UNIVERSITY OF GÄVLE

**DEPARTMENT OF TECHNOLOGY AND BUILT ENVIRONMENT**

# Environmental Aspects Review
# A Case Study of Two Sawmills in Etsako-West, Edo State Nigeria

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## Abstract

The forests are essential for healthy environment. Trees which are part of the forest help to stabilize the forest soil, improve soil fertility, reduce the velocity of wind, protect watershed and reduce the amount of carbon released into the atmosphere. Many industries use trees as raw materials and in most cases impact the environment, but there are great differences in the impact they make. There is a need therefore to continually evaluate the operational activities of these industries to ensure that the environment is protected. The use of environmental management systems like ISO and EMAS standards has helped in the evaluation of organizations and industries.

In this thesis, two sawmills Iretunde and Irepodun in Etsako-West local government area Edo state Nigeria were evaluated with the aim to determine their operational activities and how the environment is being affected by them. Sub-aims were to determine the most significant environmental aspects of the sawmill and their organizational structure. In actualizing the aim of this thesis, literature review, site investigation as well as oral interview of the staff and management of both sawmills were conducted. In the evaluation of the environmental aspects, the detailed method of environmental impact evaluation by Ammenberg (2004) was used were each environmental aspect that was weighted against nine identified criteria.

The result obtained from the environmental aspect evaluation of both sawmills shows that the use of raw materials and emissions to air are the most significant environmental aspects. In conclusion, it was observed that the both sawmills are well structured and carry out their operational activities effectively. Neither of them has registered under any environmental management system but there is a need for them to do so in order to help check their operational activities in order to reduce their environmental impact.



**Keywords:** Environmental review, environmental aspects ISO14001, sawmills, EMAS, Nigeria

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## List of abbreviations and terms

| | |
|---|---|
| ACO | Afemai Charity Organization |
| As | Arsenic |
| Cr | Chromium |
| DCGC | Datong coal gasification Corporation |
| EIA | Environmental impact assessment |
| EMCC | Environmental management consultative commission |
| EMS | Environmental management system |
| ELU | Environmental load unit |
| EMAS | Eco-Management and Audit Scheme |
| FAO | Food and Agricultural organization of the United Nations |
| FEPA | Federal environmental protection agency act |
| SWOT | Strength, weakness, opportunities and treats |
| ISO | International Standard Organization |
| IEE | Institute of electrical engineers |
| LCA | Life cycle assessment |
| LCIA | Life cycle impact assessment |
| LCI | Life cycle inventory |
| UBA | German federal environmental agency |

## Environmental criteria description

| Criteria's | Descriptions |
|---|---|
| Climate effects | Changes in the earth that affect the climate and cause increase in greenhouse gases in the atmosphere |
| Ozone layer reduction | Reduction of the ozone layer that prevents the filtration of harmful ultraviolet rays from the sun. |
| Acidification | Caused by acid depositions from anthropogenic emissions |
| Photochemical smog | Pollution caused by chemical reaction of various pollutants emitted from different sources in the atmosphere |
| Harmful air emissions to health and noise | Emissions to air that caused pollution, are harmful to health and noise |
| Effects due to metals | Environmental effects due to the use of metals |
| Effects due to organic pollutants | Environmental effect due to the use of organic pollutants |
| Introduction and spreading of foreign organisms | The introduction and spreading of foreign organisms due to operational activities that are harmful to the environment |
| Impoverishing of nature types, biotopes, spices, etc | Weakening the quality and growth of species, biotopes etc |
| Ionization | The production of ions by the removal of electrons from atoms |
| Quality, volume, extent | The quality, volume and extent of the effect of the environmental aspect |
| Sum | The total sum of the environmental aspect on each criteria |

## 1. Introduction

There is a great difference in the impact on the environment by industries and organization as a result of their operational activities and use of raw materials. Industries and organizations are aimed at transforming resources into finished products in order to benefit their customers and as such affect the environment directly or indirectly. Human activities affect the environment through various ways creating negative impacts to the natural environment and as such need to be reduced considerably to ensure that there is a clean air, water and food for everyone on the planet (Sammalisto, 2007). Since the 1960s, there has been an increasing interest on the damage to the environment that is done by industries and organizations and as such attention should be made to these activities in order to reduce their impact of humans and the environment (Welford, 2000). The issue of global warming is becoming an increasing concern worldwide today as most countries and organizations are now aimed at ensuring that their activities create less environmental impact.

In planning to build a new structure that might disturb the ground surface, remove or trim natural vegetation, or divide land into different environmental overlays, it is appropriate that this proposal is subject to environmental regulations. These environmental regulations help to control the activities of the organizations and individuals within designated groups to ensure that their activities are environmentally "friendly". There is a need therefore for the government as well as organizations to put in place rules and policies that could help guide organizational activities. Welford (2000) reported that there has been a rapid growth in recent years in environmental legislation and other policies aimed at reducing environmental impacts and as such organizations should take advantage of these.

There is a need therefore for industries and organizations to continually review their environmental impacts in order to determine which of the environmental aspect is most significant and needs immediate attention. The environmental review helps the organization to get a clear view of the environmental state and also helps to identify things that can be improved and which should be part of the company's action plan. In implementing this review, a special organisation is set up to lead the implementation system which should include survey of the company's environmental aspects and the current environmental management system (Brorson & Larsson, 2006).

The implementation of environmental management systems is becoming of great interest to industries and organizations. Organizations and industries adopt environmental management policies and carry out environmental audits and reviews in some cases due to public pressure, ethnical concern, commitment of local and central government, attraction of customers etc (Welford, 2000). Environmental management system such as ISO14001, Eco-management and Audit Scheme, are examples of EMS used by organizations to increase efficiency of operations facilitate communication between organizations and its interested parties etc (Sammalisto, 2007).

The methods of carrying out environmental review may vary between organizations but is usually a comprehensive review of all aspects of the organizations environmental performance with performance indicators identified and targets and objectives suggested. Most environmental reviews use the SWOT analysis but this varies in depth between different organizations as the methodologies, analytical tools and concept used differ between organizations. Small organizations often have certain advantages over larger organizations in ensuring effective environmental management. In smaller organizations, lines of communication are generally shorter, organizational structures are less complex, people often perform multiple functions, processes are generally well understood, and access to management is simpler. These can be real advantages for effective environmental management in small organizations (Welford, 2000).

Considering the interest in the issue of global warming worldwide, there is a high need to check organizational activities through environmental policies in order to ensure that their operations and activities are safe and do not affect the environment. The indiscriminate logging in the rainforest and uncontrolled felling of trees by sawmillers' operations are reported to have adverse effect on the environment. The adverse effect caused by the operations of forest industries includes loss of biodiversity, migration of wildlife, ecological imbalance, soil erosion, flooding, desert encroachment and disruption in hydrological cycle of water catchments area (Fuwape & Onyekwelu, 1995). Fuwape and Onyekwelu (1995) reported that clear felling of trees by sawmills as a source of raw material has been recognized as one of the factors responsible for environmental degradation in arid and semi-arid parts of Africa. Couzin (1999) reported that on the average precipitation is 30% lower and temperatures are 1 degree Celsius higher in deforested areas of the Amazon than in forested areas.

Despite the importance of forest products in Nigeria, there is an increasing rate of deforestation and forest degradation and little attempt have been made to analyse the underlying causes of deforestation and forest degradation in the country (Fuwape and Onyekwelu, 1995). Forest exploitation is beneficial to sawmill and other organizations but it equally has an adverse effect on climate change if done irrationally. The forests are essential for healthy environment with the trees helping to stabilize the forest soil, improve soil fertility, reduce the velocity of wind, protect watershed and reduce the amount of carbon released into the atmosphere. When forests are exploited beyond their capacity to regenerate, vicious cycle of environmental degradation can be set in motion. This thesis looks at the effect of sawmill's activities on one community and its environment.

## 1.1Aim/Purpose of study

This thesis is aimed at evaluating the activities of Irepodun and Iretunde sawmill in Etsako-West local government area of Edo state Nigeria in order to determine their operational activities and how the environment is being affected. Other sub aims are to make a comparison in order to find out which of sawmill has a better organised structure as well as identifying the significant environmental aspects and operational activities.

The result obtained from this thesis will be used as a guiding tool towards making possible recommendation on how both sawmills can improve their activities in order to reduce environmental aspects that may cause significant impacts on the environment.

## 1.2 Description of the study area/sawmill

The two sawmills selected for this thesis are located in Etsako-West local government area of Edo state. Edo state is among the 36 states in Nigeria and was created on the 27$^{th}$ of August 1991. The state has a population of about 3.5 million people (Wikipedia, 2008). The population figure was obtained after the 2005 population census. Edo state is located in the central southern part of Nigeria sharing boarders with Kogi, Ondo and Delta state. The state has a land area of 17 802 km2 and has 18 local governments (Wikipedia, 2008).

Etsako-West local government is among the six local governments that make-up Afemailand which is located in the north-eastern part of the capital city of Edo state and it was referred to as the Kukuruku Division after the invasion of the Nupe slave raiders of the nineteenth century (Afemai charity organization [ACO], 2008). Etsako-West is located in the western part of Afemailand with Auchi as the headquarters. The local government comprise of other small villages such as South-Ibie, Jattu, Agbede, Aviele, etc. The map of Edo state is shown in figure 1 with the circled area indicating the location of Etsako-West.

The main area of study for this thesis is South-Ibie and Jattu both in Etsako-West local government area of Edo state. These two communities have large sawmills, Irepodun and Iretunde that saw and process timber for interstate usage.

