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LEAN MANAGEMENT PRACTICES AS A STRATEGY FOR SUSTAINABLE UTILISATION OF THE WOOD RESOURCE. A CASE OF PRIMARY WOOD INDUSTRIES IN THE MANICALAND PROVINCE OF ZIMBABWE

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER IN EXECUTIVE BUSINESS ADMINISTRATION IN THE COLLEGE OF BUSINESS, PEACE, LEADERSHIP AND GOVERNANCE

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Abstract

This study sought to examine lean management practices as a strategy for sustainable utilisation of the wood resource with specific reference to primary wood industries. The study sought to assess the extent of waste generation and lumber recovery, to ascertain the factors that cause excessive processing waste and low lumber recovery in the Manicaland wood industry. The researcher adopted both quantitative and qualitative research approaches. The research adopted the descriptive research design. The population was made up of the three major primary wood industry companies operating in Manicaland Province in Zimbabwe that is Border timbers Ltd, Wattle Company and Allied Timbers which made up a total population of 2530. Purposive sampling was used to select 346 primary wood employees who made up the sample for the study. Data was collected using semi structured questionnaires. Data was analysed using descriptive statistics. The study revealed that recovery of lumber products from waste wood reduced pressure to source the raw material (logs) from forests. The study found that implementation of lean management practices had the potential of adding value to organisation. It was also found that elimination of waste of overproduction, elimination of waste of stock on hand (inventory) and elimination of waste of making defective products were lean management practices. The research also established that log size or diameter, log taper, log defects and lack of management commitment were some of the causes of excessive processing of waste and low lumber recovery. The study found out that there was a positive correlation between lean management practices and sustainable utilisation of wood resource. The study concluded that primary wood companies lacked sufficient knowledge on how to reduce excessive waste generation and were not sufficiently trained for sustainable utilisation of wood resources. Furthermore, there was no organisation of waste generated in wood industries. The researcher recommended training practices in primary wood companies towards sustainable utilisation of wood resource and organisation of waste generated. The industry needed technical advice on new conversion processes. It is hoped that future studies will be conducted on the effect of log length on lumber recovery.

Key Words: Lean management, Sustainable utilisation, Wood resource

Declaration Page

I declare that this dissertation is my original work except where sources have been cited and acknowledged. The work has never been submitted, nor will it ever be submitted to another university for the award of a degree.

Leopold Mhlanga **03.06.20**

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Dedication

This research project is dedicated to my family for their support in completion of this research. I also dedicate this project to the Almighty God.

List of Acronyms and Abbreviations

LM	Lean Management
TPS	Toyota Production System

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CHAPTER 1 INTRODUCTION

1.1 Introduction

In recent years, much has been written about the concept of lean management practices. This study sought to analyse lean management practices as a strategy for sustainable utilisation of the wood resource with specific reference to primary wood industries in the Manicaland Province of Zimbabwe. The purpose of this chapter is to examine the background information to the study, the statement of the problem, the research objectives, research questions, and significance of the study. The delimitation, limitations and the organization of the study are also discussed in this chapter.

1.2 Background to the Study

Lean principles are well known with documented savings and productivity enhancements through the elimination of waste. The participation in and management of modern supply chains is characterised by various complexities, including: intense competition, rising demand for cleaner products, environmental sustainability issues and pressures to reduce and manage waste (Ponis, & Koronis, 2012; Ponis, & Spanos, 2009). Consumers now insist on ‘cleaner’ products that minimise waste, environmental damage and pollution (Vermaak, 2008).

Production and consumption of wood products in Africa has grown over the years in all categories (Grieg-Gran, 2015), and the continent has been predicted to import wood in the future to meet its wood requirement as wood demand for local consumption grows. A study by Global Environmental Facility (2013), identified that wood needs of Africa are estimated to be about 700 million cubic meters (m3) per year and fuel

wood consumption account for about 625 million m3 with the rest consumed as industrial wood products. In 2011, wood products imported into the continent was US$8.5 billion. This was more than the total value of wood products exported from the continent which stood at $ 5.1 billion (Grieg-Gran, 2015). The implication of such inverse wood export and imports, suggests that Africa lacks the technology and capacity to produce high value-added wood products locally and relies on the exportation of primary wood products and importation of tertiary product for local consumption.

Ghana has a vibrant timber industry that directly employs about 120.000 of its population (Government of Ghana, 2012). The sector indirectly serves as a source of livelihood to a wide range of people in both rural and urban settlements (Tabi, 2001). Wood products export constitute the third foreign income earner to the country's economy (Sutton & Kpentey, 2012). Unfortunately, the number of companies within Ghana's wood industry sector has decreased in recent years (Sutton & Kpentey, 2012). Emergent markets in Asia and neighbouring Africa states also play an active role in Ghana's wood export industry.

One of the reasons for the economic growth in India is the increasing trade in forest products (wood and non-wood) that has supported the rural poor populations that depend on forests economically. According to Pandey and Rangaraju (2008), in India nearly 80 per cent of the wood of tropical hardwood species is transformed into sawn wood in comparison to 20 per cent that correspond from softwood species.

Zimbabwe is also faced with a crisis in the form of deforestation and degradation of the environment. According to the World Food Organization (1985), the 1970's and early 1980's have seen a growing realization that the forests of the world are in crisis,

and as a result the year 1985 was declared the international year of the forest. Conservation or protection encompasses various mechanisms put in place by resource users to safeguard their local resource base from extinction or depletion. These initiatives are collectively agreed through local management structures in a community set up (Mutanga, Adam & Rugege, 2009). By integrating lean management practices primary wood industries ensure sustainable utilisation of the wood resource.

Over the last 20 years Manicaland commercial forests have shrunk by 40% from 107616ha to 64621ha and continue to shrink if nothing is done (Timber Processing Federation, 2019). A variety of methodologies are available for process improvement in manufacturing industries. These include Six Sigma, Lean Management, Lean Six Sigma, Agile Management, Re-engineering, Total Quality Management, Just-In-Time, Kaizen, Hoshin Planning, Poka-Yoka, Design of Experiments, and Process Excellence. These are all designed to meet different criteria ranging from quality to productivity. Hayler and Nichols (2007) states that Six Sigma has been increasingly recognized as a powerful approach to achieve business process improvements in both manufacturing and, more recently, service, and transactional industries. TQM never precluded large improvements. It just recognizes that most improvements will be smaller and more local in nature. Since TQM became synonymous with the idea of continuous improvement, re-engineering can be viewed as another “tool” under the TQM. Just in time (JIT) is not a quality improvement policy. However, the goal of this research is to look at sustainable production. Hence, this study adopts lean management as Womack and Jones (2003) states that lean management maximise value within an organisation. It is therefore against this background that this study seeks to analyse lean management practices as a strategy for sustainable utilisation of the wood resource with specific reference to Manicaland province in Zimbabwe.

1.3 Statement of the Problem

The wood processing industries in Zimbabwe are operating in an unsustainable manner characterised by excessive processing waste and rapid depletion of the wood resource. In Zimbabwe, where the technology in use is rarely state of the art, the percentage of round wood recovered is only 40 – 45%, resulting in much higher input losses (Herzog, Balisa, Nhete, & Kamena., 2017). Timbers Producers Federation (2019) states that wood waste is broken down from the initial log entering the sawmill, the output is approximately 10% bark, 5% sawdust, and 45 % offcuts and chips. This is in addition to large amounts of unquantified infield waste left in the plantations. As a consequence, in Manicaland the sawmill industry produces a considerable amount of wood waste, estimated to be on the order of 500,000 m3 annually. Ogunwusi, (2014) observed that generation of vast waste during wood processing operations substantially reduce the quantity of wood resource availability for industrial use. It has been pointed out that less than 40% of round log from the forest are actually used at industrial level while the rest are disposed as waste. This makes the current pattern of industrial wood utilization unsustainable and a source of threat to ability of the forests to sustain the wood industry. Hence, this study attempted to fill this gap on using lean management practices as a strategy for sustainable utilisation of the wood resource with special reference to primary wood industries in the Manicaland province of Zimbabwe.

1.3.1 Research Aim

This study sought to analyse lean management practices as strategy for sustainable utilisation of wood resource in Manicaland Wood industry.

1.4 Research Objectives

The research objectives were to:

1.4.1 assess the extent of waste generation and lumber recovery in the Manicaland wood industry.

1.4.2 ascertain the factors that cause excessive processing waste and low lumber recovery in the Manicaland wood industry.

1.4.3 explore the relationship that might exist between lean management practices and sustainable utilisation of the wood resource.

1.5 Research Questions

1.5.1 What is the extent of waste generation and lumber recovery in the Manicaland wood industry?

1.5.2 What are the factors that cause excessive processing waste and low lumber recovery in the Manicaland wood industry?

1.5.3 What is the relationship that might exist between lean management practices and sustainable utilisation of the wood resource?

1.6 Significance of the Study

This research equipped the researcher with more understanding on lean management practices as a strategy for sustainable utilisation of the wood resource by primary wood industries. It also enabled the researcher to see the best alternative sustainable ways to be used by primary wood industries. In addition, the research added a developing research skill and knowledge to the researcher. Wood industries were also a key area of interest to the researcher hence the research helped the researcher to have more insight about the sustainable utilisation of wood resource.

The findings and recommendations of this study might go a long way in informing the primary wood industry on how well they can ensure sustainable utilisation of wood resource. It is hoped that the study might give primary wood industry an opportunity to share their experiences and views towards sustainable utilisation of wood resource.

It is expected that this study made contributions towards new knowledge and understanding on the issue of sustainable utilisation of wood resource. Results that were generated in this study also highlight lean management practices in the wood industry. It will help build wood industry to play a more prominent economic role in Zimbabwe. Moreover, the study contributed to the body of knowledge on wood industry in Africa in general and Zimbabwe in particular. The study also gave the researcher an in-depth understanding and knowledge of the field of wood resource. The study will also serve as a basis for future and further research.

The study is useful to those who have been mandated to draft policies related to wood industry and those who are responsible for ensuring successful implementation of strategies for sustainable utilisation of the wood resource. It will also enable government policy makers and other government agents to understand some of the underlying issues that can be worked on to improve and transform sustainable utilisation of wood resource into a vibrant business and to achieve the double expectations of employment creation and poverty eradication.

This research equipped the researcher with more understanding on lean management practices as a strategy for sustainable utilisation of wood resource in primary wood industries. It also enabled the researcher to see the best alternative sustainable ways to be used by primary wood industries to enhance sustainable utilisation of wood resource. In addition, the research added a developing research skill and knowledge to

the researcher. Primary wood industry was also a key area of interest to the researcher hence the research helped the researcher to have more insight on lean management practices as a strategy for sustainable utilisation of wood resource.

Consultants, experts, financiers, and associations of primary wood industry can use the study to better understand the key factors of lean management practices towards sustainable utilisation of the wood resource.

1.7 Delimitation of the Study

This research focused on lean management as a strategy for sustainable utilisation of the wood resource of primary wood industries. Specifically, the study focused on primary wood industries in the Manicaland Province of Zimbabwe and deliberately excluded other primary wood industries in other parts of the country. This was mainly because it was not financially feasible for the researcher to collect data from all primary wood industries in the country.

1.8 Limitation of the Study

Respondents were open and free enough to respond on questions associated with their respective primary wood industries. However, this challenge was dealt with by assuring confidentiality to the respondents and fully introducing the research as purely for academic purposes.

Time was a limiting factor since it was not possible to study the whole population of primary wood industries in Zimbabwe because the research itself was for academic purposes and as such its duration had to be within the confines of Africa University Semester Schedule. The researcher therefore used a sample which was small and manageable.

In order to carry out a comprehensive study, the researcher had to do multiple visits to the research site, and this was costly. However, in order to cut down these costs, no questionnaires were left behind. This means the researcher collected all the questionnaires administered on each day and left those which were not completed.

Some of the targeted respondents were illiterate, making it difficult to let them complete questionnaires on their own. The researcher self-administered questionnaires as a method of data collection in order to deal with this challenge.

1.9 Organization of the Study

The structure of the write up was presented as follows:

Chapter one introduced the study on lean management practices as a strategy for sustainable utilisation of the wood resource with specific reference to primary wood industries in the Manicaland Province of Zimbabwe. Hence background of the study, research objectives, research questions, and significance of study are some of the discussed issues in this chapter.

Chapter two presented the available literature which authors wrote regarding the titles of the study. The concept of lean, lean six stigma, waste generation, timber recovery, and factors responsible for high volume of waste generation and low lumber recovery are some of the discussed issues in this chapter. The literature review helped the researcher when discussing the findings in the chapter four.

Chapter three explained the methodology used in the study. The methodology and research design indicates the way the researcher conducted the research where the researcher included, the research method, research strategy, data analysis, sampling.

Chapter four presented findings of the study. Findings were analysed and presented using charts and graphs. The chapter began by presenting response rate, followed by research findings. Discussion and implication of research findings were also presented. The chapter ended with a summary.

Chapter five explained the conclusions of the study providing a brief summary of the research and suggested areas that may require future study. Recommendations were given to the relevant authorities.

1.10 Summary

This chapter has introduced this study on lean management practices as a strategy for sustainable utilisation of the wood resource with specific reference to primary wood industries in the Manicaland Province of Zimbabwe. The background for the study was presented which revealed that primary wood industries are increasingly becoming significant players in many economies and most notably in several developing countries including Zimbabwe. This was followed by a discussion of the statement of the problem for the study suggesting that most primary wood industries in the Manicaland province were not adopting lean management practices in order to enhance utilisation of wood resource. The objectives of the study were then presented. From these objectives, appropriate research questions were formulated and presented. This was followed by an interesting account on the significance of the study to both practice and theory. This was followed by a discussion on the delimitations for the study which showed that the study was going to focus on primary wood industries in the Manicaland Province and was going to deliberately exclude other primary wood industries in other parts of the country. The next chapter (chapter two) provides literature review of the study.

CHAPTER 2 REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter gives an analysis of existing research in order to identify gaps that will be filled by this study on lean management practices as a strategy for sustainable utilisation of the wood resource. A critical review of related literature was necessary to help the researcher develop a thorough understanding of and insight into previous researches that are related to the research questions. Woodward's (1965) contingency theory of organizational design, the concept of lean, the concept of sustainability and conceptual framework for lean management practices as a strategy for sustainable utilisation of the wood resource are some of the discussed issues in this chapter.

2.2 Theoretical Framework

This study adopts Woodward's (1965) contingency theory of organizational design in order to analyse lean management practices as a strategy for sustainable utilisation of the wood resource.

2.2.1 Woodward's (1965) contingency theory of organizational design

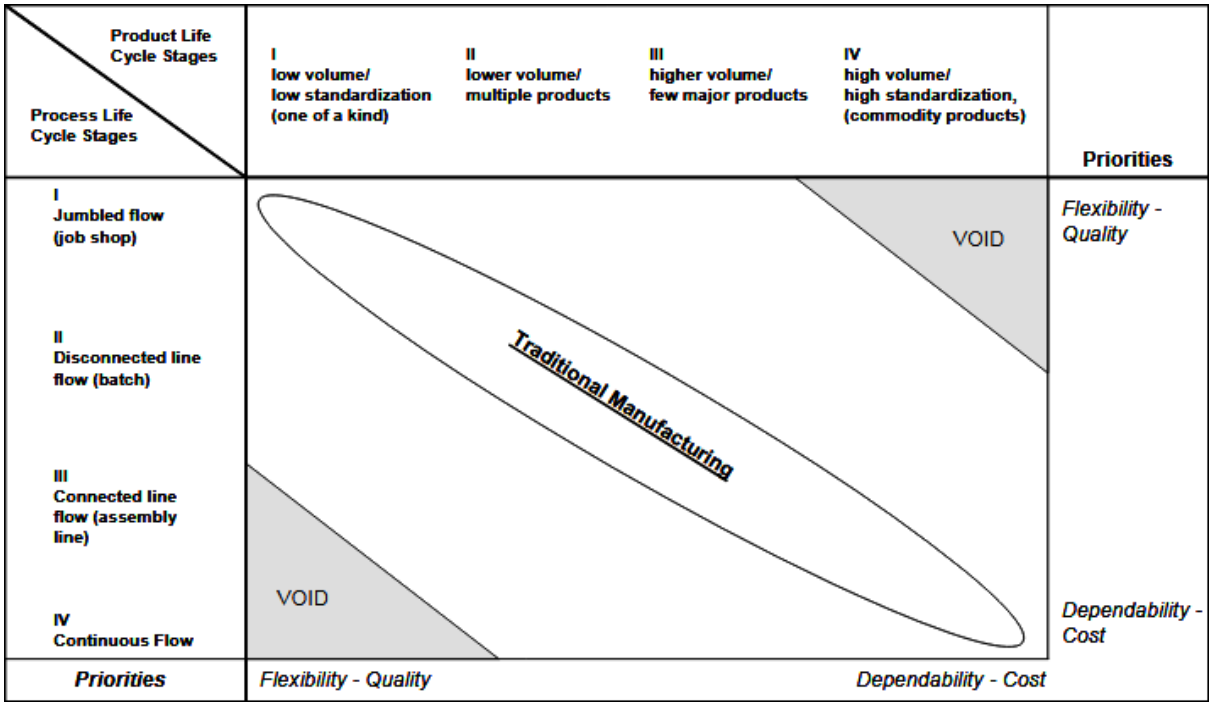
This study adopted Contingency theory which has its origins with a 1950s study of British manufacturing firms by industrial sociologist Joan Woodward. Woodward (1965) identified a correlation between the "best" organizational design and the complexity of technology used in production within successful companies. Each of these organizations was characterized by structural dimensions including number of management levels, supervisor span of control, labour ratios, formalized procedures, centralization, and overall structure.

Woodward's (1965) contingency theory of organizational design was later enhanced by the work of Robert Hayes and Steven Wheelwright in the 1970s. Hayes and Wheelwright (1979) recognized a relationship between the maturation of a product in the marketplace and the maturation of the process technology to be used in manufacture, effectively adding the product dimension to Woodward's theory. This model is known as the product-process matrix (PPM), a leading framework in contingency theory of organizational design.

Organizational design contingency models are used to link production technique and the appropriate organizational application. Similarly, the contingency model of the product-process matrix will be used in this study in order to analyse lean management practices as a strategy for sustainable utilisation of the wood resource.

The PPM, shown in Figure 2.1, specifically identified that new products to market are generally produced in low volume and should use technologies characteristic of a job shop environment; slightly more mature products suggest larger volume and should utilize technologies characteristic of an assembly line with connected line flow; and mature products will be produced as high-volume standardized products which should utilize technologies supporting continuous flow.

Figure 2.1 Product-process matrix (PPM)



Source: Hayes and Wheelwright (1979)

The PPM as prescribed by Hayes and Wheelwright, operate on the diagonal for efficiency. Hence, in an attempt to analyse lean management practices as a strategy for sustainable utilisation of wood resource, the researcher made use of Woodward's (1965) contingency theory of organizational design.

