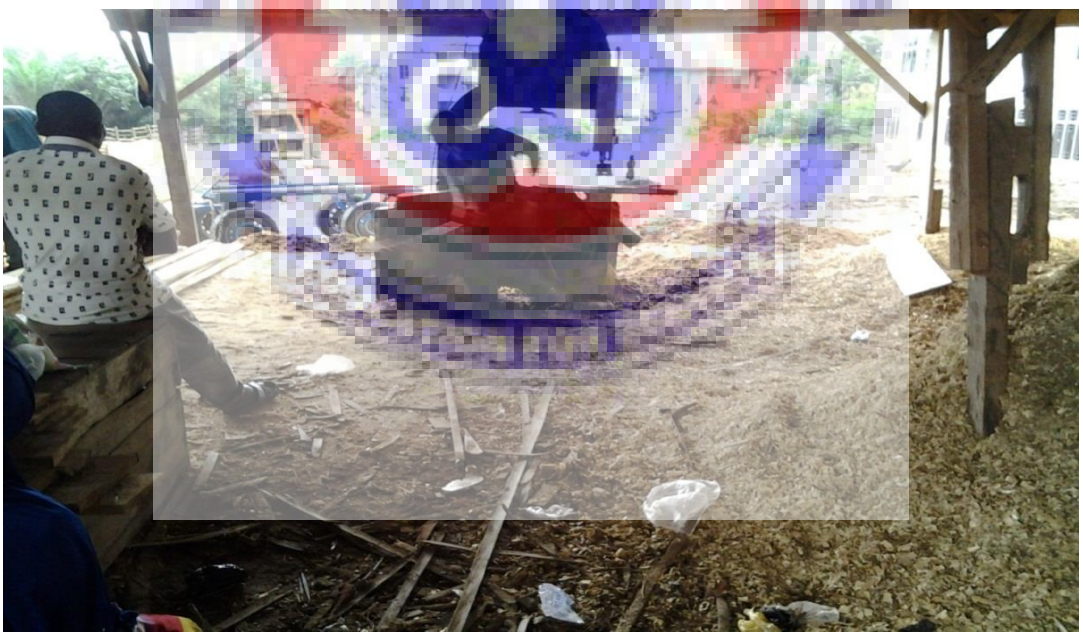

Plate 4.2: Collection of saw dust from bandsaw machine with shovel

Source: Field survey at Susanso sawmill, 2018

Plate 4.3: Bagged of wood shaving in the sawmill

Source: Field survey at Sokoban wood village, 2018

Plate 4.4: Bagged of sawdust around sawmill

Source: Field survey at Sokoban wood village, (2018)

4.4 Method of Waste Disposal Practice/Available

Sawmill generates various wastes such as; saw dusts, wood off cuts, wood backs, plain shavings and wood rejects (Dosunmu & Ajayi, 2002; Akinbode & Olujimi 2014). One of the most environmental problems facing the industry, in this jet age is the improper disposal of waste generated often in the sawmill industries (Akinbode & Olujimi 2014). To ascertain the means by which the respondents dispose waste generated, six ways of waste disposal were put before them to indicate what they practice at their shops and the result is depicted in Figure 4.4.

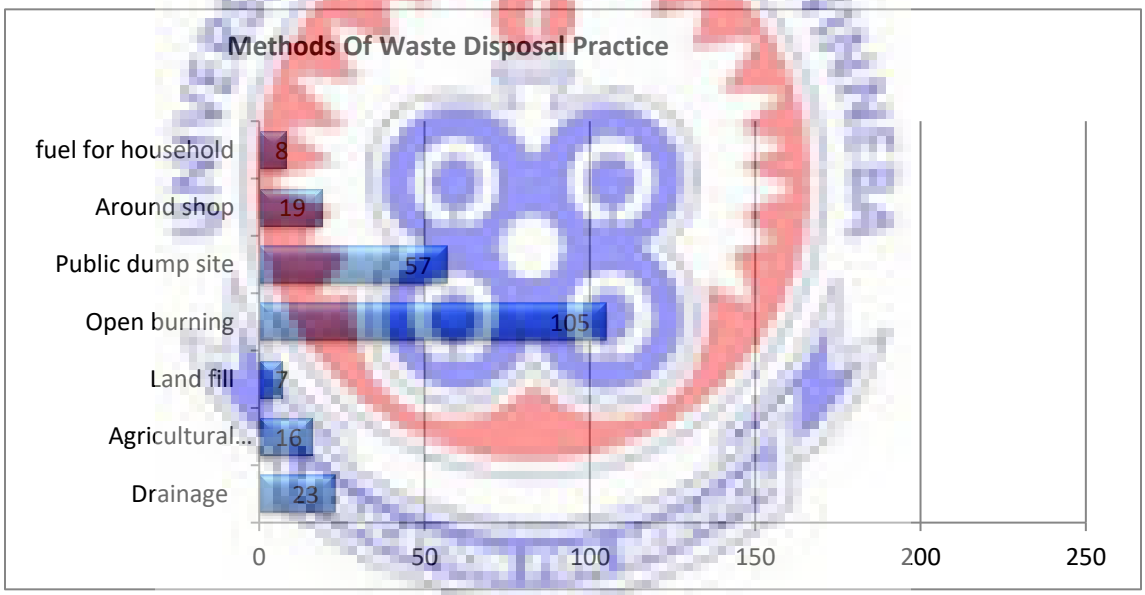

Figure 4.4: The results on the method of waste disposal practice

Source: Field survey, 2018

Lasode, Balogun and Aremu (2009) said that saw millers use several crude ways to dispose the generated wastes within the vicinity of sawmills and plank markets. The study sites indicated that wastes generated are by collection by individual for agricultural purposes which were confirmed by 16 respondents. The usage of wood waste for landfills and pot

holes was accounted by 7 respondents. The highest response 105 was practicing open burning. Disposing waste at public dump sites and around shop also had 57 and 19 respectively. The 'open dump' method of solid waste disposal is considered as both naïve and dangerous (Rushbrook & Pugh, 1999).This is because there is no control on the leachate (the contaminated liquid draining from waste) generated and constitutes a direct risk to human health. Though, open dump is initially thought to be cheap and easy it is in the long run the costliest (Eerd, 1997). Johnnessen and Boyer (1999) observed that it remains the predominant means in developing countries. 23 of respondent dispose waste generated in drainage whiles 4 of respondent disposed their waste as fuel for house cooking. There are some wood waste management practices aimed at reducing the impacts of sawmill wood wastes at the study sites. Some artisans have tried to reduce the volume of wood waste by on-site storage or disposals. Possible wood waste management (disposal) practices include collection, recycling wood waste for briquette and particle board. However late collection and lack of transportation to transport the waste from the site to designated safe places has led to majority resulting in opening burning just at the sites.