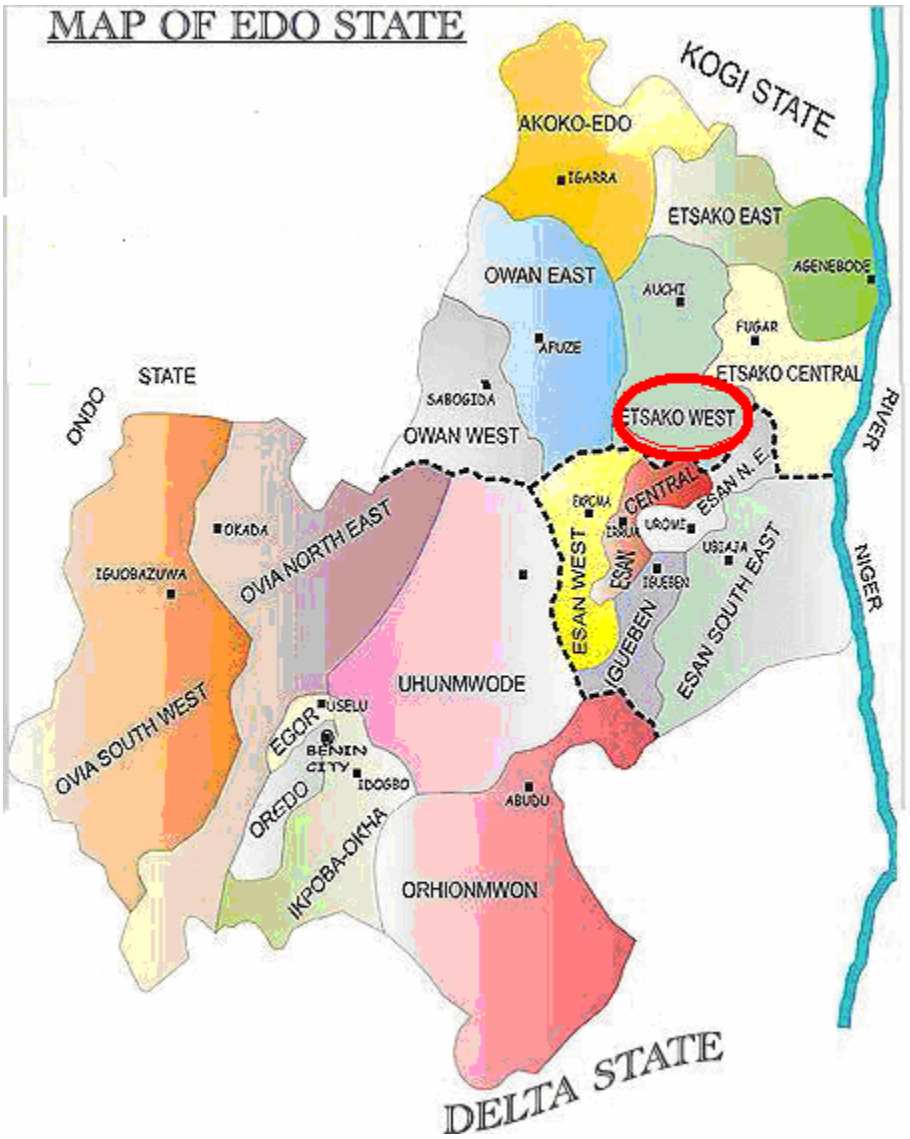


Figure 1, Map of Edo state showing the 18 local governments and Etsako-West circled, source: (ACO, 2008)

## 1.3 Irepodun sawmill

Irepodun sawmill is located at kilometer 120, along Benin-Abuja expressway Jattu. It occupies an area of approximately 30 000-50 000 square meters which include areas used for timber seasoning. Their main activity include cutting of timber logs into planks with sawed timber as its finished product. There is no actual figure on the number of timber sawed annually or weekly. The sawing of timber is dependent on the availability of electricity, timber, and the workability of the sawing machine. Irepodun have 15 employees including the manager (Epodun, 2008). Figure 2 is an example of the finished product.

Figure 2, Sawed timber from sawmill, image by author

Irepodun gets its raw material (timber) from the forest areas within and outside the local government. This timber is either purchased from the owners of the land with which it is located or obtained legally or illegally and transported. Some of the timber is obtained from government reserves, which are quite limited in the area. This is subjected to the approval of the forest reserve organization. The transported timbers are allowed to stay outside for three to four weeks so they can dry-up before they are sent to the cutting machines for cutting (Epodun, 2008). Figure 3a shows the timber from the forest been seasoned outside and allowed to dry-up naturally. Figure 3b, is the cutting machine used for the cutting of the timber to size, while figure 3c is the diesel driven truck used for the transportation of timber log from the forest to the sawmill.

Figures 3a, Seasoned timber

3b, Timber cutting machine

3c, Truck for transporting timber, images by author

The types of timber sawed include mahogany, obeche, mazonia, teak, melaina, and iroko. Irepodun produces about 40 000$m^{3,}$ which equals about 4 000 metric tons of sawdust annually and produces about 900-1200 planks daily which is the main product when there is availability of man power, electricity and good working machines. They sell a minimum of 1000 planks daily when sales are high and 70-120 planks when sales are low. There are no specific customers nor do they supply any other company. Individuals or companies come directly to purchase different type of timber planks that have been sawed to sizes for their usage (Epodun, 2008). In a situation were more quantity is needed, it is up to the manager of the company to work extensively to have the product available. Since the customers are not committed to a particular sawmill, they have the choice of buying from any place of their choice (Epodun, 2008). The operational process at Iretunde is shown in the appendix in figure 14

1.4 Iretunde sawmill

Iretunde is located in a small village called Iyakpi in South-Ibie about 11 kilometers from Irepodun and 4 kilometers from Auchi polytechnic Auchi. Iretunde performs the same operation as Irepodun, which is the cutting of timber log into planks. One major difference between them is that at Iretunde sawmill, there is a planing machine that is located just about

13 meters from the cutting machine and used for the planing of timber planks. The planing machine creates room for more customers compared to Irepodun sawmill due to the fact that most customers find it easy to buy the planks and plain them into sizes and shapes immediately for use. Figure 4, is the planing machine with two staffs on the sawmill working.

Figure 4, planing machine at Iretunde sawmill, image by author

Iretunde occupies an area of about 41 000-62 000 square meters which include areas used for timber seasoning. The number of timber sawed is dependent on the availability of electricity, timber, and the workability of the sawing machine just like the case of Irepodun sawmill. Iretunde have 23 employees including the manager and produces about 49 000$m^3$ which equals about 5 000 metric tons of sawdust annually. The cutting and transportation of timber from the forest is a similar process with Irepodun. Iretunde sawmill produces about 2000 pieces of planks daily when there is constant electricity. They have a minimum sale of 500-1000 timber planks per day and a maximum of 1 000-2000 planks (Tunde, 2008). The operational process at Iretunde is shown in the appendix in figure 14.

## 2. Methodology/Data analysis

This chapter describes the method that has been used in this thesis, how and why these methods were applied. The methods used for this thesis include the review of literature and related articles, oral interview on the management and staffs, site visitation and a prestudy of 13 companies and organization. The data analysis was based on the detailed evaluation method by Ammenberg (2004).

### 2.1 Review of previous studies

The review of previous studies was carried out in order to have an insight into the relevant field of study. In carrying out the studies, five literatures were reviewed which include Zackrisson (2003), Schebek, Buchgeister and Gernuks (2006), Ammenberg (2004), Yang and Li (2004) and Ammenberg and Hjelm (2002). These five literatures were chosen from scientific database of academic publications and journals on the internet because of their relevance to the present study. The literatures helped in identifying different methods that could be used in evaluating environmental aspects, identifying information and ideas that may be relevant to the present study and provide intellectual context that could be used in the present study, enabling the positioning of the present study in relative to other work.

### 2.2 Oral interviews on the management staff

The oral interview was conducted in form of an interactive interview on the management and staff of Irepodun and Iretunde sawmill. These involve the administration of questions related to the organizational structure, operational activities and use of resources and other relevant materials in the production process. During the interview, questions were verbally administered to the persons being interviewed and some of their responses were noted on paper while others were easily remembered. The need for the oral interview was to have information about the activities and the reaction of the staffs and other persons living around the sawmill. These helped in having relevant information on the negative effect the sawmill activities might have on the environment and the people living around it.

### 2.3 Site visitations

The site visitations were carried out before and after the oral interviews and this was to physically see the sawmill operational activities. The two different sawmills were visited individually on three different occasions before the oral interview, and three times after the oral interview. The site visitation before the oral interview was carried out in order to determine the operational activities and the extent of environmental management and impact assessment. The site visitation after the oral interview was carried out in order to certify the information obtained during the interview so as to draw a conclusion on the sawmills activities and their effects on the environment.

## 2.4 Prestudy of companies and organizations

The prestudy was conducted in order to obtain useful information on the understanding and implementation of EMS within the area of study. The interview study was conducted on randomly selected staffs of the organization and companies in order to ascertain the application and understanding of EMS within the surveyed companies and organizations. In conducting the interview, 13 different organizations were randomly selected and questions on the knowledge and implementation of EMS were asked in form of an interactive interview on some of the staff and managers of the organization.

## 2.5 Data analysis

The data analysis was carried out in order to analyze the data that were obtained during the oral interview and site visitation. Ammenberg (2004) detailed evaluation method which is based on weighting criteria's against environmental aspects to determine which of the environmental aspects is the most significant was used to evaluate the environmental aspect of the Sawmills.

In the detailed evaluation method of Ammenberg (2004) the weights between 0 and 5 are assigned to each environmental aspect with respect to their relevance to each of the criteria that the environmental aspect is been weighed against. Environmental aspect that is of great relevance to the criteria is given the weight 5. Medium relevance is given the weight 3, small relevance is given the weight 1 and no relevance is given the weight 0. The weights obtained are summed up and multiplied by the quantity of the environmental aspect to determine which of the environmental aspect is most significant.

These quantities of the environmental aspect represented with K in the table and referred to as environmental load by Zackrisson (2003) in his study are also assigned weights with great quantity having 5, medium quantity 3, small quantity 1 and no quantity 0. The sum is used to determine the significance of each environmental aspect and this is achieved by adding all the points obtained from A to J and then multiply by K. This can be expressed using and equation (A+B+C+D+E+F+G+H+I+J) * K (Ammenberg, 2004).

The values assigned to each aspect criteria is based on individual understanding of the activities of the organization that is been evaluated and the effect it has on each of the criterion that it is been weighted against. This method of adding weights conform to the literature of Zackrisson (2003) was weights are assigned to environmental aspects and multiplied by the environmental load to determine the significant environmental aspects.

The different criteria in the environmental aspect evaluation table are used to express what effect each of the environmental aspect that has been identified could have on the environment. For example, climate effects describes the effect which the environmental aspect will have on the environment, ozone layer reducing is used to express what effect the identified environmental aspect may have on the ozone layer etc. The quantity, volume and extent help to describe how much of the environmental aspect is available in quantity within the organization that is been evaluated (Ammenberg, 2004).

## 3. Theoretical Framework

Some theories have been used in the theoretical framework and are presented here. The theoretical framework is based on the theory of environmental reviews. This review has a central role in both ISO 14001 and Eco-Management and Audit Scheme (EMAS). It covers the review of legislation and other requirements, the company's environmental aspects and impacts, the in and out flow of the company, the impact of environmental issues on the choice of production methods, analysis of business potential, environmental management and analysis of some interested parties.

### 3.1 Environmental management systems

Most organizations aim at increasing their efficiency, meeting the needs of their customers and as well improve their communication with stakeholders. In order to achieve this, organizations uses modern standardization like ISO 14001 (ISO) and Eco-Management and Audit Scheme (EMAS). An Environment Management System (EMS) acts as a tool for managing the impacts of an organization's activities on the environment. It provides a structured approach to planning and implementing environment protection measures and monitors environmental performance. To develop an EMS, an organization has to assess its environmental impacts, set targets to reduce these impacts, and plan how to achieve the targets. There should be a total commitment from the top management staff to all other staffs in an organization in order for the EMS to be effective (ISO, 2008).