2.2.2 Bandura's Self Efficacy Framework

Bandura (1997) states that self-efficacy is the acceptance in one's capacity to take part in exact activities that produce in expected results. It does not centre on one's expertise, but on the decisions of whatever one is capable of doing. Flammer (2001) states that self-efficacy denotes to the individual's ability to come up with preferred results. Processes of self-efficacy ought to be self-report since an individual who can precisely depict views in one's capability is the aim of the exploration. Bandura (1997)

suggests four primary bases for self-efficacy opinions namely prior experience, modelling, resources and social persuasions.

Prior experience - Prior experience with technology is repeatedly found to be influential on technology-related self-efficacy beliefs. People are utmost likely to get additional constructive effects when they have previous familiarity with technology.

Modelling or participation in technological training is also important forecasters of technological self-efficacy (Torkzadeh & Van Dyke, 2002). Even though diverse forms of training involvements have been related with different gains investigations notes that seeing other individuals effectively accomplish the job (for example, the trainer) and gives the student a chance for strengthening technology correlated self-efficacy beliefs.

Social persuasions such as inspiration by others and firms support are crucial donors to technology-related self-efficacy beliefs. The activities and accounts of others can meaningfully change opinions of their possibilities of victory. It can be noted that if the organisation fails to support employees' effort to adopt technology and lean practices, employees are unlikely to incorporate technology. Hence, this study sought to adopt lean management practices as a strategy for sustainable utilisation of wood resource.

2.3 Relevance of the Theoretical Framework to the Study

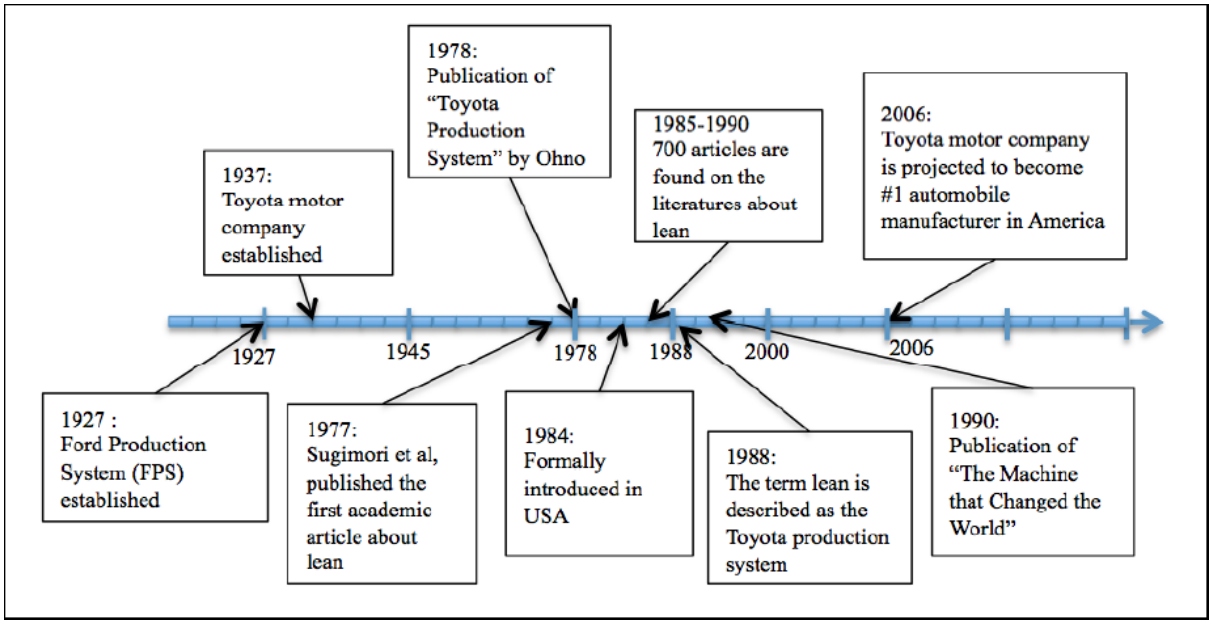
This study adopted contingency theory of organizational design because it supposed that under different circumstances different solutions may prove effective (Antal, 2010). The theory emphasises the interaction between the organisation and the environment and the importance of adaptation to the environment. Environment is in

connection with the applied technologies and innovation of the organisation. Hence, the researcher adopted this theory in order to analyse lean management practices as a strategy for sustainable utilisation of the wood resource.

2.4 The Concept of Lean

Lean manufacturing is a product of Toyota Production System (TPS). According to Spear & Bowen, (1999) the TPS was part of tacit organizational knowledge at Toyota that resulted from 5 years of tinkering. The term "lean," coined by Womack during one of his visits to the Japanese carmaker Toyota in the early 1980s (Womack and Jones 2003), has become the universally accepted term for increasing value and reducing waste. Lean manufacturing is viewed as an alternative approach to the traditional manufacturing model (Hayes, 1979). This new paradigm can be used in a wide range of factories worldwide in their operations that it could influence and serve their strategies (Katayama & Bennett, 1996). Organizations implement the lean system to benefit from reducing cost by eliminating wastes (Green, 2000). Organizations must apply them all to reach an integrated lean system and for achieving the main objective of elimination waste, reducing cost, and improving performance (Liker, 2004). Waste elimination and continuous improvement are therefore considered as the two basic elements of this concept of lean. The concept of lean leads organizations to be leaner and characterized by flexibility and to be more responsive to waste reduction (Wilson, Araba, Chinwah, & Cheeseman, 2009).

Figure 2.2 Lean historical critical phases



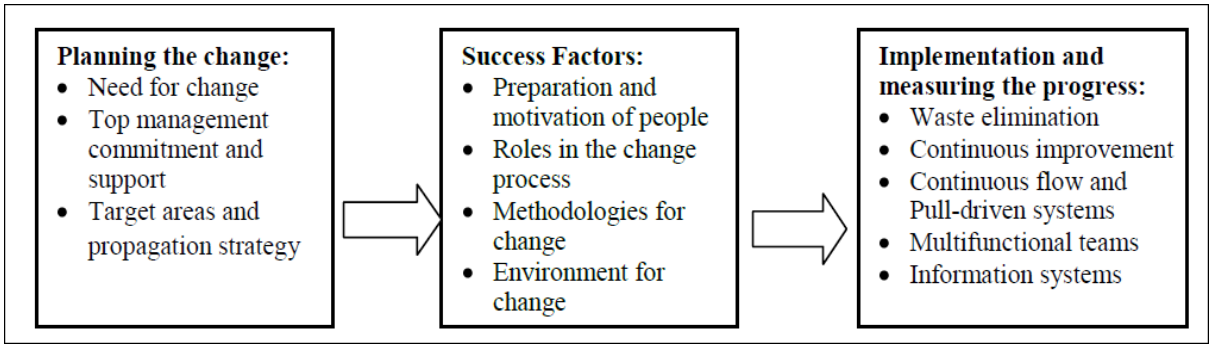
Source: Bayou and De Korvin (2008)

Lean, also known as 'lean production', is defined as efficiency with no wastage and focuses on implementing value-adding processes without interruption (BMGI Corporation 2009; Womack & Jones 2005). Lean thinking focuses on reducing or eliminating all non-value adding activities within the supply chain, thereby reducing costs at various points throughout the supply chain process (Dues et al. 2013). Lean principles deliver superior performance delivering goods to the end customer quickly, with the minimum amount of waste or inefficiency and creating the most possible value for stakeholders. According to Olesen et al. (2015), lean thinking is an enabler for any company to become more efficient in production speed and flow and is all about achieving operational excellence and sustainability.

Womack and Jones (2003) describes lean as the way to do more and more with less and less, while aiming to provide customers with what they want. The essence of a lean approach requires a commitment to eliminate waste, simplify procedures and

maximise value in a supply chain. In order to enhance value, organisations need to understand which activities truly create value for their shareholders. Value-adding activities transform materials and information into something useful and valuable, which the customer requires in a specific form at a specific point in time. Maximising value within an organisation will provide the right incentives to all employees to increase productivity and overall efficiency of an organisation (Business Blog 2012; Castillo, Alarcón & González, 2015). Lean Management is a management that meets the product demand through the removal of any waste in the management process and ending any kind of inaccurate act (Jie 2010). Lean manufacturing offers a set of tools and techniques as well as a systematic approach for eliminating manufacturing waste and increasing manufacturing flexibility, while creating a continuous improvement-based organizational culture. In this context, waste reduction relates not only to material related waste, but to all manufacturing waste (Rother and Shook 1999).

Table 2.1 Model of Lean implementation process



Source: Jie (2010)

Lean management improves the flexibility of the organization and the quality of operations, reduces the goods in stock, and improves the functioning of the process, eliminating activities that do not add value and it increases customer satisfaction. The lean-induced benefits include higher and faster throughput, better product quality, on

time delivery of finished goods, better product quality, reduced inventory levels, customer satisfaction, and shorten lead time (Eswaramoorthi, Kathiresan, Prasad, & Mohanram, 2010). Inventory decisions are risky and they make a large impact throughout the supply chain (Bowersox, Closs, & Cooper 2005). Without proper planning, a manufacturing company can run out of raw material, negatively impacting the company and its customers. As such, the successful implementation of the lean manufacturing system, depends on some crucial factors such as leadership, good management, finance, skills and expertise, as well as a strong corporate culture directed toward efficiency in the organization (Balle, 2005, Chaisorn & Lila, 2011; Nordin et al., 2010).

It seems there is a great debate over what should constitute lean management practices. Literature indicates that lean is an integrated socio technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability. However, Jostein (2009) suggests that there is no consensus definition of Lean management in the literature. Further, Hines, Holweg, and Rich, (2004) state that lean implementation differs between industries that is to say manufacturing or other sectors. Hence, it can be noted that once there is no agreed definition of the concept of lean management practices and lean implementation lack relevant information. It is important to constantly observe the concept of lean management practices. This statement therefore leads to the next valuable discussion of the importance of lean six stigma.

2.5 Lean Six Stigma

The term "Six Sigma" is a reference to a particular goal of reducing defects to zero (Pande, Neuman, & Cavanagh, 2002). Lean six stigma maximizes shareholder value

by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed, and invested capital (George, 2002). Since Lean six stigma starts with customers, its goal is to eliminate anything that doesn't meet their needs (George, Rowlands, & Kastle, 2004). Lean Six Sigma combines the two most improvement trends of our time: making work better (using Six Sigma) and making work faster (using lean principles) (George, et al., 2004).

5S is a set of techniques, all beginning with the letter "s" (Wilson, 2010). They are used to improve workplace practices that facilitate visual control and lean implementation. The 5Ss are: Separate, Set to order, Shine, Standardize, Sustain. George, et al, (2005) state that 5S enables anyone to distinguish between normal and abnormal conditions at a glance. 5S is the foundation for continuous improvement, zero defects, cost reduction, and a safe work area and is a systematic way to improve the workplace, processes, and products through production line employee involvement.

5S is a very powerful tool to lean management. The real objectives of a 5S program should be:

- To reduce waste
- To improve variation
- To improve productivity" (Bicheno and Holweg, 2009)

Thus 5S should be used as a 'pull' activity (that is it should be used when the need for it arises).

Table 2.2 Definition of 5s

Term	Definition
Sort	Clearly distinguish needed items from unneeded items and eliminate the latter.
Set in order	Keep needed items in the correct place to allow for easy and immediate retrieval.
Shine	Keep the work area swept and clean.
Standardize	Standardize cleanup.
Sustain	Make a habit of maintaining established procedures.

Source: George, et al (2005)

The principles of lean manufacturing enable the company to deliver on demand, minimize inventory, maximize the use of multi-skilled employees, flatten the management structure, and focus resources where they are needed. The main objective of lean manufacturing principles is to eliminate waste through continuous improvement (Gupta & Kundra, 2012). Nicholas (2011) states that lean principles are a set of beliefs and assumptions that drive operational decisions and actions about products and processes.

2.5.1 Womack and Jones's Lean Principles Framework

According to Womack and Jones, (1996), Lean can be established by archiving five Principles:

1. Identify value: Specifying value from the viewpoint of the end customer by product family.

2. Map the value stream: Identifying all the steps in the value stream for each product family, eliminating every step and every action and every practice that does not create value.

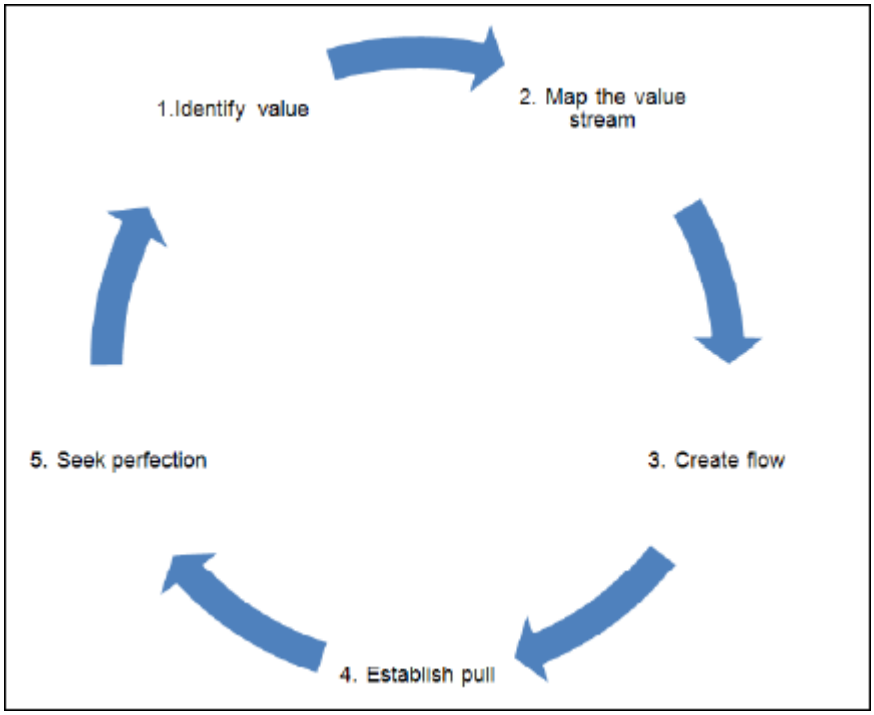
3. Create flow: Making the remaining value-creating steps occur in a tight and integrated sequence so the product will flow smoothly toward the customer.

4. Establish pull: As flow is introduced, letting customers pull value from the next upstream activity.

5. Seek perfection: As value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, then the process starts a new and continues (Table 2.3) until a state of perfection is reached, in which perfect value is created with no waste.

Womack and Jones (2003) describes lean as the way to do more and more with less and less, while aiming to provide customers with what they want. The essence of a lean approach requires a commitment to eliminate waste, simplify procedures and maximise value in a supply chain. In order to enhance value, organisations need to understand which activities truly create value for their shareholders. Value-adding activities transform materials and information into something useful and valuable, which the customer requires in a specific form at a specific point in time. Maximising value within an organisation will provide the right incentives to all employees to increase productivity and overall efficiency of an organisation (Business Blog 2012; Castillo, Alarcón & González 2015). Lean Management is a management that meets the product demand through the removal of any waste in the management process and ending any kind of inaccurate act (Jie 2010).

Table 2.3. Womack and Jones's Lean Principles Framework



Source: Womack and Jones Lean Principles (2003)

According to Womack & Jones (2003) the three major lean thinking concepts are value identification, Waste elimination and Flow (of value to the customer) generation. There is, therefore, a need for a study that provides lean management practices as a strategy for sustainable utilisation of wood resource in primary wood industries.

Lean management practices give organisations the benefit of improving the working environment for the employees (Hasle et al, 2012). Having the complete picture of the process makes it faster to identify the problems and including the workers gives them opportunities of introducing solution to enhance the working process (Okrent & Vokurka, 2004). Literature therefore indicates that implementing lean management practices is beneficial even financially as Taner and Sezen (2009) discussed the financial difference in some organisations before and after implementing lean

management practices. Hence it can be noted that primary wood industries benefit from implementing lean into their working processes. The primary wood industries gain a delay reduction in all its processes as well as a reduction in waste generation. Lean principles are applied by practices and performance measures to improve process flow and overall performance (Deshmukh, Upadhye, & Garg, 2010). The underlying goal is to optimize production processes by eliminating waste and enhancing the "leanness" of a manufacturing system. Lean principles can be implemented in various manufacturing sectors.

Table 2.4 Examples of lean implementation in different manufacturing sectors

Industry	Author	Lean Applicability	Reasons for success or failure	Current characteristics and difficulties
Mining industry	(Detty & Yingling, 2000)	Highly applicable	Easy adoption of most lean practices such as standard work, quality at the source, TPM, flexible workforce, setup reduction and continuous improvement	Some practices are not readily transferable to the mining industry: * Flow: need to take different strategies than manufacturing. Unfortunately, there are no firmly established methods for accomplishing flow in the mining industry * Pull: given the bulk nature of mining industry. Pull production differ from the regular manufacturing.
Aerospace industry	(Crute et al., 2003)	Applicable	* The low volume nature of aerospace is considered an advantage over the automotive sector, because the lower volume is closer to the lean ideal of single piece flow than a high volume environment. * The aerospace industry already uses "build to order", which represents JIT principle.	* Aerospace is considered as low volume environment, while automotive is high volume. *Different competitive priorities. *The aerospace is ten year behind automotive sector in lean manufacturing.
Process industry	(Abdulmalek et al., 2006)	Applying lean in process industry varies between process types.	The success or failure in the process industry depends on the factors: Product characteristics. Process characteristics For example: textile provide more opportunities for lean manufacturing than chemical industry	*High volume *Low variety *Fixed routing *Long change over Fixed layout.
Electronic industry	(Doolen & Hacker, 2005)	The application varies between printed circuit board, equipment manufacturers and wafer manufacturer	* Operational strategies resulting from difference in product volume and product variety. * Organizational size and type of manufacturing are significant factors to achieve the lean manufacturing.	*Rapidly rising customer expectations *Globalization of both market and competition *Acceleration pace of technological change *Rapid expansion of technology access

Using lean manufacturing can minimize the system process including processing time of production as well as costs and wastes (De Treville & Antonakis, 2006). Industries that implemented the lean manufacturing system witnessed production performance that is better and superior comparison to competitors in terms of quality and cost (Cua et al., 2001; De Menezes et al., 2010). However, adopting the lean concept is challenging for manufacturing industries especially in countries that suffer from lacking resources, tools and techniques that are necessary to implement this concept. However, this study seeks to analyse lean management practices as a strategy for sustainable utilisation of the wood resource in primary wood industries.

2.6 Waste Generation

Keeping excessive inventories, unnecessary transportation, waiting time, and reprocessing are considered waste (Womack, Jones & Roos, 1991). Wastes vary due to the differences in raw materials that are involved in production, in the actual production processes, and in the different finished products in the primary and secondary wood-product industries. Wood waste refers to materials that are unsuitable for the production of wood products. They take different forms such as bark, small chips, sawdust, wood edges, and low-quality wood rejected by the manufacturing process (Burton et al., 2003).