Wood waste (residues) from about smallscale sawmills were dumped at the common dumping site close to the mills. These residues were burnt openly twice in a week. However, because of the high moisture content, they were not able to burn completely, always leaving some amount of wood residues on the site

Plate 4.5: Disposing of waste for open burning

Source: Field survey at Kwadaso timber market, 2018

Plate 4.6: Open burn of wood waste

Source: Field survey at Sokoban wood village, 2018

From sawmills visited, it was observed that waste disposal remains one of the biggest challenges facing the smallscale sawmill industry in Kumasi metropolis. Due to the absence of proper disposal methods of the waste, about 66% of the sawmills engaged the

open air burning for the reason that it is the easier and cheaper as a result, contributing to air pollution climate change. The uncontrolled burning of waste has resulted into a serious air pollution problem in Lagos city, especially in areas along the inland waterways (Lekki & Lagos). Open Dumping and burning the wood waste eventually causes the emission of Greenhouse gas (GHG) especially methane (CH4) and carbon monoxide due to decomposition and combustion respectively (Tillman, 1978). For 100 kg wood waste dumped, there would be approximately 8 kg of CH4 emission to the atmosphere (National Technical Experts, 2004). Others depend on patronage of food vendors and charcoal making women as their fuel. Few of waste generated is used for agricultural purposes by poultry and vegetable farmers. The rest dispose waste in drainage, around sawmill or shop and also a material for filling land. (I also observed that most sawmills do not comply with the guidelines for the disposal and treatment of sawmill waste). This may be due to the fact that the government agencies charged with the responsibilities of enforcing laws governing the disposal and treatment of sawmill waste have not been active. For instance, it was gathered that sanitary inspectors and Environmental Regulatory agencies do not visit sawmills regularly or at all.

According to Tetteh (2004) plant residues decompose faster when buried than when placed on the soil surface. This may be attributed to the invasion of termites. It is most likely that the termites moved from their locality to the plots on the surface of the soil rather than from within the soil since more were found in the dump than the buried waste. They probably fed on more of the dump residues than on the buried residues. Swift et al. (1979) found out that three main factors which control the decomposition process are the quality of the

decomposing organic material, the decomposer organisms and the environmental conditions. In this case it is probable that the decomposer organisms played a major role in the decomposition of the surface applied or dump wood waste or residue.

4.5 Problems Associated with Waste Disposal on Public Health and Environment

Occupation and health interact with one another (Lucas and Gillies 2003). It is no gainsaying therefore that a man's occupation may influence his health (Omobude-Idiado, Irimonre, & Ohi-Asikhia, 2013). The research conducted showed that 6% of the respondents said there are no problems associated on wood waste disposal on public health and environment whiles 94% said there are problems on wood waste disposal on public health and environment. The respondents who opted for no stated that wood waste disposal has no implications on both public health and environment. The other side choose yes because they have realised existence of implication of wood waste disposal on public health and the environment in terms of air pollution from smoke of burning waste, offensive odour from accumulated waste, blockage of drains and deterioration of esthetics of environment etc.

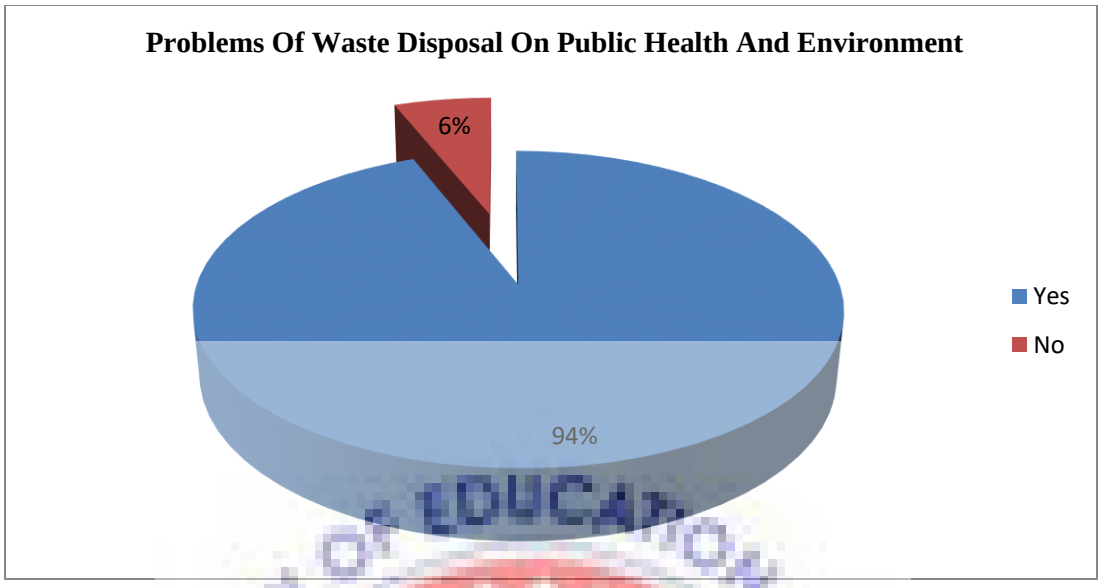

Figure 4.5: Display either problems on wood waste disposal on environment and public health

Source: Field survey, 2018

From the environmental perspective, these increasing of smoke from burn of waste in small scale sawmills in the communities are causing widespread fears of danger on the health of people. This has a dramatic effect on the metropolis climate change by causing an increase in carbon dioxide levels in the atmosphere and increasing greenhouse effect according to (EPA, 1998). A green economy is an economy that generates prosperity while maintaining a healthy environment for future generation (EEA, 2011) by reducing environmental impacts from raw material extraction and materials processing.

Wood residues like sawdust, trimmings and edgings are typically viewed as a burdensome disposal problem (FAO, 1990). Sawdust formed majority of the wood residue that was not utilized (60% of sawdust discarded). This is in line with Odoom (2004), who stated that sawdust is the only residue in significant surplus for increasing off site residue utilization. Not only does the accumulation of sawdust pose danger of fire, sawmilling running cost

are also increased owing to the need to dispose of the accumulated sawdust (Ocloo and Yeboah, 1980).

