St. Mary's University

School of Graduate Studies

Institute of Quality and Productivity Management

The Effect of Manufacturing Wastes on Operational Performances of Bottled Water Manufacturing Industries: The Case of Asku PLC

By: Addisalem Wale

July, 2023

Addis Ababa, Ethiopia

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A Master's Thesis, St. Mary University, School of Graduate Studies of the Institute of Quality and Productivity Management in Partial Fulfilment of the Requirements for the Award Degree of Masters in Quality and Productivity Management

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DECLARATION

I hereby declare that the research work which is presented in this thesis titled “The Effect of Manufacturing Wastes on Operational Performances of Bottled Water Manufacturing Industries: The Case of Asku plc.” is original work of my own and has not been presented for a degree of any other university and all the resources of references used for this thesis have been duly acknowledged.

________________	________________	_____________
Addisalem Wale:	Signature	Date

ENDORSEMENT

This thesis has been submitted to St. Mary's University, School of Graduate studies for examination with my approval as a university advisor.

Abdu Abagibe (Ph.D) Signature:___________________________

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LIST OF ACCRONYMS

RCA: Root Cause Analysis

DMAIC: Define-Measure-Analyze-Improve-Control

SIPOC: Supplier Input Process Output Customer

SOP: Standard Operating Procedure

SPSS: Statistical Package for the Social Sciences

ASQ: Americans Society for Quality

BSC: Balanced Score Card

FSSC: Food Safety System Certification

ISO: International Organization for Standardization

LM: Lean Manufacturing

LSS: Lean Six Sigma

NVAA: Non Value Adding Activity

VA: Value Adding

SIPOC: Supplier, Inputs, Process, Output, Customer

TPS: Toyota Production System

YTD: Year to Date

SD: Standard Deviation

TPM- Total Productivity Maintenance

OP: Operational Performance

VSM: Value Stream Mapping

SW: Solid Waste

SWM: Solid Waste Management

MSW: Management of Solid Waste

ABSTRACTS

The study is aimed at investigating the effect of Manufacturing wastes on the operational performance of a bottled water industries in Ethiopia taking the case of Asku plc. To validate data through cross verifications, a triangulated measurement systems were employed including survey questionnaire, semi structured interview, observation and archival data collection. Both qualitative and quantitative methods of data collection were used. And also, reviewing documents and Interviews methods were applied to collect data. Out of 110 questionnaires distributed from employee of Asku plc using purposive sampling technique a total of 88 were returned. The finding of the study revealed that the all eight lean manufacturing wastes, were present in various forms within the company under examination. It is imperative for the company to take action and address these issues to remain competitive in today's market. The correlation analysis conducted has revealed a strong relationship between manufacturing waste and the operational performance of the company. The results of the regression analysis indicate that defects, overproduction, transportation, and excess inventory have a significant impact on at least one of the operational performance measures. It is clear that the manufacturing process and the management of waste have a direct effect on the overall performance of the company. By identifying and addressing the areas of waste, such as defects and overproduction, the company can improve its operational performance and ultimately increase its profitability. In conclusion, the correlation and regression analyses conducted have provided valuable insights on the effect of manufacturing waste on operational performance. Furthermore, the analysis of secondary data obtained from Asku plc Archives reveals a concerning trend of high material rejection rates within the company, currently standing at 9.3%. This high rate of rejection is indicative of a significant amount of manufacturing waste, resulting from defects in the production process. Upon further examination of the data, it becomes clear that the company is experiencing significant downtime due to a variety of factors with 80% of this downtime being attributed to blower machine breakdowns. The company's performance in the most recent budget year was recorded as 41.9%, 37.3%, and 34.6% on the three production lines. These figures highlight the significant impact that waiting due to material, power, and machine availability has on the company's operational performance and overall efficiency. In order to address these issues and improve operational performance the researcher has suggested both short term and long-term sixes that would dramatically lower the eight manufacturing wastes.

Key Words: Lean Manufacturing, Operational Performance, Manufacturing Wastes

CHAPTER ONE: INTRODUCTION

This chapter conferred with the introduction which entails about the background of the study, statement of the problem, research questions, objectives of the study significance, scope and limitation of the study, definition of basic terms used and structure of the thesis.

1.1 Background of the Study

Manufacturing waste is an inevitable aspect of industrial production. However, the issue of manufacturing waste is not only limited to its impact on the environment but also significantly affects operational performance in organizations. The mismanagement of manufacturing waste can lead to increased costs, decreased productivity, and lower employee morale. On the other hand, effective waste management can result in cost savings, increased efficiency, improved employee health and safety, and enhanced customer satisfaction. In lean manufacturing, waste goes beyond physical material and includes any extraneous step in the process that doesn't directly add value to the end product.

MacDufile and Helper, 1997, Claimed that "Waste is defined as anything that interferes with the smooth flow of production" Wastes highlighted in Toyota Production System were overproduction, waiting, conveyance, over processing, excess inventory, unnecessary movement, defects and unused employee creativity.

Lean Manufacturing model recognizes 8 types of waste within an operation; seven originally conceived when the Toyota Production System was first conceived, and an eighth added when lean methodology was adopted within the Western World Christina, G. (2019). Seven of the eight wastes are production process-oriented, while the eighth waste is directly related to management's ability to utilize personnel. The original seven wastes: Transportation, Inventory, Motion, Waiting, Overproduction, Extra-Processing and Defects. The 8th waste of non-utilized talent was later included in the 1990s after TPS was adopted in the Western World.

According to Womack et al., 1991, "Lean approach was first pioneered by Toyota. However, the concept was first appeared in a book named The Machine that Changed the World"; which mainly highlighted Japanese production methods as compared to traditional mass production systems.

Practice of lean manufacturing in a textile company in Sri Lanka shows implementation of seven lean production practices (identify waste minimization, defects minimization, cross-functional teams, continuous improvement, JIT and pull, information availability and employee involvement as a bundle of lean production practices) results in positive manufacturing plant outcomes. G.L.D. Wickramasinghe 2017. This empirical study also revealed the importance of the duration of lean production in operation in achieving higher levels of manufacturing performance. The empirical findings from this study support Womack and Jones (1996) that the adoption of lean production can only be achieved through time.

Findings have implications for practices of export-based textile and apparel producing countries from Asia, Latin and Central America, the Caribbean, Eastern Europe, and North Africa, which are competing intensively with each other for their market share in the global export-based textile and apparel production

The issue of manufacturing waste is of major concern in the case company Asku plc. This waste affects both operational performance and the environment. Therefore, this study aims to examine the various wastes in the case company Asku plc's production process and the effect of these wastes on operational performance.

1.2 Statement of the Problem

The manufacturing waste in various forms is currently the major challenge in the bottled water manufacturing sector in Ethiopia. Due to several factors, businesses are suffering from high cost of production. These rising production costs have even forced some companies to close down. The retail price of packaged water saw a 40 percent spike in less than a year, 2022 alone saw the closure of almost two dozens of water packaging industries, forcing over 3,000 people into unemployment. (source: The Reporter, By Misganawu Fentawu, April 8 2022). The news on Capital on June 3 2019 indicates that not all bottlers have raised their prices. As production costs rises, companies are unable to compete in the market, resulting in lower sales volumes.

Today, most bottling companies not focusing on how to minimize manufacturing waste in order to decrease production cost and increase sales volume by being competent in the market. The Case company Asku plc, that produce and sale Aquaddis, a well-known brand of bottled water also faces issues related to high manufacturing waste. Therefore, the purpose of this study is to identify significant production waste that have negative effect on operational performance and to identify the root causes.

Relevant previous research conducted at various manufacturing companies generally indicates that lean implementations have a positive impact on operational performance and thus increase productivity (Collar & Bradford, J Cristobal et al 2020). As lean is the tool to eliminate waste, the study reveals that the manufacturing wastes to have a negative impact on operational performance.

According to the study conducted by Cristobal, J. et al 2020, it was concluded that lean manufacturing tools reduce the level of waste generated in production and have a positive impact in the workplace. Although the previous studies show the relationship between lean and operational performance; the direct effect of manufacturing waste on operational performance not studied and there is no enough study conducted on the effect of manufacturing waste in bottled water industries The study conducted by Tadele Kummie's in 2021 on “Evaluation of manufacturing waste and their impact on operational performance” attempts to address the problem as it pertains to a single water bottling company and the study luck to investigate the major challenges in relation to waste management practices.

As seen on the Table 1 the amount of reject rate in the year 2015 at Asku plc is very high which exceed internally set standard . The data indicates that the case company suffer from large amount of reject rates in production processes. In addition, there are issues with high inventories of finished goods and raw materials due to potential future breakdowns and problems with Ethiopia's foreign exchange. Due to the aforementioned factors, conducting this research is timely, offer valuable insight, and will assist management in understanding how these waste affect their performance and in seeing alternative solutions to the issue. Therefore, more research has to be done on the bottlers of bottled water because of the aforementioned rationale. This study explored the effect of manufacturing waste on operational performance; namely; efficiency, cost effectiveness, quality, and delivery time of bottled water manufacturing companies. The study also incorporates management of solid wastes in the industry focusing on the case company Asku plc.

Table 1 - Material rejection Asku plc

2015 YTD reject rate of materials				
Item	**Preform**	**Cap**	**Label**	**Shrink film**
STD 1	4%	2%	2%	3%
Line 2	7%	4%	2%	2%
STD 2	4%	2%	2%	2%
Line 5	8%	5%	4%	1%
Line 6	6%	3%	2%	1%
Jar Line	0%	3%	1%	-

Source: Asku plc Management Report

1.3. Research Questions

Based on the background information and the problem statement discussed earlier the following research questions were formulated.

a) What are the major sources of the manufacturing waste in the Case company- Asku plc?

b) To what extent the manufacturing wastes affect company operational performance?

c) What are the underlying factors contributing to the existence of manufacturing waste within the company?

d) What are the challenges being faced in managing manufacturing solid wastes?

1.4 Objectives of the Study

Based on the background data and problem description presented in sub-sections 1.2 and 1.3 above, the research objectives are generated.

1.4.1 General Objective

The General objective of the study is to study the effect of manufacturing wastes on operational performance and to recommend suitable lean solutions to eliminate or significantly reduce manufacturing wastes.

1.4.2 Specific Objectives

1. To identify the major source of manufacturing waste in the case company.
2. To check to what extent manufacturing waste affect company performance
3. To determine the underlying factors contributing to the existence of manufacturing waste.
4. To identify challenges in managing wastes in the company

1.5 Significance of the Study

The study identifies eight manufacturing wastes in Ethiopian bottled water manufacturing companies and demonstrates lean thinking for identifying and reducing them. It helps management identify major wastes, root causes of existence of these manufacturing wastes, and provide appropriate lean tools to eliminate them and improve operational performance. The study can serve as a source for further studies on waste reduction strategies in the industry.

1.6 Delimitation of the Study

This study focused on the analysis of manufacturing waste and its impact on operational performance and was limited to one company, Asku plc, located in the Oromia region west of the Addis Ababa Special Region of Brayu city.

1.7 Limitation of the Study

The limitation of the study was data representativeness to generalize the result to other bottled water manufacturing industries. In addition, limited secondary data was available on quantifying the solid waste data disposed in the company by the type of waste category.

1.8 Definition of Basic Terms Used in the Study

The following key terms used in this document have been defined as follows to ensure common understanding among various stakeholders of this document.

Lean: Lean is defined as a set of management practices to improve efficiency and effectiveness by eliminating wastes. The core principle of lean is to reduce and eliminate non-value adding activities and waste (Source: ASQ).

Lean Manufacturing: Lean manufacturing, or lean production, is a system of techniques and activities for running a manufacturing or service operation. The techniques and activities differ according to the application at hand but they have the same underlying principle: the elimination or reduction of all non-value-adding activities and wastes from the business (Source: ASQ).

Operational Performance: Operational Performance (OP) refers to the process of measuring a firm's performance against standard or prescribed indicators of effectiveness, efficiency, and environmental responsibility such as, cycle time, productivity, waste reduction, and regulatory compliance (Source: Business Dictionary, n.d.)

Six Sigma: Six Sigma (6σ) is a set of techniques and tools for process improvement. It was introduced by American engineer Bill Smith while working at Motorola in 1986 (source: Wikipedia)

Lean Six Sigma: Lean Six Sigma is a process improvement approach that uses a collaborative team effort to improve performance by systematically removing operational waste and reducing process variation. It combines Lean Management and Six Sigma to increase the velocity of value creation in business processes (source: Wikipedia)

1.9 Organization of the Study

This thesis proposal has been organized into Five chapters. Chapter one introduces the background of study, statement of the problem, conceptual framework, significance of the study, objectives of the study, delimitation of the study, limitation of the study, and definition of basic terms. The second Chapter presents literature review that states the study matter, provides the background and context for the research problem. Chapter three is the research design and methodology, this chapter presents the research methods, source of data, sample and sampling technique, and method of data analysis.

CHAPTER TWO: REVIEW OF RELATED LITREATURE

2.1 Introduction

In this chapter the researcher is interested in concepts relating to the study objective that have been discussed by other academics in publications such as journals, books, websites, newspapers, and so on.