Bhasin (2008) argues that disjointed lean implementation causes suboptimal organizational performance because waste and WIP are passed to other stakeholders instead of being addressed. Wastes generated in primary and secondary wood-product factories are biomass resources (Skog & Rosen, 1997). The intended use of this biomass can be divided into energy and non-energy applications. The use of biomass for energy involves combustion to meet the energy needs of homes and industrial

enterprises. Non-energy uses include the production of composite boards and wood pulp, land reclamation, animal bedding materials, landscaping, and agricultural mulch; the remainder is sent to landfills (Murphy et al., 2007).

Wood industries produce other waste that are not wood like plastic containers (which contained glue, paints, etc.),waste water during the production of plywood, chemicals or preservatives, nails, paper, sacks, nylons and tin cans (Ogunbode et al, 2013; Cambero & Sowlati, 2014).

The relevance of lean in pimary wood industries is argued to be the Lean concept's improvement approach through waste elimination, lumber recovery for the flow focus (Kollberg & Dahlgaard, 2007). Hence, it is quite important that primary wood industries consider lean management practices as a strategy for sustainable utilisation of wood resource. Therefore, adopting Lean management practices can also make primary wood industries improve on service quality and effective utilisation of the wood resource.

Table 2.5 Analysis of residues generated in wood processing (after Bowyer and Smith, 1998)

Source	Type of residue
Forest operations	Branches, needles, leaves, stumps, roots, low grade and decayed wood, slashings and sawdust
Sawmilling	Bark, sawdust, trimmings, split wood, planer shavings, sander dust
Plywood production	Bark, core, sawdust, veneer clippings and waste, panel trim, sander dust
Particle board production	Bark, screening fines, panel trim, sawdust, sander dust

Source: Owoyemu Zakaria, & Elegbede (2016)

Figure 2.3 Wood Chips (Left) and Wood Shavings (Right)

Source: Owoyemu et al (2016)

Jinini and Rinitha (2016) conducted a research on effective recycling and use of wood carving waste in wood industry. The authors found out that process of recycling waste includes storage, sorting, collection, transportation, recycling and disposing. Wood wastes includes bark, scrap lumber, sawdust, construction and demolition wastes, offcuts, ash from the burning of wood wastes, and broken furniture (Keene & Smythe, 2009). This study however seeks to assess the extent of waste generation and lumber recovery in the Manicaland Province, Zimbabwe.

2.7 Timber Recovery

Log conversion efficiency in sawmilling industry is commonly expressed as the yield or recovery of sawn wood milled from a given log (Adams, 2007). Conversion efficiency of logs into lumber is commonly expressed as lumber recovery factor (LRF) or as over run. Wood being an abundant biodegradable and renewable material available, there are good reasons to maximize its utilization in a sustainable matter (Boampong et al., 2015). Olufemi, Akindeni, and Olaniran (2012) noted that timber recovery percentage is widely used as a measure of assessing the performance of sawmills and it is estimated by dividing the total timber product in cubic meters by the

total input (log) volume. Appiah (1983) indicated that lumber yield/recovery is the most single item affecting cost/revenue relationships of a mill and therefore its profitability. Shepley (2002), and Hamner et al (2002) conducted studies dedicated to improving rough mill operations based on lumber grade and cutting requirements.

Proper utilization of the available thinning, with the appropriate technology stands a chance of improving the overall utilization of softwood plantations. Sawmill conversion efficiency affects both the profitability of the forest sector and the rate at which forest trees are harvested and that in order to conserve the environment and ensure profitability, the manufacturing of timber needs to be done in the most efficient of manner (Kambugu et al., 2005).

There are many factors that affect the recovery of timber; these include the sawing method used, condition and maintenance of the sawmill, quality of the logs, kerf width, taper and length of the log (Ofoegbu et al., 2014). The combination and interaction of several of these factors affect the overall recovery values which depreciate the capacity to process small diameter logs from forest plantations. Kambugu et al. (2005) revealed that in Uganda, four types of sawmills are commonly use namely, and these include, rolling table sawmills, dimensional swivel sawmills, band sawmills and locally manufactured sawmills in conversion of timber, however, technology has improved that new technologies of various types of band saw mills like wood miser have become pronounced.

Zhang and Tong (2004) carried out a research on modelling lumber recovery in relation to selected tree characteristics in jack pine using sawing simulator Optitek. The researcher sought to develop general tree-level lumber volume recovery models

for jack pine. However, the study found out that there is a relationship between simulated lumber volume recovery and tree characteristics.

Olufemi et al (2011) conducted a research Lumber Recovery Efficiency among Selected Sawmills in Akure, Nigeria. The research findings indicate that efficiency of sawmills was comparably higher than the results from earlier studies. The study indicated that yield could still be improved by channelling the residues in the form of slabs to other valuable products.

Whereas, Missanjo and Magodi (2015) conducted a research on Impact of Taper and Sawing Methods on Lumber Volume Recovery for Pinus Kesiya and Pinus Patula Logs in Circular Sawmills. The researcher found out that lumber recovery percentage decreased with an increase in log taper. The interaction of full-taper sawing method with any log taper category produced higher lumber volume recovery than the corresponding interaction of split-taper sawing method with any log taper.

This study therefore sought to assess the extent of waste generation and lumber recovery in the Manicaland Wood Industry.

2.8 Factors responsible for high volume of waste generation and low lumber recovery

Wenger (1984) mentions that lumber recovery factor varies with log diameter and taper. White (1974) mention major factors affecting yield as, end-use requirement, the quality of personnel, sawing methods, sawmill machinery and sawing accuracy. Petro (1984) and Williston (1988) recommended good storage practices if efficiency of conversion of logs into lumber is to be improved. Lumber recovery which is defined as the percentage ratio of volume of sawn wood output to that of volume input of logs processed in the sawmill, regardless of the types and kin of processing equipment

adopted and the species of wood involved (Badejo 1990), is low. Among the reasons for the factors that cause excessive processing waste and low lumber recovery rate according to Kukogho, Agbimien, Ojo and Adams (2011) are; Small log diameter, length, taper and quality; Kerf width of the sawing machine, Sawing variation, rough green-lumber size and size of dry dressed lumber, Product mix, decision making by sawmill personnel, Condition and maintenance of sawmill equipment and Sawing method.

One objective in the mills is to minimize the sum of kerfs, sawing variation and surface roughness. Kerf may have to be increased to control accuracy, but the sum of the three must be minimized. Aspects of a machine centre that affect conversion efficiency include inability to position the log properly before the saw, inability to convey it straight during cutting, inaccuracy of cutting tool alignment and machine vibration (Ackah, 2004).

Williston (1988) observes that logs should not be kept too long after felling before sawing. This is to avoid insect attack, stains and decay. Excessive exposure to the sun can also cause checks on logs. All these will affect the recovery and final quality of lumber. Storage of logs in the yard must be as short as possible ensuring that logs that come first are fed into the mill first. Longer storage of logs results in biological deterioration and these in turn lead to excessive flitching of the defective portions.

Log size, both diameter and length has also been found to affect sawn wood recovery and as a general rule, large diameter gives a higher recovery. For logs in the range of 30-70cm in diameter, recovery rates have been seen to drop to about half when the log diameter is halved (Tetteh, 2009). Doyle (1960) observes that the percentage of log volume converted into lumber increases slightly with log size for both balsam fir and

spruce and the rate of increase for the two species is almost identical. The maximum potential lumber recovery factor (LRF) varies with log diameter and taper and the effect of taper on recovery is less pronounced in larger diameter logs (Wenger, 1984). It must however be emphasized that effect of log diameter on recovery depends on the type of timber species, its age and the percentage of sapwood.

Addo (2001) mention that lack of skilled operators and supervisory staff in sawmills also lowers standards with respect to size and precision of cut. Most of the saw millers are still using obsolete and inefficient machines as well as unqualified personnel to meet the very strong competitive market demands of the present. This attitude of ignorance has resulted in the production of excessive waste in the sawmills (Amoako, 2008).

However, adopting lean management practices in the primary wood industries sector seem not to be an easy path way as Waring and Bishop (2010) argue that Lean has potential to improve waste generation and lumber recovery, but the potential is not easily realized as leadership is important at the implementation of lean. Kollberg and Dahlgaard (2007) conclude that it is important to design a measurement system that measure the initiatives taken, which they believe requires new thinking about the managing in organisations. Mazzocato et al. (2012) argue that Lean in primary wood industries is still at an early stage and that research on Lean is limited, with studies reporting successful Lean interventions predominating, while fewer studies report failed Lean attempts or barriers to its application. Therefore, this study seeks to add literature and knowledge to the understanding of lean management practice as a strategy for sustainable utilisation of the wood resource.

Govender and Jasson (2018) states that lack of management awareness and no lean strategy are the main challenges of lean practices. According to Longest, Rakich and Darr, (2000) management is the process, comprised of social and technical functions and activities, occurring within organisations for the purpose of accomplishing predetermined objectives through humans and other resources. Dorros (2006) sees the management of any institution or organization as determined by the policies, structures, processes and cultural values in which it is practiced and adapted to the context in which it seeks to achieve results. Decisions made by primary wood industries managers not only focus on ensuring that the industry receives the most appropriate, timely and effective services possible, but also address achievement of performance targets that are desired by the manager. Ultimately, decisions made by an individual manager affect the organisation's overall performance (Thompson, Buchbinder & Shanks, 2011). The shortage of staff and a lack of management training are some of the issues that have an effect on management practices and sustainable utilisation of resources (Hintea, Mora & Ticlau, 2009).

2.9 The concept of sustainability

Sustainability is the often-used abbreviated term for sustainable development (Brown et al. 2005). Sustainable development was coined in the late 1980s by the Norwegian Prime Minister Brundtland as "Meeting the needs of the present without compromising the ability of future generations to meet their own needs" (UNWCED 1987 p.1) and now used by the World Business Council for Sustainable Development (WBCSD) and many others. In general, sustainability is a characteristic of a state that can be maintained indefinitely at a certain level (SME 2008). The principle of sustainability is not just an environmental one but is about simultaneously delivering social and

economic benefits (Brassington and Pettitt 2005; Gilligan & Wilson 2003; Grayson et al. 2008). These shortages of natural resources are now becoming the limiting factor to growth. And economising on the scarcest resource stays logical.

Primary wood industries could gain benefits from lean implementation including cost saving, time saving and timeliness of service, productivity improvement, and quality enhancement (Graban 2009; Mazzocato et al 2010). Sustainability of resources is one of the key factors in conserving competitive advantage to service sector including primary wood organisations (Jabnoun & Rassai, 2005). Womack et al. (2005) reported positive impact on productivity, cost, quality, and timely delivered service after having implemented lean management.

Table 2.6 Relationship between Lean and Sustainability

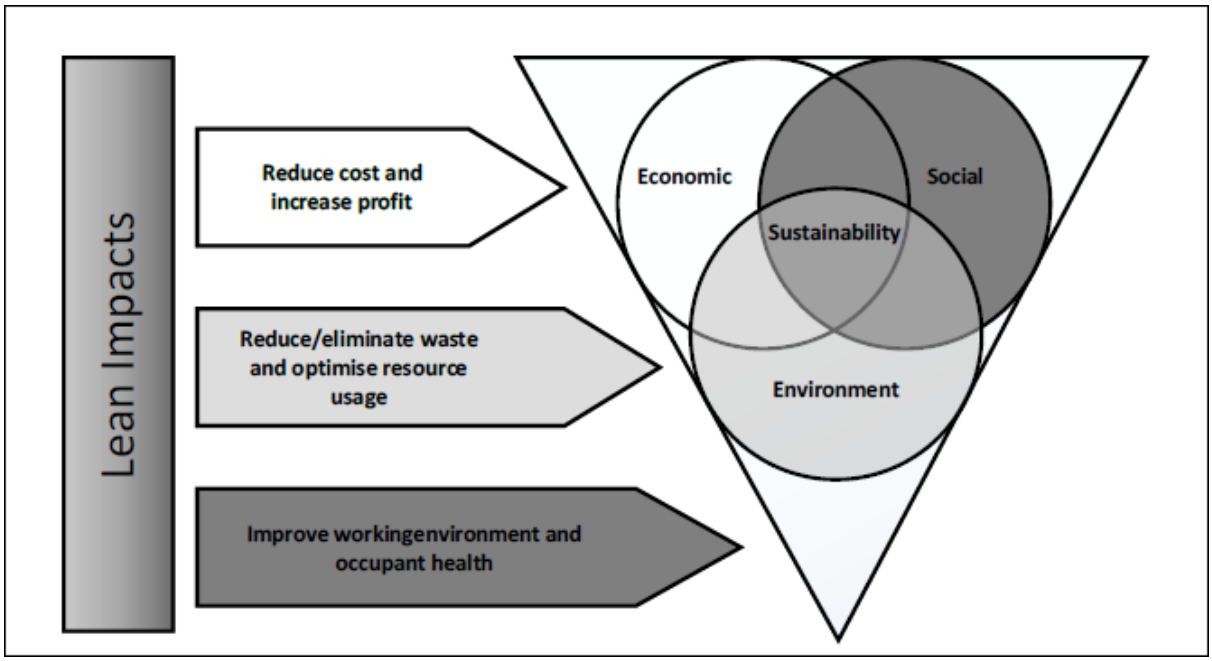
LEAN	SUSTAINABILITY
Long term philosophy- create value for people, community/ including environment/, economy	Invest in long term- consider people, community, financials, environment
Create the right process to produce the right result	Ensure the ecosystem is in balance, if necessary, intervene in system
Add value by developing people and partners	Invest in people- consider stockholders including your staff and partners/e.r. suppliers/
Continuously making problems visible a solving root causes drivers organizational learning	Be transparent and consider the whole system vs. treating symptoms
Minimize or eliminate waste of any kind	Creating waste harms something else in the system

Source: Kovacova (2013)

Sustainable manufacturing is defined as the creation of manufactured products that use processes that are non-polluting, conserve energy and natural resources, and are economically sound and safe for employees, communities, and consumers." Sustainable manufacturing includes the manufacturing of "sustainable" products and the sustainable manufacturing of all products. The former includes manufacturing of renewable energy, energy efficiency, green building, and other "green" and social equity-related products (Langewalter, 2004). Abulafaraa, Salonitis, Al-Ashaab and

Ala'raj (2019) states that lean practices are mainly focused on economic issues, nevertheless, they can also positively contribute to initiatives related to environmental.

Figure 2.4 Lean contributions towards sustainability



Source: Abulafaraa, et al (2019)

Lean practices can actually yield sustainability improvements. Hence, in order to achieve a higher sustainability level, lean practices should be adopted.

2.10 Empirical Review

Jerie (2012) conducted a research on occupational health and safety problems among workers in the wood processing industries in Mutare, Zimbabwe. The study sought to assess the exposures and perceived risks (occupational, lifestyle and psychological factors) of workers in the wood processing industries in Mutare, Zimbabwe. Research findings indicates that the wood sector in Zimbabwe needs to be guided by a comprehensive national policy dealing with safety and health issues in the wood

processing sector. The author also found out that wood workers seem not to be covered by appropriate national safety and health standard.

Mwacharo (2013) investigated on the challenges for implementing lean management techniques. The researcher found out that the main challenge that the companies had was in having workers who were not motivated or not accepting the change. The researcher found out that companies need to understand the importance of motivating their workers as they are the ones who will ultimately deem the lean implementation a success or failure. Dora and Kumar (2016) find that there are barriers and challenges that small and medium enterprises (SMEs) should avoid in order to implement the lean system. The study found out that lack of resources, resistance to change, lack of top management commitment, reduced manufacturing lead time and lack of training hinder effective implementation of lean management.

Adu-Sarpong (2017) conducted a research analysing the sources of wood supply to sustain domestic wood demand with specific reference to selected wood markets in Kumasi-Ghana. The study sought to investigate the sources of wood supply to Ghana's domestic wood markets focusing on the contribution of legal wood by the mainstream timber companies. The research findings indicate that the formal timber processors supply 73% of their processed lumber to the export market and 27% to the domestic market.

Tasdemir and Gazo (2018) did a systematic literature review for better understanding of lean driven sustainability. The authors reviewed 477 past articles published in five major databases from 1990 to 2018. The study found out that increased level of globalization, climate change, resource scarcity, and awareness of social and

environmental responsibilities are some of the factors that drive the evolution of industries.

Choudhary and Ghadge (2019) carried out a research titled, “An integrated lean and green approach for improving sustainability performance: A case study of a packaging manufacturing SME in the UK.” The study presents that most companies adopted lean without a strategic deployment vision which led to scattered implementation of lean tools and projects without desired success. The study found out that Green Integrated Value Stream Mapping (GIVSM), has an effect for improving both operational efficiency and environmental performance.

There are several studies that have also been conducted on lean management practices in other sectors that include Small to Medium Enterprises and even the health sector that include the studies indicated below;

Min et al. (2012) examined the impact of lean implementation to the hospital performance in term of quality and efficiency. The first measure was quality measures, which related to process quality measure, outcome quality measures, and perceived quality measure. Outcome quality measures were represented by risk-adjusted in hospital mortality and risk-adjusted readmission rate. Perceived quality measure was represented by patient satisfaction. The second measure is efficiency measure comprised of ratio of observed cost to adjusted expected cost. It can be note that operational performance of health care organizations impacted from lean implementation. Lean management practices have got positive implications not only in South African health sector but also in the African region. The implication for the continent of Africa is that organisations in the continent can attract more foreign

tourists when competing with other emerging tourist destinations such as the BRICS countries, especially Brazil and China (World Travel and Tourism Council, 2017).

Damen (2017) conducted a research on Health Care Service Quality and Its Impact on Patient Satisfaction with specific reference to Al-Bashir Hospital. The study aimed to measure the impact of perceived health care service quality on patient satisfaction at a major government hospital in Jordan. The study found out that there is a positive impact of perceived health care service quality on overall patient satisfaction in the health care sector.

D'Cunha and Suresh (2015) conducted a research on the measurement of service quality in healthcare. Authors found out that majority of the patients were satisfied with the facilities provided in the hospital, physician's quality care and with the quality care by the nurses.

Mosadeghrad (2015) carried out a research on factors influencing healthcare service quality in Iranian context. The study found out that healthcare quality can be improved by supportive visionary leadership, proper planning, education and training, availability of resources, effective management of resources, employees and processes, and collaboration and cooperation among providers.

Hongoro et al. (2005) uses a prospective approach to measures the service quality of hospital tuberculosis services in Zimbabwe hospitals. The study shows that prospective exploration of health care quality for specific diagnosis can provide insights into hospital-level quality issues.