4.6 Effects of wood disposal on environment

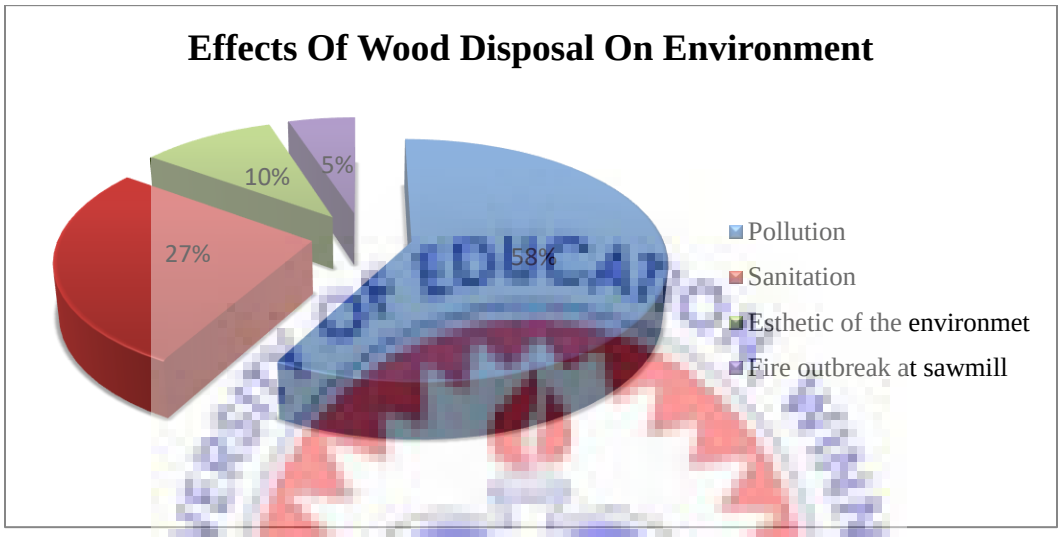

Figure 4.6: Shows effects of poor wood disposal on environment

Source: Field survey, 2018

Pollution has been defined by Akachukwu, (2000) as phenomena where natural ingredients are replaced or damaged by presence of dangerous unnatural ingredients - which have potentiality to cause imbalance to the system and to create number of health hazards to animals and human beings. It's shown in the figure 4.6 that waste generated from sawmills is improperly disposed which contribute major pollution in the metropolis in form of smoke in the air, blockage of drainage and producing bad odour this constituted 58 percent of respondents. The view that when heaps of waste is kept around shops or dump site. They cause sanitation threat to working environment and metropolis constituted 27 percent of the respondent. Indiscriminate dispose of wood waste affects the esthetic of the metropolis 10 percent of the respondent opted on this. 5 percent of the respondent answered that wood waste causes fire outbreak at sawmills.

Plate 4.7: Chocked gutter by wood waste

Source: Field survey at Ahwiah timber market, 2018

Plate 4.8: Indiscriminate disposal of wood waste around mill in raining season

Source: Field survey at Sokoban wood village, 2018

Plate 4.9: Flooded gutter

Source: Field survey at Kwadaso timber market, 2018

The study revealed that improper solid waste disposal has adverse effect on the environment. Most of the respondents were aware of effect but yet they dispose waste indiscriminately.This. From the response given by respondents state that improper disposal of waste has destroyed their environment by spoiling the beauty, been odour, smoke their health and has made the working environment unattractive.

The effect has made them uncomfortable living in their own environment. According to Ogunbode et al. (2013) sawdust often spilled on open spaces, sometimes occupy lands for development. They also constitute bad working environment for those working in the area, due to accumulation of wastes over a period of time most especially during raining season.

The mills visited employed water for the lubrication of circular saw blades used in lumber breakdown. The water was sprayed in excess amount, wetting the sawdust. This made the sawdust very difficult to combust without pre-drying, and this is one cause of low utilization of sawdust as a boiler fuel. Also lack of storage facilities caused the sawdust to be stored outdoors, exposing them to environmental conditions such as rain water and moisture from the atmosphere rendering the sawdust difficult to burn.

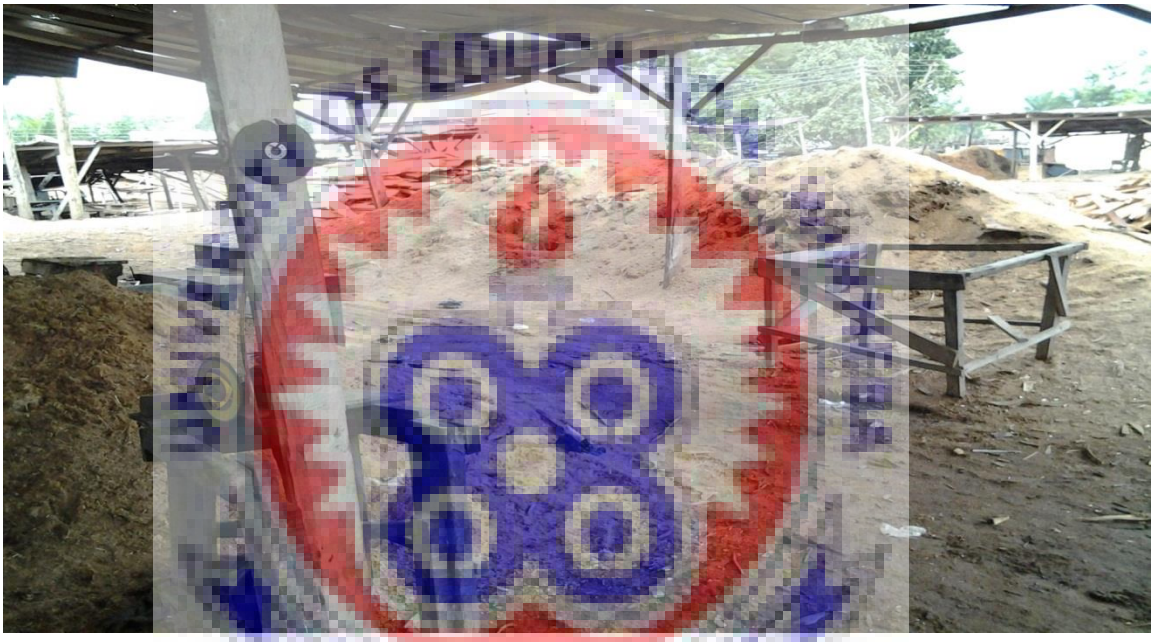

Plate 4.10: **Heap of sawdust in and out of sawmill**

Source: Field survey at Susanso sawmill, 2018

Plate 4.11: Sawdust closing drainage

Source: Field survey at Akwatia-Line sawmill, 2018

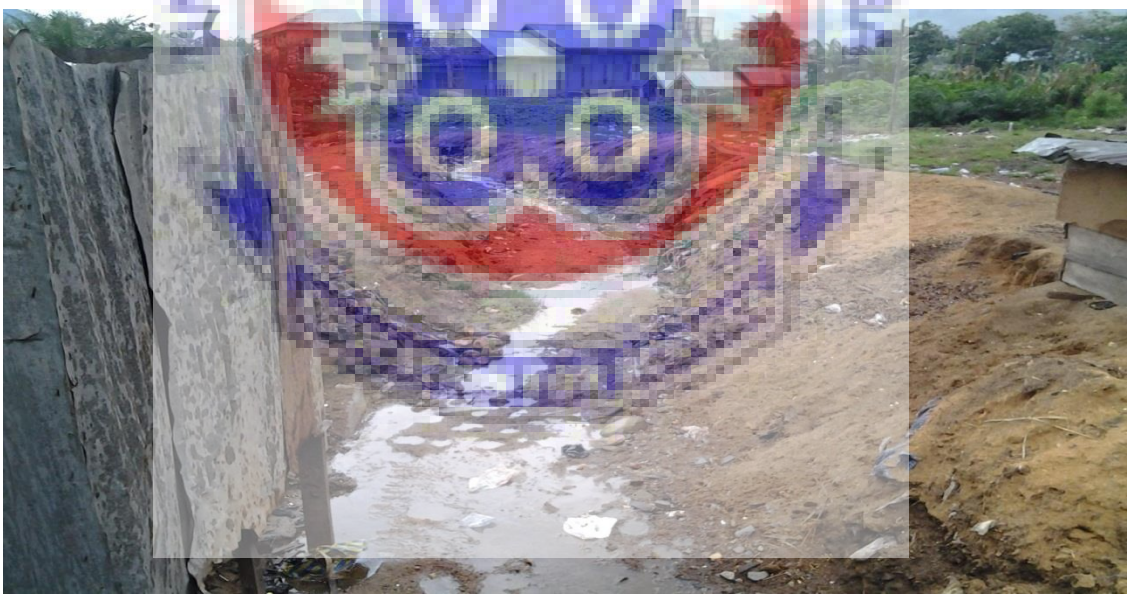

Plate 4.12: Heaps of sawdust on edges of drainage (waterway)

Source: Field survey at Susanso sawmill, 2018

4.7 Effect of waste of wood waste disposal on human health

The figure 4.7 below shows knowledge of respondents on link between poor waste disposal and health.