2.2 Theoretical

2.2.1- Lean Manufacturing Concept

Lean concept has been widely accepted in the service and manufacturing industries. Numerous literatures have reviewed the lean benefits and applications. The term lean was first coined by Krafcik (1988). Subsequently, Womack, Jones, and Roos (1991) used the term lean production to describe the Toyota production system (TPS). The term "lean process" in the literature has many definitions. Shah and Ward (2007) defined lean process as "an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing internal variability".

Hopp and Spearman (2004) defined lean as the production of goods or services that minimizes buffering costs associated with excess lead times, inventories, or capacity. McLaughlin (2019) claims that lean management is an organizational management strategy that upholds the idea of continuous improvement, a long-term strategy that methodically produces incremental, step-by-step adjustments in the process to increase productivity and quality. Lean management is a system of management created to increase productivity by reducing or eliminating waste Collar & Brandford (2012). Therefore, lean management refers to continual improvement through waste elimination. Lean Management strategies eliminate inefficient processes and allow businesses to become more productive. Businesses can employ Lean Manufacturing technology to develop a competitive advantage (Belekoukias, Garza-Reyes & Kumar, 2014). Reducing operational waste is the ultimate goal/aim of being lean and environmentally friendly, (Sarkis, 2012). As a result, the community and organizations both gain from the application of Lean Manufacturing (Negrao, et.el 2017). Lean manufacturing techniques include cost reduction, pollution reduction, and quality improvement (Street, Fliedner, & Mathieson, 2009). Managers are aware of a variety of wastes, such as excess production, waiting, storage, further refining, additional travel, and flaws (Endsley, Magill, &

Godfrey, 2006). JIT and Jidoka are two shorthand phrases that sum up the history of lean. Lean philosophy emphasizes waste minimization by offering inexpensive items (Vinodh & Joy, 2012).

The three core principles of lean manufacturing are:

(1) identification of value;

(2) elimination of waste; and

(3) the generation of smooth flow (Womack et al., 1990).

2.2.2 Waste in Lean Management Context

Waste is any activity that does not add value to what customer wants in the process along the value stream . The Lean Manufacturing model recognizes 8 types of waste within an operation; seven originally conceived when the Toyota Production System was first conceived, and an eighth added when lean methodology was adopted within the Western World. Seven of the eight wastes are production process-oriented, while the eighth waste is directly related to management's ability to utilize personnel.

The Eight Wastes of Lean Manufacturing

Overproduction – an example of waste in operations, producing extra product components before they are actually needed is a waste of time and resources.

Transportation – improving the efficiency of transporting materials from location to location can significantly aid in a factory's manufacturing waste reduction.

Motion – any unnecessary motion – including both movement of machine parts when they are in operation mode and employees walking around to do a task manually that could be automated – is considered a non-value-add and adds to waste.

Excess inventory – having more inventory than what's needed to fill existing orders could lead to high storage costs and other issues and is a sign that it's time to evaluate manufacturing waste management procedures.

Waiting – down time (i.e. when a machine isn't working and is awaiting maintenance or when waiting for raw materials to arrive) is an example of lean manufacturing waste and may be a result of poor planning or scheduling.

Over Processing – poor product design, lack of efficient communication and human error can all lead to extra steps taking place during the production process. This over-processing results in unnecessary waste.

Defects – a byproduct of defective products is wasted time and materials that could have been spent making a usable product. A manufacturing data collection system can help identify the root cause of the defects so that the problem can be fixed at the source.

Untapped Skill – not using employees' talents to their full capacity leads to a huge waste in operations, as company's lose out on potential ideas, skills and improvements.

2.2.3 The Relevance of Lean Management to an Organization

According to Demeter & Matyusz (2011), the importance of lean techniques is described as a concept that protects competitiveness and leads to improved performance. Demeter & Matyusz (2011), brings an argument about the benefits of lean which is basically reliant on concepts than practical phenomenon on the ground. The argument of tools selection is also very important. Tools such as; Kanban, the 5S, TPM, and SMED are commonly applied but it is always prudent to establish the relevance of the tool to the specific waste to be eliminated otherwise the organization risks applying an irrelevant tool (Pearce & Pons, 2013).

2.2.4 Operational Performance

Operational performance refers to the measurable aspects of the outcomes of an organization's processes, such as reliability, production cycle time, and inventory turns. Operational performance in turn affects business performance measures such as market share and customer satisfaction (Voss, Åhlström, & Blackmon, 1997). "Operational performance (OP) relates to the manufacturing plant's capabilities to more efficiently produce and deliver products to customers" (Zhu, Sarkis, & Lai 2008).

A performance measurement system plays an important role in managing a business as it provides the information necessary for decision-making actions and therefore it is essential to measure the right things at the right time in a supply chain. But firms often fail to maximize the benefits of lean strategies because they often fail to develop the performance measurement metrics needed to evaluate the improvement in effectiveness and efficiency (Gunasekaran et al., 2004).

2.2.5 Lean Manufacturing and its Impact in Operational Performance

Operational performance dimensions explored in various studies are cost, quality, flexibility, and reliability. Rahman et al. (2010) found that Just-in-Time, flow management, and waste reduction are significant regarding the operational performance. Inman & Green (2018) reported that the involvement of suppliers and customers is aimed at reducing all categories of waste from overall processes. Belekoukias, Garza-Reyes, and Kumar (2014) indicated the most significant impact of JIT on operational performance indicators: cost, reliability, quality response, speed, and flexibility. Implementing lean systems-based strategies improves organization adaptability by ensuring the product's versatility, manufacturing duration, and lead times. The performance of lean approaches eliminates waste from the manufacturing cycle, makes the movement of development more flexible, and reduces the lead-time (Bento, Schuldt & Carvalho, 2020; Belekoukias et al., 2014).

There is a positive relation, both direct and indirect, between LM Practices and Operational Performance. Inman & Green, 2018; Negrao et al., (2017). Piercy and Rich (2015) discovered that adopting lean can lead to sustainable results. Poor adoption, therefore, will lead to better environmental performance Negrao et al., (2017). The lean production practices have a positive effect on operational efficiency. Tourki (2010) argues that companies that embrace lean manufacturing have an advantage over others to thrive in the global economic climate.

2.3 Empirical Article review

The study conducted by Muhammad et. el (2021) on impact of lean manufacturing on operational performance at a textile industry reveals that companies cut wasteful processes and increase their efficiency by implementing lean strategies. The study was conducted on 122 textile firms using lean manufacturing technologies in Pakistan. The results of the study revealed that lean manufacturing practices significantly impact the operational performance of textile firms. The study's findings suggest that the involvement of customers, suppliers, and employees cause an increase in the operating performance of firms. Moreover, it is established that some lean manufacturing practices such as 5S, automation (Jidoka), Justin time (JIT), equipment layout, and continuous improvement (Kaizen) have a significant and positive effect on the operational performance of firms. The study's results show that lean production methods can be adopted to improve operating performance and competitiveness.

Another study by Rahman's. et.al.(2010) on Impact of lean strategy on operational performance: a study of Thai manufacturing companies indicate that all three lean constructs are significantly related to operational performance. The paper provides insights into the adoption of lean practices in an Asian context and using survey data as opposed to case studies, and provides further evidence that lean practices are significant in enhancing operational performance. A survey was conducted among the managers in the manufacturing industry in Thailand. The data was collected from 187 manufacturing companies in Thailand. The research examined the extent to which lean practices are adopted by manufacturing organizations and their impact on firms' operational performance. The results show that all lean constructs are significantly related to operational performance.

Another study conducted on the impact of using different lean manufacturing tools on waste reduction by Leksic, I. et.al (2020) revealed that Total Productive Maintenance, Poka-Yoke, Kaizen, 5S, Kanban, Six Big Losses, Heijunka, Takt Time, Andon, OEE, SMED, and KPIs are best waste management techniques.

Belekoukias, Garza-Reyes & Kumar (2014), discuss the benefits that an organization gets from implementing lean methods and tools to improve its operations and process. Their investigation was based on five lean practices which include; Just-In-Time (JIT), Automation, Total Productive Maintenance, Kaisen, and Value Streaming on their impact on the modern measures such as price, speed, reliability, and quality. They found that JIT and Automation pose the most significant impact on operational performance, while Kaisen, TPM, and Value Streaming pose lesser or even negative impact on operational performance.

2.4 Environmental and Social Issues due to Solid Waste Mismanagement

Environmental contamination due to solid waste mismanagement is a global issue. Open dumping and open burning are the main implemented waste treatment and final disposal systems, mainly visible in low-income countries. Navarro. F and Vincenzo. T (2019) review in their paper the main impacts due to waste mismanagement in developing countries, focusing on environmental contamination and social issues.

In developing countries, the management of Ssolid waste is worsened by unsustainable practices that improve the environmental contamination and the spread of diseases. In particular, the open dumping in uncontrolled sites, open burning of waste fractions and the mismanagement of the leachate produced in final disposal sites, are the main issues detectable Modak, P et.al (2015). The situation is worsened in areas with additional problems of high-density population, traffic, air and water pollution. Uncontrolled disposal in open spaces near water bodies are issues widespread in these contexts, which corresponds to public health issues Manaf, L.A et al (2009). Environmental contamination and social issues in developing countries due to SW mismanagement. Results show that the SWM system should be considered in an integrated manner in order to cope with the reduction of the environmental footprint and to improve the targets of the solid disposal system. There is a clear linkage between poor SWM and environmental and health issues.

The increase in production of plastics result high generation of plastic disposals and mismanagement of wastes are the main causes of environmental pollution and human health effects Beshir, A. et.al (2021). Plastic products and their wastes are a global problem, but with regional inconsistency. Plastic is burnt releasing toxic gases into the atmosphere, liberates hazardous halogens and pollutes air, harmful to internal nervous system, carcinogens, heart disease, aggravates respiratory ailments such as asthma and emphysema and cause rashes, nausea or headaches. Recently many researches were indicated that plastics brought miscellaneous effects on environment (Legesse Adane and Diriba Muleta , 2011)

Ethiopian government made a proclamation and signed international convection about solid waste management (SWM) in 2007. Unfortunately, the articles of SWM Proclamation were not included legal frameworks about plastic industries if they distributed low quality plastic for consumers and the product that is not labeled how it is biodegradable or not as well as necessary safety instructions T. Tadesse (2009).

The study of Beshir A. et.al. (2021) revealed that several types of plastic wastes were generated in Gode town. The study shows, the major generated plastic wastes in the study area were plastic bags/festal (46%), water and soft drink bottles (34%), household utensils (16%) and others (4%)

including plastic shoes, cooking oil and detergent containers. Plastic bags from different sources were presented in massive numbers and surplus as wastes most probably after a single use.

In Ethiopia several researches showed that plastic wastes were the major type of solid waste generated in some cities. Yohanis and Genemo (2015) were identified that from the total wastes generated in Jigjiga City, 28% of the wastes were plastic bottles and bags from both residential and commercial areas. Tesfaye [20] was identified 64 % of the total solid wastes in Addis Ababa city were non-biodegradable organic wastes. In Addition, the study done by Lema et. Al. (2019). indicated the type of wastes generated in Assela, Ethiopia includes; Plastic (34.8%), Food residual (31.4%), paper (30.3%), metal wastes (1%) and other wastes (2.5%).

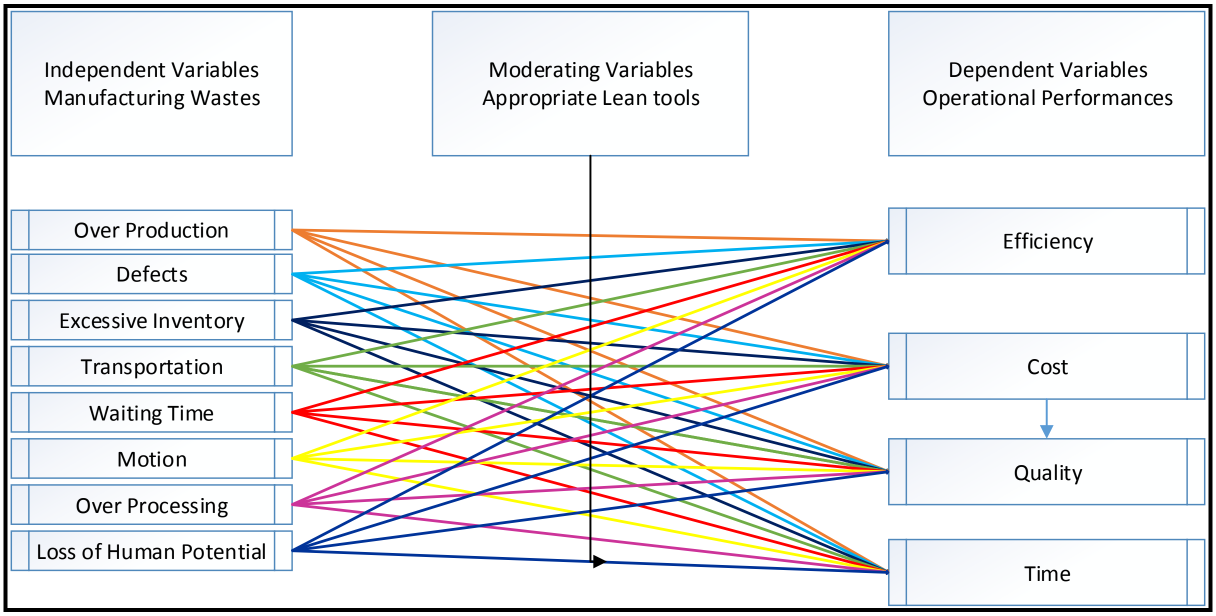
Manufacturers of water bottling and soft drink were identified as chief suppliers of polyethylene terephthalate (PET) plastic bottles to the environment which have toxic additives and causes cancer, impaired immunity, and endocrine disruption, developmental and reproductive effects. The study by E. Matiwos (2014) shows that the bottled water consumers gradually increased at home, work places and recreation centers as a replacement for of tap water regardless of careless on environmental effect after use.