Lean has been widely applied in healthcare systems in Canada, the United States, and the United Kingdom, patients, front-line staff, healthcare managers, and policy makers regarding the effectiveness of Lean management approaches in health care (Burgess

2013; Hamilton 2014; Kaplan 2014). It was noted that the application of Lean within the health care sector is still at the preliminary stage, applying selected tools and techniques as a piecemeal approach for improvements and its total focus on cost reduction (Swank, 2003). In support of this claim (Yasin and Alavi, 2007; Carlborg et al., 2013) added that it is imperative for other sectors to understand how the customer focused Lean approach can improve their performance and to drive their organisation forward.

Literature indicates that none of the researches have been conducted on lean management practices. Hence this study sees to fill in this gap by analysing lean management practices as a strategy for sustainable utilisation of the wood resource with specific reference to Manicaland Province of Zimbabwe.

2.11 Conceptual Framework

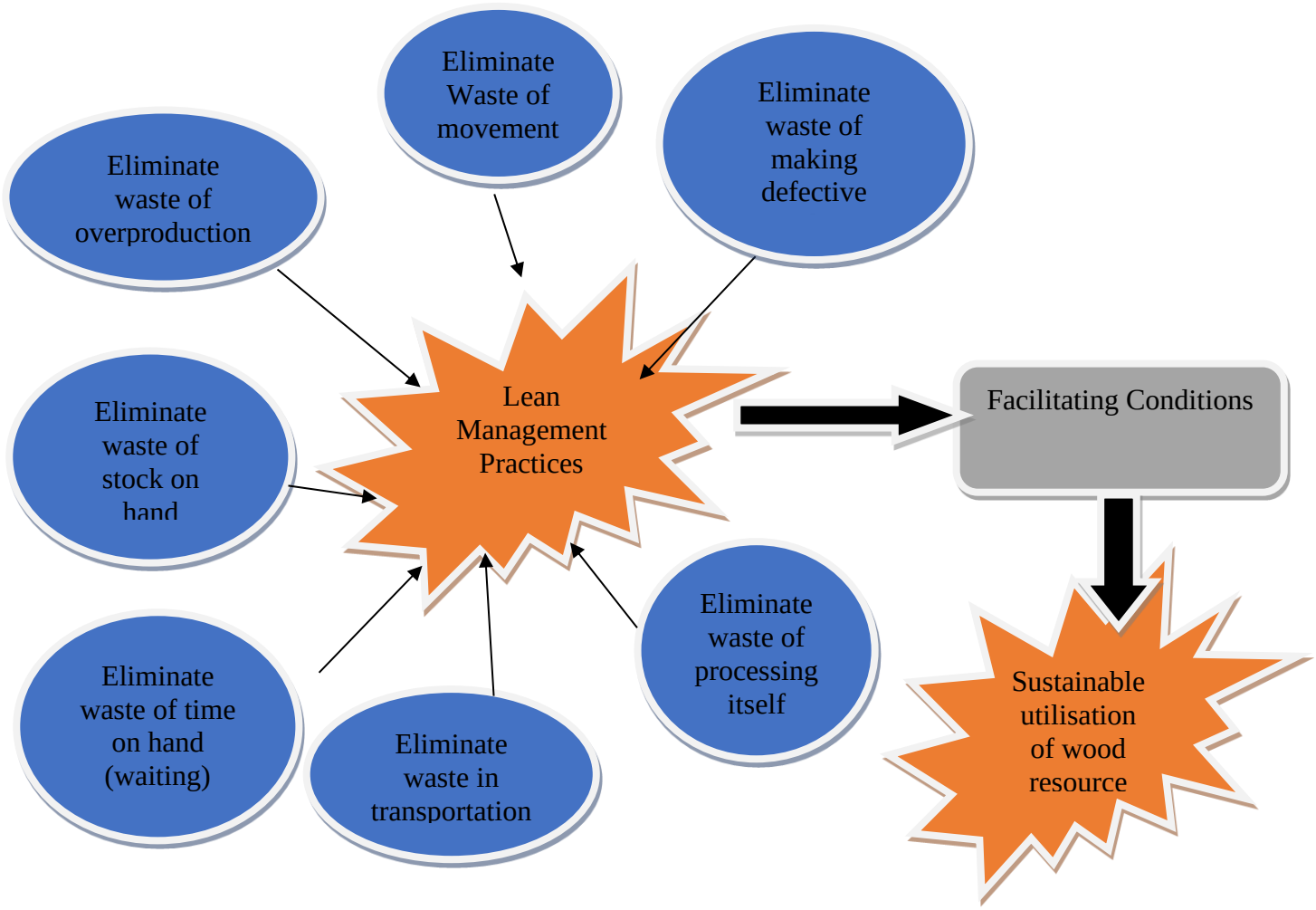


Figure 2.5 Conceptual Framework for lean management practices as a strategy for sustainable utilisation of the wood resource.

Source: Compiled by researcher (2019)

Figure 2.5 shows that lean management practices emphasise on minimal inventories of raw materials and elimination of waste. Primary wood industries require facilitating conditions for sustainable utilisation of wood resource. This means that lean management practices ensure sustainable utilisation of wood resource.

2.11.0 Description of variables

Independent variable: Lean management practices. Lean management practices are integrated set of activities designed to achieve production using minimal inventories of raw materials, work-in-progress, and finished goods (Jacobs, Chase & Aquilano, 2009). Thus, the lean philosophy emphasises the prevention and removal of waste within organisations.

Dependant variable: Sustainability. Sustainability seeks to meet the needs of the organization and its stakeholders today while also protecting, sustaining, and enhancing the environmental, social, and economic resources needed for the future. Landrum and Edwards (2009) defined a sustainable business as a business that operates in the interest of all current and future stakeholders in a manner that ensures the long-term health and survival of the business and its associated economic, social, and environmental systems.

2.11.1 Overproduction

It is pointless to produce more than the customer demands or producing it too early before it is needed. This upturns the risk of uselessness and the risk of producing the wrong thing (Capital, 2004). It tends to lead to excessive lead and storage times. In addition, it leads to excessive work-in-process stocks which result in the physical dislocation of operations with consequent poorer communication (Hines and Rich, 2007).

2.11.2 Defects

Physical defects directly add to the costs of goods sold and this may include errors in paperwork, late delivery or generation of unnecessary scrap (Capital, 2004). When

defect occurs, rework may be required. Generation of defects will not only waste material and labour resources, but it will also create material shortages, hinder meeting schedules, create idle time at subsequent workstations and extend the manufacturing lead time (Rawabdeh, 2005). Increasing the number of defects paves way for the produce consume loss. In addition, repairing defective parts increases transportation efforts.

2.11.3 Inventory

Inventory imply having unnecessarily high levels of raw materials, works-in-process and finished products. Extra inventory leads to higher inventory financing costs, higher storage costs and higher defect rates. (Capital, 2004). Inventory leads to increase lead time, prevents rapid identification of problems and increase space requirements. Inventory ought to be eliminated in order to get effective purchasing (Rawabdeh, 2005). Raw materials inventory for a long time increases defects. Hence, high levels of inventory entail more transportation between the store and the production floor.

2.11.4 Transportation

Unnecessary transportation ought to be eliminated to reduce cost and this includes moving materials between workstations. It must be noted that the more a product is transported, it is more likely to have higher delays or increase in damage. Transportation between processing stages results in prolonging production cycle times, the inefficient use of labour and space (Capital, 2004). Any movement in the firms could be viewed as waste. Double handling and excessive movements are likely to cause damage and deterioration with the distance of communication between processes (Hines and Rich, 2007). Insufficient transportation methods and unsafe

transportation equipment's increase the probability of production defects. In addition, improper handling of the products may cause parts damage.

2.11.5 Waiting

Waiting is the idle time for workers or machines due to inefficient production flow on the factory floor. Waiting includes small delays between processing of units (Capital, 2004). When time is being used ineffectively, then the waste of waiting occurs. This waste occurs whenever goods are not moving or being worked on. Waiting time for workers may be used for training or maintenance activities and should not result in overproduction (Hines & Rich, 2007). Waiting of parts in work-in-process inventory may cause unnecessary motion of workers and machines. This may be due to lack of material in warehouses or failure of machinery for processing.

2.11.6 Motion

Motion includes any unnecessary physical movements or walking by workers which divert them from actual processing work. This might include walking around the factory floor to look for a tool, or even unnecessary or difficult physical movements, due to poorly designed ergonomics, which slow down the workers (Capital, 2004). Waste of movement should be eliminated as it involves poor ergonomics of production, where operators have to stretch, bend and pick up when such actions could be avoided (Rawabdeh, 2005). Unnecessary moving has negative effects as this can cause damage and injury to the operator.

2.11.7 Over processing

Over processing is unintentionally doing more processing of work than the customer requires in terms of product quality (Capital, 2004). Over-processing occurs in

situations where overly complex solutions are found to simple procedures. The over-complexity discourages ownership and encourages employees to overproduce to recover the large investment in the complex machines (Hines and Rich, 2007). Because of the higher production rate, the probability of raw materials defects increases. This also implies that there is an increase of waiting of semi-finished products between machines. Insufficient and improper processes lead to produce defects.

Table 2.7 Environmental impacts linked with manufacturing wastes

Waste Type	Environmental Impacts
Transports	• Energy and fuel used for unnecessary transports • Emissions from unnecessary transports
Waiting	• Potential material spoilage or component damage causing waste • Wasted energy from heating, cooling, and lighting during production downtime
Motions	• More packaging required to protect components during movement • Damage and spills during transport • Transportation of hazardous materials requires special shipping and packaging to prevent risk during accidents
Inventory	More packaging to store WIP • Waste from deterioration or damage to stored WIP • More materials needed to replace damaged WIP • More energy used to heat, cool, and light inventory space
Overprocessing	• More parts and raw materials consumed per unit of production • Unnecessary processing increases wastes, energy use, and emissions
Overproduction	• More raw materials and energy consumed in making the unnecessary products • Extra products may spoil or become obsolete requiring disposal • Extra hazardous materials used result in extra emissions, waste disposal, worker exposure, *etc.*
Defects	• Raw materials and energy consumed in making defective products • Defective components require recycling or disposal • More space required for rework and repair, increasing energy use for heating, cooling, and lighting

Source: The Lean and Environment Toolkit (2013)

2.12 Summary

This chapter has reviewed related literature concerning lean management practices as a strategy for sustainable utilisation of the wood resource. Some of the discussed issues in this chapter include concept of lean, waste generation and lumber recovery. The next chapter (chapter three) presents the methodology of the study.

CHAPTER 3 METHODOLOGY

3.1 Introduction

This chapter set out to give a description of how the research was executed, embracing all the activities and procedures undertaken during the study. It gives an insight of the research methodology that was adopted and how the information was collected and analysed. Aspects such as the research design, sample design, data sources and data collection instruments used are the focus of this chapter.

3.2 Research Design

A research design provides answers to what type of data should be collected to achieve research objectives, where the data should come from and how the data should be analysed so that research questions are answered. Research design can be found in many forms which include but are not limited to descriptive research, explanatory research and exploratory research.

3.2.1 Explanatory research

Kowalczyk, (2015) defined explanatory research as an attempt to connect ideas to understand cause and effect so that researchers can explain what is going on. Thus, explanatory research looks at how things come together and interact. In addition, Joy (2016) found that explanatory research is the research whose primary purpose is to explain why events occur to build, elaborate, extend or test theory. Joy (2016) adds that explanatory research allows the research to test very specific theories and make amends to previous theories.

3.2.2 Exploratory research

Exploratory research is not intended to provide conclusive evidence but helps scholars to have a better understanding of the problem (Saunders et al., 2012). They add that when conducting exploratory research, the researcher ought to be willing to change their direction as a result of revelation of new data and new insights. Sekaran and Bougie (2009) state that exploratory studies can be done where facts are known, but more information is needed. According to Kowalczyk (2015) exploratory research is defined as the initial research into a hypothetical or theoretical idea. This is where a researcher has an idea or has observed something and seeks to understand more about it. Thus, an exploratory research project is an attempt to lay the groundwork that will lead to future studies or to determine if what is being observed might be explained by a currently existing theory. Most often, exploratory research lays the initial groundwork for future research (Kowalczyk, 2015).

3.2.3 Descriptive research design

This research adopted descriptive research design because it allowed the researcher to collect a large amount of data from a sizable population of primary wood industry in Manicaland Province in Zimbabwe. It is a scientific method which involves observing and describing behaviour of a subject without influencing it in any way. Bishop, Richard and Boyle. (2017) states that descriptive research is resultant of non-experimental studies with the purpose of describing characteristics of a phenomenon. This design was appropriate for this study because it described what was happening at the present moment and this was in alignment with the study objective of investigating the degree of sustainable utilization of the wood resource among Zimbabwean primary wood industry. The researcher adopted descriptive research design because it provided

accurate and valid representation of the factors relevant to the research. The approach further allowed the researcher to collect primary and secondary data which was used to come up with meaningful conclusions and recommendations.

3.2.4 Research Philosophy

This research adopted both quantitative and qualitative methodologies. Positivist (quantitative) and phenomenological (qualitative) research constitute the two major research philosophies. According to Van Wyk (2017) states that quantitative research methods are usually associated with deductive approaches (based on logic), while qualitative research methods are usually associated with inductive approaches (based on empirical evidence). According to Greene (2007) the use of a combination of qualitative and quantitative data can improve an evaluation by ensuring that the limitations of one type of data are balanced by the strengths of another. It is against this background that this research study adopted both the qualitative and quantitative methodologies (mixed methods research).

3.2.5 Survey Research Strategy

For the purposes of this study, the researcher adopted survey. According to Egan et al (2015), a survey is a method of gathering data in a reliable method from participant. Survey research is therefore used to answer questions that have been raised, to solve problems that have been posed or observed, to assess needs and set goals, to determine whether or not specific objectives have been met, to establish baselines. The survey allowed the researcher to collect a large amount of data from a sizable population of economically. The survey method was used as it helped the researcher to investigate how lean management practices can be utilized as a strategy for sustainable utilisation of wood resource.

3.3 Population and Sample

3.3.1 Population

The entire group of people from which the sample might be drawn is the total population (Boyle, 2016) . Target population refers to the total collection of units about which the researcher wishes to make some inferences (Dudovskiy, 2015). It is therefore a full set of individuals from which study participants can be drawn from (Wilson, 2010). In this study, the population was made up of the three major primary wood industry companies operating in Manicaland Province in Zimbabwe that is Border timbers Ltd, Wattle Company and Allied Timber. (Timber Production Federation, 2019) stated that Border timbers Ltd, Wattle Company and Allied Timber constituted 2530 employees.

3.3.2 Sampling

Dudovskiy (2015) notes that sampling is a procedure in which a researcher selects a portion of the targeted population from which data for the study will then be gathered from. In most cases, researchers are faced with limited time and unavailability of other resources that are needed during the research process. The primary purpose of sampling is that by selecting some elements of a population, the researcher can draw conclusions about the entire population. To overcome these challenges, a small representative sample is often picked, and data will then be collected from that sample.

3.3.2.1 Sampling Techniques

Dudovskiy (2015) notes that there are two types of sampling techniques which can employed in the selection of a set of individuals who will participate in a study namely: probability and non-probability sampling methods.

- Probability sampling

The probability sampling technique include all selection where observations are to be included on a purely random basis from the population. Probability sampling techniques refer to sampling techniques in which the selection of participants is based on an orderly way (Saunders et al., 2012). Thus, a probability sample is one in which each element of the population has a known non-zero probability of selection. Examples of probability sampling methods according to literature include;

Simple random - a random sample is one in which each unit included in the sample will have certain preassigned chance of inclusion in the sample (Singh and Masuku, 2014).

Systematic- each member of the study population is either assembled or listed, a random start is designated, and then members of the population are selected at equal intervals.

Stratified- is obtained by separating the population elements into overlapping groups, called strata, and then selecting a simple random sample from within each stratum (Latham, 2007).

Cluster- each member of the study population is assigned to a group or cluster, then clusters are selected at random and all members of a selected cluster are included in the sample (Latham, 2007).

- Non-Probability sampling

The probability of each case being selected from the total population is not known and it provides a range of alternatives techniques to select samples based on your subjective judgment (Saunders et al., 2009).

Table 3.1 Non-probability sampling techniques

Type of sampling	Description
Haphazard/convenience	Involves the selection of cases based on their availability for the study.
Quota	Interviewers select a sample that yields the same proportions as the population proportions on easily identified variables.
Purposive/ judgmental	Involves the selection of cases that judged to represent similar characteristics.
Snowball	Group members identify additional members to be included in the sample.

Source: Latham (2007)

This study used non-probability sampling method. In non-probability sampling, the probability of each case being selected from the total population is not known and it provides a range of alternatives techniques to select samples based on your subjective judgment (Saunders, Mark, & Bezzina, 2016). The non-probability sampling techniques that were used in this study include convenience sampling and purposive sampling. Convenience sampling involves the choice of participants centered on their disposal for the study (Carson, Richard, Groves, & List. 2014). Convenient sampling was used because it was a relatively inexpensive way of getting a sufficient number of respondents and was a fast way of selecting respondents. On the other hand, purposive or judgmental sampling involves the selection of cases that are judged to represent similar characteristics (Carson et al, 2014). This technique was utilized because it allowed the researcher to select the primary wood industries operating in Manicaland Province that enabled the researcher to answer research objectives. Therefore, the

researcher used discretion and judgment to choose the respondents that had the information that could help in the study.

3.3.3 Sample Size

Cohen, (2015) states that a sample is a division of the whole population in a given area. Wilson (2010) defines sample size as the aggregate of all individuals who take an active role during a research. Determining this sample size is very important during a research since the precision of findings seem to depend heavily on the sample size from which data for a study was collected (Saunders et al., 2012). The researcher arrived at the sample size by taking a sample which was slightly below half of the population so that generalisation of finding would be feasible. The researcher adopted Slovins Formula to get sample size. Because it was not possible to study an entire population (such as population of all primary wood industry companies in Manicaland Province in Zimbabwe), a smaller sample was taken using a random sampling technique. Slovin's formula allows a researcher to sample the population with a desired degree of accuracy. Slovin's formula gave the researcher an idea of how large the sample size needed to be to ensure a reasonable accuracy of results.

Slovin's formula is written as:

$n=N\div (1+Ne2)$

Where n = Number of samples, N = Total population and e = Error tolerance.

For the purposes of this study, the researcher used Timber Production Federation 24th Annual General Meeting information that Board Timbers Ltd, Wattle Company and Allied Timbers showed a total number of 2530 of employees. For this survey, a margin

of error of 0.05 was considered sufficiently accurate. Using Slovin's formula, the required sample survey size equals n=N÷ (1+Ne2) primary wood employees:

n=2 530÷ (1+2 530 x0.05x0.05)

n= 2530÷7.3

n = 346

The sample size for the study consisted of 346 primary wood employees.

3.4 Data Collection Instruments

Data can either be primary or secondary. Bryman and Bell (2007) distinguish between primary and secondary data. Saunders et al. (2012) aver that secondary data refer to the use of data that was collected to solve some other problem other than the one in hand whilst primary data refers to the use of first-hand information that is collected by a researcher during the research process specifically to solve a problem in hand. Primary data originates directly from respondents who answer questionnaires and interviews whilst secondary research comes from other published researches that are already in the body of knowledge. This study used both primary and secondary data as depicted in Table 3.2.