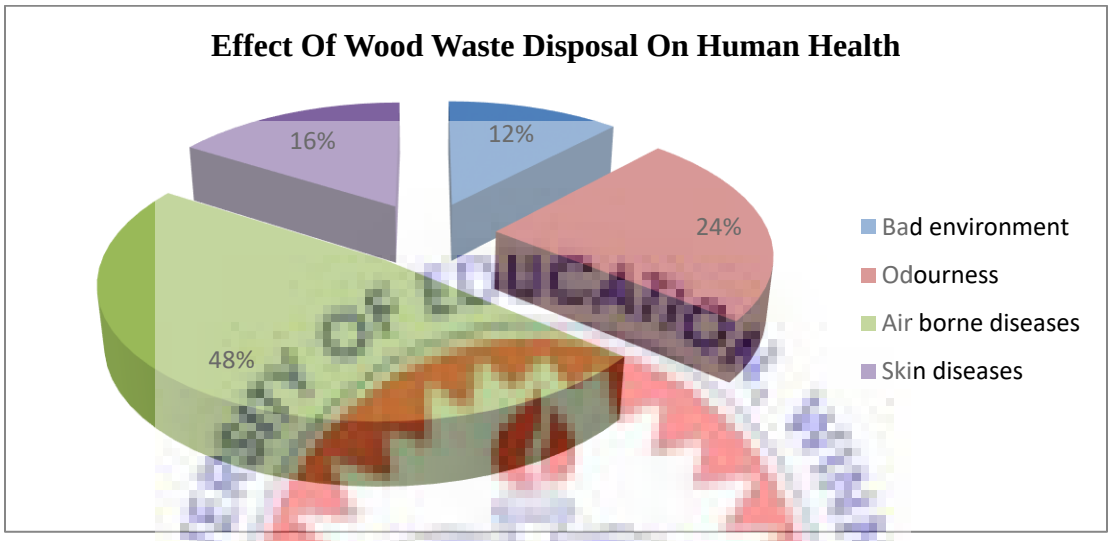

Figure 4.7: Knowledge of respondents on link between poor waste disposal and health

From the figure above 48% of the respondent opted risk of air borne diseases as their answer because of contamination of smoke when waste are burnt without control. 24% of respondent said they were very much affected by offensive odour during raining season. 16% of respondent opted that when waste are not timely disposed off constitute source of skin diseases due to accumulation of waste over a period of time especially during raining season. Dosunmu and Ajayi, 2002 stated that if waste are not timely disposed, they become breeding places for worms and insects, they also constitute health hazards. While 12% of respondents also pose waste generated in sawmills makes bad working environment for those working in the area. The reason given was lack of education in waste management, place to dispose waste generated and late collection of waste. According to Theodore and

Hattington (1981) as stated by Amunega (2002), there is lack of adequate knowledge and experience about the importance of health education within industry. This has made them prone to diseases. Ehor and Onohwakpor (2002) concluded that the prime responsibility for occupational safety and health lies with the employers.

Sawdust is the only residue in significant surplus for increasing offsite residue utilization (Odoom, 2004). Very little potential exist for increasing the direct utilization of surplus sawdust because of technical and economic constraints. Wood dust has several hazards associated with exposure to it in the workplace. In general, exposure to excessive amounts of wood dust is considered to have an irritant effect on eyes, nose and throat in addition to pulmonary function impairment and is considered a human carcinogen Osha (2012). The presence of wood residue at dumping sites close to the sawmills mar the scenic beauty of the surrounding area and cause health challenges to the inhabitants.