Based on the reviewed literature, the majority of literature mentions the impact of lean manufacturing on operational performance. There are few literatures talking about impact of solid waste on environmental and health aspect of firm performance. Based on the results of the reviewed literature, we find common ground that cost, quality, efficiency, and time can be used as indicators of operational performance. According to the reviewed literatures above implementation of appropriate lean tools will have a positive impact on operational performance. Although the literatures reviewed are not done on impact of waste on operational performance, the result of the study on impact of Lean on operational performance indicate that there is a negative impact of manufacturing wastes on operational performance. Therefore, the study of impact of manufacturing wastes on operational performance is crucial. Because wastes are an inherent component of every manufacturing organization, appropriate lean tools can be applied to them to minimize its impact on operational performance. Appropriate lean tools will help the organizations to reduce or eliminate manufacturing waste of any type. The literatures also revealed plastic waste in bottled water company have environmental impact on environment and health. Bottled water companies have difficulties on collection and removal of this wastes which have a non-financial impact on firm performance.

2.8 Conceptual Framework

Conceptual framework illustrates the expected relationship between your variables. It defines the relevant objectives for your research process and maps out how they come together to draw coherent conclusions. Depending on their intended use, variables may be classified as independent, dependent Variables. Variables that explain other variables are called independent variables, those that are explained by other variables are dependent variables.

Figure 1 Conceptual Framework



Source: Self developed based on literature review

The eight manufacturing wastes (independent variables), as shown in the conceptual framework, are what cause a company's operational performance (dependent variables) to decline. However, by carefully choosing the right lean tools and making sure they are used effectively, the impact of those wastes can be removed or reduced. Incorrect application of lean strategies results in inefficiencies of an organization’s resources and reduced employee confidence in lean strategies (Marvel et al., 2009). Therefore, applying the appropriate strategy at the appropriate time for the right purposes is very important. The success of any particular management strategy normally depends upon organizational characteristics, which implies that all organizations should not or cannot implement a similar set of strategies in their particular case (Shah and Ward, 2003)

CHAPTER THREE: RESEARCH METHODOLOGY

This chapter discussed the methods used to collect and analyze data to effectively answer the research questions and fulfill the research questions. It includes research approach, data collection method and sampling technique, data gathering technique, data collection procedure, data analysis method, and data reliability and validity.

3.1 Background Information on Bottled Water Manufacturing

Introduction of bottled water was started in Ethiopia as Highland Springs brand by Apex Bottling Company in 1999, the sector has seen tremendous growth (Ethiopian Business review November 2013). A survey conducted by Ethiopian Central Statistics Agency (CSA) 2010/2011 discovered that about 51 soft drinks and bottled water manufacturing companies have been registered with a capital of ETB 1,106,223,000.00. Now, the around 110 bottled water producing plants are operational in Ethiopia, some of them at current status are forced to stop their operation due to several economical related issues.

“Producing and marketing bottled water is actually not as easy as many would think” says Adebabay. Like any other manufacturing business, water bottling industry needs the appropriate technology, correct installation of machines, well trained employees, an efficient and effective management system, and the right amount of energy. In Ethiopia, though bottled water business has started recently, many companies have invested on it. Initially, competitive advantages were taken from increased production volume, price reduction and proximity to large markets.

However, nowadays, those enablers seem to be no longer a competitive advantage as they have been achieved by many of them. The most important enabler has never been though-waste reduction. The concept is not well known by the sector as their immediate choice is implementation of ISO 9001 quality management and ISO 22000 food safety management standards. These standards are essential, but their effectiveness is arguable when policy and practice to reduce/ eliminate manufacturing waste are not integrated.

The case company Asku plc was established in Addis Ababa in 2015 to produce purified water in bottles and jars. It has three bottled water production lines and one Jar line with a total design capacity of 54,000 bottles of water per hour. The company has established and obtained international certification for quality and food safety management systems based on the requirements of ISO 9001:2015 and ISO 22000:2018 respectively. However, manufacturing waste has not been adequately addressed as material reject rate increased due to different reason which require management attention. Holding excess inventory due to the push production system, finished products have been overproduced and have been subject to quality deterioration due to prolonged storage. Some of the reasons were that the categories of production waste, such as movement waste, waiting waste, overwork waste, are not readily discernible by individuals unless revealed by research of this nature. In addition, the company's employees have misconceptions like holding large quantities of input materials is seen as a guarantee of ensuring business continuity, and overproduction (production Volume) is a basis for incentive system of employee.

This research has specifically explored the sources and effect of the manufacturing wastes on operational performance of bottled water industry. Research method, data sources, sample technics, data collection tools, data collection procedures, data analysis method, and ethical considerations are all introduced in this chapter.

3.2. The Research Approach

The purpose of this study was to investigate the effect of manufacturing waste on Asku plc's operational performance. There are three basic research approaches: quantitative, qualitative and mixed (Kothari, C.R. 2012). Depending on the research objectives, scientific research projects can be classified into three types of his: Exploratory, descriptive, explanatory Anol, B. (2012). In this study, a mixed approach using both qualitative and quantitative data was used and a descriptive research design was used. Surveys and document reviews are primarily used for data collection. In some fields, researchers use semi-structured interviews to gather additional information using canned questions. Appendix 1.

3.3 - The Research Design

This study used descriptive survey and mixed approach where a survey questioner, semi structured interview, observation and archive document review used to collect data. Descriptive analysis provides the opportunity to describe relevant aspects of manufacturing wastes and their impact on operational performance of bottled water manufacturing companies in Ethiopia.

Therefore, due to the nature of the study, which needs an accurate representation of the characteristics without any intervention and to show the relationship between manufacturing waste and operational performance it is the best to use a descriptive research method.

3.4. Data Collection Method

The data source on this study is primary data from Asku plc archive and secondary data. TO gather data from primary source survey questioner, semi structured interview and observation were used. The case company's archive document has been searched for secondary data. The instrument used in data collection is mixed approach (both quantitative and qualitative data collection instrument is used). A survey questioner of Likert scale was developed to use by the respondents. The questionnaires were developed based on a five-item Likert scale. Responses were given to each statement using a five-point Likert-type scale, for which 1 = "strongly disagree" to 5 = "strongly agree." The responses were summed up to produce a score for the measures. The researcher uses 2014 and 2015 annual report as a secondary data and analyzed.

3.5 Sample & Sampling Techniques

Sampling is a technique of selecting individual members or a subset of the population to make statistical inferences from them and estimate the characteristics of the whole population. The purposive sampling technique, also called judgment sampling, is the deliberate choice of a participant due to the qualities the participant possesses. the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience. Bernard, H. R. (2002). On this research a non-probability purposive sampling was used.

3.6.1 Population

The population of interest is the study's target population that it intends to study or treat. The main focus of this study is Asku plc. A total of 365 employees were present in the case company under study. The researcher uses purposive sampling method to determine sample size. The criteria used were based on employee's service year in the company, educational background and service year in operation. 123 employees are selected using purposive sampling as shown in table 2. The sample incorporate all departments of Asku plc such as: technical, production, quality, warehouse and supply managements. Managers, team leaders (heads), shift leaders, supervisors, maintenance and production planners, senior technicians, technical expats, from all three production lines at Asku plc were the target group.

3.6.2 Sample Size Determination

The table below shows the number of employee in a case company under study, a total of 365 employees were present in the company under study. And taking purposive sampling all positions starting from Operators are selected, the educational background of the respondents was decided to be minimum technical school diploma. Taking these criteria, the total number of population 154 as shown on Table 2 below. A simple random sampling method was used for the quantitative analysis and purposive sampling methods is used to select the representative respondents for interview. The simple random sampling ensures that each member of the population has an equal chance for the selection or the chance of getting a response which can be more than equal to the chance depending on the data analysis justification. In this study, both probability (simple random sampling) and nonprobability (purposive) sampling technique was used.

Table 2 Number of employee in a case company and samples

SN	Department	No of Employee	Samples	Remark
1	Plant Manager Office	3	1	
2	Quality	12	12	
3	Cleaners	27	0	
4	Production Coordination	3	3	
5	Line 2	39	15	
6	Line 5	42	15	
7	Line 6	45	15	
8	Jar	24	0	
9	Palletizing Unit	18	0	
10	Water Treatment	6	0	
11	Utility	9	10	
12	Production Planning	9	9	
13	Maintenance & Engineering	37	35	
14	Warehouse - FG	41	8	
15	Warehouse - RM	12	6	
16	Admin & Finance	38	25	
Total		**365**	**154**	

A simple random sampling method was used to select respondents for the study from purposively selected target population. Simple random sampling ensures that each member of the population has an equal chance being selected.

Cochran's sample size formula for categorical data is:

$$n = \frac{t^2\, p(q)}{d^2}$$

Source: James E. Baarttllettttt,2001

Where

n = initial Sample Size

t = value for selected alpha level of .025 in each tail = 1.96. (the alpha level of .05 indicates the level of risk the researcher is willing to take that true margin of error may exceed the acceptable margin of error).

(p)(q) = estimate of variance = .25. (maximum possible proportion (.5) * 1- maximum possible proportion (.5) produces maximum possible sample size).

d = acceptable margin of error for proportion being estimated = .05 (error researcher is willing to except).

Using this formula:

$$n_0 = \frac{(1.96)^2\,(0.5) * (0.5)}{(0.05)^2} = 384$$

Since the population is small (123), we can modify the sample size we calculated in the above formula by using this equation:

$$n_1 = \frac{n_0}{1 + n_0 / \text{Population}} = \frac{384}{1+384/154} = 110$$

Therefore, using simple random sampling technique the sample size was decided 93.

3.6. Data Gathering Tools

For this specific purpose a survey questionnaire, semi structured interview and observation was used to collect primary data. Secondary data is taken from management report of the year 2014 and 2015 Ethiopian calendar. The questionnaire is to evaluate and measure sources of wastes and their impact on operational performances in the case company. Hence the questionnaire used is an opened ended question and five-point scale evaluation mechanism to obtain the required information from the company. The Likert scale was positively and negatively worded ranging from 1, strongly disagree, to 5 "strongly agree" which was designed to be marked by the respondents.

3.7. Data Collection Procedure

For primary data collection survey questioner, Interview and observation was used. The procedure is listed as follows:

- Get Approval from the company top management to collect data
- Conduct meeting with employee to explain the purpose
- Distribute questioner and finally collect the filled questioner.

The company archive data for the for the year 2014 and 2015 in Ethiopian calendar has studied. After the data collected and checked for its cleanness the quantitative data were entered and analysis has been done using SPSS computer tool.

3.8 Methods of Data Analysis

The data was analyzed using Statistical Package for Social Sciences (SPSS) to accurately analyses the data collected. Frequencies, percentages, mean, standard deviations, was used for data analysis collected from questionnaire. To investigate the relationship between a dependent variable and an independent variable correlation (r) matrix were used.

Multiple Regression Analysis is a major statistical tool for predicting the unknown value of a variable from the known value of variables. Multiple linear regression models are reasonably the most important and extensively used multivariate statistical techniques in most relationship studies that involve ratio/interval variables. This model uses when there are two or more independent variables to predict the value of one dependent variable. The Model for this study was developed using eight independent factors (eight manufacturing wastes) or predictors which have influences on the effect four operational performance indicators (Cost, Quality, time and Efficiency). (Douglas Montgomery et al.., 2012). $Y = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 + \beta6X6 + \beta6X7$. Where Y is the dependent variable, β0 is the constant term/intercept, x1, x2,…x7 are the independent variables, β1,

$\beta 2 \ldots \beta 7$ are the slope coefficient of continuous variable and random error/ residual term. Qualitative data taken from interview and observation is organized and connected with quantitative data. Content analysis was used to analyses the qualitative data collected via interview and observation. The result of qualitative and quantitative data is integrated based on research questions, the quantitative data collected and analyzed was supported by the qualitative data collected via interview and Observations.

The data are presented and analyzed in such a way that they contain the most important information that can answer basic research questions in the best possible way, ensure the goals of the study and also show future implications of the study.

3.9 Ethical Considerations

The researcher has respected human dignity by not revealing the identity of the respondents in the study. The respondents have told that the information they provided will be kept confidential and that their identities would not be revealed in association with the information they provided. The target respondents are fully informed about the purpose, method, and intended possible uses of the research, what their participation in the research entails and what risks than informed consent were given for study participants. The confidentiality of information supplied and the anonymity of respondents were respected. Conclusions and recommendations reached on were not biased and purely based on the data collected and the feedbacks received from the respondents.

For the data collected from primary and secondary sources appropriate statistical tools were used. Goodness of our measurement instruments like: validity and reliability are sets of logical tests that was used in judging the quality of the result of a research. Cronbach's alpha is the most common measure of internal consistency ("reliability"). It is most commonly used when you have multiple Likert questions in a survey/questionnaire that form a scale and you wish to determine if the scale is reliable.