Some companies engage in environmental strategy in order to minimize the environmental impact of the company's processes, and making good use of available resources hence reducing environmental impacts and maximising profits (Brorson & Larsson, 2006). This thesis will only be looking at ISO 14001 and EMAS for its theoretical framework.

### 3.2 ISO 14001

International organisation of standards (ISO) has developed over 17000 International Standards on a variety of subjects and 1100 new ISO standards are published every year (ISO). The standard for an environmental management system (ISO 14001:2004) ISO 14001, which was adopted in 1996 with the intent not only of raising expectations for environmental practice worldwide but also to facilitate trade and reduce trade barriers (ISO, 2008).

The ISO 14001 series encompasses EMS, auditing, performance evaluation, labelling, life cycle assessment and product standards. The organizational evaluation of ISO 14001 is used to evaluate the firm or organization while the product and process evaluation includes labelling, life cycle assessments and environmental attributes in product standards and focuses on the evaluation and analysis of product and process characteristics (Tibor & Feldman, 1996).

In the ISO 14001 series, organisation are expected to establish and maintain a procedure to identify the environmental aspects of its activities, products and services that it can control and over which it can be expected to have an influence in order to determine those which have or can have significant impacts on the environment. The ISO 14001 standards are process and not performance standards. The standards do not mandate a particular organization's optimum

environmental performance level but describes a system to help an organization achieve its own environmental objectives (Tibor & Feldman, 1996).

## 3.3 Eco-Management Auditing Scheme (EMAS)

The Eco-Management and Audit Scheme (EMAS) is a voluntary initiative designed to improve companies' environmental performance only in the European nations and was initially established by the European Regulation 1836/93, which has been replaced by the Council Regulation 761/01. EMAS ensures that organisations improve their environmental performance on a continual basis and through publications recognise and reward those organizations that comply with the environmental regulations and encourage more and more companies and organizations to continuously improve and contribute more into the development of the environment (EMAS, 2008).

EMAS requires that a company should identify the direct and indirect environmental aspects of its activities, products or services, arrive at a list of significant environmental aspects, based upon the relative environmental impact of each environmental aspect, identify the environmental aspects that can be controlled or over which you have influence and finally, develop a procedure to keep this information up-to-date (EMAS, 2008). The environmental aspects include the element of an organization's activities, products or services that can interact with the environment and as such create significant impact or problems on the natural environment.

EMAS been a standard used only in the European Nations, it is not a worldwide accepted standard like the ISO standards. The policies applications and implementation of EMAS is only restricted to European countries. EMAS is a European Union council regulation (No.1836/93), requiring implementation in all European Union Member States and as such it implies only to European nations. This thesis has only mentioned EMAS as an environmental management system but it has no relevance to the area of study and as such will not be further discussed or used. This is because the area of study for this thesis is located in Nigeria which is a country in Africa and as such is not guided with the EMAS regulations.

## 3.4 Previous studies

Until recently many researchers have shown interest in the field of environmental management systems and the evaluation of significant environmental aspects. The review of different literatures on Environmental management systems forms an important part in a thesis where its purpose is to provide the background to and justification for the research undertaken and looking at what work has already been done in relation to the research area for this thesis. Some of their findings and suggestions are reviewed here.

Schebek et al. (2006) carried out an assessment for Volkswagen in Emden in Germany to determine its environmental impacts and environmental targets within environmental management system (EMS). The main aim of their research was to develop a systematic verifiable and reproducible approach to comply with the revised EMAS scheme.

The EMAS scheme according to Schebek et al. (2006) only assigns a central role within the environmental management systems and as such does not provide a method of assessing the environmental aspects with regards to their environment. The EMAS guideline only outlines

the significant environmental targets. The EMAS comprehensive list gives the necessary environmental aspects to be considered which includes energy and material-related aspects such as energy requirements or emissions to air or water as well as aspects such as the risk of environmental accidents or visual appearance (Schebek et al. 2006). Schebek et al. (2006) identified in there researches the quantitative assessment of impacts and the possible ways with which quantitative assessment of environmental impact can be carried out.

Based on the conclusion of their research, the Ecopoint method of environmental impact assessment was selected as the best method for the evaluation of the Volkswagen production site. This method of environmental impact assessment is based on a single score and uses a standardized method of identification and assessing the environmental effects. This method also has pitfalls as the Ecopoint method is associated to Switzerland and as such it is not globally accepted. The second pitfall in the method is that it is based on political targets and legal thresholds, which are only partly based on scientific knowledge.

The review to determine the environmental aspects when manufacturing products mainly out of metals and or polymer in their production phase was carried out by Zackrisson (2003). The research was aimed at offering evidence that a production phase focus in environmental management is justified at least environmentally and to demonstrate a method for identifying and evaluating environmental aspects associated with metals and or polymer in their production phase

Zackrisson (2003) in his research identified the need of first determining the initial environmental review by which a deeper understanding is needed about an organization environmental impact before an environmental management system is developed. In his research, he carried out an environmental review of 11 companies in Sweden using the Industrial research and development corporation (IVF) template for initial environmental review to investigate the significance and ranking of environmental aspects from a particular manufacturing sub-sector that can be drawn from the available date. In his research, data were collected for the analysis using the ISO14031 standard. The ISO 14031 according to Zackrisson recommends that not only inputs and outputs should be considered for an environmental review instead management areas should also be included. Zackrisson included legal and other requirements, accidents, raw materials and compounds, chemicals and chemical products, energy consumption, waste and recycling, water and effluent emissions to air and water, transportation, local environmental impact as well as products in its data analysis.

As a result of the difficulties to compare different types of environmental impacts, Zackrisson (2003) converted all the identified impacts to the same units by weighting or evaluation method. This was to enable him determine which of the impacts is most significant in a life cycle assessment. The use of the template for environmental review, which uses Swedish environmental priority strategies in product design value at each environment load unit, was used for the calculation. The method used by Zackrisson (2003) in his analysis uses the life cycle assessment which involves the multiplication of an emission with the environmental load units (ELU) to compare and rank the environmental aspects quantitatively in order to identify significant environmental aspects.

By the use of this method, it was possible to achieve an approximate ranking of the companies' environmental impacts. As a means of certification of the results obtained, Zackrisson used the Eco-indicator 99 which is a method of calculation for weighting

environmental impact by including the ecosystem, human health and scarcity of raw materials in addition with the EPS-2000 which uses the end-point approach and monetary weighting for assessment and the EPS-1996 were used to verify the results.

From his findings, it was observed that using both Eco-indicator 99 and EPS 2000 and EPS 1996, gives the same ranking results for the 11 companies investigated. The largest environmental impacts normally can be associated with the use of disposed phase of products rather than the manufacturing phase. In his conclusion, it is possible to do ranking of environmental aspects using environmental load. Zackrisson (2003) observed some limitations in the use of LCA weighting methods like EPS and Eco-Indicator. He suggested that the user should usually show sense of understanding of the weighting method because it is usually very difficult to know which environmental impact a specific index cover.

Ammenberg and Hjelm (2002) carried out a research on the relationship between environmental management systems and continual environmental performance improvement. From there research, they realised that more than 30 000 companies are using standardised environmental management systems according to the ISO14001 or EMAS as a guarantee for good environmental performance. Ammenberg and Hjelm (2002) based their research on a comparison of the environmental review of small enterprises before and after their EMS implementation and this were aimed at showing how environmental performance of their firms is developed. Ammenberg and Hjelm choose to study environmental reviews and how it involves flow of material and energy. Ammenberg and Hjelm carried out their study on Hackefors joint EMS, which comprises of 26 small enterprises.

Ammenberg and Hjelm (2002) used a six step method in evaluating the connection between environmental management systems and continual improvement. In the first step, materials in each environmental review were collected and these include energy, water, goods, waste and by-products. The second step was the decision on the functional unit which served as an extent of measurement of the extent of operational number of pollution produced annually. The third step was the use of Eco-efficiency to calculate environmental performance. In this calculation, positive output for each company was divided by a measure linked to environmental impact with an increased rate indicating increased efficiency. The fourth step involves the comparison of the eco-efficiency.

The fifth step was a comparison using importance factor ranging between 1000, 100, and 10. This numbers were used to represent the importance of importance of the environmental aspects. The sixth and final step was to determine the total environmental score. This was achieved by multiplying and comparing factors of importance for each environmental aspect accounted for. Ammenberg and Hjelm (2002) in their research realised that in-spite of the fact that organizations implement environmental management systems such as ISO14001; it is not a guarantee for continual improvement but the application of environmental management systems lead to a reduction in environmental aspects.

Yang and Li (2004) carried out an environmental management planning for Datong coal Gasification Corporation (DCGC) in the Shanxi province of China in order to check for compliance. Datong Gasification Corporation produces and distributes ammonia, sulphur, benzol, and sulphate. Yang et al, (2004) carried out a cleaner production program using the ISO14001 and carried out an environmental management planning collectively with the environmental protection department of Datong Corporation using a monitoring program

which helps to determine the extent of compliance with all applicable environmental management and standards.

Yang and Li (2004) in their research carried out an environmental aspect evaluation of Datong coal Gasification Corporation in consultation with the environmental management consultative commission (EMCC) of Datong Corporation and divided the company into five different units comprising of coal handling unit, coke ovens, Gas purification plant, wastewater treatment plant and utility section of the coking factory. In identifying the environmental impacts, five small groups of EMCC plus DCGC staff from each area and other specialization helped to identify the different impacts their area might cause on the environment.

Yang and Li (2004) followed the ISO14004 planning process, which involves the selection of activities, products or services, identifying environmental aspects of the activities, identifying environmental impacts and evaluating the significant environmental impacts. After the identification of the Corporations activities, the impact identification was carried out using the DCGC environmental aspect and impact register plus risk ranking. The five small groups of EMCC and other specialist of DCGC identified 66 environmental effects. These environmental effects were evaluated based on physical and business issues. This helped in identifying which of the environmental effect is most significant.

The factory was found to have significant environmental impact on areas like air emission, noise emission, solid waste and liquid waste. The use of monitoring program has helped in identifying the significant environmental impact of Datong Corporation and the extent of compliance with all applicable environmental management and standards. In conclusion of their research, they realised that Datong Corporation factories process methods and equipments are made without any focus on environmental impacts.

Ammenberg (2004) identified three possible methods of evaluating environmental aspects. These methods include the easy evaluation method, comparison in pair's evaluation method and the detailed evaluation method. The three methods of environmental aspects evaluation identified according to Ammenberg gives an accurate result when properly used. The usability of any of the three methods is based on individual understanding.