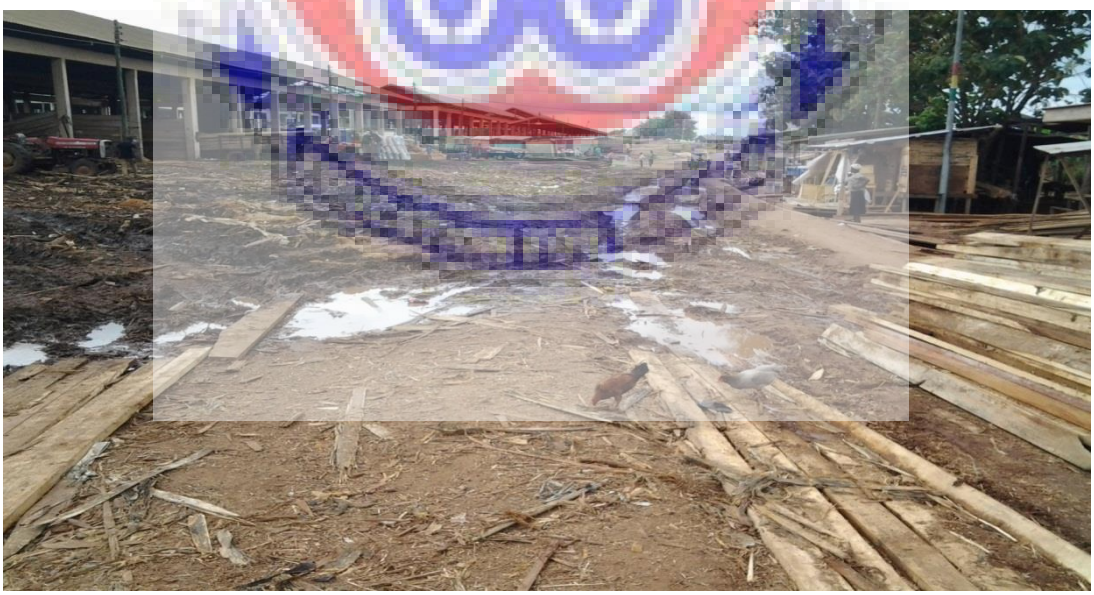

Plate 4.13: Disposed waste at work environment

Source: Field survey at Sokoban wood village, 2018

Plate 4.14: Sawdust used for land fill in raining season

Source: Field survey at Sokoban wood village, 2018

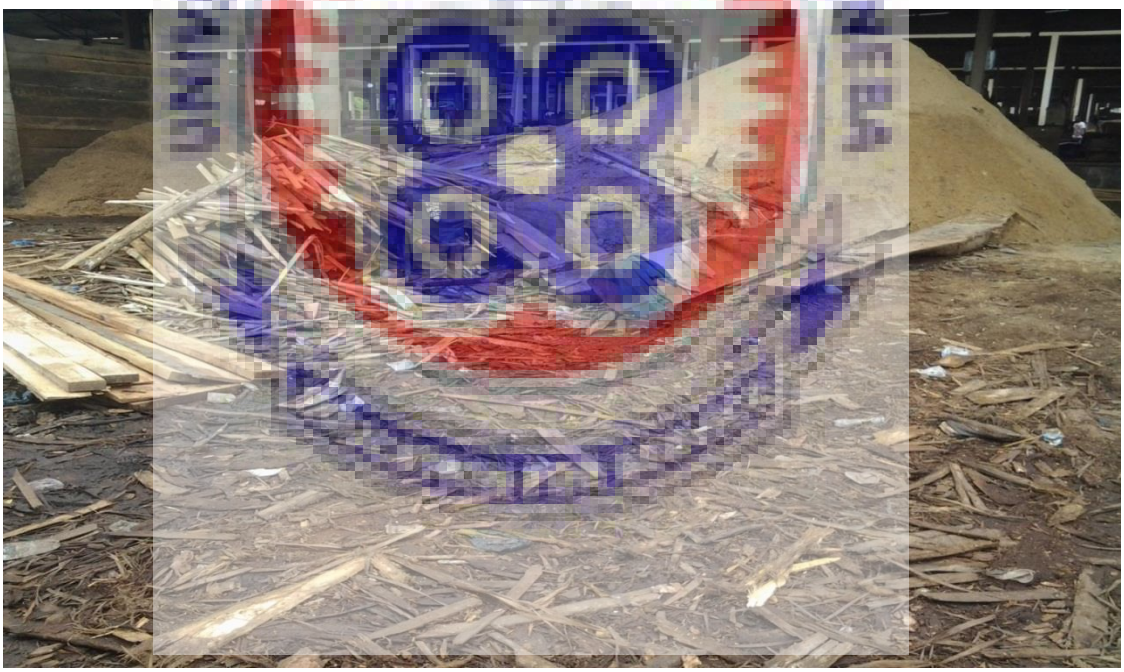

Plate 4.15: Heaps of undisposed waste at sawmill in raining

Source: Field survey at Ahwiah timber market, 2018

Dosunmu and Ajayi, 2002 stated that if waste are not timely disposed, they become breeding places for worms and insects, they also constitute health hazards Sawdust which

formed majority of the wood residue generated from sawmills that was not utilized and was discarded by open burning. It poses several challenges to the environment and health of workers in the timber industries (Lasode *et al.*, 2013). Wood dust becomes a potential health problem when the particles become airborne. Breathing these particles may cause allergic respiratory symptoms. Osha (2012). In addition to the health effects of wood dust, airborne dust can create the potential for a dust explosion (OSHA, 2012), which can burn down an entire timber industry. This can cause financial loss to the timber industry.

4.7.1 Health Problem Associated with Poor Disposal of Wood Waste

Health problems suffered by the people at sawmill and areas wastes is dispose are cold or cough, nasal bleeding, throat irritation, chest pain, itching skin and eye irritation, diseases. Table 4.3 shows kinds of health problems confronting people at mills and areas of disposing waste.

Table 4.3: Health problems at sawmills

Health problems	Frequency	Percentage (%)
Cold /Cough	88	37
Nasal bleeding	12	5.4
Throat irritation	11	4.6
Chest pains	20	8
Itching skin	74	31
Eye irritation	33	14
Total	**238**	**100**

Source: Field survey, 2018

From table 4.3 it is indicated that majority of people in sawmills suffer or complain of prolong cold, representing 37 percent. The next is skin itching 31percent, followed by eye irritation which consist of 13 percent, others are chest pain 8 percent, nasal bleeding 5.4

percent and throat irritation 4.6 percent. In a study conducted by Adegbenro and Fabiyi (2002) headache /fever topped the list of health problems experienced by the workers with 90% while hearing problem was experienced among the workers with 25%.

It was realized from the study that, improper dispose of solid waste has affected the health of people at sawmill, nearby residents. According to Ezeji and Onoh (2008) Safety could be defined as planned measures or precautions that should be taken to control situations and acts in an endeavour to prevent injuries to the persons concerned, injuries to others who may be around the working place and damage to workshop equipment and materials. Majority of the sawmill workers and inhabitants of the residential areas agreed that they were aware of diseases such as headache, Cough, body pains and fever sawmills that can affect their health. Safety gadgets, protective devices and environmental health aid were not available or adequate.

In an interview with some residents around the dumping sites, they complained of nasal irritation, throat irritation, chest pain and itchy eyes. It was also observed that the place was aesthetically unclean and the whole scene was a real fire hazard to the surrounding sawmills.

Plate 4.16: Smoke from burning wood waste at dump site near to sawmill and residents

Source: Field survey at Akwatia-Line sawmill, 2018

Plate 4.17: Heaps of saw dust at dump site in raining season

Source: Field survey at Sokoban wood village, 2018

An interview with some residents around the dumping site revealed that, they had frequent irritation in the nose, throat and eye, cold and chest pains. This proved work done by Dosunmu & Ajayi (2002). Which state that sawdust was heaped at the dumping site for a very long period before burning, thus becoming breeding spaces for worms and germs, liberating obnoxious odour and exposing workers to unhygienic working environment. Sawdust therefore has to be utilized for economic benefits and to reduce environmental impact in society.

4.8 Sanitation Bye-law on Wood Waste Disposal in sawmills

The research conducted showed that 7% of the respondents said there is sanitation bye-laws at the sawmills whiles 93% said there are no bye-laws governing waste disposal. This is represented in the figure below.

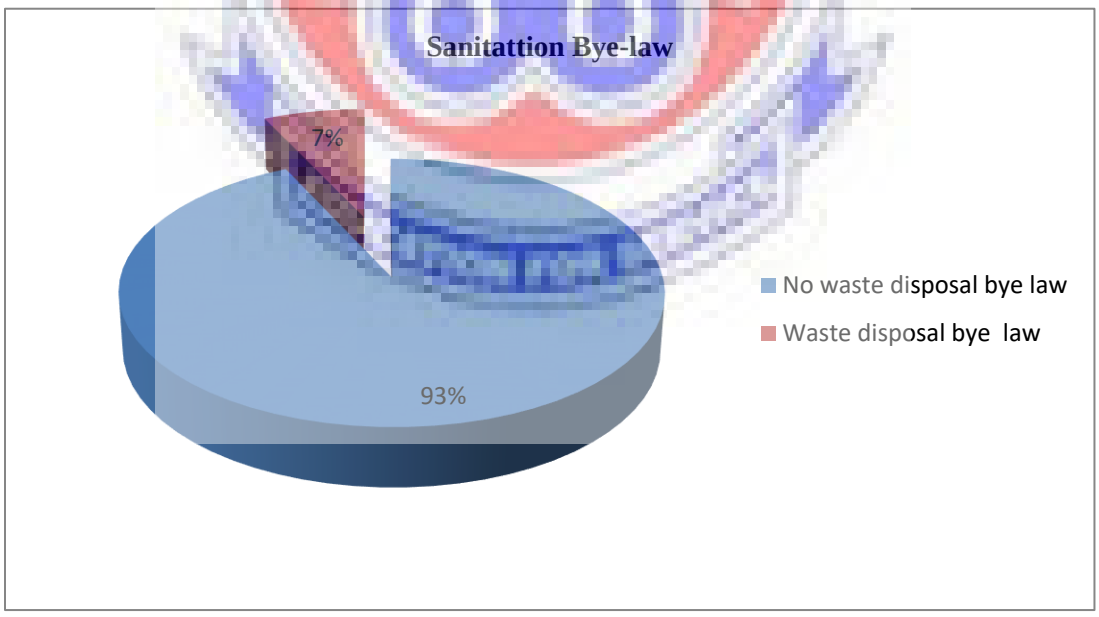

Figure 4.8: Either there sanitation law on waste management

Source: Field survey, 2018

From the figure 93% of the respondents said there is no sanitation bye-law in the community whereas 7percent said there is existence of sanitation bye-law. According to the Ministry of Local Government and Rural Development (MLGRD) (2004), general waste management in Ghana is the responsibility of the MLGRD, which supervises the decentralized Metropolitan, Municipal and District Assemblies (MMDAs). However, the ministry indicates that, regulatory authority is vested in the Environmental Protection Agency (EPA) under the auspices of the Ministry of Environment and Science. The Metropolitan, Municipal and District Assemblies are responsible for the collection and final disposal of solid waste through their Waste Management Departments (WMDs) and their Environmental Health and Sanitation Departments (EHSD). The ministry further indicates that in an effort to address the problem of waste management, Government has over the years put in place adequate national policies, regulatory and institutional frameworks. Due to this the Environmental Sanitation Policy (ESP) was formulated in 1999. Various relevant legislations for the control of waste have also been enacted.