Table 3.2 Sources of information for the study

Primary sources	Secondary sources
Questionnaires	Media (Internet, newspapers etc.)
	Journals, books, articles

3.4.1 Primary Data

Primary data is collected when the researcher notes what happened or what was actually said at the time. Aggarwal and Jorion (2009) postulate that primary data is gathered by the researcher from start to finish, directly from respondents.

The researcher adopted primary data because it is described as first-hand information and is original in nature. Aggarwal et al. (2009) also stated the advantages of primary data which include less likelihood of error because the researcher is gathering from original sources. Data is also unbiased, and it provides the researcher more control in data collection. Researchers normally collect primary data because data needed to solve a current problem might not be available from secondary sources and had to be gathered from the relevant people.

3.4.1 Research Instruments

Research instrument refers to the tools that are employed by researchers in collecting primary data (Teddlie, 2007). Questionnaires, interviews and participation observations are the most widely used research tools in collecting primary data for a research study. This study employed a questionnaire in gathering data from primary wood employees in Manicaland Province.

Questionnaires: The researcher designed questions and arrange them in a meaningful way to form what is known as a questionnaire. A questionnaire can be best defined as a file consisting of carefully constructed questions enclosing the subject which respondents should respond to (Saunders et al., 2012). The use of the questionnaire in this study followed the adoption of the descriptive research design in which a survey was employed in providing data that was used to examine lean management practices

as a strategy for sustainable utilization of wood resource. Questionnaires can either be open ended or close ended. An open-ended question is one which permits a free response for an individual while close ended questions also referred to as fixed alternatives, provides a set to which the respondent has to choose the answer from the provided alternatives, (Mathers et al. 2009). Questions from the questionnaire were designed in such a way that met the demands of this research. The researcher administered the questionnaires to primary wood industries in Manicaland Province. The researcher utilized both open-ended questions and closed ended questions.

Moreover, questions from the questionnaire were designed in such a way that met the demands of the research which aimed at understanding lean management practices as a strategy for sustainable utilization of wood resource. The researcher made use of questionnaires because it enabled the researcher to explain, in person, the purpose of the study and the importance of the potential respondent's participation when administering the questionnaires. The study made use of questionnaires since it allowed a large number of people to be reached relatively easily and economically. Responses in questionnaire were also relatively easy to analyse.

The questionnaire that was administered in the study consisted of two sections that is Section A and Section B. Section A covered the demographic information of respondents. Demographic characteristics such as age, gender and educational level were asked. Section B was structured in alignment to research questions in order to examine lean management practices as a strategy for sustainable utilization of the wood resource. The first objective sought to determine the extent of waste generation and lumber recovery in the Manicaland wood industry. The second objective sought to determine factors that caused excessive processing waste and low lumber recovery in the Manicaland wood industry. The third objective sought to look at the relationship

that existed between lean management practices and sustainable utilisation of the wood resource.

Sections B of the questionnaire consisted of items that respondents were asked to rate their responses. The responses on these items were measured on a 5-point Likert Scale. The ratings that were as follows: 1 indicate “Strongly Disagree”, 2 indicate “Disagree”, 3 indicate “Neutral”, 4 indicate “Agree” and 5 indicate “Strongly Agree”.

3.4.2 Secondary Data

Secondary data is data acquired from various literatures that is already in the body of knowledge (Burns & Bush, 2006). Secondary data is normally gathered through a desk research and primary data is collected from the relevant people through a field survey (Teddlie, 2007). Textbooks, journals, and newspapers are some examples of were secondary data is gathered.

The researcher adopted secondary data because it enabled the researcher to gain knowledge by viewing the research problem through the eyes of past and present scholars. Low cost was its main advantage whilst the ability to acquire information easily was also another advantage. This however can also be a problem as certain knowledge may become irrelevant over time. The validity of data had to be analysed were possible to ensure it is still applicable at this time. The researcher collected secondary data that contributed to solving the research problem adequately.

3.5 Pilot Study

According to Arain (2010), a pilot study is a mini version of a full-scale study or a trial run done in preparation of the complete study. Thus, the pilot study of the current research can therefore be defined as a pre-testing of the questionnaires. One of the

advantages of conducting a pilot study prior to the main research is that necessary changes can be made on the research instruments so that the main research will have minimal problems (Saunders et al., 2009).

3.6 Data collection procedure

Step 1: The researcher selected a sample of 346 representatives from the primary wood industries in Manicaland Province.

Step 2: The researcher explained to the respondents the purpose of the study and ask for their co-operation.

Step 3: The researcher distributed 346 questionnaires to the selected sample.

Step 4: The researcher asked the key participants to fill-in the questionnaires.

Step 5: The researcher collected the questionnaires from the respondents and thanked them for their participation.

Step 6: The researcher analysed the findings from the respondents using the Statistical Package for the Social Sciences (SPSS).

3.7 Analysis and Organisation of Data

The SPSS 16.0 version tool was used to analyze data in this study. The analysis of data comprised of descriptive statistics, regression, and correlation analysis. Data was presented as follows;

Information was presented in the form of two-way tables because it provided a more precise, systematic and orderly presentation of data in rows and columns. Two-way tables examine the relationships between the two categorical variables. Two-way frequency tables are especially important because they are often used to analyze survey

results. Tables were utilized for this purpose because they served as a clear and concise way of data presentation (Adams et al., 2008).

Information was also presented using graphical method so that findings could be clear as shown using charts and diagrams. The researcher struck a balance between data and theoretical commentary in order to provide a clearer meaning of the data (O'connor, 2011). This allowed results to be clearly explained using percentages, graphs and commentary. These in turn allowed for easy comparison of the data.

3.7.1 Reliability and Validity

3.7.1.1 Reliability

Reliability of measurement refers to its consistency, that is, the extent to which a measuring device produce the same results when applied more than once to the same sample under similar conditions. The research used the following types of reliability.

3.7.1.1.1 Test-retest reliability

Test-retest reliability is used to assess the consistency of a measure from one time to another. In order to measure the test-retest reliability, the same test was given to the same test respondents on two separate occasions.

3.7.1.1.2 Inter-rater reliability

Inter-rater reliability is the extent to which two or more individuals (coders or raters) agree. The researcher checked consistency of responses with the implementation of a rating system in the questionnaire.

3.7.1.2 Validity

Colson et al (2016) confirms that validity refers to the degree to which any measurement approach or instrument succeeds in describing or quantifying what it is designed to measure. Validity is the extent to which any measuring instrument measures what it is intended to measure (Thatcher, 2010). The research used the following types of validity in the questionnaire.

3.7.1.2.1 Content validity

Content validity regards the representativeness or sampling adequacy of the content of a measuring instrument. The researcher ensured that each research question was going to be represented in the questionnaire.

3.7.1.2.2 Criterion validity

Criterion validity is used to demonstrate the accuracy of a measure or procedure by comparing it with another measure or procedure which has been demonstrated to be valid. To this regard, the researcher used the questionnaire in a variety of situations in order to see how predictive it was.

3.7.1.2.3 Concurrent validity

Concurrent validity is a measure of how well a particular test correlates with a previously validated measure. Concurrent validity was checked by ensuring results of a new questionnaire were consistent with results of established measures.

3.8 Ethical Consideration

3.8.1 Informed consent

Before carrying out the research, the researcher informed the respondents about the reason for conducting the research through a consent form. The participants were allowed to voluntarily participate in the study. No coercion or duress was used in the study. In addition, the respondents had absolute freedom of choice of whether to continue with the research or not.

3.8.2 No harm to participants

In the consent form the researcher ensured the respondents that there was no harm because of participating in the research. The researcher strongly emphasised that the information from the study was purely for academic purposes only.

3.8.3 Confidentiality and anonymity

Confidentiality was maintained throughout the study. The researcher had a non-disclosure of confidential information agreement with the participants. Real names of the participants were not used.

3.8.4 Permission

The researcher asked for permission before conducting the research from the relevant authorities and respondents. The respondents were asked to sign a consent form before taking part in the study as an indication that they were agreeing to participate.

3.9 Summary

This chapter has discussed and justified the research methodology that was used in the study. The chapter outlined the research design, research strategies, target population, and the research instrument for the study. This study adopted descriptive research design. Both the qualitative and quantitative methodologies (mixed methods research) were adopted in this study. Furthermore, the survey was adopted as the overall research strategy in conducting the research. In this study, the population was made up of all employees in primary wood industries in Manicaland Province in Zimbabwe. Non-probability sampling techniques were used in this study. The proposed sample size for this study consisted of 346 participants. Moreover, this study used both primary and secondary data. Additionally, the researcher used questionnaires for the purposes of this study. The SPSS 16.0 version tool was used to analyse data in this study. The next chapter (chapter 4) present and analyse data collected.

CHAPTER 4 DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter presents and analyze data collected from the research. The chapter provides responses obtained from the distribution of questionnaires to employees in primary wood industries (Border timbers Ltd, Wattle Company and Allied Timber) in the Manicaland province of Zimbabwe. From its 'discussions, the study generated purely quantitative data. The discussions used questionnaires to gather data from the targeted population. The purpose of this analysis was to present, analyse and interpret data from the mass of collected data. The research findings were linked to the research questions and objectives of this research study. This chapter also presented response rate, demographics of the respondents and the research findings. The researcher adopted graphical presentations to present data.

4.2 Data Presentation and Analysis

4.2.1 Response Rate

Response rate was the level at which the targeted sample responded to the administered research instruments. Table 4.1 shows the response rate of the participants.

Table 4.1 Response Rate

Description	Number of study subjects	Number of responses received	Response Rate (%)
Questionnaires	346	277	80

The response rate was calculated as follows:

$$\frac{\text{Absolute frequency}}{\text{Targeted frequency}} \times 100 = \text{Response rate}$$

A sample of 346 was chosen by the researcher. 346 questionnaires were given to employees in primary wood industries in the Manicaland province of Zimbabwe. Out of 346 distributed questionnaires, 277 were completely filled and returned. Questionnaire response rate was 80%. This implied that there was high questionnaire response rate. Fincham (2012) argued that response rates approximating 60% should be the goal of researchers.

The response rate was considered good and it justified the basis for making conclusions and recommendations on lean management practices as a strategy for sustainable utilisation of the wood resource in primary wood industries. That at most showed that the respondents were cooperative in the research thereby making it easier to generalise the finding of the research study on the population.

69 questionnaires out of 346 questionnaires were not responded to. The 69 questionnaires could not be answered due to time constraints and pressure at workplace in the wood industries for the respondents to attend to questionnaires, some were too reluctant to complete the questionnaires and others lost their questionnaires.

4.2.2 Gender of the respondents

For the purposes of this study, the researcher considered both males and females. Gender composition of the respondents is shown in figure 4.1.

Figure 4.1 Gender of the respondents

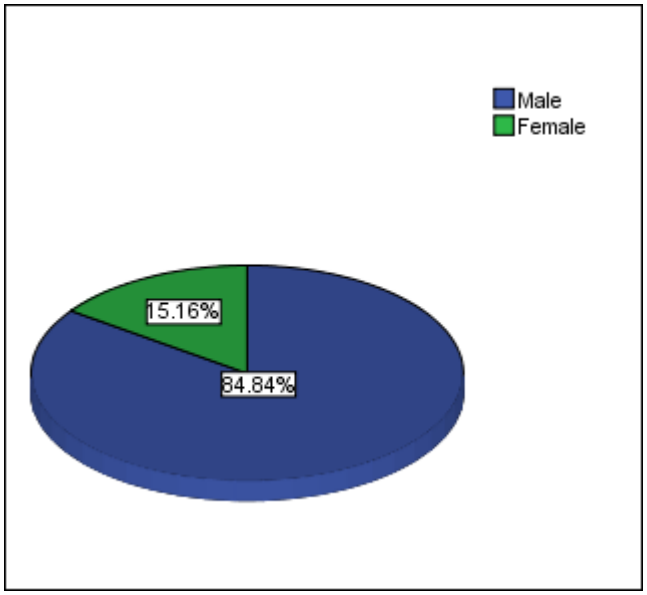


Figure 4.1 shows that males constitute 84.84% and females constitute 15.16%. There are more males than females working in primary wood industries in the Manicaland province of Zimbabwe. This distribution in terms of gender was necessary as the researcher was of the opinion that since sustainable utilisation of the wood resource was an important issue in wood industries, it was necessary to get the opinions of both males and females. Hence, it was necessary to strike a balance between the two.

4.2.3 Age of the respondents

Figure 4.2 shows age distribution of employees in primary wood industries in the Manicaland province of Zimbabwe. The participant's age ranged from below 30 to above 51years.

Figure 4.2 Age of the respondents

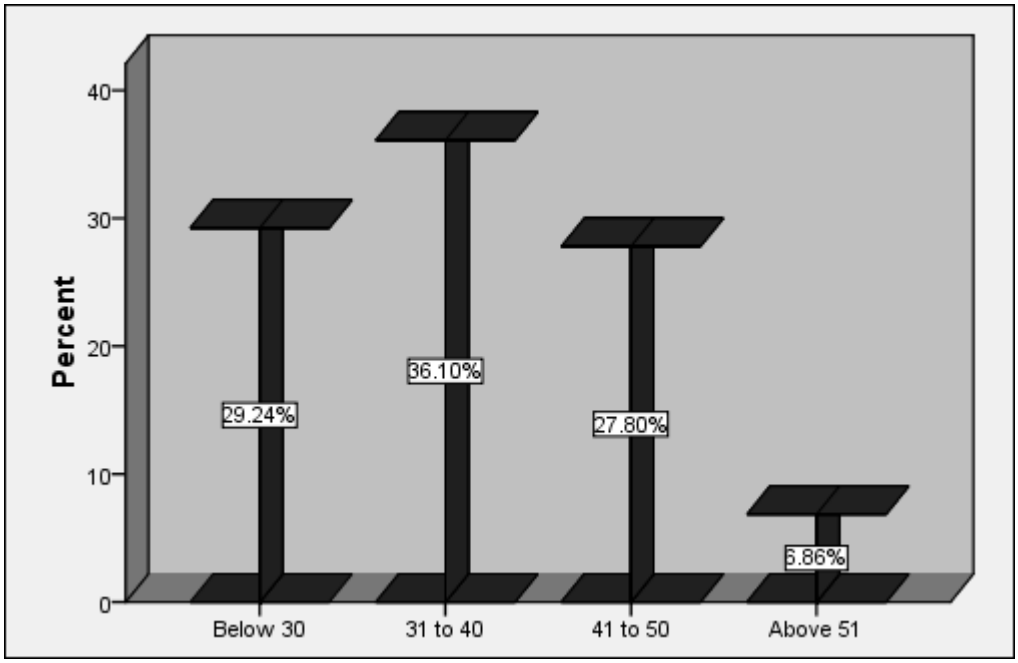


Figure 4.2 presents that 29.24% of the participants were in the below 30 years age group. 36.10% of the participants were in the 31 to 40 years age group. 27.80% of the participants and 6.86% of the participants were in the 41 to 50 years age group and above 51 years age group respectively. The findings imply that the majority of the participants (36.10%) were in the 31 to 40 years age group. Most probably the elderly would not get the time to fill in the questionnaire.

4.2.4 Educational Level

Educational level was the academic extent to which the participants would have accomplished. The study also sought to understand the education level of the participants as this influenced their understanding on Lean management practices as a strategy for sustainable utilisation of the wood resource. Educational level was divided from school certificate to doctorate. This is presented in figure 4.3.

Figure 4.3 Education level

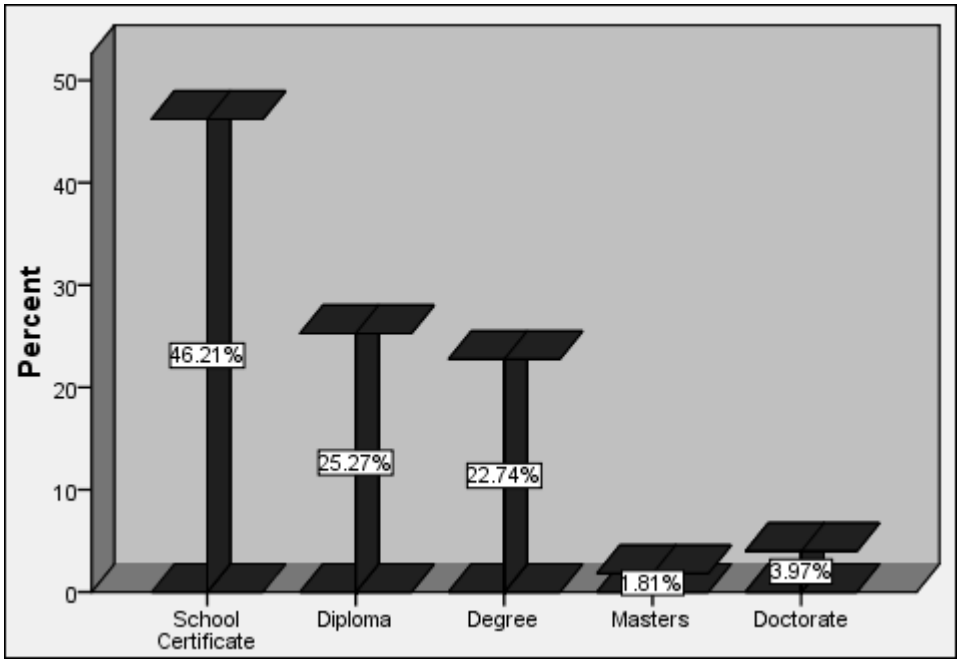


Figure 4.3 shows that 46.21% of the participants and 25.27% of the participants had school certificates and diploma respectively. 27.74% of the participants had degrees. 1.81% of the participants and 3.97% of the participants had masters and doctorate degrees respectively. The results imply that the majority of the participants (46.21%) had school certificates, followed by diploma (25.27%). The research findings indicated that the population in primary wood industries in the Manicaland province of Zimbabwe was made up well with educated participants who were capable of providing relevant information to the researcher.

4.2.5 Duration of employment

Duration of employment was the total number of years being served by an employee at an organization. The researcher sought to understand the duration of employment of the participants in order to analyse lean management practices as a strategy for

sustainable utilisation of the wood resource. The research findings are shown in figure 4.4.