The easy method of environmental aspect evaluation is based on three criteria's, which includes environmental impact, law demanded and the interest demand. The environmental aspects are judged according to this criterions and a particular score between 1 and 3 is used for the weighting. The total weights obtained for each environmental aspect are summed up in order to know which of the environmental aspect has the most significant impact. One disadvantage about this method is that few criteria are used in the evaluation of the environmental aspect and as such there might be some criteria's with which an aspect is most significant but not judge with.

The comparison in pair's method of environmental aspect evaluation as described by Ammenberg is based on comparing the environmental aspects against each other's in order of importance. The application of this method depends strongly on the understanding of the user and the organization that its environmental aspects are been evaluated. The detailed evaluation method is a more complex method of environmental aspect evaluation.

The method is similar to that of the easy evaluation method as described by Ammenberg. In the detailed evaluation method, weights are added to 11 criteria's. These criteria's are used to judge the relevance of each environmental aspect and the score between 0 and 5 is used to weigh the importance of the aspects to each criteria. The total weight for each aspect is summed together and these are compared to other total weights obtained from other aspects to determine which of the environmental aspect is most significant. The usability of this method is also dependent on the understanding of the user and the type of organization that its environmental aspects are been evaluated.

## 4. Environmental review of the sawmill

### 4.1 Organization of the sawmill

The operation of both Iretunde and Irepodun is well structured from the management to the staff and this is aimed at enhancing efficiency and productivity. In the operational process, each staff is assigned to a specific task but collectively they work together to attain a single goal which is efficiency and high productivity. The organization at Irepodun is divided into seven sections which include the management team comprising of the manager and his wife that oversees the affairs of the sawmill, two truck drivers for conveying timber from the forest to the sawmill, four staff responsible for the loading and unloading of the timber to the trucks using manual jack, two staff for packing of sawed timber, three staffs responsible for the felling of timber, one staff responsible for the operating of the cutting machine, cleaning and sharpening of machine (saw doctors) and one staff responsible for sales. All operations are carried out independently (Epodun, 2008). Figure 5 is the organizational structure of Irepodun sawmill. The management team is situated at the middle of the image because it acts as the general overseer of the operational activities.

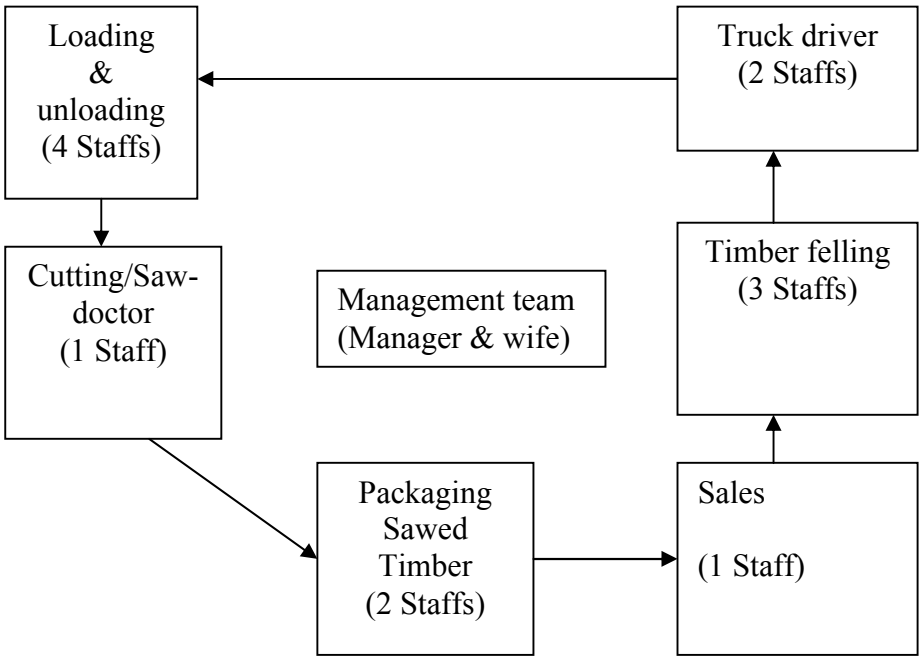


Figure 5, Organizational structure of Irepodun, image by author

The organizational structure of Iretunde is similar to that of Irepodun only that they have an extra operation timber planning. As a result of the size of the sawmill, they assign more staff to different units. The management team comprises of the manager, his wife, and three persons who are responsible for sales and monitoring of the planing process, four staff for timber felling, two staffs for machine blade sharpening, five truck drivers, three staff for packing and stocking sawed timber, and three staffs responsible for the loading and unloading of the timber to the trucks using manual jack, and one staff for operating the cutting machine

(Tunde, 2008). Figure 6 is the organizational structure of Iretunde sawmill. The general operational process of both sawmill is shown in figure 14 on the appendix.

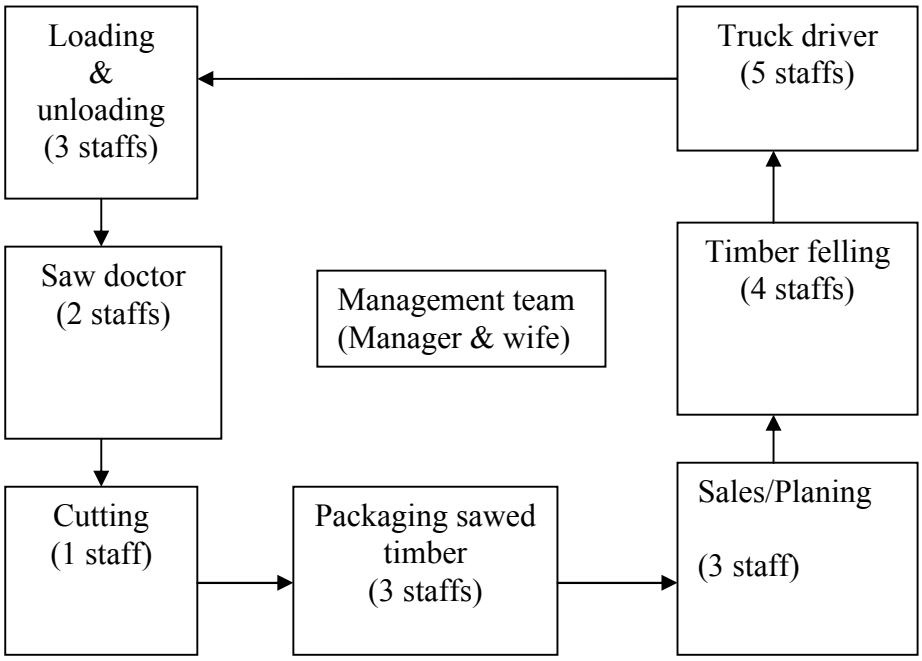


Figure 6, Organizational structure of Iretunde, image by author

## 4.2 Environmental work today

The management of both Iretunde and Irepodun have their own personal environmental principles that comply with the sawmill's environmental and social responsibility in-spite they are not registered under any standard nor subjected to environmental auditing and evaluation. They set their own environmental principles, which provide the basis for its overall environmental work. The environmental work is aimed at providing sustainable development creating harmony between the environment and the nature, and the people living within and around the area.

## 4.3 Legal and other requirements

Legal and other requirements is one of the elements of an EMS which requires each facility to identify and evaluate all the applicable legal and other requirements to which the organization subscribes that apply to the environmental aspects of any activity, operation, service, or process of the facility (ISO, 2008). It is important to determine all the activities in the organization, in addition to the environmental programs, that must abide by environmental legal and other requirements which can be inform of governmental policies or organizational policies. The Federal laws, executive orders, directives, and instructions provide basic guidance to organizations. It is the responsibility of each facility to identify all the applicable legal and other requirements that impact any environmental aspect of any activity, operation, service, or process included in the EMS (ISO, 2008)

The Federal Government of Nigeria has promulgated different laws and regulations to safeguard the environment. These laws include the Federal environmental protection agency Act of 1988(FEPA Act) which ensures the industries prevent and manage solid and hazardous wastes, the Environmental impact assessment act of 1992 (EIA act), harmful waste act of 1998 etc. These laws are meant to guide individuals, companies and organizations in order to ensure that their activities are not harmful to the environment. In Nigeria, each state also has the freedom to create their environmental laws (Oghogho & Bukola, 2006).

Irepodun and Iretunde are not registered under any environmental law. They control their activities with a primary aim of maximizing profit. The forest protection agency is the only functional agency that visits sawmills to check for unregistered log transported to sawmill illegally. Most staffs of the forest agency in most cases only visit to collect stipends from the managers without carrying out their duties (Epodun & Tunde, 2008).

4.4 Inflow and outflow

Iretunde and Irepodun depend on a lot of resources, which enables it to function effectively. These resources and the necessary tools needed to transform the raw materials into finished products make up the sawmill's inflow while the finished products as well as the different emissions that occur during the production process make up the out flow. In order to attain a sustainable environment, it is advisable to ensure that the amount of emissions is minimal in order not to be of negative influence to the environment and nature.

The inflow of both sawmills include timber which is the raw material, machines used for the cutting of the timber, transportation of timber to and out of the sawmill, chemicals used for the cleaning and running of the machines, the manpower needed to carry out the different process as well as energy and diesel for generating electricity and running of the diesel driven trucks.

The outflow is divided into three sections, which include emission to ground, emission to air and the products and waste. The major product that forms the outflow is the sawed timber. Other products include sawdust, off cuts etc. There is a need to ensure that there is a balance between the inflow and outflow of resources in order to reduce the amount of environmental impacts that could affect the environment. The inflow and outflow of both sawmills are the same. Figure 7 is a sketch describing the inflow and outflow at both Iretunde and Irepodun sawmill.