4.9 Suggestions from Respondents on how Waste Generated should be Manage

Table 4.4: Display how waste generated can be managed

Suggestion on how waste should be manage	Frequency	Percentage %
Paying for the collection and dispose of waste	19	8
Contribution to buy waste containers	27	11
Strict enforcement of existing sanitary laws at sawmills	30	13
Provision of approved dumping sites closer to sawmills	48	20
More education on the effects of indiscriminate refuse disposal	87	37
Provision of dust extractors	27	11

Total	**238**	**100**

Source: Field survey, 2018

The table 4.4 above display suggestions from respondents on what waste generated can be managed to improve disposal practices. Due to the people attitude on waste management and their low level of education, 87 of the respondents representing 37% which constitute the majority want more education on the effects of indiscriminate refuse disposal. 27 of the respondents preferred sawmill owners contribute to buy waste containers since there is no or less dumping place this was represent by 11%. 19 of the respondents stated that paying for collection and disposal of waste is a means to manage improperly waste disposal represent 8% with reason because the waste management institution operating in the communities are private companies so paying certain amount to them will encourage the company to improve on their services. 13% of the respondents thought strict enforcement of existing sanitary laws will help in waste management because that will make them very responsible for their actions.11% of the respondents said that the provision of air extractors will be the best to collect all waste generated to one place. 20% of the respondents preferred approved dumping sites closer to them since they transport far distance to dump their waste. From the responses, it was noted that, they wanted to reduce their waste. This showed that if proper waste management is done, they will definitely reduce waste to save their environment which will prevent them from environment related diseases.

4.9.1 Involvement of State or Authorities in Waste Management at Sawmill

To determine the sole responsibility of waste management at sawmills, the question posed to the respondents, 36% of respondents accepted that wood waste generated from sawmills

are their responsibility to dispose it properly without coursing harm to the environment. However, majority of respondents constituting of 64% assert that state authorities are not doing enough assist the sawmills to manage wood waste generated. Figure 4.9 show the responsibility of waste management in management of wood waste at small scale saw mills.

Figure 4.9: Responsibility of waste management

Source: Field survey, 2018

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATION

5.1 Summary of Findings

The objective one of the study was to determine the process in which smallscale sawmills collect wood waste generated as compare to medium scale and large scale sawmills.The study the found out that smallscale sawmill wood waste generated from their daily activities are let go for free without gaining any income from them. It was released that sawmill owners have to hire the service people or vehicle to dispose off waste.

The objective two of the study was to examine the methods of disposal by smallscale sawmills as compared to large scale sawmills. It was observe that wood waste generated from their daily activities are disposed around sawmills and nearby dump sites.

The objective three and four was to assess wood waste disposal implication on the environment and evaluate health hazards on the workers coursed by wood waste dispose around sawmill. The study made it known that poor wood waste disposal has adverse effect on the environment as well as human health. During raining season heaps of waste which

cannot be burnt regularly release very offensive odour and create bad working environment.

5.2 Conclusion

A large amount of wood waste is produced by small scale sawmills especially in Kumas timber markets. The issue of wood waste generation and disposal is a common problem in all the timber markets in the country, and unfortunately, this valuable natural resource often ends up taking up valuable landfill space or is burnet illegally, negatively impacting the environment. This thesis sought to create awareness on proper disposal of wood waste by smallscale. It specifically assessed how small scale sawmills residues are managed and disposed off and suggested appropriate measures for dealing with wood waste disposal in Kumasi metropolis.

Wood waste residue is generated from a variety of sources and production processes, including sawing, planning, mortising, lathe turning, and sanding. The study showed sawing and planning as the highest waste generation sources. Large piles of wood residue are commonly stored at wood processing facilities. Residues of sawmilling process such as bark, chips, sawdust, shavings and slabs were generated, however, sawdust was the highest waste generated by the artisans. Majority were also collecting their waste by manual clearing. The artisans have also resorted to open burning as the means of disposing their waste. Lack of transportation to transport the waste from the site to designated safe

places has led to majority resulting in opening burning just at the sites. There was general assertion that state authorities were not doing enough to manage waste at the surveyed sites. Ideally, the easiest and most cost-effective way of managing any waste is not to generate it in the first place. But once the waste is generated, one can decrease the amount of waste produced by developing a few "good housekeeping" habits. Reassessing daily practices and overall product design of the artisans may significantly reduce the amount of wood waste they discard. A significant positive correlation between methods of collecting waste and methods of disposal practiced were identified. When waste has been minimized at the source, consideration must be given to its potential reuse. This means reprocessing the waste to manufacture composite boards, animal bedding, mulches, charcoal and generation of energy.

Finally, sawmill wastes such as wood off-cuts, sawdust, back peals etcetera are not all hazardous in term of all of its economics importance. Only it should be probably managed in other not to arm man and is environment. In addition to this, sawdust has a limitless range of uses in society.

5.3 Recommendations

Based on the findings of this research, the following recommendations were made

1. The Sawmills' managers or owners should;
    a. Burning should not be done in the late afternoon or evening, as the air will be stable. Since they are a ground level source of pollution, the burning

should be confined to sunny hours around the middle of the day so that there will be adequate upward dispersal thus keeping the ground-level air clean.

b. Wastes should not be burnt on very windy days because the smoke will be carried a large horizontal distance before it rises clear of buildings

c. Show concern for their workers and the inhabitants around their premises in terms of their disposal of wastes.

2. The state and the metropolitan authorities should monitor sawmills through the environmental health officers to know that they are in good condition and conducive for working environment, and to organize seminar on how to protect their health.
3. The workers and the inhabitants of the sawmill environment should be advised to visit the hospital regularly for medical check up.
4. The waste yield from the sawmill industry is about one third of the whole of the material involved. The fundamental difficulties in utilizing this waste is the economics of collecting adequate quality of waste to justify the installation of an additional processing plants that can utilize the waste.
5. Sawmill wastes as fuel it can be used to produce banquet fuel for cooking. Sawmill wastes are highly combustible, most especially if they are dry. The most combustible wood fuel is charcoal and followed closely (in descending order) by dry soft wood material (e. g. sawdust pellets, planer shavings etc.).
6. Chip / Particle Board is another way of utilizing wood waste is in the manufacture of chipboard or wood-particle board. Saw dusts and wood off-cuts can be separated from other waste at source. The wood off-cuts and rejects are crushed to make chips

and mixed in turn with sawdust. Binders, such as resins, are used as to bind the particles together. The mixture is then poured into appropriate moulds to form any desired board size.