3.10.1 Reliability

Reliability concerns the extent to which a measurement of a phenomenon provides stable and consistent results (Carmines and Zeller, 1979). Reliability also concerns repeatability. According to Saunders (2003), reliability refers to the extent to which the data collection method or methods provide consistent results (J. Briony, 2006). SPSS software provides statistics for reliability analysis: Among the reliability models, Alpha (Cronbach) is used in this study. Cronbach's alpha is the most common measure of internal consistency, i.e. how closely a set of elements are related as a group. It is used as a measure of scale reliability. It is most commonly used when you have multiple Likert questions in a survey/questionnaire that form a scale and you wish to determine if the scale is reliable. In this study, a reliability analysis for the internal consistency of the measurement on the Likert scale is used. In addition, several measures are taken to ensure that the results are free from material error, from the design of the questionnaire to the interpretation of the results.

Before full scale data collection was commenced, reliability and validity of the questionnaires were tested and assessed to verify that they were consistent and accurate, respectively to measure what was intended to be measured. The researcher has distributed 20 questionnaires for conveniently selected Respondents and pilot study conducted. The result obtained from these people is used to test the reliability using Cronbach's alpha coefficient.

The table No 3 below shows the Cronbach's alpha coefficient of the Manufacturing wastes & operational performance measures.

Table 3-Chronbach's alpha coefficient

No	Manufacturing wastes	Cronbach's Alpha	No of Item
1	Defect	0.815	3
2	Over Production	0.789	3
3	Waiting	0.834	3
4	Transportation	0.753	3
5	Excess Inventory	0.882	4
6	Motion	0.887	3
7	Excessive Processing	0.853	3
8	unutilized skill	0.750	3
Over all Cronbach's á (independent Variables)		**0.886**	**8**

Source: Own Survey 2023

3.10.2 Validity

Validity is the extent to which a scale or set of measures accurately represents the concept of interest. According to Mujis (2004, p.82), validity basically concerns whether we are measuring what we want to measure and is probably the single most important aspect of measurement. Content validity represents assessment of the degree of correspondence between the items selected to constitute a summated scale and its conceptual definition (Hair et al, 2014, p. 90). In this study extensive review of the literature on lean manufacturing wastes and operational performance was conducted to develop a content-valid constructs. The researcher adapted instruments from previous researches to carefully select the variables & their measurements. In addition, the questioner was distributed to experts to give comments on the content and revised accordingly before used.

CHAPTER 4: DATA ANALYSIS PRESENTATION AND INTERPRETATION

4.1- Introduction

This chapter delves into the analysis of data collected from both primary and secondary sources, including responses from employees and the company archive of Asku plc. A total of 110 questionnaires were distributed to carefully selected employees, with 88 of them being returned as completed and usable, resulting in an impressive response rate of 80 percent, which is considered robust. To ensure accuracy, all completed questionnaires were thoroughly checked for completeness and consistency. The Statistical Package for Social Sciences (SPSS) V 25 was utilized for statistical analysis, including descriptive statistics, correlation and regression analysis.

Table 4 Response Rate

Description	Qty	Percent
Questionnaire Distributed	110	100
Questionnaires returned	91	82.73%
Questionnaires not returned	16	14.54%
Incomplete	3	2.73%
Usable Response	88	80%
Response Rate	80%	

Source: Survey data 2023

This response rate was representative and satisfactory enough to draw conclusions for the study. According to *Mugenda O.M & Mugenda A.G (1999)*, a 50% response rate is adequate for reporting and analyzing the results; a response rate of 70% and above is said to be excellent in the case for this research.

4.2 Demographic Information

Table 5 Profile of Respondents

Variable	Description	Frequency	Percent
Gender	Male	68	77.3
	Female	20	22.7
	Total	88	100
Age	18 -25	12	13.6
	26-30	39	44.3
	31-35	23	26.1
	36-40	6	6.8
	>40	8	9.1
	Total	88	100
Qualification	Diploma	15	17%
	First Degree	60	68.2%
	Masters	13	14.8%
	Total	88	100
Work Experience	1-5 years	42	47.7%
	6-10 Years	39	44.3%
	11-15 years	1	1.1%
	>15 Years	6	6.8%
	Total		
Work Position	Operator	6	6.8%
	Supervisor	27	30.7%
	Quality Control	15	17%
	Mechanic/ technical	14	15.9%
	Manager / Head	17	19.3%
	Senior Expert	9	10.2%
	Total		

Source: survey result 2023

The questionnaires were specifically designed to target key personnel from each department of Asku plc, including Quality Control, Managers/Heads, Supervisors, Mechanics, Operators, and Experts. These individuals were chosen for their extensive knowledge and expertise in the subject matter of the study.

Table 5 provides a detailed breakdown of the demographic information collected from the respondents. This includes personal data such as gender, age, educational qualifications, work experience, and job position. By gathering this information, we can gain a better understanding of the characteristics and backgrounds of those who participated in the study.

Gender

Upon examining the data presented in Table 5, it is evident that the majority of respondents, 68 (77.3%), are male, while only 20 (22.7%) are female. This disparity highlights a gender imbalance within the selected sample units. It is possible that the low number of female employees in the manufacturing industry is due to the physically demanding nature of the work, which may not be conducive to female employees. To address this issue, it is imperative to explore ways to make the work environment more accommodating to women. This could involve implementing policies that promote gender diversity and inclusivity, providing training and support for female employees, and creating a culture that values and respects the contributions of all team members. By taking these steps, we can create a more equitable and welcoming workplace that empowers all employees to thrive and succeed. It is essential to recognize the value that women bring to the manufacturing industry and to ensure that they have equal opportunities to contribute to its success.

Age of respondents

In addition, the survey result on table 5 indicate age range of participants, with 12 respondents falling between the ages of 18-25, 39 respondents between 26-30 years old, 23 respondents between 36-40 years old, and only 8 respondents over the age of 41. This indicates that the majority of respondents were young, which is believed to provide a realistic and logical response to the questions asked.

Job position of respondents

In terms of job positions, table 5 shows majority of participants held positions as supervisors (27%), quality control personnel (15%), managers (17%), and technical personnel (14%), with a minimum educational qualification of a diploma. The research aimed to cover all relevant levels of job positions and service years in the company to ensure a comprehensive understanding of the issue at hand.

Service year in the company

The service years of respondents were also analyzed, with 47.7% having 1-5 years of service and 44.3% with 6-10 years of service. The remaining 1.1% had 11-15 years of service and 6.8% had over 15 years of service in the company. The data on service year indicates that very young and new blood are the majority in the company holding critical positions. These data indicate the issue of high turnover in the company, as old experienced employee are leaving and young new graduates are recruited and holding the positions.

Qualification of respondents

As seen on Table 5, 60% of respondents have first degree, followed by 15% diploma and 13% master's degree. This indicates that the respondents had a good educational background to understand the problem and prepared questionnaire. Overall, the results provide valuable insights into the perspectives of employees in the company.

4.3 Descriptive Statics of Study Variables

A statistical method for determining equivalence between groups involves analyzing the mean and standard deviations of variables of interest for each group in a study. In this particular study, the mean and standard deviation of the manufacturing waste construct were analyzed using SPSS V 25 software, and the results are presented in Table 7. To assess the impact of manufacturing waste on organizational performance, eight types of manufacturing waste were identified, and the responses of Asku plc employees were scored based on their practices of these variables. This analysis provides valuable insights into the relationship between manufacturing waste and organizational performance.

Table 6 Criterion - referenced scale definitions

Mean rating	Respondents level of agreement	Description of respond agreement level
1.00 – 1.49	Strongly disagree	Very low (VL)
1:50 – 2:49	Disagree	Low
2:50 – 3:49	Neutral	Medium
3:50 – 4:40	Agree	High
4:50 – 5:00	Strongly agree	Very High

Source: MacEachron, 1982

Here noted as "3" means "neither agree nor disagree, while value "4" means "agree". Hence, if Value 3 is recorded as any of the subsequent measurement, it means that level is neither high nor low, or in other words it is in "average or medium level". If a value of (4) is obtained, it means s "high" level. Similarly, value one (1) and five (5) mean "very low" level and "very high" level respectively while value two (2) mean "low" level. Based on the above table the researcher discussed on the findings of the descriptive statistics of effect of plant and equipment strategies on factory performance based on referenced scale.

4.3.1 – Descriptive statistics and frequency analysis - Manufacturing wastes

Table 7 : Descriptive statistics result of defect

Indicators of wastes	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Mean score of construct	Standard Deviation	SD of Construct
Defect									
Preform , cap and bottle reject from the line is very high	-	-	-	68.2	31.8	4.3182	**4.32**	.46844	**.58562**
Finished products rejects is high	-	3.4	2.3	54.5	39.8	4.3068		.68410	
QC department give order to stop the line due to occurrence of defect	-	1.1	3.4	55.7	39.8	4.3409		.60432	
Overall Agreed Result (Agree + Strongly Agree) - Defect				**96.6%**					

Source: Own survey, 2023

An analysis of the summary mean scores on defect reveals that the overall mean score ranges from 4.3 to 4.34, with a minimum standard deviation of .46844 and a maximum standard deviation of .46844 for all independent variables, as shown in Table 7. The mean value represents the average response of respondents on a particular dimension, while the standard deviation indicates the diversity of responses for a given variable. Interestingly, the mean value for manufacturing waste is closer to 4.0, indicating that most participants agree that the eight manufacturing wastes are a significant source of waste in the company. The standard deviation shows that the respondents' answers are not widely dispersed, with most falling within +1 standard deviation of the mean. In addition to mean and standard deviation, the frequency of respondents who agree or strongly agree with the questions raised about manufacturing waste in the organization is also noteworthy. Table 7, shows, the overall rating of respondents on defect was 96.6%, which is the highest among other manufacturing wastes. This finding is further supported by secondary data obtained from the study company for the years 2014 and 2015 Ethiopian Calendar, as discussed in Section 4.6.

Overall, these findings suggest that there is a consensus among respondents that manufacturing waste as defect is a significant issue in the company, and that efforts should be made to address it.

Interestingly, 100% of respondents agreed on the presence of high defects in the form of material rejects, such as preforms, caps, bottles, and labels. Additionally, 94.3% of respondents agreed on the occurrence of defects due to finished product rejects during the production process, while 95.5% of respondents agreed on the presence of line stoppage due to defective process output. Furthermore, secondary analysis through observation revealed that the production floor of all lines had a significant amount of material rejects during a shift. Bottles in plastic bags, preforms, and caps in crates were accumulated on the production floor for 24 hours and removed every morning, then transported to a separate scrap store.

In conclusion, the analysis clearly indicates that defects are a major concern for the company and need to be addressed promptly to reduce waste and improve overall efficiency.

Table 8 : Descriptive statistics result of overproduction

Indicators of wastes	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Mean score of construct	Standard Deviation	SD of Construct
Over Production									
We experienced overproduction due to inaccurate market forecasting	-	-	-	54.5	45.5	4.4545	4.34	.50078	.625857
Due to overproduction, there was a problem of storage space	-	5.7	5.7	53.4	35.2	4.1818		.78118	
Over production creates high rejection in store due to long storage and product deterioration.	-	1.1	2.3	53.4	43.2	4.3864		.59561	
Overall Agreed Result (Agree + Strongly Agree) – Over Production				**95%**					

Source: Own survey, 2023

Based on the Likert scale definition provided in Table 6, the results on table 8 indicate that overproduction is a significant issue for the company. The descriptive Likert scale result for overproduction has a mean value of 4.34 and a standard deviation of 0.625857, which falls under the highly agree category. Furthermore, the survey results show that 95% of respondents believe that overproduction negatively impacts operational performance. The main cause of overproduction is inaccurate market forecasting, which was indicated by 100% of respondents. Additionally, 88.6% of respondents agreed that space constraints due to high production volumes is a major issue. Qualitative data collected through observation also supports these findings. The plant often stops production due to space shortages, resulting in products being de-palletized and stacked on the floor with storage heights exceeding recommended levels. Furthermore, 96.6% of respondents reported that products are damaged while in storage due to prolonged storage times. During observations, it was also evident that products deteriorated while in the warehouse, particularly on the packaging.

Older products in the store were covered by dust, and plastic packs were damaged by de-palletizing and palletizing activities. Additionally, primary packaging was deformed due to high stacking in the warehouse.

In conclusion, the survey and observation results clearly indicate that overproduction is a significant issue for the company, negatively impacting operational efficiency and causing damage to products. It is crucial for the company to address this issue by improving market forecasting and implementing better storage practices to prevent further damage to products.