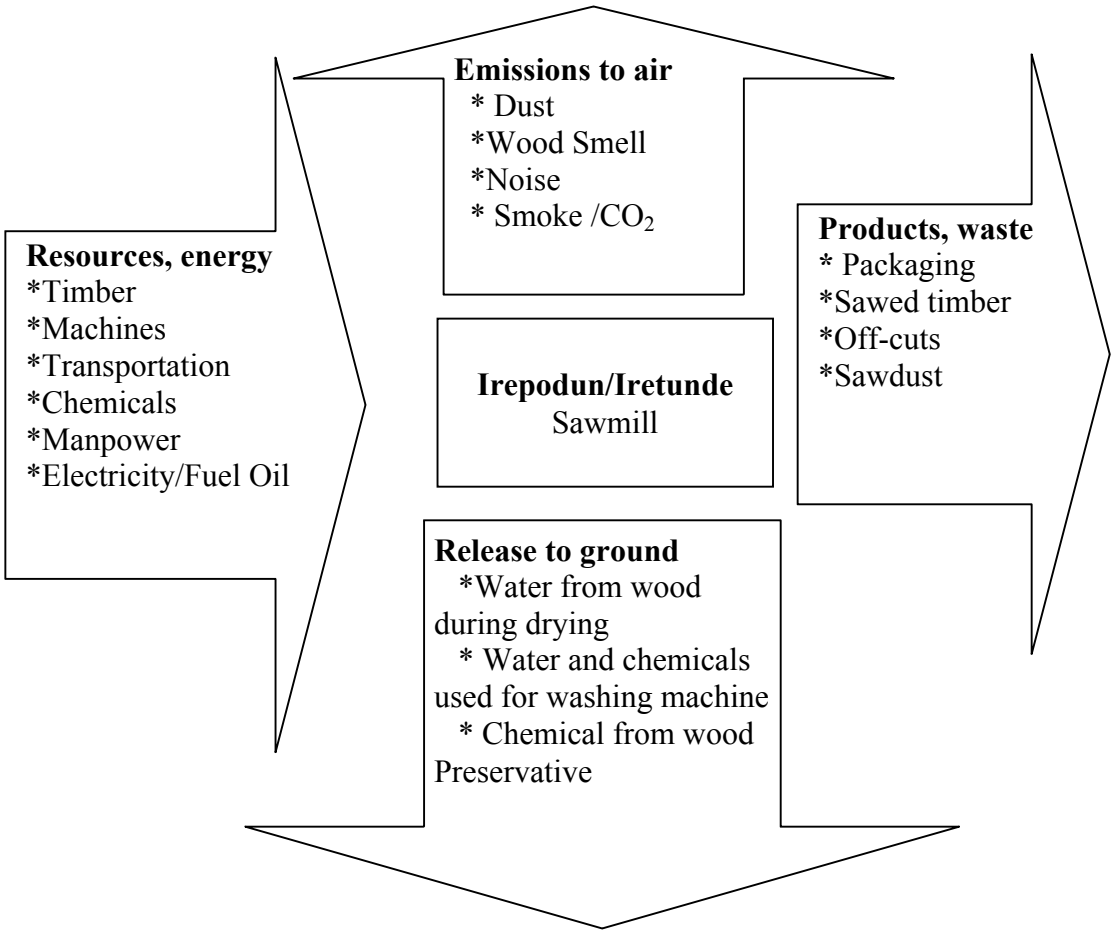


Figure 7, Inflow and outflow of the sawmills, source: Epodun & Tunde, 2008

## 4.5 Analysis of the inflow and outflow

### 4.5.1 Resources & energy

Resources are assets that are available and used for the operational activities. They include the entrepreneur skills that are used in producing goods and services, people, equipment and other things needed to plan, implement and evaluate the production process. All the activities that are carried out in the operation and production process make use of energy. This includes the operating of the trucks and electricity generation. Both Iretunde and Irepodun sawmill uses approximately 1GWh of electricity per annul (Epodun & Tunde, 2008). One limitation about the amount of energy used is that there is no exact of quantifying the amount of energy used by both sawmills. Irepodun uses about $39m^3$ of diesel for operating its trucks and other machines while Iretunde uses about $51m^3$ of diesel for its trucks and other machine operation (Epodun & Tunde, 2008).

Timber

Timber is the primary resource that is used in both sawmills. When there is no timber in supply, the company will not be able to produce. Timber used at Irepodun and Iretunde is obtained from the large and small forests within and outside the local government. The exploitation of forest tress poses a threat to the forest and the environment as it affects biodiversity, causes climate change, exposes it to erosion etc. As earlier mentioned, the timber logs are transported were they are allowed to season before they are sawed into planks using the cutting machine as shown in figure 3b above. Figure 8 shows images of timber deposited

and allowed to season before been sawed. This timber is mahogany, obeche, mazonia, teak, melaina, and iroko.

Figure 8, Mahogany, obeche, mazonia, teak, melaina, and iroko timber yet to be sawed, image by author

Machines

There are three functional machines at Iretunde sawmill which include the cutting machine, blades sharpening machine and wood planing machine. This is similar to that of Iretunde sawmill but they do not engage in wood planing and as such do not have a wood-planing machine. The cutting machine is used for the cutting of timber into different sizes between 50-150mm thick and at least 200mm wide. The blade-sharpening machine as shown in figure 9 is used in both sawmills for the sharpening of the cutting machine blades and other tools (Epodun & Tunde, 2008). The Planing machine is only available at Iretunde sawmill and it is used for the planing of timber into different sizes according to customer request (Tunde, 2008).

Figure 9, blades sharpening machine, image by author

Transportation

The movement of timber, staffs and finished product by customers within and outside the sawmill is carried out using different land transportation means. Within the site at Irepodun sawmill, there are two diesel driven trucks used mainly for the transportation of timber log from the forest, six vehicles belonging to other staffs. The customers do the transportation of the finished product and the type of transportation used depends on the volume of sawed timber that was purchased (Epodun, 2008). Similar transportation process is carried out at Iretunde sawmill only that as a result of the size, there are more transportation. The sawmill has five diesel driven trucks which are mainly used for timber log transportation from the forest and eleven vehicles belonging to the staffs. Just like it is at Irepodun sawmill, transportation of sawed timber that has been purchased are carried out by the customers (Tunde, 2008).

Chemicals

Iretunde and Irepodun use some chemicals in the cleaning of their machine cutters and profilers. They also use some other chemicals in the servicing of its machines, and diesel as fuel for operating its trucks and other energy generating plants. These chemicals are used in quite a small quantity. Irepodun and Iretunde use Chromated Copper Arsenate as wood preservative which is harmful to both humans and the environment. The list of the different chemicals and there usage is shown on table 1 below. Both Irepodun and Iretunde sawmill use similar chemicals in their daily activities but the amount of chemicals used annually as shown in the table were approximated values for both sawmills as there are no specific record of the amount of chemicals used. These chemicals are usually purchased and controlled by the management of the sawmill and the individual that is responsible for the usage of the chemical does so under the supervision of the management team (Epodun &Tunde, 2008).

There is no formal training for staffs handling the chemicals in both sawmill. The management team stores all the needed chemicals in a safe store and provide them when needed for use. The manager supervises the usage of the chemical. Some chemicals like diesel and motor oil are not stored as they are purchased directly from servicing stations (Epodun &Tunde, 2008)

Table 1, Chemical list for Irepodun/Iretunde sawmill, source: Tunde & Epodun, 2008

| **Name on substance** | **Area for use** | **Use 2007** | **Storage amounts** |
|---|---|---|---|
| Other Chemicals | Testing for change to less hazardous substances | 24 liters | 30 liters |
| Diesel | Fuel | 40000 liters | 50000 liters |
| Lubricating oil | Lubrication | 100 liters | 180 liters |
| Binol Cool 311 | Cutting oil in milling | 194 liters | 200 liters |
| Magnuspray 206 | Cleaning of mills/cutters(”knives”) | 30 liters | 30 liters |
| Hydraulic oil | Hydraulic oil | 301 liters | 400 liters |
| Motor oil | Motor oil/cutting and planing machine | 248 liters | 250 liters |
| Chromated Copper Arsenate (CCA) | Timber preservative | 17 liters | 20 liters |

Manpower

Manpower is referred as the total supply of persons available and fitted for service. These persons are indexed by requirements including jobs lists, slots, or billets characterized by descriptions of the required people to fill them. In both the Irepodun and Iretunde, the number of manpower working for the effectiveness and productivity ranges from the management team, to all other staffs. Iretunde sawmill uses a total of 21 persons performing different operational roles, while Irepodun uses 15 persons in its operations.

4.5.2 Emissions to air

Emissions to air can be seen as part of the output from Iretunde and Irepodun sawmills. These emissions are depended on the amount of resources used in the production process and the industrial processes including large combustion plants used for generating energy, metals, minerals, chemicals for washing and cleaning of machines, wood preservatives and saw dust combustion.

Dust

Dust is one substance that is emitted to air at both sawmill in large quantity. The rate of dust particles emitted to air from Iretunde sawmill is considerably higher than that of Irepodun sawmill. This is because of the large amount of production at Iretunde sawmill and the availability of a planing machine attached to the sawmill. The wood dust from sawed timber in both sawmills are accumulated in an open area and as such allowed to be blown around by wind or washed away by water. This creates a lot of dust particle within and outside and hence creating a bad environment.

Another reason for high dust emission to air is as a result of timber sawing in an open area and as such there is no control of the dust as it is allowed to freely get into the air. Figure 10a is a picture of dust particles from the sawing machine while figure 10b is the wood dust particles from the planing machine at Iretunde sawmill.

Figure 10a, Dust from sawing machine

Figure 10b, Dust from planing machine, images by author

A lot of smokes are emitted to air from the burning of wood and sawed dust in both sawmills. Wood and wood dust burning contributes smoke to the atmosphere and this smoke produces dust and soot inform of tiny particles. When wood burns, gases and fine particles produced which are microscopic. These microscopic particles can get into eyes and respiratory system, where they can cause health problems such as burning eyes, runny nose, and illnesses. Smokes contribute about 80% of air pollution and affect the environment we live in. Smoke contains carbon monoxide, sulfur oxides, nitrogen oxides and volatile organic compound (Pechan, 2003)

Both sawmill burn some of their wood waste and sawed dust, while some are collected by villagers for wood fire. The burning of the sawed dust emits smoke daily into the atmosphere and as well produce ash that can be distributed by wind, which pollutes the air hence creating a bad environment. Figure 11 is a picture of burnt sawed dust. The ashes that are remains from the burnt sawed dust are washed away by water, buried underneath the earth surface or blown around by wind.

Figure 11, Ash of burnt wood and sawed dust. Image by author

Wood smell

There is a pleasant smell coming from the timber log. This smell is a natural smell of the timber and at times mixed with the smell of the chemicals used in preserving the timber log or spraying the sawed timber. The spraying of the sawed timber is to differentiate the purchased timber from the un-purchased ones. This smell is emitted to the environment in small quantity and has no effect on the environment. As a result of the hazardous chemicals used as preservatives for the timber, when inhaled in high quantity can be harmful to humans and the environment and as such should be used in small quantity.

Noise

These are emission that comes from the different machines that are used in the processing of the timbers. The noise that comes from the machines is harmful to humans as it causes distractions and discomfort to humans. This noise emitted to air is in a large quantity as most of the machines used for the production process are used out door in an open area. There have been some complains of noise disturbance by persons living close to the sawmills (Tunde & Epodun, 2008).

$CO_2$

The carbon dioxide emitted to air build up in the atmosphere and is probably the main causes of global warming. Energy supply is the greatest contributor of $CO_2$ with transportation, industry, etc contributing about 20% of the total $CO_2$ that is emitted to the atmosphere (Brorson & Larsson, 2006). The $CO_2$ that is emitted to air at both sawmills comes from the exhaust of the trucks and other transportation machines that uses diesel or fuel coming in and out of Irepodun and Iretunde. The amount of $CO_2$ emissions from both sawmills is in a limited quantity but can affect the environment significantly if in excess.