7. Litters of wood wastes could be used as litters for animals. Since they are easily available, affordable and disposable, it could serve as better alternatives most especially in the poultry.
8. It is recommended that the sawmill industries should be relocated if there should exist a friendly and inviting residential area, there should be a buffer between them. This is due to the fact that the two land uses cannot complement each other rather they contradict each other because residential land use cannot be used alongside with industrial land use due to the heavy pollution discharge from the industry (Sawmill)

REFERENCES

Adegbenro, C. A. & Fabiyi, A.K. (2002). Health Hazards among Workers in a Saw-Mill Industries in *Bodija Market Ibadan Nigerian School Health Journal*, 1&2, 123-132 Adeniyi.

Agyeman, E.K.O. (1998). *Economic Assessment of Wood Residue Produced in Sawmilling: A case study*. MSc. Thesis, KNUST, Kumasi. Unpublished. pp 113.

Akachukwu, A.E. (2000). Sawmilling waste in Nigeria and its effects on the environment. *The Nigerian Field*. 65, 219-223.

Akindenis, J.O., Olaniran, S.O. & Olufemi, B. (2012). Lumber recovery efficiency among selected sawmills in Akure, Nigeria/Iskoristenje drvne sirovine u promatranim pilanama podrucja Akure u Nigeriji. *Drvna Industrijia*. 63.1 pp 15.

Amunega, S. B. (2002). Occupational Hazards in Odo-Okun Sawmill in Ilorin West Local Government Area of Kwara State: *Causes and Prevention Nigerian School Health Journal*, 14, 1&2 25-33

Anaele, E.O., Adelakun, O.A. & Olumoko, B.A. (2014). Re-engineering Technical Vocational Education and Training (TVET) towards Practice Skill Needs of Sawmill Workers against Workplace Hazards in Nigeria. *Journal of Education and Practice*, ISSN 2222- 288X (Online) 5, 7 150-157

Attuquayefio, K. D. & Abdulai, A. R. (2013). *Environmental and Social Management Plan (ESMP)*: Construction of access roads with kerbs and drains at Sokoban wood

village, Kumasi Metropolitan Assembly, Ghana.

Carson, W. P. (1985). State of the Knowledge Report: The ecology of Accra – Winneba plains with some aspects of related savanna ecosystem in Impact of human activities on the structure and productivity of savanna ecosystem in Ghana. *Ghana National Committee for man and the biosphere programme*, 1. UNESCO.

Christersson, L., Verwijst, T., & Amatya, S.M. (2005). *Wood production in agroforestry and in short-rotation forestry systems– synergies for rural development*. Proc. IUFRO: Conf. (session 12, 128), Brisbane.

Dost, A.W. (1966). Progress in Wood Residue use in California. Paper presented at the Spring Meeting of the Northern Section of Forest Products *Journal. Berkeley, California*. pp 42. www.spinger.com Accessed date 10-04-09.

Dosunmu, O. O. & Ajayi, A. B. (2002). *Problems and management of sawmill waste in Lagos*, (January), 271–278.

Eerd, M.V. (1997). *The occupational health aspect of waste collection and recycling:* an inventory study in India.

Effah, B., Antwi, K., Boampong , E., Jack Nti Asamoah, J. N. & Osei, A. (2015). *The management and disposal of small scale sawmills residues at the Sokoban and Ahwia wood markets in Kumasi*.

Elijah, F.B., Elegbede, I. (2015). Environmental Sustainability Impact of the Okobaba Sawmill Industry on some biogeochemistry characteristics of the Lagos Lagoon. Poult. Fish Wildl. Sci., 3: 131. doi: 10.4172/2375-446X.1000131.

Environmental Protection Agency (2002). Ghana's State of the Environment Report EPA,

MES, MLGRD, (2002) Ghana Landfill Guidelines: Best Practice Environmental Guidelines. Accra, Ghana.

Environmental Protection Agency (2002). Ghana's State of the Environment Report EPA, MES, MLGRD, (2002) Ghana Landfill Guidelines: Best Practice Environmental Guidelines. Accra, Ghana.

FAO (2004). *Assessing forestry project impact: issues and strategies,* F.A.O. Rome: 4-6.

FAO (1991). African fisheries and the Environment FAO Regional Office. Accra, RAFR/91/02, Accra, Ghana: 26.

Fuwape, J.A. (2001). Forest resources and economic development in Ondo State. *Paper Presented at Ondo State Economic Summit*. 1-15.

Ghani, W.A.W.A.K., Mohd, A., da Silva, G., Bachmann, R.T., Taufiq-Yap Y.H., Rashid U. & Ala'a, H. (2013). Biochar production from waste rubber-wood-sawdust and its potential use in C sequestration: *Chemical And Physical Characterization. Industrial Crops and Products, 44*: 18-24.

Ghann, P. (2002). *Quantification of wood waste in some selected single product wood industries in Kumasi and their use for energy generation.*

Holmes, N. (1976), "*Environment and the industrial society*". Holder and Stoughton Publishers, Great Britain, pp 169-180.

Ibrahim, S. M., Jimoh, I. O. & Idowu, O. O. (2012). *Management of Sawmill Wastes in Nigeria* : Case Study of, 2012.

Issues. (2000). *Waste and Recycling*. Vol. 14. Craig Donnellan; Independence Educational Publishers, The Burlington Press, Cambridge. 44 pp.

Johnnessen, L.M. & Boyer, G. (1999). *Observations of Solid Waste Landfills in Developing Countries*; Africa, Asia.

Jupp, V. (2006). *The Sage Dictionary of Social Research Methods*, London: SAGE Publications Ltd.

Keene, S., Smyth, C. (2009). End-*of-Life Options for Construction and Demolition of Timber Waste:* A Christchurch Case Study. Univ. Canterbury, New Zealand

Kumah, A.M. (2007). *The Situation of Solid Waste in Ghana*. Accra, Ghana

Mensah, A. & E. Larbi, (2005). *Solid Waste Disposal in Ghana*. WELL FACTSHEET - Regional Annex, http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/RSA%20Solid%20waste.htm

MLGRD (2004). Sanitation Country Profile Ghana (2004). (http://www.un.org/esa/agenda21/natlinfo/countr/ghana/SanitationGHANA04F.pdf)

Nathanson, J. A. (2014). *Solid-waste management*. http://www.britannica.com/EBchecked/topic/553362/solid-waste-management.

Neal, A. W. (1974). "*Formation and use of industrial By-products: A guide*". Business books Ltd, London, pp 56-59.

Nketiah, S. K., Atakora, S. B. & Brew-Hammond, A. (2001). *Ghana Sawmill Energy Efficiency Study*. Final Report. Intermediate Technology Consultants (ITC) and UK Department for International Development (DFID): xiii.

Odebunmi, S.G. (2001). *Solid waste transportation in Lagos state: developing a sustainable model.* Ph.D. Seminar, Univ. Lagos, Lagos. Nigeria.