Table 9: Descriptive Statistics result of Waiting

Indicators of wastes	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Mean score of construct	Standard Deviation	SD of Construct
Waiting									
There are cases where the plant stops operation while it awaits raw material supplies.	5.7	6.8	5.7	72.7	9.1	3.7273	3.61	.93129	1.03583
The production process frequently experiences unplanned disruptions	6.8	26.1	11.4	44.3	11.4	3.2727		1.17177	
Preventive maintenance and changeover took longer than expected.	3.4	9.1	11.4	52.3	23.9	3.8409		1.00443	
Overall Agreed Result (Agree + Strongly Agree) – Waiting				**71.2%**					

Source: Own survey, 2023

According to the survey results shown on table 9, the average rating for waiting times on a Likert scale is 3.61, with a standard deviation of 1.03583. Additionally, 71.2% of respondents highly agreed that there is waste associated with waiting times across the company. Furthermore, majority of respondents (81.8%) agreed that there are instances where the factory stopped operating due to waiting for raw materials. Similarly, 76.2% of respondents agreed that waiting times were caused by prolonged preventative maintenance and product changeovers. Interestingly, over half of the respondents (55.7%) agreed that the company had experienced an unplanned shutdown that resulted in production being halted. This highlights the need for the company to address these issues and implement measures to reduce waiting times and prevent future shutdowns. Overall, these findings suggest that waiting times are a significant concern for employees and that the company should take steps to address these issues to improve productivity and efficiency.

Table 10: Descriptive statistics result of Transportation

Indicators of wastes	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Mean score of construct	Standard Deviation	SD of Construct
Transportation									
The plant layout is poor, resulting in unnecessary transportation of materials from store to production and from production to warehouse.	-	1.1	15.9	71.6	11.6	3.9318	4.15	.56315	.59227
There are situations where the operation is delayed due to transportation-related problems (bringing materials from the supplier).	-	-	-	68.2	31.8	4.3182		.46844	
There is unnecessary transportation of finished products to other store.	-	4.5	5.7	54.5	35.2	4.2045		.74524	
Overall Agreed Result (Agree + Strongly Agree) - Transportation				**91%**					

Source: Own survey, 2023

The issue of transportation wastage is a crucial one that affects various aspects of a company's operations. This includes the transportation of raw materials, plant layout, and finished product transportation. As shown on Table 10 the study found that the mean value of transportation wastage was 4.15, with 91% of respondents highly agreeing on the presence of transportation related wastes. The study also revealed that the primary contributor to transportation-related wastage was the transportation of packaging materials, as indicated by 100% of respondents followed by the transportation of finished goods, with 89.7% of respondents, and poor plant layout, with 83.2% of respondents. The distance between the supplier and the plant was also a significant factor, as raw materials stores were far from the operation and required movement by forklift. Additionally, finished products were transferred to a sister company warehouse, "Yehule Gebeya Store," and sales trucks loaded products from there, resulting in double transportation issues for the company.

Further qualitative analysis conducted through interviews with production and technical managers revealed that employee transportation was also a significant source of transportation-related waste. In some cases, machine failures occurred during the night shift, and shift technicians were unable to solve the problem on their own. Key personnel are living far from the company resulted in delays in maintenance until these technical personnel arrived, which was considered transportation waste during night-time operations.

A carbonated soft drink production manager also noted that some of the raw materials used to store ingredients for sodas and juices were stored outside the factory in a sister company's warehouse, which was far from the factory. These materials were then transported to the required production facility, resulting in additional transportation costs for the company.

In conclusion, transportation wastage is a significant issue that affects various aspects of a company's operations. It is crucial for companies to identify and address these issues to reduce costs and improve efficiency.

Table 11: Descriptive statistics result of Excess Inventory

Indicators of wastes	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Mean score of construct	Standard Deviation	SD of Construct
Excess Inventory									
The company holds excess inventory of raw materials which tie up capital	9.1	2.3	14.8	62.5	11.4	3.6477	3.76	1.02878	1.12144
Finished product inventories are high during the non-pick season.	8	19.3	4.5	40.9	27.3	3.6023		1.29135	
Due to the large inventory level, difficult to implement FIFO	4.5	11.4	1.1	45.5	37.5	4.000		1.12444	
Due to prolonged storage, products at the warehouse are damaged	2.3	14.8	8.0	51.1	23.9	3.7955		1.04121	
Overall Agreed Result (Agree + Strongly Agree) – Excess Inventory				**75%**					

Source: Own survey, 2023

The data collected through the Likert scale survey revealed that the mean value for excess inventory was 3.7, with a standard deviation of 1.12144. This finding was highly agreed upon by 75% of the respondents, who answered with either "agree" or "strongly agree." Furthermore, the survey results indicated that 75% of the respondents believed that excess inventory led to product degradation and quality deterioration, while 68.2% found it difficult to implement the FIFO (first in, first out) method due to excess inventory.

Qualitative data analysis, including observations in the finished goods warehouse, revealed that product stacking was not conducive to implementing the FIFO method. During product loading, fresh products were prioritized for sale, while older off-pallet products remained in the warehouse. This was because the older products needed to be re-palletized before being loaded onto the truck. During an interviews with factory quality assurance managers said that they have issues related to implementation of FIFO due to inconvenience in storage of products. He mentioned that internal and external quality system auditors had made several findings in this regard and action taken not consistent and this is due to constraint of space.

In conclusion, the survey and qualitative data analysis highlighted the negative impact of excess inventory on product quality and the challenges associated with implementing the FIFO method. These findings underscore the need for effective inventory management strategies to ensure product quality and customer satisfaction.

Table 12: Descriptive statistics result of Motion

Indicators of wastes	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Mean score of construct	Standard Deviation	SD of Construct
Motion									
Machines and equipment are not designed in a way to reduce motion (walking, lifting, reaching, bending, stretching, and moving).	3.4	5.7	5.7	65.9	19.3	3.9205	4.23	.88696	.71161
In most cases, looking for spare parts for machinery takes too long, resulting in time loss due to tool boxes not being placed near the machine.	-	-	-	43.2	56.8	4.5682		.49817	
A considerable amount of time is lost by travelling here and there due to shared resources	-	4.5	5.7	53.4	36.4	4.1259		.74790	
Overall Agreed Result (Agree + Strongly Agree) - Motion				**92%**					

Source: Own survey, 2023

The respondents in the study have identified motion waste as a significant issue, with a mean value of 4.23 and a standard deviation of .71161 as shown on Table 12. The primary causes of excessive motion were found to be poor workplace design, lack of spare parts near machines, and shared resources, with a response rate of 92%. Upon observation of the manufacturing process, we also noted movement issues. Material handlers were seen using manual carts to transport materials from storage to production areas, and heavy materials had to be lifted manually to feed into machinery. 85.2% of respondents agreed that improper workplace design was a leading cause of excessive motion. Another area that resulted in high motion at the workplace was the search for spare parts for machinery maintenance, with 100% of respondents agreeing. Spare parts and tool rooms were poorly organized and located far from production areas, resulting in excessive movement during operations. Shared resources were also identified as a cause of motion waste, with 89.8% of respondents agreeing. Furthermore, mechanics and electricians did not have individual toolboxes, resulting in delays in maintenance activities as they had to share resources, which took up a significant amount of time.

To address these issues, the researcher recommends implementing a more efficient workplace design, organizing spare parts and tool rooms, and providing individual toolboxes for mechanics and electricians.

Table 13: Descriptive statistics result of Excessive Processing

Indicators of wastes	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Mean score of construct	Standard Deviation	SD of Construct
Excessive Processing									
There are situations where the warehouse is de-palletize the product to free up space in the store.	6.8	13.6	8.0	50.0	21.6	3.6591	3.55	1.16349	1.09762
The firm does a lot of repacking operations since the goods was handled incorrectly during loading and unloading.	1.1	18.2	5.7	64.8	10.2	3.6477		.93514	
Excessive monitoring on some CCPs and OPRPs every 30 minutes by QC where they have never been found outside of the limit	9.1	18.2	14.8	44.3	13.6	3.3523		1.19424	
Overall Agreed Result (Agree + Strongly Agree) – Excessive Processing				**68.2%**					

Source: Own survey, 2023

Table 13 shows the mean value of excessive processing is 3.55 with a standard deviation of 1.09762, indicating that respondents highly agree that it is a manufacturing waste. The data on excessive processing reveals that 68.2% of respondents believe that there is excess processing due to redoing work such as de-palletizing, repacking, re-inspection, and unnecessary laboratory tests. De-palletizing refers to the removal of products from pallets and stacking them on the floor without pallets to save storage space. One of the areas of over-processing identified was de-palletizing and palletizing activities, which was agreed by 71.6% of respondents. Respondents agreed that de-palletizing is a process that does not add value to the company. During observation, it was found that de-palletizing activity was due to a lack of space or shortage of pallets for production. The FG Warehouse Manager stated in an interview that the shortage of pallets for production is one of the major reasons for de-palletizing of products.

Another area of excessive processing discussed was the quality control test conducted on raw water. It was observed that the plant uses in-house groundwater for the production process, and its physicochemical characteristics have not changed for longer periods. However, QC tests these parameters on an hourly basis, which does not add any value to the company. 57.9% of respondents agreed that this is a problem in the organization. During the observation, the researcher discovered a significant accumulation of damaged products in the finished goods warehouse, waiting re-inspection and sorting. According to the warehouse manager's interview response, the products were de-palletized and then palletized again before being loaded onto sales trucks. This process incurs a cost for the company, as they pay a rate of 4 birr per pack for both de-palletizing and palletizing. Additionally, a high amount of damage was observed in a crate waiting for repackaging.

To address these issues, the company should consider finding alternative storage solutions to reduce the need for de-palletizing. Additionally, they should review their quality control processes to ensure that they are adding value to the company and not wasting resources. It is also crucial for the company to address these issues promptly to avoid further financial losses and maintain customer satisfaction. The accumulation of damaged products not only incurs additional costs but also reflects poorly on the company's quality control measures. The company should consider implementing more efficient and effective processes to minimize damage during handling and transportation. This could include investing in better packaging materials or providing additional training to employees responsible for handling the products.

Table 14: Descriptive statistics result of Unutilized Human skill

Indicators of wastes	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	**Mean**	**Mean score of construct**	**Standard Deviation**	**SD of Construct**
Unutilized Human skill									
The company fails to utilize employee potential due to poor motivation.	2.3	13.6	8.0	54.5	21.6	3.7955	3.63	1.00755	1.07905
The right people are not assigned to the right place.	5.7	14.8	3.4	65.9	10.2	3.6023		1.04540	
Employees and Managers are not participating in strategic undertaking	6.8	18.2	11.4	45.5	18.2	3.5000		1.18419	
Overall Agreed Result (Agree + Strongly Agree) – Unutilized Human Skill				**72%**					

Source: Own survey, 2023

The untapped potential of human skill has a mean value of 3.63 with a standard deviation of 1.07905. The respondents have identified this as a significant issue due to poor motivation and a lack of appropriate skill utilization. Additionally, managers are not prioritizing strategic activities and instead focusing on daily routines, which further exacerbates the problem. The respondents' feedback indicates that 76.1% believe poor employee motivation is a contributing factor, 76.1% feel that individuals are not being assigned to the appropriate roles, and 63.7% believe that management is not adequately involved in strategic management. These findings highlight the need for a more strategic approach to human resource management and a focus on employee motivation and skill development.

Generally, the study revealed that the majority of the eight manufacturing wastes were present in the case company's operations, with significant response rates. Defect related manufacturing waste has been identified as the most prevalent waste, with a mean value of 4.32 and a respondent frequency of 96.6%. Overproduction waste follows, with a frequency of 95% and a mean value of 3.61. Motion waste has agreed response rate of 92% and a mean value of 4.23, while transportation waste has a mean value of 4.14 and an agreed response rate of 91%.

The study has shown that the company needs to focus on reducing these wastes to improve its production efficiency and reduce costs. By addressing these wastes, the company can increase its productivity, reduce lead times, and improve customer satisfaction. The findings of this study provide valuable insights for the company to optimize its production processes and achieve its business objectives.

4.3.2 – Descriptive statistics and frequency - Operational Performance Indicators

Table 15: Descriptive and frequency analysis of Operational Performance - Cost

Operational performance Indicators	Indicators of wastes	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Standard Deviation	Mean score of construct	SD of Construct
Cost	Cost of production increased due to existence of manufacturing wastes.	-	1.1	2.3	48.9	47.7	4.4318	.60259	4.32	.57966
	Competitiveness with price in the market is affected negatively as a result of increased costs of manufacturing	-	-	5.7	71.6	22.7	4.1705	.50791		
	Inspection and monitoring process is increased deploying excess manpower	-	2.3	1.1	54.5	42	4.3636	.62848		
	Overall agreed response rate				**95.8%**					

Source: Own survey, 2023

Cost

As shown on Table 15, the presence of manufacturing wastes has a significant effect on costs. In fact, 96.6% of respondents reported that the existence of these manufacturing wastes affects costs. This is further supported by the fact that 94.3% of respondents reported an increase in product prices due to high manufacturing costs, negatively affecting the competitiveness of the product. Additionally, the high monitoring and inspection process required for manufacturing also resulted in a high resource cost, with 96.5% of respondents reporting this observation. Overall, respondents agreed that manufacturing wastes have a significant impact on operational performance, with a response rate of 98.5%. The mean value of the Likert scale data on cost was 4.32, with a standard deviation of .57966, indicating a high level of agreement among respondents.

These findings support the theoretical explanation that wastes are directly associated with costs. In the world of business, nothing is wasted without a cost. It is important for companies to identify and eliminate manufacturing wastes in order to improve operational performance and reduce costs.