Figure 4.4 Duration of employment

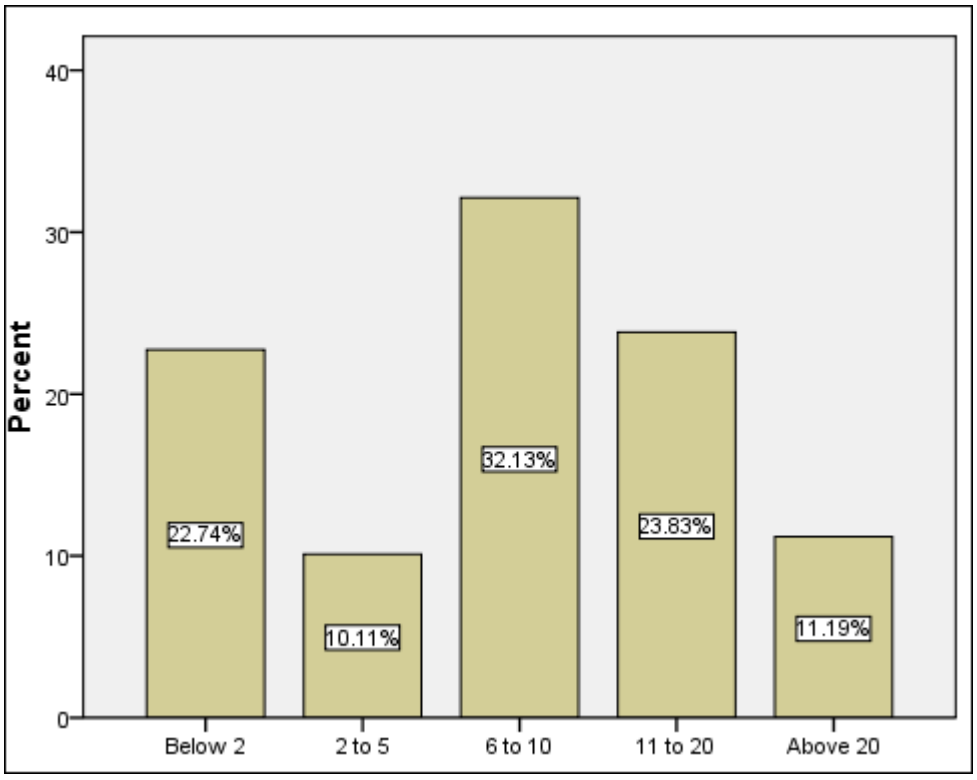


Figure 4.4 shows that 22.74% of the participants and 10.11% of the participants had below 2 years working experience and 2 to 5 years working experience respectively. 32.13% of the participants had 6 to 10 years working experience. 23.83% of the participants and 11.19% of the participants had 11 to 20 years working experience and above 20 years working experience respectively. The research findings indicated that most of the respondents (32.13%) had 6 to 10 years working experience in primary wood industries in the Manicaland province of Zimbabwe. The findings pointed out that the population of the study was made up of quite experienced staff.

4.2.6 Level of management

Level of management was the grade of supremacy of the employees at work. The researcher divided management levels into Non-managerial. Lower, middle and executive. The findings of level of management are presented in figure 4.5.

Figure 4.5 Level of management

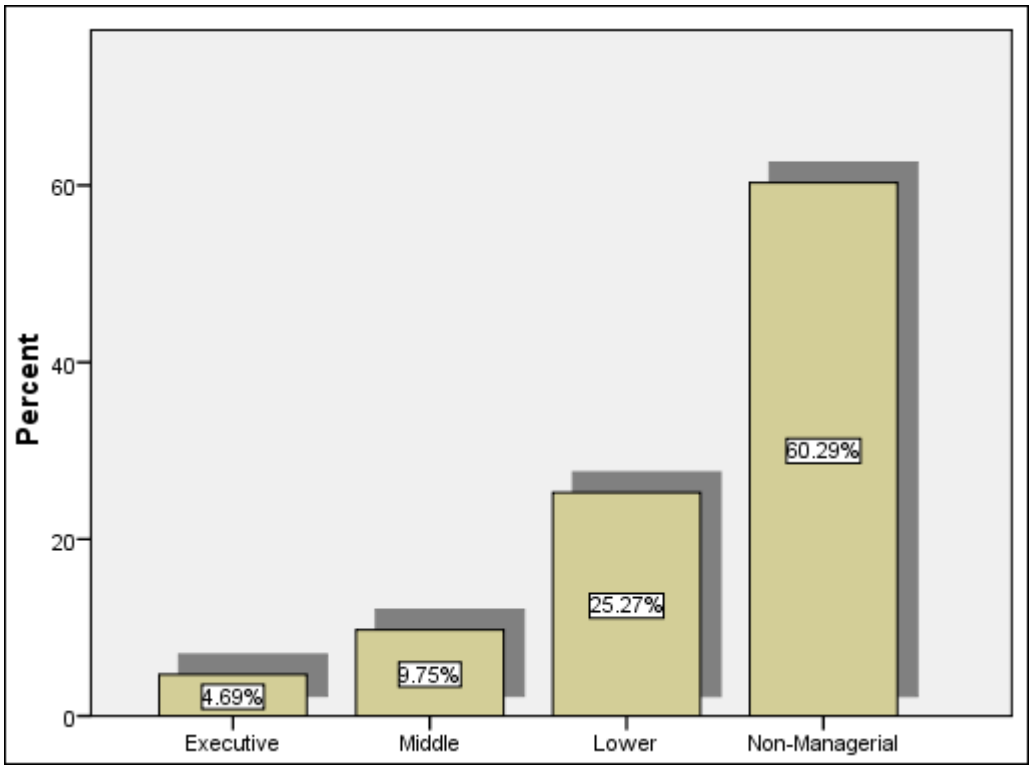


Figure 4.5 shows that 60.29% of the participants and 25.27% of the participants were in the non-managerial sector and lower sector respectively. 9.75% of the participants were in the middle sector. Only 4.69% of the participants were in the executive sector. The research findings indicated that the majority of the participants (60.29%) were in the non-managerial sector.

4.2.6.1 Department

Department represented the field area which participants work in the organization. Research findings are presented in Figure 4.6.

Figure 4.6 Department

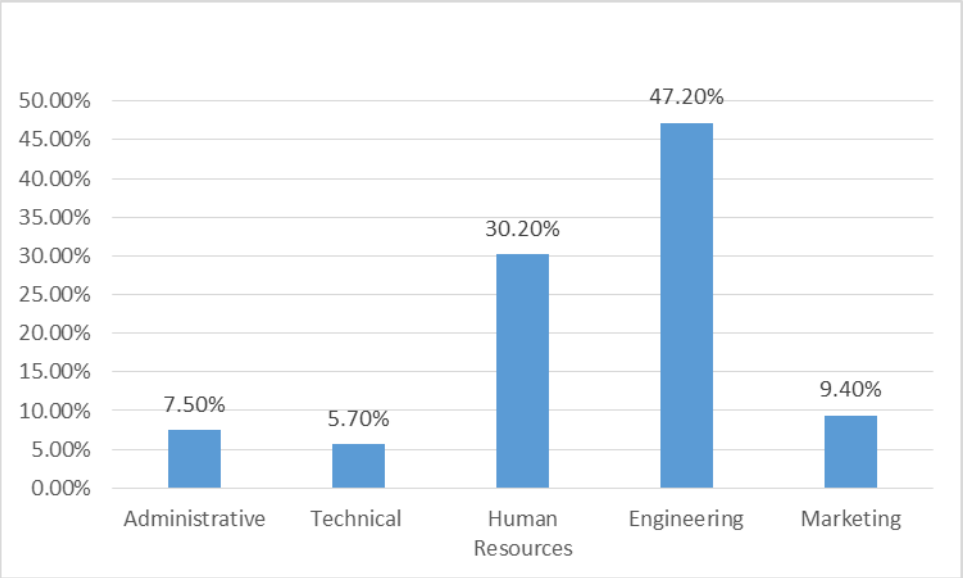


Figure 4.6 shows that 7.5% of the participants and 5.7% of the participants were in the administrative and technical department respectively. 30.2% of the participants and 47.2% of the participants were in the human resources department and engineering department respectively. 9.4% of the participants were in the marketing department. The findings indicate that most of the respondents (47.2%) were in the engineering department.

The participants further indicated their employment status in the questionnaires. The participants were indicated to be full time employed or part time contracted in their respective primary wood industries. Most of the participants were engaged in the primary wood industries as full-time employees.

4.2.7 Waste generation and lumber recovery in the Manicaland Wood Industry

The researcher in an attempt to get insight on the extent of waste generation and lumber recovery in the Manicaland Wood Industry asked the participants several questions which are as follows.

4.2.7.1 Wood consumers you produce for;

The researcher asked the participants to indicate the kind of wood consumers which the companies targeted. Research findings are presented in Table 4.2.

Table 4.2 Wood consumers

Item	Frequency
Building and construction	277
Furniture	5

Table 4.2 shows that all the participants indicated that they produced wood for building and construction. Furniture industry was almost non-existent with only 5 participants who indicated that they produced wood for furniture industry.

4.2.7.2 There is an organised waste generation and lumber recovery at your company

The researcher asked the participants to indicate the extent they agree that there was an organised waste generation and lumber recovery at your company. The responses are shown in figure 4.7.

Figure 4.7 There is an organised waste generation and lumber recovery at your company

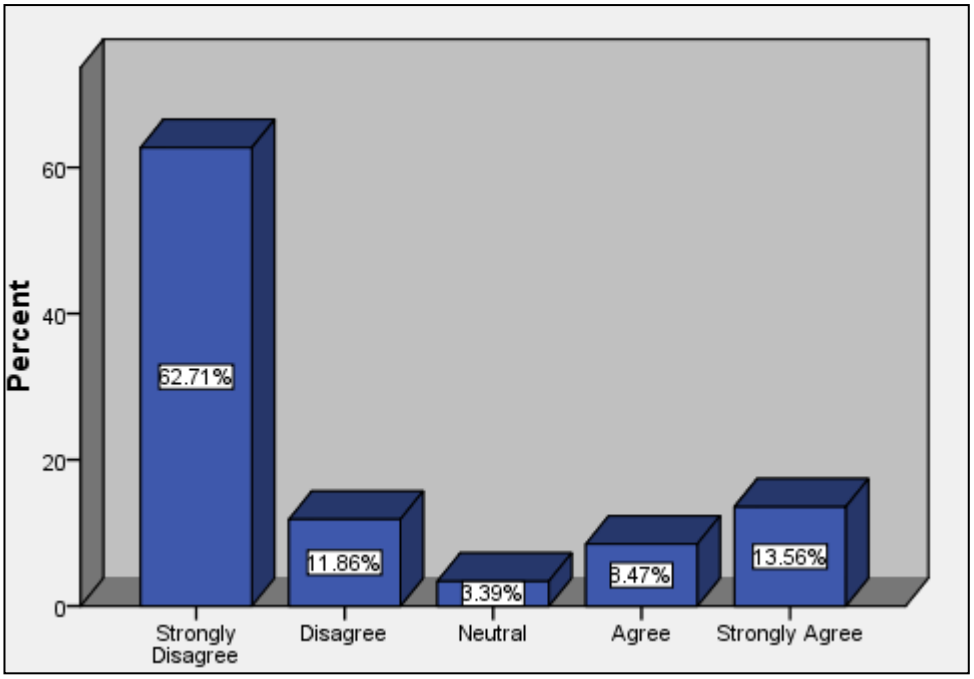


Figure 4.7 presents that 62.71% of the respondents strongly disagreed that there was an organised waste generation and lumber recovery at their company. 11.86% of the respondents disagreed there was an organised waste generation and lumber recovery at their company. 8.47% of the respondents and 13.56% of the respondents agreed and strongly agreed respectively that there was an organised waste generation and lumber recovery at their company. Only 3.39% of the respondents were not sure if there was an organised waste generation and lumber recovery at their company. The research findings indicate that most respondents strongly disagreed that there was an organised waste generation and lumber recovery at their company.

4.2.7.3 Recovery of lumber products from waste wood reduces the pressure to source the raw material (logs) from forests

Participants were asked to indicate the extent they agree that recovery of lumber products from waste wood reduces the pressure to source the raw material (logs) from our forests. The responses are shown in figure 4.8.

Figure 4.8 Recovery of lumber products from waste wood reduces the pressure to source the raw material (logs) from forests

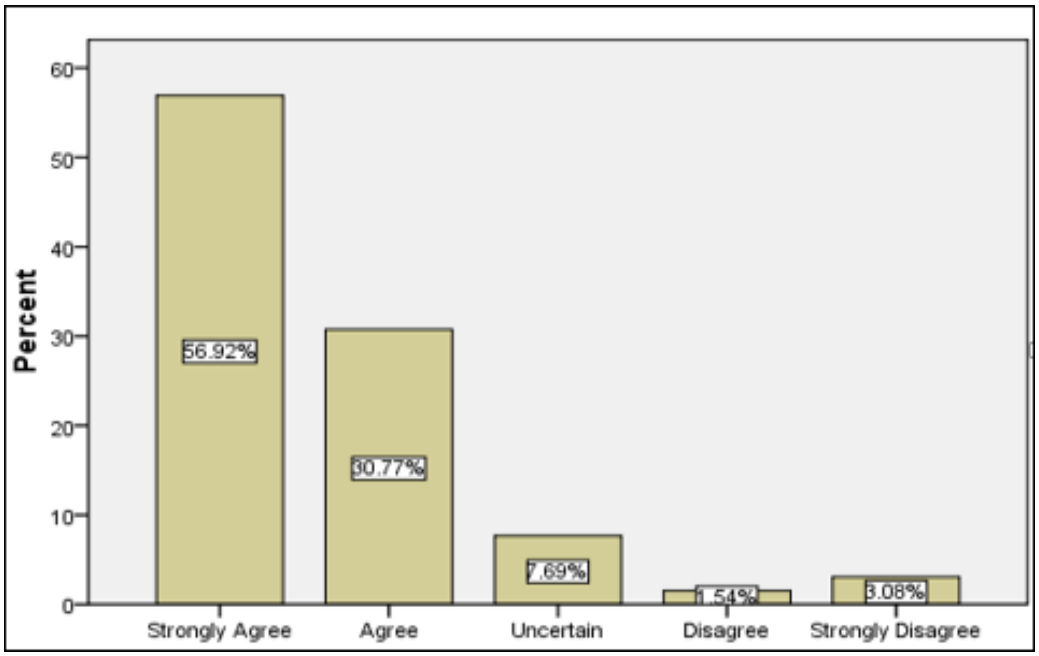


Figure 4.8 shows that 56.92% of the participants strongly agreed that recovery of lumber products from waste wood reduces the pressure to source the raw material (logs) from our forests. 30.77% of the respondents agreed that recovery of lumber products from waste wood reduces the pressure to source the raw material (logs) from our forests. 3.08% of the respondents and 1.54% of the respondents strongly disagreed and disagreed respectively that recovery of lumber products from waste wood reduces the pressure to source the raw material (logs) from our forests. 7.69% of the

participants' were not sure recovery of lumber products from waste wood reduces the pressure to source the raw material (logs) from our forests. The research findings indicated that the majority of the respondents (56.92%) strongly agreed that it was important to have recovery of lumber products from waste wood as it reduces the pressure to source the raw material (logs) from our forests. Research findings concured with literature as Dues et al (2013) argued that lean thinking focuses on reducing or eliminating all non-value adding activities within the supply chain.

4.2.7.4 The implementation of lean management practices will add value to your organisation

Participants were asked to indicate the extent they agreed that the implementation of lean management practices will add value to your organisation. Figure 4.9 presents the results.

Figure 4.9 The implementation of lean management practices will add value to your organisation

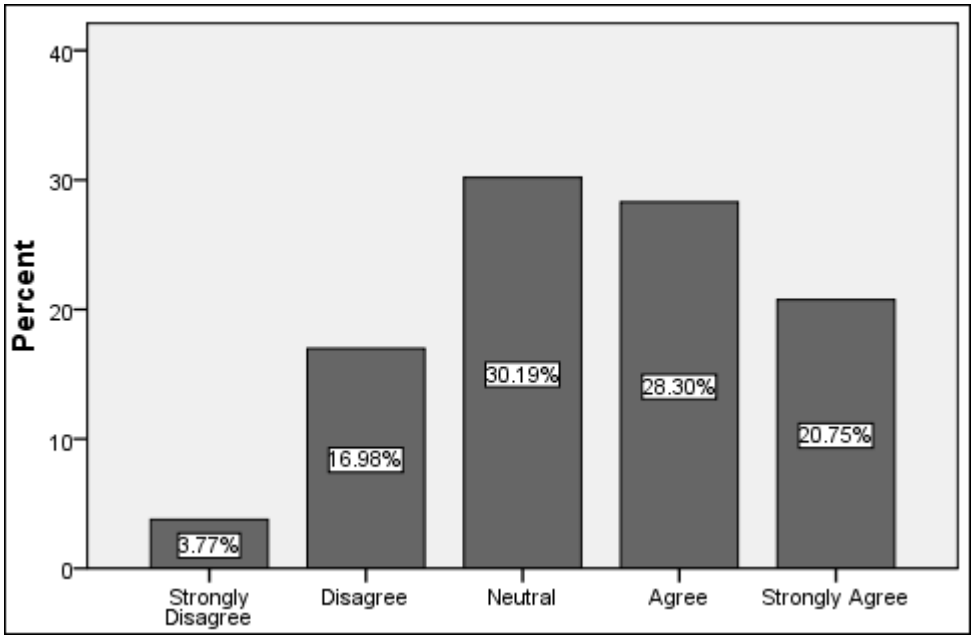


Figure 4.9 shows that 3.77% of the participants and 16.98% of the participants strongly disagreed and disagreed respectively that the implementation of lean management practices adds value to their organisations.30.19% of the participants were not sure if the implementation of lean management practices adds value to their organisations. 28.30% of the participants and 20.75% of the participants agreed and strongly agreed respectively that the implementation of lean management practices adds value to their organisations. The research findings indicated that the majority of the participants (30.19%) were not sure if the implementation of lean management practices will add value to their organisations. Research findings concured with literature as Castillo et al (2015) argued that maximising value within an organisation provided the right incentives to all employees to increase productivity and overall efficiency of an organisation.

4.2.7.5 Descriptive statistics for lean management practices

Participants were asked to indicate their level of agreement upon practices of lean management that need to be implemented at their organisations. Table 4.3 presents the research findings.

Table 4.3 Descriptive statistics for lean management practices.

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Eliminate waste of overproduction.	277	1	5	3.46	1.463	2.140
Eliminate waste of stock on hand (inventory).	277	1	5	4.22	1.076	1.157
Eliminate waste of time on hand (waiting).	277	1	5	3.89	1.239	1.535
Eliminate waste in transportation.	277	1	5	3.80	1.294	1.675
Eliminate waste of processing itself	277	1	5	3.93	1.061	1.126
Eliminate Waste of movement.	277	1	5	3.87	1.332	1.775
Eliminate waste of making defective products.	277	1	5	3.87	1.047	1.096
Valid N (listwise)	277					

Table 4.3 shows descriptive statistics on the practices of lean management, the statement “Eliminate waste of stock on hand (inventory)” had the highest mean score of 4.22. This was followed by the statement “Eliminate waste of processing itself”

with a mean score of 3.93. The statement “Eliminate waste of processing itself” had the lowest mean score of 3.46. Basically, it was important to note that all of the mean scores relating to lean management practices were in the high zone of approval.