Ofosu-Asiedu, A., Addae-Mensah, A.G. & Foli, E.G. (1988). *Wood residues identification at originating points*. FAO Final Technical Report. pp 4-5

Ogunbode, E.B., Fabunmi, F.O., Ibrahim, S.M., Jimoh, I.O., Idowu, O.O. (2013). Management of sawmill wastes in Nigeria: Case study of Minna, Niger State. *Greener J. Sci. Eng. Tech. Res., 3(2):* 034-041.

Olawuni, P. O. & Okunola, O. H. (2014) *Socioeconomic Impacts of Sawmill Industry on Residents*. A Case Study of Ile-Ife, Nigeria.

Olujimi, J. (2015). *Effects of Sawmill Wastes in Residential areas of Ogbese and Akure Townships* , Ondo State , (November).

Omobude-Idiado, S.N., Irimonre, E.L. & Ohi Asikhia, M., (2013), *Occupational Health Hazards in Sawmill Industries in Benin City*.

Omole, J. O., Fabunmi A. A., & Akosile C. O. (2018). Respiratory function of sawmill workers and their relationship to duration of exposure to wood dust seen in Nigeria, *Journal of Environmental and Occupational Science*, 7, (1), 9–16

Puopiel, F. (2010). *Solid waste management in GHANA*: The case of Tamale Metropolitan Area. KNUST, Ghana.

Robson, C. (2002). *Real World Research*, (2nd ed). Blackwell, Oxford.

Rushbrook, P. & Pugh, M. (1999). Solid waste landfills in middle and low income countries. The World Bank.

Saunders, M. Lewis, P. & Thornhill, A. (2009). *Research Methods for Business Students*, (5th ed.), England: Pearson Education Ltd.

Scorer, R. S. (1968). "*Air Pollution*", Pergamon Press.GB.

Tchobanoglous, G., Theisen, H. & Eliason, R. (1977). *Solid Wastes: Engineering Principles and Management issues.* McGraw-Hill Publishing Company, USA.

Tchobanoglous, G., Theisen, H. & Vigil, S. (1993). *Integrated Solid Waste: Engineering principles and management issues.* McGraw-Hill Publishing Company, USA.

Tillman, D. A., (1978). "*Wood as an Energy Resources*" Academic Press N. Y. pp 65-85.

Top, Y. (2015). Waste generation and utilisation in micro-sized furniture-manufacturing enterprises in Turkey. *Waste Management*. https://doi.org/10.1016/j.wasman.2014.09.028

Tsiboe, I. A. & Marbell, E. (2004). *A Look at Urban Waste Disposal Problems in Accra*. Roskilde University, Denmark.

USEPA (United State Environmental protection Agency (2005). Environmental Education. Available online at http://www.epa.gov.envied (assessed 29 May 2007).

White, P., Franke, M. & Hindle, P. (1997). *Integrated solid waste management*: a lifecycle inventory. London, Blackie Academic Professional.

APPENDIX

QUESTIONNAIRE FOR RESPONDENTS

PREAMBLE

My name is Brefo Evans, a master student of the University of Education, offering Master of Technology in Wood, conducting a research on the topic "**Environmental effects of small-scale sawmill woodwaste disposal in the Kumasi metropolis".** The interview will take less minutes of your time and your assured that all responses will be kept confidential. This means that your interview responses will only be used for only academic purposes.

Tick only one answer in the boxes provided

SECTION A: Socio-demographic data of respondents

1. Sex

[ ] Male

[ ] Female

2. Age

[ ] 18-25

[ ] 26-35

[ ] 35-4

[ ] 46-70

3. Level of education

[ ] Primary school

[ ] J.H.S (Junior High School)

[ ] S.H.S (Senior High School)

[ ] Tertiary

5. What is your major Occupation?

[ ] Wood machinist

[ ] Petty Trading

[ ] Timber merchant

[ ] Public servant

Other, specify.....

SECTION B

Please select an option by ticking (√) in the right column in accordance to the process of collection wood waste from sawmills.

	Process of collection wood waste	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1	Wood waste are collected by air extractors					
2	Hands are used to collect/gather wood waste					
3	Wood waste generated are collected by bags					
4	Trucks are used for collection of waste from sawmills					
5	Wheel barrow is used collect waste from sawmill					
6	Tractor is means of collection waste generated					
7	Waste generated from sawmills are sorted					
8	Off cut from lumber are packed for further processing					

Please select an option by ticking (√) in the right column in relation to the method sawmills used to dispose wood waste.

	Method of waste disposal practice	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
9	Waste generated from sawmill is burned openly					
10	Waste generated from sawmills or work shop are used as fuel in households					
11	Waste from sawmills is used to fill land and pot holes					
12	Waste generated from sawmills dumped in open places					
13	Waste generated from sawmills used for agricultural purposes					
14	Are waste collected dispose on time					
15	Waste generated from mills are dispose in along roadside					
16	Waste generated from mills are dispose in nearby gutter's					
17	Waste generated from mills are dispose at public dump site					
18	Waste generated from mills are dispose around workshop					
19	Do you feel odor from where waste are disposed					

Please select an option by ticking (√) in the right column in relation to improper disposal of wood waste on the environment.

	Effect of disposal waste on environment	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
20	Does improper disposal of waste affect the environment					
21	Do you know poor waste disposal promotes the spread of diseases					
22	Are you aware of poor waste disposal affect esthetic of the environment					
23	Have you experience fire outbreak due to undisposed heap of waste in the sawmill					
24	Do you frequently experience fire outbreak at your sawmill resulting from waste disposal					

Please select an option by ticking (√) in the right column in relation to improper disposal of wood waste and human health.

	Effect of disposal waste on human health	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
25	Do you know poor waste disposal promotes health hazards					
26	Does waste dispose around sawmills makes you fall sick					
27	Do you feel comfortable woodworking in shop with heap of waste around					
28	The waste disposal practices causing problem to the public health					

Tick (√) any of the under-listed conditions which you normally experience as you do your normal business here as a result of poor wood waste disposal.

	Type of Health Problems	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
29	Have you experience prolonged cold or cough due to heap of wood waste at sawmill					
30	How often do you experience nasal bleeding as a result of huge dust waste in the shop					
31	Have you experience throat irritation before					
32	Has dust accumulated in in shop makes you feel chest pain					
33	Do you feel skin itching when waste are padded around sawmill.					
34	How often you feel nasal irritation					
35	How often do you feel eye irritation					

SECTION C

INTERVIEW GUIDE FOR KEY INFORMANTS

36. How will you assess wood waste disposal situation within the Kumasi metropolis?

……

……

37. Is wood waste disposal practices causing problem to the public health and the environment?

[ ] Yes

[ ] No

If 'yes', what exactly is the problem?

……

……

38. Which waste management institution is responsible for the collection of waste for disposal?

……

……

39. How often do they come for collection?

……

……

40. What does the community face regarding solid waste disposal?

……

……

41. What are the causes of waste to the community regarding solid waste disposal?

……

……

42. Is there any measures put in place to ensure disposal of wood waste by the Metropolitan authorities?

……

……

43. What are some of the major difficulties you come across in an effort to ensure proper waste disposal practices?

……

……

44. What suggestion do you have as a way of improving waste disposal practices within the Metropolis?

……

……