Table 16: Descriptive and frequency analysis of Operational Performance - Quality

Operational performance Indicators	Indicators of wastes	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Standard Deviation	Mean score of construct	SD of Construct
Quality	Complaint from consumer increases	-	3.4	-	58	38.6	4.3182	.65294	4.3	.60357
	Due to Manufacturing wastes our product preference is less in the market	-	2.3	6.8	51.1	39.8	4.2841	.69396		
	Manufacturing waste have effect on generating non-conforming product.	-	-	-	69.3	30.7	4.3068	.46382		
	Overall agreed response rate				**95.8%**					

Source: Own survey, 2023

The result on Table 16 revealed that the eight manufacturing wastes had a significant impact on the quality. The overall response rate for these issues was 95.8% indicating a strong agreement among respondents. The findings were further supported by interviews with quality department employees, who reported a high number of customer complaints related to package quality (specifically shrink film) and bottle strength. The Quality Manager said that "The small gram preforms used for bottle of 1L and 2L made it difficult for customers to handle and pour the product into a glass, resulting in dissatisfaction. Personnel in quality department personnel indicates an increased number of customer complaints due to quality issues, a decrease in product preference in the market related to package quality, and an increase in non-conforming products related to quality of package.

To improve quality and customer satisfaction, it is essential to address manufacturing wastes and implement measures to reduce their impact. This study highlights the importance of waste reduction in the manufacturing process and its direct correlation to customer satisfaction.

Table 17: Descriptive and frequency analysis of Operational Performance - Delivery Time

Operational performance Indicators	Indicators of wastes	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Standard Deviation	Mean score of construct	SD of Construct
Delivery Time	Because of manufacturing wastes the company fail to meet customer expectation in terms of delivery	-	3.4	8.0	58	30.7	4.1591	.70932	4.13	.80295
	The eight manufacturing wastes have been negatively impacting on our ability to deliver results to the customers	3.4	3.4	1.1	61.4	30.7	4.1250	.86851		
	Machine downtime and maintenance time is prolonged and consequently we are unable to improve our productivity.	1.1	5.7	5.7	56.8	30.7	4.1023	.83101		
	Overall agreed response rate				**89.4%**					

Source: Own survey, 2023

The data analysis conducted on the impact of manufacturing waste on delivery time has revealed significant results, as depicted in Table 17. The respondents have rated the overall delivery time at 89.4%, indicating that manufacturing waste has a considerable effect on the timely delivery of finished products to customers. The inability to meet customer expectations regarding delivery time was agreed by 88.7% of the respondents. This result is supported by the result of an interview with dispatchers who did paper work in sales. The dispatcher indicated during that over-processing of the product dispatching process has a detrimental effect on the delivery time of products to customers. The agent trucks are often left waiting for extended periods due to excessive paperwork and approval processes related to product dispatch. Furthermore, the effect of manufacturing waste on delivering expected results was agreed by 92% of the respondents. The prolonged maintenance and product changeover times were also identified as significant contributors to delays, with 87.5% of the respondents agreeing with this observation. Therefore, it is imperative to address these issues promptly to ensure timely delivery of products and meet customer expectations. By streamlining the product dispatching process and reducing paperwork and approval processes, the agent trucks can be dispatched promptly, resulting in faster delivery times. Additionally, reducing maintenance and product changeover times can further improve delivery times and customer satisfaction.

Table 18: Descriptive and frequency analysis of Operational Performance - Efficiency

Operational performance Indicators	Indicators of wastes	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Mean	Standard Deviation	Mean score of construct	SD of Construct
Efficiency	Plant Efficiency is low due to the eight manufacturing waste	-	-	-	71.6	28.4	4.2841	.4535	4.23	.64950
	Due to the manufacturing wastes Employee Performance and productivity become low	-	4.5	5.7	54.5	35.2	4.2045	.74524		
	Due to high material defect most of the time we do not meet our target production volume	-	4.5	5.7	53.4	36.4	4.2154	.74970		
	Overall agreed response rate				**93.21%**					

One of the operational performance indicators that is impacted by the eight manufacturing wastes is efficiency, which includes achieving line utilization, meeting production targets, and increasing productivity. The result on Table 18 shows the overall response rate for this area is 93.2%, with 100% of respondents agreeing that the presence of manufacturing waste leads to low plant efficiency. Additionally, 89.7% of respondents reported a decrease in employee productivity due to manufacturing waste, and 89.8% agreed that achieving targeted production volumes is negatively affected by the presence of waste.

It is clear that the manufacturing wastes have a significant impact on the efficiency of the production process. Addressing these wastes is crucial for improving productivity and meeting production targets. By implementing strategies to reduce waste and increase efficiency, companies can improve their overall performance and remain competitive in the market.

In General, the impact of the eight manufacturing wastes on the operational performance of the case company was found to be significant across all four operational performance measures. The respondents themselves manifested the significant occurrence of the eight manufacturing wastes and their impact on operational performance measures. Upon analyzing the mean of operational performance measures, it was discovered that cost performance and quality scored the highest mean rating of 4.32 and 4.3, respectively, with a standard deviation of 0.57966 and 0.60357. Delivery time and efficiency scored 4.13 and 4.23, respectively, with a standard deviation of 0.80295 and 0.64950. These results indicate that almost all respondents agree on the effect of the manufacturing wastes on operational performance. Furthermore, the overall mean rating of all the manufacturing waste constructs and operational performance constructs is above the midpoint in the Likert scale. This suggests that the majority of respondents believe that the eight manufacturing wastes are present and have a significant effect on operational performance.

Previous study conducted by Taddele Kummie in Ethiopia on Evaluation of manufacturing waste and their impact on manufacturing performance have shown consistency in that wastes were significantly present in both manufacturing and support processes of the study company and these wastes were also significantly negatively impacting on the operational performances of the case company.

An empirical study conducted on impact of lean manufacturing on operational performance at textile companies by Muhammad N. et.al (2021) indicate companies can cut wasteful activities by implementing lean strategies and increase their performance which is in line with the result of this study. The study reveal lean manufacturing practices significantly impact the operational performance of textile firms.

In conclusion, the findings of this study highlight the importance of addressing the eight manufacturing wastes to improve operational performance. By eliminating these wastes, companies can enhance their cost performance, quality, delivery time, and efficiency, ultimately leading to greater success and profitability.

4.4 **Correlation Analysis**

Table 19: Correlation between each independent with dependent Variable

Correlations			
		Defect	Operational Performance
Defect	Pearson Correlation	1	.605**
	Sig. (2-tailed)		.000
**. Correlation is significant at the 0.01 level (2-tailed).			
		Over Production	Operational Performance
Over Production	Pearson Correlation	1	.914**
	Sig. (2-tailed)		.000
**. Correlation is significant at the 0.01 level (2-tailed).			
		Waiting	Operational Performance
Waiting	Pearson Correlation	1	.255*
	Sig. (2-tailed)		.017
*. Correlation is significant at the 0.05 level (2-tailed).			
		Transportation	Operational Performance
Transportation	Pearson Correlation	1	.497**
	Sig. (2-tailed)		.000
**. Correlation is significant at the 0.01 level (2-tailed).			
		Excessive Inventory	Operational Performance
Excessive Inventory	Pearson Correlation	1	.123
	Sig. (2-tailed)		.255
		Motion	Operational Performance
Motion	Pearson Correlation	1	.503**
	Sig. (2-tailed)		.000
**. Correlation is significant at the 0.01 level (2-tailed).			
		Excess processing	Operational Performance
Excess processing	Pearson Correlation	1	.126
	Sig. (2-tailed)		.241
Unutilized skill	Pearson Correlation	1	.205
	Sig. (2-tailed)		.056

Source: Own survey 2023

In research, inferential statistics such as correlation and regression are commonly utilized to establish the existence and strength of relationships between independent and dependent variables. Correlation analysis are used to draw conclusions about the relationships among study variables and to test hypotheses that relate predictors to variables that affect outcomes. One of the most basic and useful measures of association between two or more variables is correlation. (Marczyk Geoffrey, De Matteo David & Festinger David, 2005 p.216). Pearson's "r" gives information the direction of the relationship: a positive sign indicates a positive direction, a negative sign indicates a negative direction, a value of 0 represents lack of correlation; the strength of the relationship: the closer to 1 (+ or –) the stronger the relationship (Mujis, 2004 p.144). The correlation tests have been conducted in order to determine whether there is a correlation between the independent variables and the dependent variables operational performance. The results of each dependent variable's correlation with the independent variables are then explained in table 19.

Table 19 shows a strong correlation between the Defect, Over production and and operational performance measures. The p-value of all manufacturing wastes are less than 0.01 for most variables. The correlations between the eight manufacturing wastes and operational performance measures range from 0.123 to 0.914. However, there is a weak correlation between operational performance and excessive inventory, excessive processing, and unutilized skill. The highest correlation was observed between overproduction and operational performance, with a correlation coefficient of 0.914. This was expected since the company produces more than necessary and holds high stock, which ties up money and increases the risk of product deterioration and damage in the warehouse. The second-highest correlation was between defects and operational performance, with a correlation coefficient of 0.605. This was also anticipated as increased defects result in high rejection rates and manufacturing costs.

It is crucial for the company to identify and address manufacturing wastes to improve operational performance. By reducing overproduction and defects, companies can increase efficiency, reduce costs, improve product quality and improve delivery time.

4.5 Regression Analysis

Correlation will not tell us the effect of one variable to another, but it only tells us the relationship, Correlation is the basis for regression i.e. if two variables do not have relationship which shows no relationship. Here the researcher done regression analysis for the dependent variables which have correlation with independent variables. Before running multiple linear regression analysis, the researcher conducted basic assumption tests for the model. These are normality of the distribution, the linearity of the relationship between the independent and dependent variables and multi-collinearity tests.

4.5.1 – Normality Test

According to Hair et al (2014, p.73), the most fundamental assumption in multivariate analysis is Normality, referring to the shape of the data distribution for an individual metric variable and its correspondence to the normal distribution, the benchmark for statistical methods. Multiple regressions require the independent variables to be normally distributed. Skewness and kurtosis are statistical tools that enable the researcher to check if the data is normally distributed or not. On the other hand, kurtosis provides information about the peak of the distribution (Pallant, 2007 P.56.)

According to Smith and Wells (2006), kurtosis is defined as "property of a distribution that describes the thickness of the tails. The thickness of the tail comes from the number of scores falling at the extremes relative to the Gaussian/normal distribution". On the other hand, Skewness is a measure of symmetry.

The skewness value provides an indication of the symmetry of the distribution. A distribution or data set is symmetric if it looks the same to the left and right of the center point. To test the normal distribution of data of all variables, Kurtosis and Skewness statistics were computed, and the results are reported in Table 20. From the results, it is clear that Skewness and Kurtosis values fall within the +2 and -2 range. It implies normal distribution of data of all variables used in the study.

Table 20: Normality Test (skewness and Kurtosis)

Descriptive Statistics							
	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Cost Performance	88	4.3220	.38307	.207	.257	-1.173	.508
Quality Performance	88	4.3030	.34882	.493	.257	-.388	.508
Delivery Performance	88	4.1288	.45326	-.737	.257	2.107	.508
Efficiency Performance	88	4.2348	.48518	-.245	.257	.106	.508
Valid N (listwise)	88						

Source: Survey result 2023

More over the histogram & P-P plots of the model illustrate that the normality assumption is achieved since the bars make a normal curve and the normal P-P plot –points lie closer to the diagonal line as shown on Appendix 1- Assumption of Normality and Linearity.

4.5.2 – Linearity Test

Standard multiple regression can only accurately estimate the relationship between dependent and independent variables, if the relationships are linear in nature. If the relationship between independent variables and the dependent variable is not linear, the results of the regression analysis will under-estimate the true relationship. The most common way to assess linearity is to examine scatter plots of the variables and to identify any nonlinear patterns in the data (Hair et al, 2014 p.74). This assumption was assessed through the investigation of the scatter plot of residuals against predicted values and the normal plot of regression standardized residuals for the dependent variables. As it can be shown in Appendix 1 **the standardized residual plots** did not exhibit any nonlinear pattern to the residuals, thus ensuring that there was no violation of linearity. Hence the assumption of linearity was met.

4.5.3 – Multi collinearity Test

Multi collinearity which refers to the relationship among the independent variables is another issue in the assumption testing. Multi collinearity problem exists when the independent variables are too highly correlated. The presence of high correlations (generally .90 and higher) is the first indication of substantial collinearity (Pallant, 2007 p.149 and Hair et al, 2004 p.196). The two most common measures for assessing both pairwise and multiple variable collinearity are tolerance and its inverse, the variance inflation factor (VIF). A direct measure of multi collinearity is tolerance, which is defined as the amount of variability of the selected independent variable not explained by the other independent variables. A second measure of multi collinearity is the variance inflation factor (VIF), which is calculated simply as the inverse of the tolerance value (Hair et al, 2014 p. 196).

According to Hair et al, the suggested cut off VIF is 10 which means that tolerance value less than 0.1 and VIF value greater than 10 indicates there is sever multi collinearity & violets the assumption of linear regression. Tolerance and VIF test performed to confirm the absence of severity of multi collinearity problem. From Tolerance and VIF's values in Table 14 below, it is clear that tolerance values are above 0.10, and similarly, all VIF values are less than 2. Therefore, the problem of the severity of multi collinearity among the manufacturing wastes does not exist because all the variables fulfill the criteria of tolerance (should be >0.1) or VIF (variance inflation factor), which is < 2. Therefore, all independent variables can be jointly regressed in a single regression model.