4.5.3 Releases to ground

Water from wood during drying

The timber log that is supplied usually contains moisture. These timbers are dried up in an open air before they are sawed. When the timber is been dried in an open area, some of the moisture in the timber is evaporated into air while some runs freely into the earth surface. Due to the chemicals that are used as preservatives for the timber logs that are usually added when the timber are left outside to dry.

The water released to ground contains some chemicals, which might be harmful to the environment. Chemicals like Arsenic (As) and Chromium (Cr) used as wood preservatives which are usually added to the timber when allowed to season to prevent termites and other wood infections are hazardous chemicals. The effect of this chemicals on the water released to ground cannot be ascertained as there are no measurements to certify the effect. There is a need to ensure that the amount of Chromated copper Arsenate used as wood preservative be reduced considerably in order to reduce the possible effect on the environment (Tunde & Epodun, 2008).

Water and chemicals used for washing machine

Some chemicals like water, lubricating oil and magnusspray 206 are used in the washing of the machines. These chemicals are used directly and in some cases, alongside with water. This water and chemicals are allowed to run freely into the ground. This is the situation at both sawmills as chemicals and other liquid used in washing and cleaning of machines and tools are allowed to run freely into the ground.

4.5.4 Products & waste

Products and packaging

The final product of both sawmills is the sawed timber. These sawed timbers are arranged according to their different types for easy identification by customers. There are no special materials used for the packaging of the finished products. The products are arranged in blocks of 100 planks under a small open tent as shown in figure 12. Customers come and select whatever choice of planks they need, pay for them and provide transportation to take the purchased product to their place of need (Tunde & Epodun, 2008).

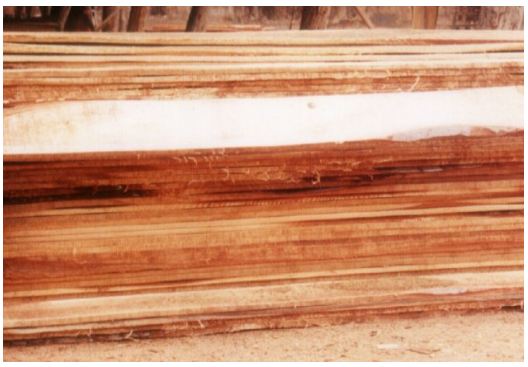

Figure12, ready sawed timber ready for sales, image by author

Waste

Off cuts and sawdust

During the process of production, there are some off-cuts of timber which are about 130 $m^3$ annually, and about 40 000 $m^3$- approximately 4000 metric tons of sawdust produced at Irepodun sawmill. The off cuts and sawdust are collected by individuals for the purpose of firewood while some of the off-cuts are sold to local community members who may need them for personal usage. Other off-cuts and sawdust are burnt if not collected, sold or used. Iretunde sawmill produces about 215 $m^3$ annually of off-cuts and 49000 $m^3$- approximately 5000 metric tons of sawdust. The process of handling both the off-cuts and sawdust is similar to both sawmills (Tunde & Epodun, 2008). Figure 13 is a picture of some off-cuts from the sawmills

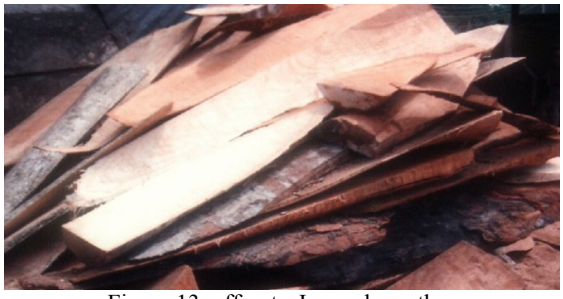

Figure 13, off-cuts. Image by author

4.6 Environmental aspect evaluation model

The environmental model used in this thesis is the detailed method of environmental aspect evaluation by Ammenberg (2004). This method as described in the methodology adds weights to environmental aspects and weighs them against different environmental criteria which includes climate change, ozone layer reduction, acidification, photochemical smog, harmful air emissions to health and noise, effects due to organic pollutants, introduction and spreading of foreign organisms, impoverishing of nature types, biotopes, spices etc, ionization, quality, volume and extent. These environmental criteria have been briefly described in the list of abbreviations and terms. Table 2 and 3 shows the results obtained from the environmental aspect evaluation of both sawmill.

Table 2, Environmental aspect evaluation of Irepodun sawmill, source: Ammenberg (2004)

| **Environmental aspect** | A. Climate effects | B. Ozone layer reducing | C. Acidification | D. Photochemical smog | E. Harmful air emissions to health and noise | F. Effects due to metals | G. Effects due to organic pollutants | H. Introduction and spreading of foreign organisms | I. Impoverishing of nature types, biotopes, spices etc | J. Ionisation | K. Quantity, volume, extent | ***Sum*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transportation | 5 | 3 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 39 |
| Electricity | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 15 |
| Emission to Air | 5 | 3 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 5 | 75 |
| Emission to ground | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 4 |
| Emission to Water | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 2 |
| Raw material | 5 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 5 | 55 |
| Packaging | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| Waste | 3 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 3 | 24 |
| Use of chemicals | 0 | 1 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 6 |

Table 3, Environmental aspect evaluation of Iretunde sawmill, source: Ammenberg (2004)

| **Environmental aspect** | A. Climate effects | B. Ozone layer reducing | C. Acidification | D. Photochemical smog | E. Harmful air emissions to health and noise | F. Effects due to metals | G. Effects due to organic pollutants | H. Introduction and spreading of foreign organisms | I. Impoverishing of nature types, biotopes, spices etc | J. Ionisation | K. Quantity, volume, extent | ***Sum*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transportation | 5 | 3 | 1 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 45 |
| Electricity | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 15 |
| Emission to Air | 5 | 3 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 5 | 80 |
| Emission to ground | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 5 |
| Emission to Water | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 2 |
| Raw material | 5 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 5 | 55 |
| Packaging | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| Waste | 5 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 3 | 30 |
| Use of chemicals | 0 | 1 | 3 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 6 |

In the environmental aspect evaluation model shown in table 2 and 3, each environmental aspect based on the effect each of the environmental aspect been evaluated has on the each criteria. The environmental criteria are briefly described in the list of abbreviations and terms.

## 5. Result

During the course of this thesis, different results were obtained at the different sections of the analysis of both sawmills and the final results obtained are presented in this chapter.

### 5.1 Environmental aspect analysis

During the environmental aspect analysis of both sawmills using the detailed evaluation method of Ammenberg (2004), different results were obtained.

#### 5.1.1 Transportation

Transportation is a major contributor to air pollution, with motor vehicles accounting for a large share of nearly all the major pollutants found in the atmosphere. Transportation emits carbon dioxide, nitrogen dioxide, particles, lead, benzene etc. These emissions affect the environment and as such create environmental impact (Brorson & Larsson, 2006). The effect of transportation is noticeable in both sawmills based on the environmental aspect evaluation as shown in table 2 and 3.

Iretunde has more transportation effect on the environment compared to Irepodun sawmill. This can be seen in the environmental aspect evaluation with Iretunde having 45 points from its transportation evaluation and Irepodun 39 points as shown in table 2 and 3. As earlier mentioned, Iretunde sawmill has 5 trucks and a total of 23 staffs while Irepodun has 2 trucks and 15 staffs. The high number of vehicles at Iretunde sawmill accounted for the high transportation effect due to $CO_2$ emissions on the environment. Iretunde also engages in wood planing which helps to attract more customers and hence increases inflow and outflow of transportation.

#### 5.1.2 Electricity

Electricity generation is the leading cause of industrial air pollution in some developed part of the world today. Most of our electricity comes from coal and other fossil fuels power plants. Producing energy from these resources takes a severe toll on our environment, polluting our air, land and water. Electricity consumption in both sawmills are classified has having the same environmental effect. This is because both sawmill get their source of electricity from one place and they both depend on electricity as the only means of operating their machines. The environmental effect caused by electricity in both sawmill is minimal.

#### 5.1.3 Emission to Air

Air pollution is a result of when harmful substances are allowed into the air. The main pollutants affecting the air are carbon monoxide, nitrogen dioxide, sulphur dioxide produced from the combustion or car engines and energy generating plants, lead, ground level ozone, small particles from wood and dust burning etc. Air pollution can affect the climate, depletion of the ozone layer; has regional effect as well as local effect, cause acidification, etc (Brorson & Larsson, 2006).

From the evaluation of the environmental aspects, emission to air is the most significant environmental aspect in both sawmills. This is characterized by many factors including non-control of dust particles to the air, emission from transportation, emission due to wood and sawdust burning etc.

### 5.1.4 Emission to ground

The discharge to ground can include process water, cleaning water from the cleaning of equipments, spillages, leaks, storm water, sanitary wastewater etc. The use of non degradable compounds, chronically toxic compounds as well as compounds that are bio-accumulating in living organisms could cause environmental hazards when allowed to run freely to water (Brorson & Larsson, 2006).

There is a noticeable emission to ground in both sawmills. This is as a result of the non control of the chemicals and other substances used for the washing and cleaning of machines and other tools in the sawmills as well as the chemical used as wood preservatives that contains chemicals like Cr and As that is harmful to human and the environment. The water and chemicals are allowed to run freely to the ground and this might damage the ground and in some cases cause degrading of the soil.

### 5.1.5 Emission to Water

The discharge to water can include process water, cleaning water from the cleaning of equipments, spillages, leaks, storm water, sanitary wastewater etc. The use of non degradable compounds, chronically toxic compounds as well as compounds that are bio-accumulating in living organisms could cause environmental hazards when allowed to run freely to water (Brorson & Larsson, 2006). There is no surface water around both sawmills and as such there are no significant effects of emission to water. The groundwater water can be affected by the release of chemical from the wood preservatives and other chemical substances used in the sawmills. The amount of ground water that might be affected was not determined in this thesis but there is a possibility of ground water contamination due to the use of chromated copper Arsenate (CCA) as wood preservative.

### 5.1.6 Raw material

The major raw material used in both sawmill is timber. From the result of the environmental aspect of both sawmill, the use of raw material by Irepodun sawmill is the second most significant environmental aspect. The use of raw material is the third most significant environmental aspect in Iretunde sawmill.

### 5.1.7 Packaging

Most packaging is not harmful to the environment in terms of toxicity. However, because many common packaging materials do not degrade easily once they are discarded, they keep on adding to the large volume of solid waste that we produce. If packaging can decompose quickly it will be recycled naturally. These include transportation packaging, secondary packaging and sales packaging (Brorson & Larsson, 2006). In the sawmills, there are no

special materials for the packaging of finished products and as such there are no much significant environmental impacts associated with packaging.