4.2.8 Factors that cause excessive processing of waste and low lumber recovery in the Manicaland Wood Industry

The researcher sought to understand factors that caused excessive processing of waste and low lumber recovery and asked participants several questions.

4.2.8.1 Lean management practices eliminate zero-value activities

Participants were asked to indicate their level of agreement to the statement that lean management practices eliminated zero-value activities. Figure 4.10 shows the research findings.

Figure 4.10 Lean management practices eliminate zero-value activities

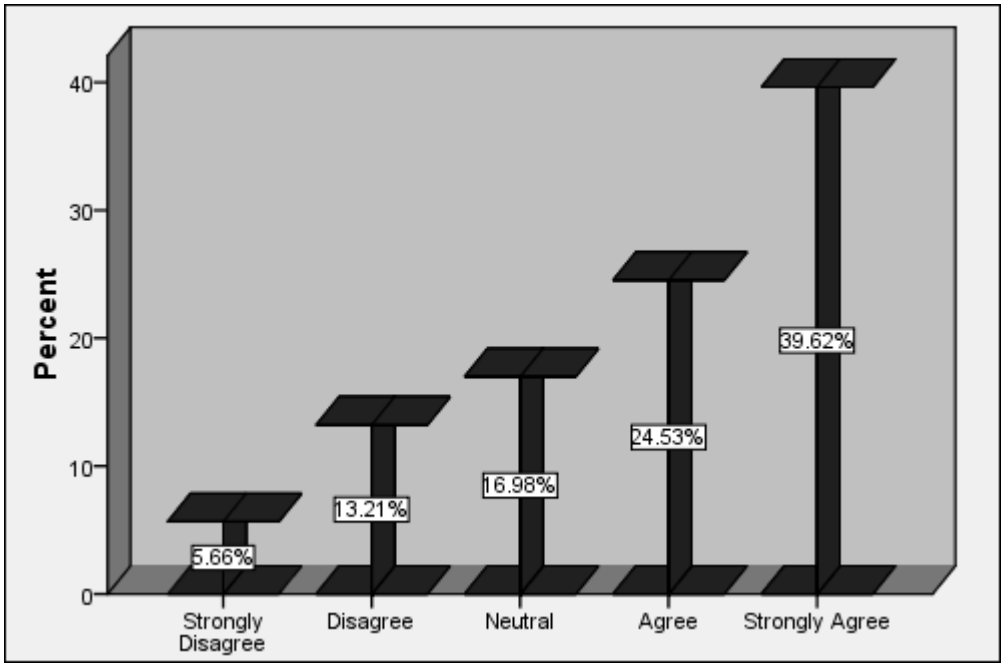


Figure 4.10 shows that 5.66% of the participants and 13.21% of the participants strongly disagreed and disagreed respectively that lean management practices eliminate zero –value activities. 16.98% of the participants were not sure if lean management practices eliminate zero –value activities. 24.53% of the participants and 39.62% of the participants agreed and strongly agreed respectively that lean management practices eliminate zero –value activities. The research findings indicated that most of the participants strongly agreed that lean management practices eliminate zero –value activities.

4.2.8.2 Causes of excessive processing of waste and low lumber recovery

The researcher asked the participants to indicate level of agreement on the causes of excessive processing of waste and low lumber recovery. Results are shown in Table 4.4.

Table 4.4 Descriptive statistics for causes of excessive processing of waste and low lumber recovery

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Lack of Training.	277	1	5	3.80	1.448	2.140
Poor Communication.	277	1	5	4.18	1.177	1.157
Log Size/Diameter.	277	1	5	3.54	1.132	1.535
Log Taper.	277	1	5	4.26	.926	1.675
Log defects.	277	1	5	3.32	1.363	1.126
Lack of Management commitment.	277	1	5	3.26	1.113	1.775
Lack of resources.	277	1	5	4.44	1.575	1.096
Log Wood Density.	277	1	5	3.62	1.237	1.497
Valid N (listwise)	277					

Table 4.4 shows descriptive statistics for causes of excessive processing of waste and low lumber recovery. The factor “lack of resources” had the highest mean score of 4.44. This was followed by the factor “log taper” with mean score of 4.26. Poor communication had a mean score of 4.18. The factor “lack of management commitment” had the lowest mean score of 3.26. Basically, it was important to note that all of the mean scores relating to causes of excessive processing of waste and low lumber recovery were in the high zone of approval. Literature concured with the research findings as Ofoegbu et al., (2014) stated that sawing method used, length of log and quality of logs affected recovery of lumber. Additionally, the results concured with literature as Ackah (2004) stated that poor quality of logs of contributed towards low lumber percentage recovery.

4.2.9 Relationship that might exist between lean management practices and sustainable utilisation of the wood resource.

The researcher sought to understand the relationship that might exist between lean management practices and sustainable utilisation of the wood resource. Participants were asked several questions which are as follows;

4.2.9.1 Attitude towards lean management practices and sustainable utilization of wood resource

The researcher sought to understand participants’ attitude towards lean management practices and sustainable utilization of wood resource. Feedback from the participants is presented in figure 4.11 below.

Figure 4.11 Attitude towards lean management practices and sustainable utilization of wood resource.

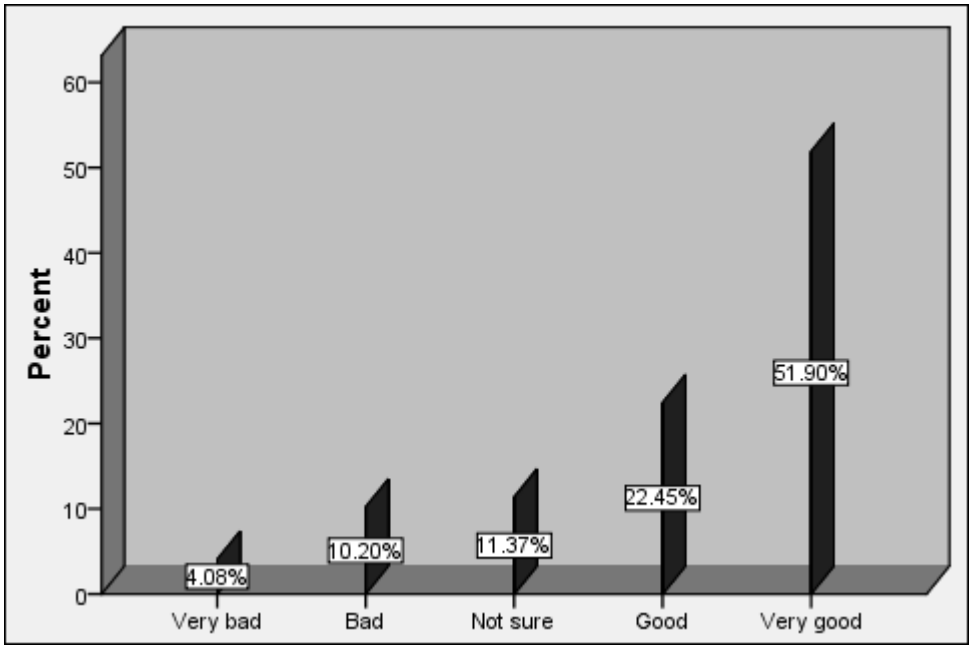


Figure 4.11 presents that 4.08% of the participants indicated that they have very bad attitude towards lean management practices and sustainable utilization of wood resource. 10.20 % of the participants indicated that they have bad attitude towards lean management practices and sustainable utilization of wood resource. 11.37% of the participants indicated that they were not sure if they have a positive or negative towards lean management practices and sustainable utilization of wood resource. 22.45% of the participants said that they have good attitude towards lean management practices and sustainable utilization of wood resource. 51.90% of the participants indicated that they have very good attitude towards lean management practices and sustainable utilization of wood resource. The research findings indicated that the majority of the participants (51.90%) have very good attitude towards lean management practices and sustainable utilization of wood resource.

4.2.9.2 Trained for sustainability utilisation of the wood resource

The researcher sought to understand whether participants have ever been trained for sustainability utilisation of the wood resource. The results are shown in figure 4.12.

Figure 4.12 Trained for sustainability utilisation of the wood resource

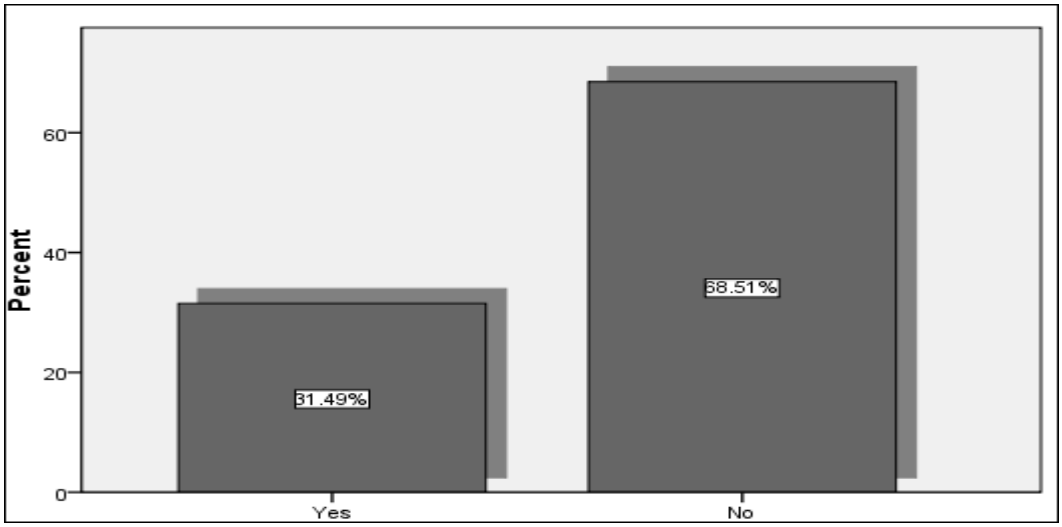


Figure 4.12 indicate that 31.49% of the participants have been trained for sustainability utilization of the wood resource. 68.51% of the participants have not been trained for sustainability utilization of the wood resource. The research findings indicated that most of the participants have not been trained for sustainability utilization of the wood resource.

4.2.9.3 The implementation of lean management practices will improve job performance.

The researcher wanted to understand whether the implementation of lean management practices will improve job performances of employees in their respective organisations. Responses to this are highlighted in figure 4.13.

Figure 4.13 The implementation of lean management practices will improve job performance

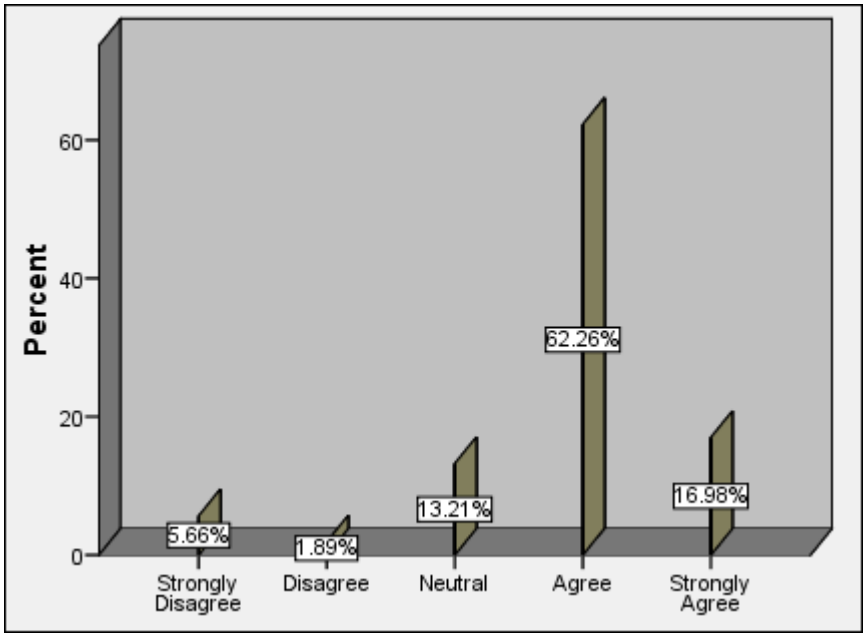


Figure 4.13 indicate that 5.66% of the participants and 1.89% of the participants strongly disagreed and disagreed respectively that the implementation of lean management practices improve job performance. 13.21% of the participants were not sure whether the implementation of lean management practices will improve job performance or not. 62.26% of the participants and 16.98% of the participants agreed and strongly agreed respectively that the implementation of lean management practices will improve job performance. The research findings indicated that the majority of the participants (62.26%) agreed the implementation of lean management practices improve job performance.

4.2.9.3 Adhering to lean management practices will ensure sustainable utilization of wood resource.

The researcher asked the respondents the extent they agree that adhering to lean management practices will ensure sustainable utilization of wood resource. The research findings are presented in figure 4.14.

Figure 4.14 Adhering to lean management practices will ensure sustainable utilization of wood resource.

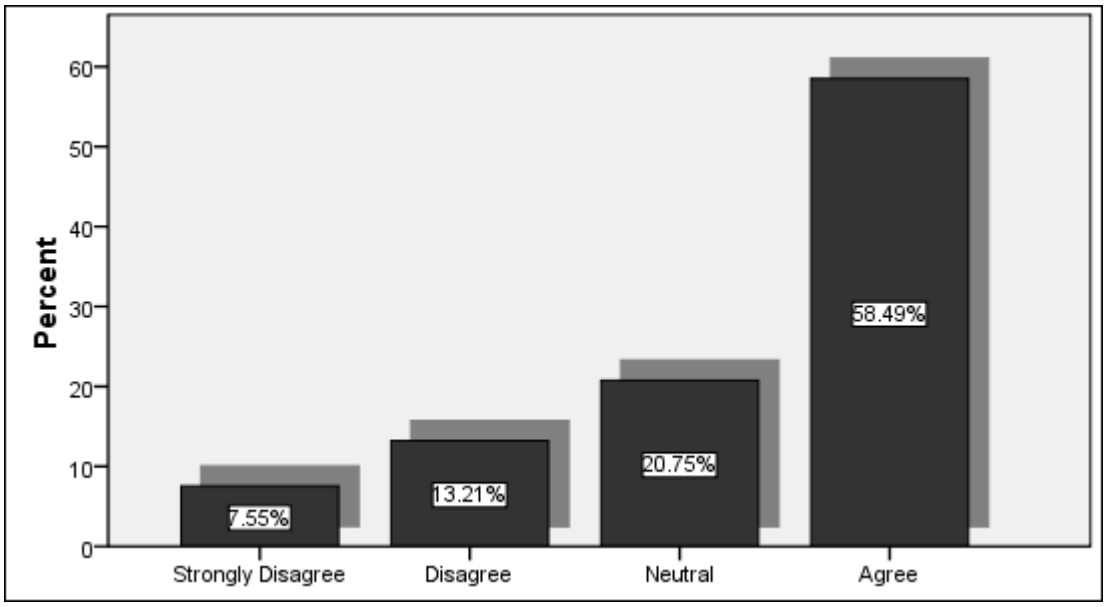


Figure 4.14 presents that 7.55% of the participants and 13.21% of the participants strongly disagreed and disagreed respectively that adhering to lean management practices ensures sustainable utilization of wood resource. 20.75% of the participants were not sure whether adhering to lean management practices ensure sustainable utilization of wood resource or not. 58.49% of the participants agreed that adhering to lean management practices ensure sustainable utilization of wood resource. The research findings indicated that the majority of the participants (58.49%) agreed that

adhering to lean management practices ensures sustainable utilization of wood resource.

4.2.10 Correlation analysis of lean management practices and sustainable utilization of wood resource

The researcher sought to conduct correlation analysis in order to understand the relationship between lean management practices and sustainable utilization of wood resource. The results are shown in table 4.5.

Table 4.5 Correlation analysis of lean management practices and sustainable utilization of wood resource

		Lean management practices	Sustainable utilization of wood resource
Lean management practices	Pearson Correlation	1	.956**
	Sig. (2-tailed)		.000
	N	277	277
Sustainable utilization of wood resource.	Pearson Correlation	.956**	1
	Sig. (2-tailed)	.000	
	N	277	277

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.5 presents correlation of lean management practices and sustainable utilization of wood resource (r=0.956), based on n=277 observations with pairwise non-missing values. It can be observed that the Pearson correlation coefficient for lean management practices and sustainable utilisation of wood resource .956, which was significant ($p < .001$ for a two-tailed test), based on 277 complete observations. These results imply that lean management practices and sustainable utilization of wood resource had a statistically significant linear relationship ($p<.001$). The direction of the relation was

positive meaning that these variables tend to increase together that is more lean management practices, the more there exist sustainable utilisation of wood resource.

4.2.11 Regression Analysis

In order to understand the impact of lean management practices upon sustainable utilization of wood resource, the researcher ran a linear multiple regression test using SPSS version. The findings from the regression model are tabulated in Table 4.6.

Table 4.6 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.967[a]	.935	.931	.332

Predictors (Constant). Eliminate waste of overproduction, Eliminate waste of stock on hand (inventory), Eliminate waste of time on hand (waiting), Eliminate waste in transportation, Eliminate waste of processing itself, Eliminate Waste of movement and Eliminate waste of making defective products.

The correlation coefficient r measured the strength and direction of a linear relationship between two variables. Table 4.6 shows that lean management practices (Eliminate waste of overproduction, Eliminate waste of stock on hand (inventory), Eliminate waste of time on hand (waiting), Eliminate waste in transportation, Eliminate waste of processing itself, Eliminate Waste of movement and Eliminate waste of making defective products) had a positive effect to sustainable utilisation of wood resource. From the findings, the correlation coefficient of lean management practices was estimated at r = 0.967. The adjusted R square coefficient of determination which showed the variation between in the dependent variable due to changes in the independent variable was R squared= 0.931. This showed that about

93% of participants indicated that lean management practices enhance sustainable utilisation of wood resource.

Table 4.7 ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	77.320	3	25.773	234.000	.000[a]
	Residual	5.397	49	.110		
	Total	82.717	52			

Predictors (Constant). Eliminate waste of overproduction, Eliminate waste of stock on hand (inventory), Eliminate waste of time on hand (waiting), Eliminate waste in transportation, Eliminate waste of processing itself, Eliminate Waste of movement and Eliminate waste of making defective products.

Dependent variable. Sustainable utilization of wood resource

Table 4.7 shows ANOVA[b] statistics. The table indicated that the regression model predicted the dependent variable significantly well. The regression model statistically significantly predicted the outcome variable (that is, it is a good fit for the data). F statistics (F = 234.000) and (Sig = 0.000). This showed that the whole model was significant. In other words, this meant lean management practices impacted positively on sustainable utilisation of wood resource.

4.2.12 Reliability tests cronbach's alpha

The researcher conducted reliability statistics in order to check whether the questionnaire was reliable or not. Research findings are presented in Table 4.8.