Table 21: Collinearity Statistics (Tolerance and VIF)

	Collinearity Statistics	
	Tolerance	VIF
(Constant)		
Defect	.632	1.582
Over Production	.508	1.970
Waiting	.889	1.125
Transportation	.799	1.251
Excessive inventory	.889	1.124
motion	.680	1.470
Excess processing	.932	1.073
unutilized skill	.868	1.152

Source: Survey result 2023

4.5.4 – Test for Independence of Observation

Independence of observation requires that the dependent measures for each respondent be totally uncorrelated with the response from other respondents in the sample. Durbin-Watson statistic uses to test the assumption that residuals are independent (or uncorrelated). The Durbin-Watson statistic ranges in value from zero to four. A value of closer to two indicates no autocorrelation. A value towards zero indicates positive autocorrelation. Conversely, a value towards four indicates negative autocorrelation (Saunders, M., Lewis, P. & Thornhill, A., 2009 p.467). The Durbin-Watson values in this study are found to be in the range of 1.297 and 2.271 as shown on table 22 which is closer to two that ensures that the assumption of independence of error terms is not violated. In summary since the general assumptions of the data are satisfied, it is eligible to perform multiple regression.

From the values given in Table 22, the value of R-square is decisive. R-square (coefficient of determination) offers the degree of effect of manufacturing wastes (independent variables) over operational performance (dependent variables). This value shows a 65.1% effect of manufacturing wastes over Cost performance and remaining 35% is due to other factors described by an error term. In the same way manufacturing wastes effect quality performance by 54%, Delivery time by 88.4% and Efficiency by 74.8%.

Table 22: Model Summary

Model Summary [b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
	.807[a]	.651	.615	.23785	2.271
a. Predictors: (Constant), unutilized skill, motion, Excess processing, Excessive inventory, Waiting, Transportation, Defect, Over Production					
b. Dependent Variable: Cost Performance					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
	.736[a]	.541	.494	.24952	2.034
a. Predictors: (Constant), unutilized skill, motion, Excess processing, Excessive inventory, Waiting, Transportation, Defect, Over Production					
b. Dependent Variable: Quality Performance					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
	.940[a]	.884	.872	.26787	1.297
a. Predictors: (Constant), unutilized skill, motion, Excess processing, Excessive inventory, Waiting, Transportation, Defect, Over Production					
b. Dependent Variable: Delivery Performance					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
	.865[a]	.748	.722	.21206	1.997
a. Predictors: (Constant), unutilized skill, motion, Excess processing, Excessive inventory, Waiting, Transportation, Defect, Over Production					
b. Dependent Variable: Efficiency Performance					

Source: Survey result 2023

4.5.5 Regression Results of Manufacturing wastes and Operational Performance

Operational Performance Indicator – Cost

The results of the regression analysis, presented in Table 22, demonstrate that the model is significant at a p-value of less than 0.05. The multiple correlation coefficient R value of 0.807 indicates a positive relationship between the independent and dependent variables. Additionally, the R^2 value of 0.651 suggests that the independent variables account for 65.1% of the variance in cost performance. The adjusted R^2 value of 0.615 further indicates the generalizability of this model in other populations.

The ANOVA table reveals a p-value of 0.000, which is less than 0.005, demonstrating that the operational performance model is significant at a 1% level of significance. The analysis of variance result, with an F-ratio of 18.192 and a significance level of 0.000, which is below 0.005, indicates that manufacturing wastes have a statistically significant effect on the cost performance of Asku plc.

Further analysis of the model's parameters, as shown in the coefficients' table, indicates that Defect ($\beta = 0.203$), Over Production ($\beta = 0.425$), waiting (0.030), transportation (0.073), Excess Inventory (0.056), motion (0.050), Excess Processing (0.008), and Unutilized Skill ($\beta = 0.026$) were found to be statistically significant at a p-value of less than 0.05.

According to the standardized beta coefficients in Table 14, the independent variables - defect, over processing, waiting, transportation, excess inventory, motion, excess processing, and unutilized skill - can predict the dependent variable of cost performance. However, only two of these variables, defect and over processing, are statistically significant in predicting cost performance with a p-value of less than 0.05. The remaining six variables are not statistically significant in predicting the dependent variable.

The regression analysis shows that defect and over processing are the most significant factors responsible for the variation in cost performance for Asku plc. Specifically, 19.8% of the total variance in cost performance is attributed to defect, while 61.9% is accounted for by over processing. The remaining six variables have an insignificant effect on cost performance.

In summary, the regression analysis provides valuable insights into the factors that impact the cost performance of Asku plc. The results suggest that addressing issues related to Defect and Over Production could lead to significant improvements in cost performance. These findings have important implications for the company's operations and can inform decision-making processes aimed at improving efficiency and reducing costs.

Table 23: Regression between Manufacturing wastes and Cost Performance (Model summary, ANOVA, Coefficient)

Model Summary [b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.807[a]	.651	.615	.23785	2.271

a. Predictors: (Constant), unutilized skill, motion, Excess processing, Excessive inventory, Waiting, Transportation, Defect, Over Production

b. Dependent Variable: **Cost Performance**

ANOVA [a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.234	8	1.029	18.192	.000[b]
	Residual	4.413	78	.057		
	Total	12.646	86			

a. Dependent Variable: **Cost Performance**

b. Predictors: (Constant), unutilized skill, motion, Excess processing, Excessive inventory, Waiting, Transportation, Defect, Over Production

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.062	.523		2.029	.046	.020	2.104		
	Defect	.203	.086	.198	2.359	.021	.032	.374	.632	1.582
	Over Production	.425	.064	.619	6.594	.000	.297	.553	.508	1.970
	Waiting	.030	.063	.034	.475	.636	-.095	.154	.889	1.125
	Transportation	.073	.079	.069	.925	.358	-.084	.230	.799	1.251
	Excessive inventory	-.056	.054	-.073	-1.029	.307	-.163	.052	.889	1.124
	motion	.050	.084	.048	.598	.552	-.117	.218	.680	1.470
	Excess processing	.008	.046	.011	.165	.870	-.084	.099	.932	1.073
	unutilized skill	.026	.063	.029	.408	.684	-.100	.151	.868	1.152

a. Dependent Variable: Cost Performance

Source: Survey result 2023

Operational Performance Indicator – Quality

The results of the regression analysis are presented in Table 24 below. The model was found to be statistically significant at a p-value of less than 0.05. The multiple correlation coefficient value of 0.736 indicates a positive relationship between the independent variables and the dependent variable, quality. The R^2 value of 0.541 suggests that the independent variables account for 54.1% of the variance in quality performance. The adjusted R^2 value of 0.494 indicates that the model can be generalized to another population. The analysis of variance result with an F-ratio of 11.501 and a significance level of 0.000 indicates that the quality performance of Asku plc is dependent on manufacturing wastes. Further analysis of the coefficients' table reveals that Defect ($\beta = 0.246$), Over Production ($\beta = 0.232$), and Transportation ($\beta = 0.341$) are statistically significant at a p-value of less than 0.05. The remaining five factors with a p-value greater than 0.05 are statistically insignificant in predicting the dependent variable, quality.

The regression analysis suggests that Defect, Over Production, and Transportation are the most significant factors responsible for the variation in quality performance of Asku plc. Specifically, 26.3% of the total variance in quality performance is attributed to Defect, 37% to Over Production, and 35.3% to Transportation.

In conclusion, the results of the regression analysis provide valuable insights into the factors that affect the quality performance of Asku plc. The findings suggest that addressing Defect, Over Production, and Transportation can significantly improve the quality performance of the company.

Table 24: Regression between Manufacturing wastes and Quality Performance (Model summary, ANOVA, Coefficient)

Model Summary [b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.736[a]	.541	.494	.24952	2.034

a. Predictors: (Constant), unutilized skill, Motio, Excess processing, Excessive inventory, Waiting, Transportation, Defect, Over Production

b. Dependent Variable: Quality Performance

ANOVA [a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.729	8	.716	11.501	.000[b]
	Residual	4.856	78	.062		
	Total	10.585	86			

a. Dependent Variable: Quality Performance

b. Predictors: (Constant), unutilized skill, motion, Excess processing, Excessive inventory, Waiting, Transportation, Defect, Over Production

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.264	.549		2.302	.024	.171	2.357		
	Defect	.246	.090	.263	2.723	.008	.066	.425	.632	1.582
	Over Production	.232	.068	.370	3.438	.001	.098	.367	.508	1.970
	Waiting	-.001	.066	-.001	-.016	.988	-.132	.130	.889	1.125
	Transportation	.341	.083	.353	4.118	.000	.176	.506	.799	1.251
	Excessive inventory	-.073	.057	-.105	-1.294	.200	-.186	.040	.889	1.124
	motion	-.034	.088	-.036	-.384	.702	-.210	.142	.680	1.470
	Excess processing	.000	.048	.000	-.005	.996	-.096	.096	.932	1.073
	unutilized skill	-.005	.066	-.006	-.072	.943	-.136	.127	.868	1.152

a. Dependent Variable: Quality Performance

Source: Survey result 2023

Delivery Time

Table 25: Regression between Manufacturing wastes and Delivery Time

Model Summary [b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.940[a]	.884	.872	.26787	1.297

a. Predictors: (Constant), unutilized skill, motion, Excess processing, Excessive inventory, Waiting, Transportation, Defect, Over Production

b. Dependent Variable: Delivery Performance

ANOVA [a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	42.679	8	5.335	74.346	.000[b]
	Residual	5.597	78	.072		
	Total	48.276	86			

a. Dependent Variable: Delivery Performance

b. Predictors: (Constant), unutilized skill, motion, Excess processing, Excessive inventory, Waiting, Transportation, Defect, Over Production

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-2.656	.589		-4.507	.000	-3.830	-1.483		
	Defect	.136	.097	.068	1.401	.165	-.057	.328	.632	1.582
	Over Production	1.106	.073	.825	15.243	.000	.962	1.251	.508	1.970
	Waiting	.106	.070	.061	1.502	.137	-.034	.246	.889	1.125
	Transportation	.039	.089	.019	.433	.666	-.139	.216	.799	1.251
	Excessive inventory	-.019	.061	-.013	-.318	.751	-.141	.102	.889	1.124
	motion	.176	.095	.087	1.858	.067	-.013	.365	.680	1.470
	Excess processing	.019	.052	.015	.364	.717	-.084	.122	.932	1.073
	unutilized skill	.052	.071	.030	.733	.466	-.089	.193	.868	1.152

a. Dependent Variable: Delivery Performance

Source: survey result 2023

The regression model presented in Table 25 above is highly significant at the $p < 0.05$ level. The multiple correlation coefficient value of $r = 0.940$ indicates a positive relationship between the independent and dependent variables. Additionally, the R^2 value of 0.884 suggests that the independent variables collectively account for 88.4% of the variance in Delivery performance. The ANOVA table reveals a significant F-test value of 74.346, indicating a linear relationship between the dependent variable and independent variables. Upon further analysis of the coefficients, it was found that only one variable, Over Production ($\beta = 0.825$), was statistically significant at the $P < 0.05$ level.

In summary, the regression model presented in Table 16 is highly significant and effectively predicts Delivery performance. The results suggest a positive relationship between the independent and dependent variables, with Over Production being the only statistically significant variable.

Efficiency

The table in question, Table 26, displays a multiple correlation coefficient value of $r=.865$, indicating a positive relationship between the independent and dependent variables. The R^2 value of 0.748 suggests that the independent variables accounted for 74.8% of the variance in Efficiency, the dependent variable. Additionally, the adjusted R^2 value of .722 indicates that this model can be generalized to another population.

The ANOVA table shows a significant F-test value of 28.988, confirming that the relationship between the dependent variable and independent variables was linear and that the model accurately predicted Efficiency performance. Further analysis of the model's parameters revealed that, out of the eight variables, Over Production, transportation, excess inventory, and motion were statistically significant at the $p < 0.05$ level. These independent variables were found to be the primary sources of variation in the model.

Overall, these findings suggest that the identified independent variables have a significant impact on Efficiency performance. By addressing these variables, organizations can improve their Efficiency and ultimately achieve greater success.

Table 26: Regression between Manufacturing wastes and Efficiency

Model Summary [b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.865[a]	.748	.722	.21206	1.997

a. Predictors: (Constant), unutilized skill, motion, Excess processing, Excessive inventory, Waiting, Transportation, Defect, Over Production

b. Dependent Variable: Efficiency Performance

ANOVA [a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.429	8	1.304	28.988	.000[b]
	Residual	3.508	78	.045		
	Total	13.937	86			

a. Dependent Variable: Efficiency Performance

b. Predictors: (Constant), unutilized skill, motion, Excess processing, Excessive inventory, Waiting, Transportation, Defect, Over Production

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.365	.467		2.924	.005	.436	2.294		
	Defect	.136	.077	.127	1.775	.080	-.017	.289	.632	1.582
	Over Production	.559	.057	.776	9.733	.000	.445	.674	.508	1.970
	Waiting	-.039	.056	-.042	-.700	.486	-.150	.072	.889	1.125
	Transportation	.234	.070	.211	3.326	.001	.094	.374	.799	1.251
	Excessive inventory	-.109	.048	-.136	-2.253	.027	-.204	-.013	.889	1.124
	motion	-.175	.075	-.161	-2.334	.022	-.325	-.026	.680	1.470
	Excess processing	.051	.041	.072	1.229	.223	-.031	.132	.932	1.073
	unutilized skill	.008	.056	.009	.146	.884	-.103	.120	.868	1.152

a. Dependent Variable: Efficiency Performance

Source: Survey result 2023

The study prove the hypothesis Manufacturing wastes have an effect on operational performance cost. Previous study as discussed on empirical literature review also indicate similarity with this result as manufacturing wastes have significant effect on operational performance. This is indicated on previous study indirectly because the study was focused on lean practice and revealed implementing appropriate lean tool will reduce manufacturing wastes and enhance operational performance.