### 5.1.8 Waste

Waste is regarded as unused resources. The handling of waste is regarded as one of the most pressing societal problem. The noticeable waste at both sawmills are wood off-cuts and sawdust. There is a poor management of waste at both sawmill. The handling of the wood waste and sawdust through burning contributes significantly to environmental effect because of the emission of smoke, particles and other substances. As a means of reducing the environmental effect caused by this waste, the wood waste can be sold for the purpose of firewood and they can also be used as a means of energy generation.

### 5.1.9 Use of chemicals

Everything in the world is made of chemicals, whether naturally occurring or synthesized by humans. Most of the ways we use chemicals are beneficial, but we sometimes use them in ways that cause harm and as such become a negative influence to the environment. Chemicals are used in different units of the sawmills for machine washing, wood preservatives, engine lubrications etc.

The volume of chemicals used in both sawmill are at the minimal. In-spite of the fact that there is no special care in the handling of the chemicals in both sawmills, the greatest advantage is that very harmful chemicals are not used in high quantity and as such there are no grate environmental effect caused by the use of chemicals by the sawmills.

## 5.2 Significant environmental aspect

Both sawmills have environmental aspects with some of the aspects been more significant than the others. The detailed environmental aspect evaluation method of Ammenberg (2004) was used in the evaluation of the environmental aspect. From the result obtained in the environmental aspect evaluation of both sawmills as shown in table 2 and 3, emission to air is the most significant environmental aspect in both sawmills and the use of raw materials been the second most significant environmental aspect. The lowest environmental aspect in both Sawmills is produced from packaging.

## 5.3 ISO14001 on Irepodun and Iretunde

Both the Irepodun and Iretunde sawmills are not certified according to any environmental standards but it has the liability and duty to control their activities and ensure that the environment is free of hazardous substances the will be of negative impact to the environment. The entire staffs and management team of both sawmills usually achieve this as they work collectively together to ensure that operational activities create less environmental impacts. Both sawmills have no idea or has even heard about the ISO14001 standard neither have they used any means of standard in their operational activities. Irepodun and Iretunde sawmill carry out their operations and organizational activities based on the personal concept and instructions by the managers.

## 5.4 Prestudy of companies and organizations

On a prestudy carried out on thirteen different companies and organizations within Etsako-West in order to determine their involvement and application of environmental management systems. Among the companies and organizations surveyed include a polytechnic, four bottled water producing company, three cassava processing plant, four marble processing companies at Ikpeshi and an electronics sales shop. The result shows that only the polytechnic which is a higher institution of learning has knowledge about EMS and none of the companies or organization including the polytechnic has established an environmental management system. These companies and organizations only carry out review on their production and profit achieved without emphasis on the effect of its activities on the environment.

## 6. Discussion

This thesis examines Irepodun and Iretunde sawmills in Etsako-West, Edo state Nigeria to determine the structure of both sawmills, the environmental management system that has been used or implemented in this sawmills and the determination of the activities and environmental aspects and significant environmental impact. The analysis of the environmental aspects was carried out using Ammenberg (2004) detailed method of environmental aspect evaluation. This method of environmental aspect evaluation is based on weighting environmental aspects against eleven criteria. Each of these criterions is used to describe the effect each of the environmental aspect have on the environment.

The use of Ammenberg (2004) detailed method of environmental aspect evaluation conforms to Zackrisson (2003) to determine the environmental aspects when manufacturing products mainly out of metals and or polymer. In Zackrisson's (2003) research, the template for environmental review which uses Swedish environmental priority strategies in product design value at each environment load unit was used for the calculation. It involves the multiplication of an emission with the environmental load units (ELU).

In this study, the use of Ammenberg (2004) detailed method of environmental aspect evaluation produced a similar result compared to that of Zackrisson (2003) used in their research as described in the literature review. Each environmental aspect was identified and the environmental aspects that were identified were assigned weights in order of importance and significance to environmental effects. The sum of these weights was then multiplied by the quantity of the aspect in order to get a value for the ranking of the environmental aspect.

From the evaluation of the environmental aspects of both sawmills as shown in table 2 and 3, emissions to air have been identified as the most significant environmental aspect that needs immediate attention. This was as a result of the fact that there is a high rate of wood and sawdust burning that leads to a high emission to air. There is no waste management control in any of the studied sawmills and as such they are subjected to the burning of its waste. This contributes lots of gaseous substances and particles into the air and as such affect the environment.

During the production process, lots of wood dust is also emitted. Both sawmill carry out their operations in an open area and as such there is no control of the wood dust. This dust is also emitted to air and as such causes environmental impacts and health aspect. Transportation processes also contributes to emission to air. In the process of transportation, trucks and other vehicles use fuel oil that can emit gases like carbon dioxide, sulfur dioxide, nitric dioxide etc. these gases are also emitted to air and as such have impact on the climate, the ozone layer and can cause acid rain.

The second most significant environmental aspect observed is the use of raw materials. Most of the raw materials are from near and far forest and the raw material is timber, which comes from trees. When producing timbers, trees are being cut down that may cause the climate effects, acidification, impoverishing of nature types, biotopes, spices etc. The impacts may not be directly affecting the sawmill but do have an indirect effect. Deforestation increases the amount of carbon dioxide in the atmosphere. The continued degradation of our forest heightens the threat of global warming because the trees and other plants that take up carbon

dioxide from the atmosphere to be used for photosynthesis are gone. Both sawmills have the no limitations to the felling of trees for their production process.

The weighting of the environmental aspects usually is based on individual understanding of environmental aspects and its effects. This might have a significant effect on the result and as such environmental aspects that are seen or regarded and not significant if wrongly evaluated, might eventually be the most significant environmental aspect if evaluated properly by someone who has the necessary competence and knowledge to assess environmental aspects. This shows that the use of the weighting techniques of environmental aspect evaluation is a reliable way of evaluating environmental aspects when better knowledge is known about its application and use.

The prestudy carried out during the study has shown that some organizations within Etsako-West do not have knowledge about EMS in spite of the fact the area harbours a higher institution of learning. This shows that the level of awareness is low and as such special attention and care is not given to environmental issues. The use of the Ammenberg (2004) detailed environmental aspect evaluation method has proven to be a reliable method in the evaluation of environmental aspect. The use of interactive interview in obtaining information has also proven to be a valid and reliable way of obtaining information from people in an organization. One limitation of the interactive way of interview is that there interviewer might end up forgetting useful information since they were not documented.

There is a need to usually have a direct visitation to the organization that is been reviewed in order to have a better understanding of the organizations activities. The environmental review process is intended to help public officials and organizations make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment. Environmental reviews documents provide full and fair discussion of significant environmental impacts and as such shows those aspects of an organizations operation that needs immediate attention in order to sustain the environment

The use of oral interview in obtaining information for an environmental review of an organization is not enough to provide the needed information that could help actualize the desired results. There is a need for site visit of the organization that is been reviewed in order to facially see structure, activities and operation of the organizations which was the case in this thesis. During the site visitation it was possible to see the different operational process in and as well obtain images. One major problem encountered during this study was the inability to visit directly the forest from which timber was exploited. This would have given a better understanding on the amount of damage that has been done to the forest.

The major raw material used in both sawmill is timber. These timbers are obtained from both nearby and far forest hence causing deforestation and this increase the amount of carbon dioxide in the atmosphere. The continued degradation of our forest heightens the threat of global warming because the trees and other plants that take up carbon dioxide from the atmosphere to be used for photosynthesis are gone. It was impossible to visit the forest from where the timber are been exploited as the managers refused to disclose the location were the timbers are obtained from. Visitation of the forest would have helped in determine the extent with which the forest is being used and the visible effect it has caused on the environment

## 7. Conclusion/Recommendation

The review of the literatures of Zackrisson (2003) and Schebek et al. (2006) have given an insight on the importance of life cycle assessment as a means of environmental impact evaluation. The articles of Yang and Li (2004), Ammenberg and Hjelm (2004) and Ammenberg (2002) gave an insight on other methods of evaluating environmental aspects as well as the importance of environmental management systems. One common observation in the researchers evaluated is that it is very important for the user to understand the weighting method been used and as such apply the appropriate weights to each environmental aspects that has been identified in order to have an accurate result.

The effect of timber exploitation from the forest is of great importance and as such should be given special attention as unlawful deforestation of the forest could lead to an increase in environmental effect and impact. Forest timber when removed exposes the soil to erosion and as such causes leaching.

In 2006, students living in the residential buildings 12 meters to Iretunde sawmill had a protest to the management team of the sawmill complaining bitterly that timber log deposited close to their building attract mosquitoes, snakes, and scorpions and also prevent free movement. They also complained that the noise from sawmill is non-conducive for reading and there is a high dust disturbance. The sawmill was forced to adjust its operations by sawing timber during the day when students are in classes, and stocking its timber logs distance away from the student's residence (Tunde & Epodun, 2008).

This study began with a review of the activities of Iretunde and Irepodun sawmills in Etsako-West in Edo state Nigeria in order to determine their activities and environmental aspects and impacts. Both Iretunde and Irepodun sawmill optimise the human and natural resources available to them to make more profit. They pay attention only to their operational activities and neglect its effects on the environment. It can be concluded that

(a) Iretunde and Irepodun sawmills are not registered under any standard, such as ISO14001.

(b) The sawmills are managed by the management team who are responsible for all activities, policies and operational control. It would have been better to have an external monitoring team that could help regulate the sawmills operations in order to ensure an impact free environment.

(c) The environmental aspect such as emission to air, use of raw materials, transportation and waste of both sawmill are significant and as such causes treat to the environment.

(d) The staffs work effectively and collectively together to actualize the desired objectives of the Sawmill, which is to improve production and efficiency.

It could be recommended that that other environmental aspects that are not mentioned as significant should not be neglected. This is because environmental aspects that are minimal can accumulate and becomes significant. It is also recommended that most sawmills in Nigeria should place proper policies on the exploitation of forest trees, which is the raw material use. This will help protect the forest from been deforested and also help sustain and recycling of $CO_2$ in the atmosphere.

## 8. Need for further studies

This thesis has looked at the structure of Irepodun and Iretunde sawmills, the environmental management system that has been used or implemented, the activities, environmental aspects and significant environmental impacts. The result obtained during the analysis of Iretunde and Irepodun sawmills have shown that there are significant environmental impact caused as a result of their operational activities. The use of transportation, emission to air, raw materials and waste have been identified as significant environmental aspects with emission to air been the most significant in both sawmills. Some of the impacts maybe regarded as minimal but in the real sense, the environment is been damaged.