Table 4.8 Reliability statistics

	Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
Extent of waste generation and lumber recovery in the Manicaland Wood Industry	.730	.730	11
Factors that cause excessive processing waste and low lumber recovery in the Manicaland Wood Industry	.962	.962	10
Relationship between lean management practices and sustainable utilisation of the wood resource	.938	.938	4

The researcher had devised 11 questions with 5-point Likert scale to measure the extent of waste generation and lumber recovery in the Manicaland Wood Industry. Table 4.7 showed cronbach's alpha was .730 which showed that the questionnaire was reliable.

In an attempt to measure the factors that caused excessive processing waste and low lumber recovery in the Manicaland Wood Industry, the researcher had devised 10 questions. The results showed cronbach's alpha was .958 which showed that the questionnaire was reliable.

In addition, the researcher had devised a four-question to measure the relationship that might exist between lean management practices and sustainable utilisation of the wood

resource. The results showed cronbach's alpha was .938 which showed that the questionnaire was reliable.

4.3 Discussion and Interpretation

The research findings indicated that majority of the participants produce wood for building and construction. Primary wood industries do not have organised waste generation and lumber recovery at their company probably due to lack of knowledge or ignorance. However, the study indicated that participants are aware that it was important to have recovery of lumber products from waste wood as it reduces the pressure to source the raw material (logs) from forests. Participants indicated that lean management practices are important as they remove unwanted process. Research findings concurred with literature as Dues et al (2013) argued that lean thinking focuses on reducing or eliminating all non-value adding activities within the supply chain.

In addition, the study presents that excessive processing of waste and low lumber recovery was influenced by lack of training, log size and log defects. This implied that employees in primary wood industries process wood without sufficient care and knowledge towards sustainable utilisation of wood resource.

4.4 Summary

This chapter has presented and analysed research findings from the questionnaires. Several aspects of the research topic namely waste generation and lumber recovery, factors that causes excessive processing of waste and low lumber recovery were expressed. Data was presented through graphs and tables. Descriptive statistics, correlation and regression analysis of both independent and dependent variables under

study were conducted using SPSS software package. The next chapter (chapter 5) provides conclusions, recommendations and areas of further research.

CHAPTER 5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The preceding chapter has presented and analyzed the research findings. This chapter concludes the findings and provides recommendations. It is organized in alignment with the stipulated research questions. The study is also going to present areas of further research.

Chapter one of the study presented background of the study, statement of the problem, research objectives and research questions on lean management practices as a strategy for sustainable utilisation of the wood resource. In addition, the chapter also discussed significance of the study, delimitation of the study and limitations of the study. Chapter two reviewed literature from other researchers on the lean management practices as a strategy for sustainable utilisation of the wood resource. The chapter compared, contrasted and discussed ideas by other scholars from books, as well as published and unpublished literature. Some of the topics aired out include waste generation, lumber recovery, factors that causes excessive processing of waste and low lumber recovery as well as lean management practices. The researcher also used Woodward's (1965) contingency theory of organizational design as theoretical framework of the study. Chapter three discussed the research design, population, target population and sampling techniques, research instruments, data collection and data analysis. Data was collected using questionnaires from primary wood industries (Border timbers Ltd, Wattle Company and Allied Timber) in the Manicaland province of Zimbabwe. Data presentation and analysis, summary, ethical consideration and validity and reliability were also covered in this chapter. Chapter four looked at data presentation and analysis in line with key areas of the research guided by the

questionnaires administered to the target population of the study. Data was analyzed and presented through tables, graphs and summary analysis.

5.2 Discussion

5.2.1 Demographic Profile of Respondents

The research findings indicated that primary wood companies are being run by well-educated and knowledgeable people. It was also established that the majority of the employees are males. Additionally, the study revealed that most of the employees in primary wood companies have served for more than 6 years.

5.2.2 Waste generation and lumber recovery in the Manicaland Wood Industry

An interesting finding was that the majority of the participants indicated that they produced wood for building and construction. The study also revealed that most participants indicated that their companies lack an organised waste generation and lumber recovery system. Furthermore, respondents agreed that it was important to have recovery of lumber products from waste wood as it reduced the pressure to source the raw material (logs) from forests. Respondents also indicated that the implementation of lean management practices will add value to organisation. All the participants agreed that elimination waste of overproduction, elimination of waste of stock on hand (inventory), elimination of waste of time on hand (waiting) are lean management practices.

5.2.3 Factors that cause excessive processing of waste and low lumber recovery in the Manicaland Wood Industry

The study found out that participants agreed that lean management practices eliminate zero-value activities. The study also revealed that lack of training, poor

communication, log size/diameter, log taper and lack of management commitment are some of the factors that cause excessive processing of waste and low lumber recovery in the Manicaland Wood Industry.

5.2.4 Relationship that might exist between lean management practices and sustainable utilisation of the wood resource

The research findings indicated that most of the participants have got a positive attitude towards lean management practices and sustainable utilization of wood resource. Majority of the participations were not sufficiently trained for sustainable utilization of the wood resource. Most respondents noted that the implementation of lean management practices enhance job performances. The research findings indicated that there was a positive correlation between lean management practices and sustainable utilization of the wood resource. This study clearly showed that lean management practices could be effectively applied to improve the sustainability of wood resource.

5.3 Conclusions

5.3.1 Waste generation and lumber recovery in the Manicaland Wood Industry

There was excessive waste generation and low lumber recovery in primary wood companies in Manicaland province of Zimbabwe. The participants lacked sufficient knowledge and understanding on how to reduce excessive waste generation and lumber recovery in wood processing.

5.3.2 Factors that cause excessive processing of waste and low lumber recovery in the Manicaland Wood Industry

Lack of training, log size or diameter, log taper and log wood density were some of the factors that caused excessive processing of waste and low lumber recovery. Hence, primary wood industries were failing to sufficiently take note of log taper or log size in wood processing.

5.3.3 Relationship that might exist between lean management practices and sustainable utilisation of the wood resource

There was a positive relationship between lean management practices and sustainable utilization of wood resource. The study found out that lean management practices have got a positive linear relationship with sustainable utilization of wood resource.

5.4 Implications

This study contributed to the understanding of lean management practices as a strategy for sustainable utilisation of wood resource. The research provided empirical evidence on the relationship that exist between lean management practices and sustainable utilisation of wood resource. The study made use of questionnaires as a research instrument. Other studies can also adopt qualitative approach (interviews) for data collection to understand lean management practices as a strategy for sustainable utilisation of wood resource.

5.5 Recommendations

5.5.1 Waste generation and lumber recovery in the Manicaland Wood Industry

There was need for organisation waste generation and lumber recovery in wood industries. The study recommends that primary wood industries have a maintenance culture of the wood resource. Maintenance culture should be encouraged in sawmills as expected in a well-managed sawmill.

5.5.2 Factors that cause excessive processing of waste and low lumber recovery in the Manicaland Wood Industry

Organizations must adopt training practices to enhance sustainable utilization of wood resource. Cognate experience should be a major determinant in the appointment of headrig operators in sawmills. There should be a checklist to ensure that selected performance measures are useful to the organization.

5.5.3 Relationship that might exist between lean management practices and sustainable utilisation of the wood resource

The saw millers should be given technical advice on new conversion process regularly especially on small diameter logs in order to realize benefits of lean management practices. Participants have to understand that optimal volume yield can be achieved from every log by applying optimal sawing pattern, log rotation on the carriage and improved operators' expertise.

5.6 Suggestions for Further Research

Further research can also be conducted on the inclusion of employees in policies and sustainable strategies for utilization of wood resource. This study would be able to

provide insights into other sustainable ways of promoting sustainable utilization of wood resource since it would also offer insights into the challenges and experiences of employees in primary wood companies. Further study can also be done on the effect of log length on lumber recovery.

5.7 Summary

This chapter has summarized the research study on the analysis of lean management practices as a strategy for sustainable utilisation of the wood resource. This points out to the importance of lean management practices towards sustainability of wood resource in wood industries. Furthermore, the study also presented the findings, conclusions drawn from the study and provided recommendations on how primary wood companies industries (Border timbers Ltd, Wattle Company and Allied Timber) can enhance sustainable utilization of wood resource. The chapter also highlighted some of the areas for further research.

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APPENDICES

APPENDIX 1 Questionnaire Survey Instrument

Dear Participant

My name is Leopold Mhlanga. I am a final year student at Africa University. I am conducting a research in the study title:

Lean management practices as a strategy for sustainable utilisation of the woodresource. A case of primary wood industries in the Manicaland province of Zimbabwe.

I invite you to participate in this study by completing the attached questionnaire as honestly and objectively as possible. Your responses will significantly contribute to the research and will enable me to form an opinion as well as recommendations in my dissertation. The completed questionnaires will be collected by……/……/……. The information gathered will be treated in strict confidence and a summary of the results will be available on request. The questionnaire is anonymous as you are not required to fill in your name. Additionally, I assure you that any information you will provide shall be used for academic purposes only.

Your participation in this project is voluntary. You may refuse to participate or withdraw from the project at any time with no negative consequence. There will be no monetary gain from participating in this research project. It should take you about 20 minutes to complete the questionnaire. I hope you will take the time to complete the questionnaire and submitting it at your earliest convenience

For information you can contact me on 0774 445 094 or email on leopoldmhlanga@yahoo.com. I wish to thank you in advance for your cooperation and assistance in this exercise.

Thanking you in advance

_____

Leopold Mhlanga

Researcher (STUDENT)

Date……. **Questionnaire Code…….**

Instructions: Please fill in the following with the appropriate response to questions asked.

Section A: Demographics

Please select the appropriate category that best describe you by putting an X in the Mark column.

Variable	**Category**	**Mark**
Sex	Male	
	Female	
Age (Years)	Below 25	
	26 to 30	
	31 to 40	
	41 to 50	
	Above 51	
Education Level	School Certificate	
	Diploma	
	Degree	

	Masters	
	Doctorate	
Duration of Employment (years)	Below 2	
	2 to 5	
	6 to 10	
	11 to 20	
	Above 20	
Level of management	Non-Managerial	
	Lower	
	Middle	
	Executive	

SECTION B. KEY QUESTIONS

WHAT IS THE EXTENT OF WASTE GENERATION AND LUMBER RECOVERY IN THE MANICALAND WOOD INDUSTRY?

1. Which kind of wood consumers do you produce for?

   Carving industry [ ] Building and construction [ ] Furniture [ ] All of the above [ ]

   Other, please specify……

2. Do you agree that there is an organised waste generation and lumber recovery at your company?

   Strongly Disagree [ ] Disagree [ ] Not Sure [ ] Agree [ ] Strongly Agree [ ]

3. Do you agree that recovery of lumber products from waste wood reduces the pressure to source the raw material (logs) from our forests?

   Strongly Disagree [ ] Disagree [ ] Uncertain [ ] Agree [ ] Strongly Agree [ ]

4. Do you believe the implementation of lean management practices will add value to your organisation?

   Strongly Disagree [ ] Disagree [ ] Not Sure [ ] Agree [ ] Strongly Agree [ ]

5. Please indicate your level of agreement to the following lean management practices that need to be implemented at your organisation.

Item	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
Eliminate waste of overproduction					
Eliminate waste of stock on hand (inventory)					
Eliminate waste of time on hand (waiting)					
Eliminate waste in transportation					
Eliminate waste of processing itself					
Eliminate Waste of movement					
Eliminate waste of making defective products					

WHAT ARE THE FACTORS THAT CAUSE EXCESSIVE PROCESSING WASTE AND LOW LUMBER RECOVERY IN THE MANICALAND WOOD INDUSTRY?

1. To what extent do you agree that lean management practices eliminate zero-value activities?

   Strongly Disagree [ ] Disagree [ ] Not Sure [ ] Agree [ ] Strongly Agree [ ]

2. Please show your level of agreement to the following causes of excessive processing of waste and low lumber recovery;

Item	**Strongly Disagree**	**Disagree**	**Not Sure**	**Agree**	**Strongly Agree**
Lack of Training					
Poor Communication					
Log Size/Diameter					
Log Taper					
Log defects					
Lack of Management commitment					
Lack of resources					
Log Wood Density					

WHAT IS THE RELATIONSHIP THAT MIGHT EXIST BETWEEN LEAN MANAGEMENT PRACTICES AND SUSTAINABLE UTILISATION OF THE WOOD RESOURCE?

1. What is your attitude towards lean management practices and sustainable utilization of wood resource?

   Very bad [ ] Bad [ ] Not sure [ ] Good [ ] Very good [ ]

2. Have you ever been trained for sustainability utilisation of the wood resource?

   Yes [ ] No [ ]

   If Yes, Please explain where;

   .....

   .....

   .....

3. Do you agree that the implementation of lean management practices will improve the way you do your job at your company?

   Strongly Disagree [ ] Disagree [ ] Not Sure [ ] Agree [ ] Strongly Agree [ ]

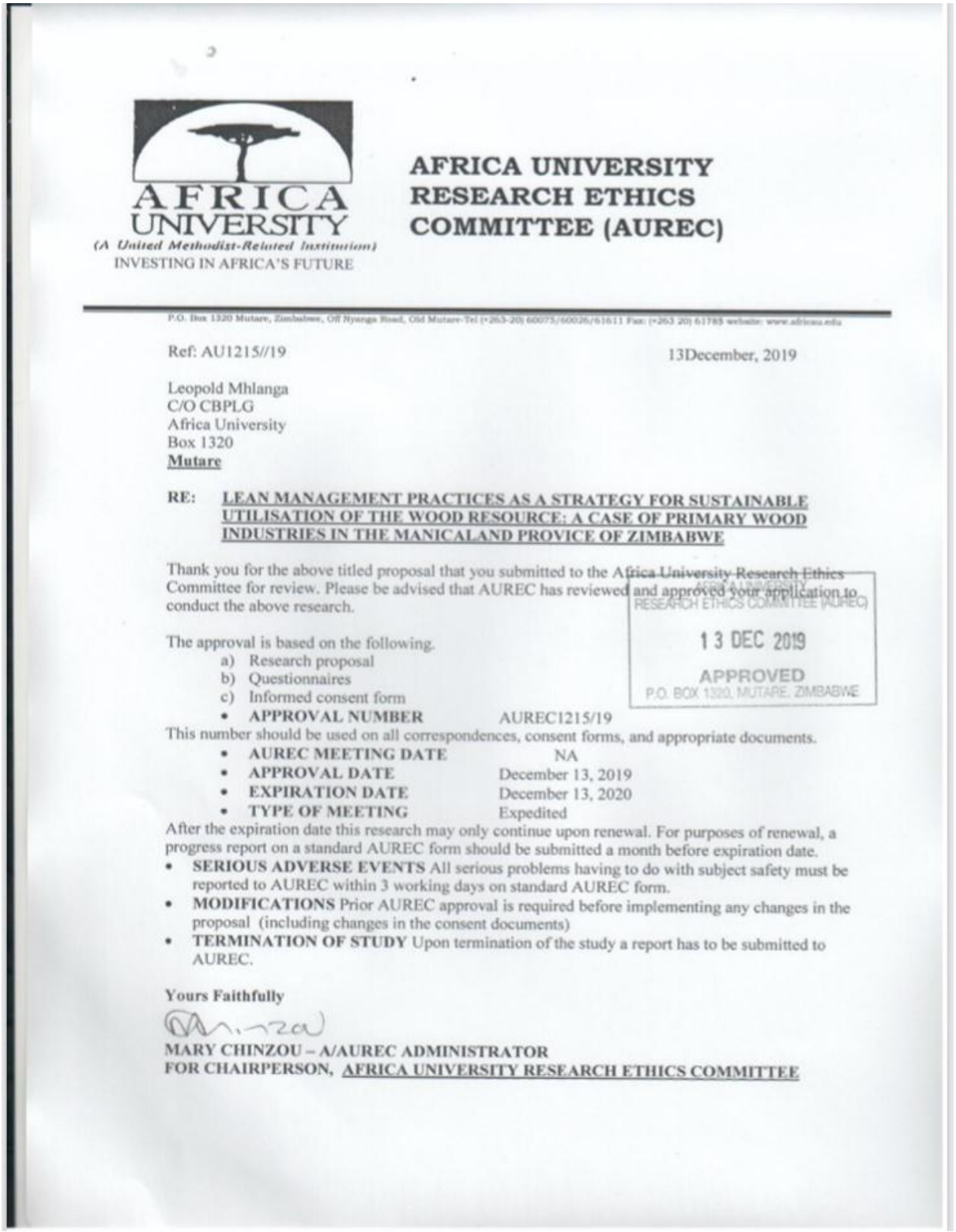
4. Do you think adhering to lean management practices will ensure sustainable utilization of wood resource?

   Strongly Disagree [ ] Disagree [ ] Not Sure [ ] Agree [ ] Strongly Agree [ ]

Thank you for taking your time to be a participant in this research.

THE END

APPENDIX 2. AUREC Approval Letter



AFRICA UNIVERSITY
(A United Methodist-Related Institution)
INVESTING IN AFRICA'S FUTURE

AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE (AUREC)

P.O. Box 1320 Mutare, Zimbabwe, Off Nyanga Road, Old Mutare-Tel (+263-20) 60075/60026/61611 Fax: (+263 20) 61785 website: www.africau.edu

Ref: AU1215//19

13December, 2019

Leopold Mhlanga
C/O CBPLG
Africa University
Box 1320
Mutare

RE: **LEAN MANAGEMENT PRACTICES AS A STRATEGY FOR SUSTAINABLE UTILISATION OF THE WOOD RESOURCE: A CASE OF PRIMARY WOOD INDUSTRIES IN THE MANICALAND PROVICE OF ZIMBABWE**

Thank you for the above titled proposal that you submitted to the Africa University Research Ethics Committee for review. Please be advised that AUREC has reviewed and approved your application to conduct the above research.

AFRICA UNIVERSITY
RESEARCH ETHICS COMMITTEE (AUREC)
13 DEC 2019
APPROVED
P.O. BOX 1320, MUTARE, ZIMBABWE

The approval is based on the following.

a) Research proposal
b) Questionnaires
c) Informed consent form

- **APPROVAL NUMBER** AUREC1215/19

This number should be used on all correspondences, consent forms, and appropriate documents.

- **AUREC MEETING DATE** NA
- **APPROVAL DATE** December 13, 2019
- **EXPIRATION DATE** December 13, 2020
- **TYPE OF MEETING** Expedited

After the expiration date this research may only continue upon renewal. For purposes of renewal, a progress report on a standard AUREC form should be submitted a month before expiration date.

- **SERIOUS ADVERSE EVENTS** All serious problems having to do with subject safety must be reported to AUREC within 3 working days on standard AUREC form.
- **MODIFICATIONS** Prior AUREC approval is required before implementing any changes in the proposal (including changes in the consent documents)
- **TERMINATION OF STUDY** Upon termination of the study a report has to be submitted to AUREC.

Yours Faithfully

MARY CHINZOU – A/AUREC ADMINISTRATOR
FOR CHAIRPERSON, AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE

APPENDIX 3. Plagiarism report