Due to the fact that there are other sawmills around Etsako-West local government which is the area of study for this thesis, Edo state, Nigeria and in the world in general, there is a need for continual studies on the environmental impact caused by sawmills. These studies would help widen the scope and understanding on the impact of sawmills activities on the environment. As part of my suggestions for further studies, the following have been suggested

- Further studies should be carried out on the validity of using the Ammenberg (2004) detailed method of environmental aspect evaluation on larger sawmills in order to determine the usability of the model

- Further studies should be carried out using different environmental aspect evaluation model and comparing the result obtained to the model of Ammenberg (2004)

- Further studies should be carried out to determine the extent of forest encroachment due to timber exploitation on the environment within Edo state and Nigeria in general

- The effect of EMS implementation on small and medium organizations in Nigeria should be studied in order to determine the advantages organizations in Nigeria will gain implementing EMS.

## 9. References


**Afemai charity organization.** (2008). ACO. Retrieved March 14, 2008, from: http://www.skadiri.com/Afemai%20Charity/Afemailand.htm

**Anabverokhai, I.** (2008). Prestudy of 13 organizations and companies in Etsako-West to determine their understanding of EMS, unpublished, carried out on the 12 of May 2008

**Ammenberg, J.** (2004). *Miljö Management, studentlitteratur.* Lund Sweden

**Ammenberg, J., & Hjelm, O.** (2002). The connection between environmental management system and continual environmental performance improvements. *Cooperate environmental strategy vol 9.*no 2. Retrieved May 12, 2008, from www.corporate-env-strategy.com

**Brorson, T., & Larsson, G.** (2006). *Environmental Management, how to implement an environmental management system within a company or other organization*, EMS AB, Stockholm Sweden

**Couzin, J.** (1999). "Landscape Changes Make Regional Climate Run Hot and Cold" *Science Magazine,* 283, 317-319.

**Eco-Management and Audit Scheme.** (2008). EMAS. Retrieved March 17, 2008, from: http://ec.europa.eu/environment/emas/index_en.htm

**Edo state**. (2008). In the wikipidia the free encyclopedia. Retrieved March 17, 2008, from: wikipedia online http://en.wikipedia.org/wiki/Edo_State

**Fuwape, J., A. & Onyekwelu, J. C.** (1995). The effect of uncontrolled fuel wood collection on the environment. *Proceedings of Man and Biosphere training workshop*, 239-244

**International organisation of standards.** (2008). ISO. Retrieved February 16, 2008, from: http://www.iso.org/iso/home.htm

**Oghogho, M., & Bukola, A.** (2006). *The International comparative legal guide to: Environmental Law 2006.* Published and reproduced by Global Legal Group Ltd, London. Retrieved June 26, 2008 from: http://www.alukooyebode.com

**Pechan,** (2003). Residential wood combustion frequently asked questions. *Mid Atlantic regional air management*. Retrieved March 20, 2008, from: http://www.marama.org/index.html

**Sammalisto, K.** (2007). *Environmental management systems-a way forward towards sustainable development in Universities*, University of Lund, IIIEE, Sweden

**Schebek, L., Buchgeister, J., & Gernuks, M.** (2006). Assessment of environmental aspects and determination of environmental targets within environmental management systems (EMS) – development of a procedure for Volkswagen. *Journal on cleaner production*, *15,* 1063-1075. Retrieved March 12, 2008 from: www.elsevier.com/locate/jelepro

**Tibor, T., & Feldman, I.** (1996). *ISO 14001: A guide to the new environmental management standards*. Irwin, Burr Ridge, IL.

**Welford, R.** (2000). *Corporate environmental management 3, towards sustainable development*. Earthscan London.

**Yang, Z. F., & Li, W.** (2004). Environmental management planning for Datong Coal Gasification Corporation, Shanxi province. *Environmental informatics achievers, volume 2* 197-211. Retrieved April 20, 2008, from: http://www.iseis.org

**Zackrisson, M.** (2003). Environmental aspects when manufacturing products mainly out of metals and/or polymer. *Journal of cleaner production 13,* 43-49. Retrieved March 14, 2008, from: www.sciencedirect.com

## Interviews

**Abibu, S.** (2008). Manager, Edo state micro-project cassava processing industry Ikpeshi, 30 minutes oral interview conducted on the 4th of April 2008

**Ahmed, A.** (2008). Staff department of General studies, Auchi polytechnic Auchi, 30 minutes oral interview on the 20th of April 2008

**Ahmed, G.** (2008). Assistant manager, Freedom group of companies 13 Auchi-Igarra road Ikpeshi, Edo state Nigeria, oral interview for 35 minutes conducted on the 4th of April 2008

**Chairman, U.** (2008). Director, Chairman Udo cassava milling machine, sharp corner, Sabo quarters Iyakpi South-Ibie Edo state Nigeria 30 minutes oral interview conducted on the 26th of May 2008

**Christopher, M.** (2008). Manager, Chrisman Mable Company, 16 Benin-Auchi express way Auchi Edo state Nigeria, 23 minutes oral interview conducted on the 7th of April 2008

**Darlington, F.** (2008). Etege enterprises, Marble processing and distribution, 103 Auchi-Igarra road Ikpeshi, Edo state Nigeria,

**Epodun,** (2008). Manager, Irepodun Sawmill, kilometer 120, along Benin-Abuja expressway Jattu, Etsako-West Edo State Nigeria, 3 hours oral interview conducted on the 23rd February, 18th April and 30th of May 2008

**Evans,** (2008). Manager, Elvis waters, behind king's palace, Egbogio village, South-Ibie, Edo state Nigeria, 26 minutes oral interview conducted on the 16th of May 2008

**Musa, I. (**2008) Manager Global imaginations Marble company, head office 147 Igbe road Auchi, Edo state Nigeria, 25 minutes oral interview conducted on the 16th of April 2008

**Raphael, G.** (2008). Manager, Queen-Raf pure water, behind Oyakhamho residence Sabo quarters Iyakpi, South-Ibie Edo state Nigeria, 15 minutes oral interview conducted on the 21st of May 2008

**Sado, B.** (2008). Director, Sado cassava processing Mill, behind Ekhabele primary school Sabo South-Ibie Edo state Nigeria, 21 minutes oral interview conducted on the 19th of May 2008

**Tunde,** (2008). Manager, Iretunde Sawmill, 21 old Agenebode road, South-Ibie Iyakpi, Etsako-West Edo state Nigeria, 2 hours 30 minutes oral interview conducted on the 23rd February and 28th of May 2008

**Victor, M.** (2008). Sales boy, victory pure water, 13 old Jattu road opposite mechanic village Iyakpi South-Ibie Edo state Nigeria, 24 minutes oral interview conducted on the 26th of May 2008

**Zekeri, M.** (2008). Staff, ZOZO pure water, 28 Benin-Auchi express road opposite Auchi polytechnic main gate Edo state Nigeria, 30 minutes oral interview conducted on the 3rd of June 2008

**Standards Used**

**ISO14001:** ISO Standard covering the environmental management and auditing of organisations and other environmental issues

**ISO 14031:** ISO Standard coving the evaluation of Environmental Performance

**ISO 14004:** ISO Standard that provides guidance on the development and implementation of environmental management systems and principles and their co-ordination with other management systems

## Appendix

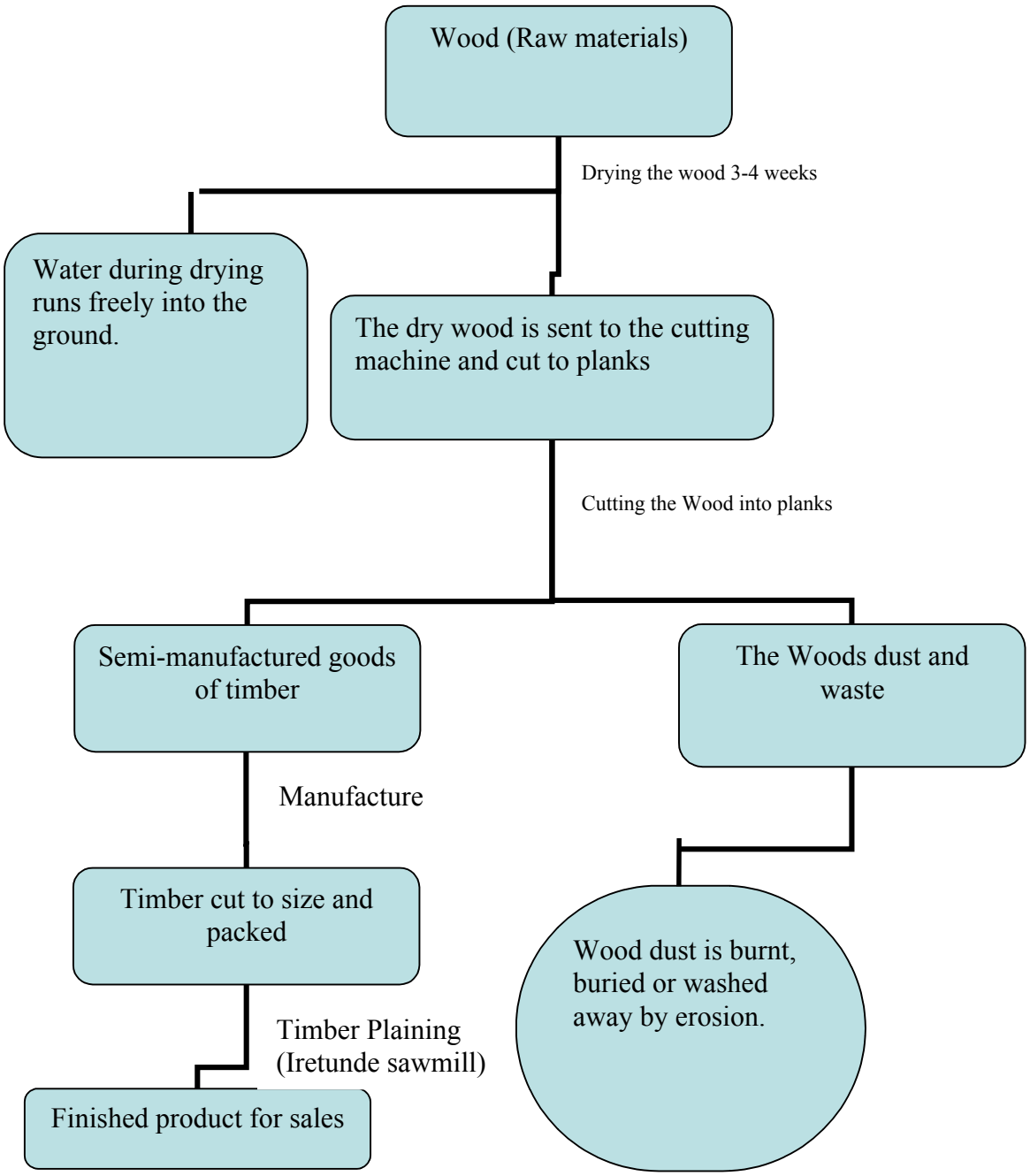


Figure 14, The Irepodun/Iretunde operation process