Table 27: Summary regression results - Coefficients.

Dependent Variable	Independent Variables	Result	Reason 5% Confidence interval
Cost Performance	Defect	Supported	Beta = 19.8 at sig .021
	Over Production	Supported	Beta = 61.9 at sig .000
Quality Performance	Defect	Supported	Beta = 26.3 at sig .008
	Over Production	Supported	Beta = 37 at sig .001
	Transportation	Supported	Beta = 35.3 at sig .000
Delivery Performance	Over Production	Supported	Beta = 82.5 at sig .000
Efficiency Performance	Over Production	Supported	Beta = 77.6 at sig .000
	Transportation	Supported	Beta = 21.1 at sig .001
	Excess Inventory	Supported	Beta = 13.6 at sig .027
	Motion	Supported	Beta = 16.1 at Sig .022

Source: Survey Result 2023

4.6 Secondary Data Analysis

4.6.1 – Defect Analysis

The data for this report was collected from Asku plc's management report. Asku plc has four production lines, three of which are bottle lines (Line 1, Line 2, and Line 3) and one jar line. Line 1 has a capacity of producing 1500 bottles per hour, dedicated solely to 2L production. Line 2 has a capacity of producing 1100 bottles per hour for 1 L production, while Line 3 has a capacity of producing 2940 bottles per hour of 0.6 L bottles. The Jar line has a capacity of producing 80 jars per hour.

Table 28 shows the quantity of materials rejected on the production line for the budget year 2014 and 2015 in Ethiopian calendar. The results are expressed as a percentage against production in the graph below (Fig 2). As seen from the graph, the materials rejection rate is high on all lines. The major concern is Preform reject, which is 9.3% on Line 1, 7.5% on Line 2, and 6.3% on Line 3. The second-highest reject rate is Cap, which shows 5%, 4.4%, and 4.1% on Line 1, 2, and 3, respectively. Although the reject rate on the jar line appears small, the cost of these rejects is more than double when transformed into the price of the material. Therefore, we cannot neglect these rejects either. The company has set a target of 2% for each material reject.

Looking at the Pareto chart of total defects in 2015, it is clear that preform holds the highest concern, followed by cap and label defects. Therefore, the company needs to focus on these three defects seriously.

Table 28: Material rejection quantity 2014 and 2015 Ethiopian Calendar

Materials Reject (pcs) 2014				
	Line 1	Line 2	Line 3	Jar Line
Annual Production Volume	28,501,651	39,096,636	43,725,742	3,643,812
Preform (4.5%)	1,295,212 (4.5%)	2,599,072 (6.64%)	1,550,402	2,062 (0.05%)
Labels (1.3%)	387,091 (1.3%)	1,390,736 (3.56%)	1,047,797	2,926 (0.08%)
Cap (2.44%)	696,077 (2.44%)	1,696,090 (4.34%)	993,104	19,857 (0.54%)
shrink (gm)- std 40gm /pcs	4,371.41 (0.38%)	1,625.67 (0.1%)	2,035.80	
Materials Reject (pcs) 2015				
	Line 1	Line 2	Line 3	Jar line
YTD Production Volume	16,115,011	24,577,538	28,893,766	476,446
Preform	1,507,625 (9.35%)	1837222 (7.47%)	1825867(6.31%)	16631 (3.5%)
Labels	335607 (2.08%)	972,651 (3.9%)	614873 (2.13%)	15 (0.003%)
cap	810838 (5.03%)	1,090,096 (4.43%	1178339 (4.08%)	2326 (0.5%)
shrink (gm)	2579.47 (0.4%)	1082.45 (0.1%)	1189.07 (0.1%)	

Source: Source: Asku management report 2014 / 2015

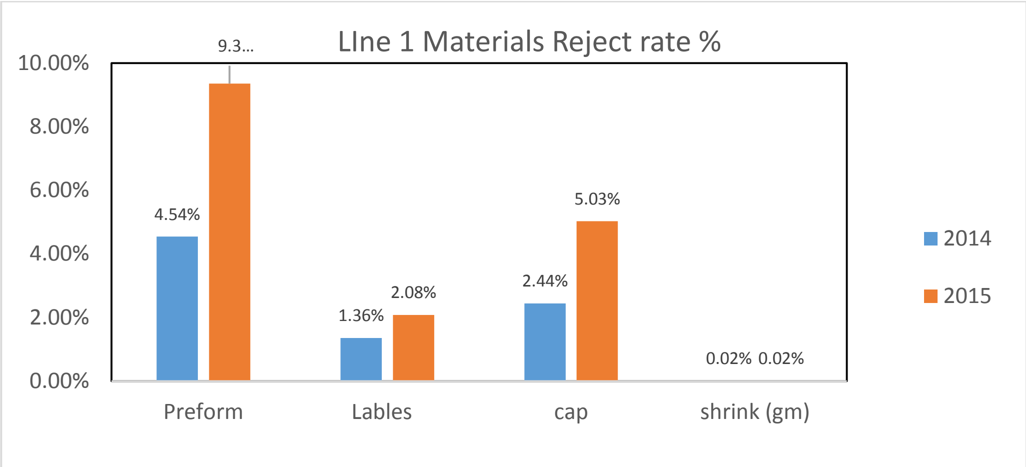


Figure 2: Line 1 Reject rate Asku plc 2014 and 2015

As shown on Fig 2 on line 1 preform rejection rate (9.3%) was the major contributor for defect waste followed by cap rejection which is 5%. There is a significant amount of increase from 2014 to 2015. In 2015 all material reject rate is above internal company standard which was set as 2%.

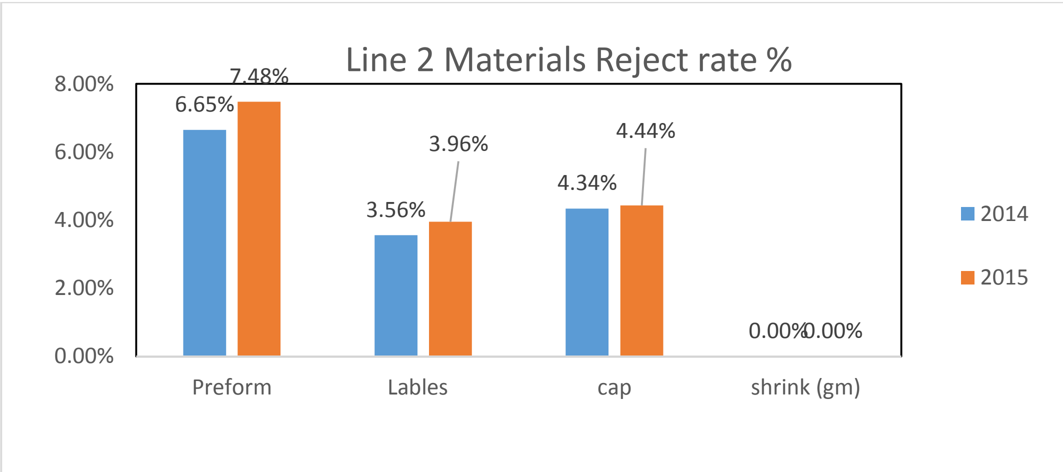


Figure 3: Line 2 Reject rate of Asku plc 2014 and 2012

Fig 3 shows the reject rate of line 2. The result indicates high amount of reject rate in both years on all materials.

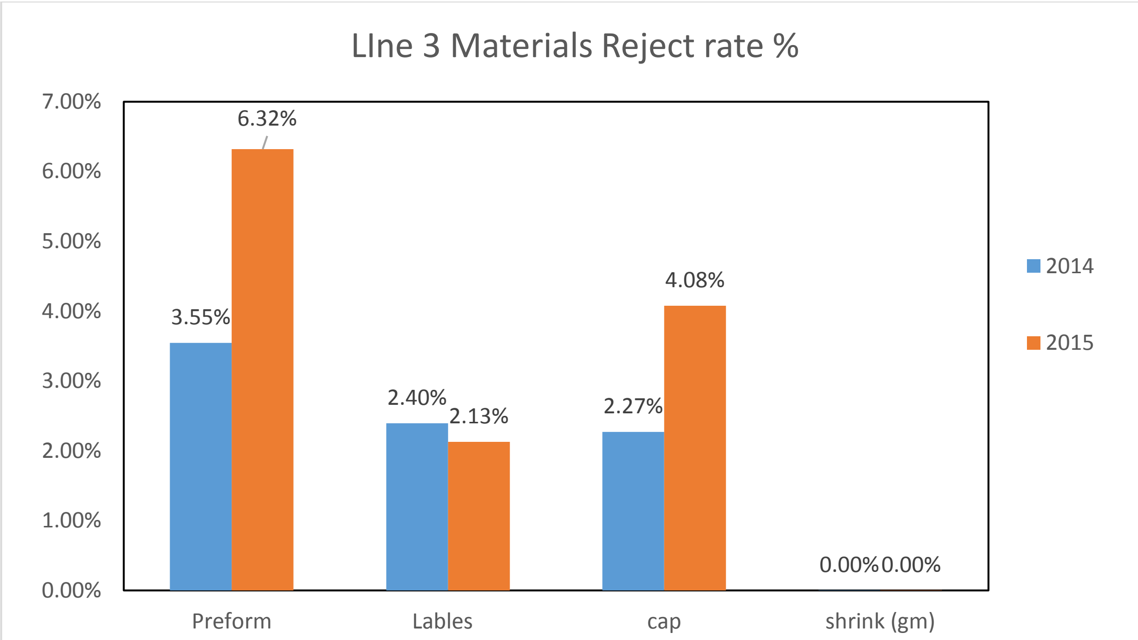


Figure 4: Line 3 Reject rate Asku plc 2014 and 2015

Fig 4 shows the reject rate of line 3. The result indicates high amount of reject rate in both years on all materials and the quantity tremendously increased from 2014 to 2015 Ethiopian calendar for preform and cap.

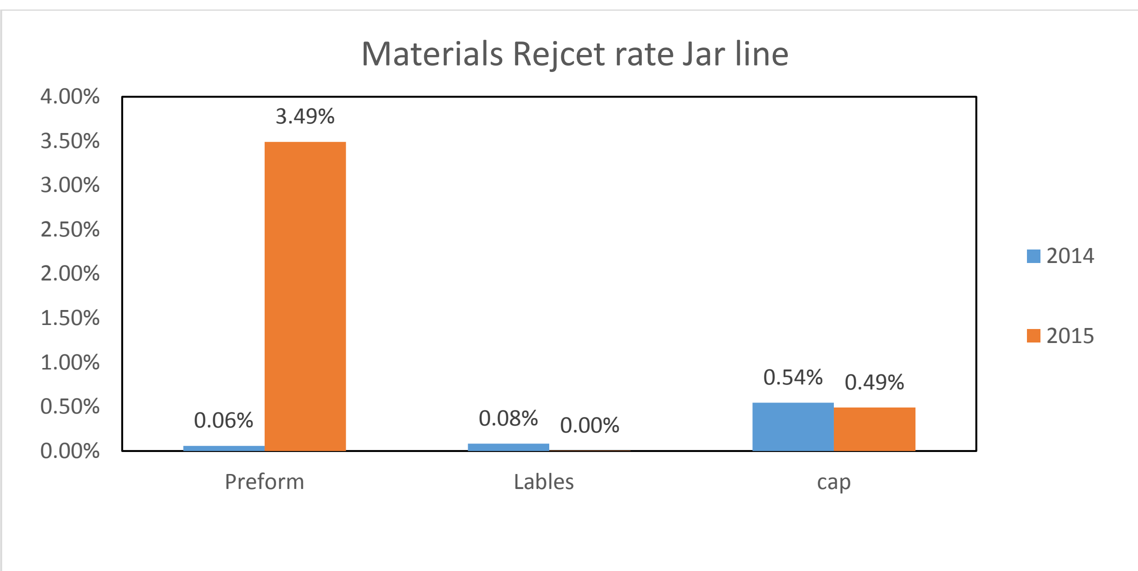


Figure 5: Jar line material rejection

As seen on Fig 2 to Fig 5, the reject rate of all lines are increased in the year 2015 which shows appropriate attention was not given for the problem. The increment on reject indicates that there is poor management system in place to manage rejections. The qualitative study via questioner and observation indicates similar result. The Quality and production managers indicates Defect is the most significant waste in the company due to poor quality of materials (Preform, Cap, labels). During observation on each lines bottles low out at the bottom during filling due to material thickness in balance at the bottom of the preforms. The Quality Manager said there is issue related to cap quality, this happen when the cap supplier changes raw materials.

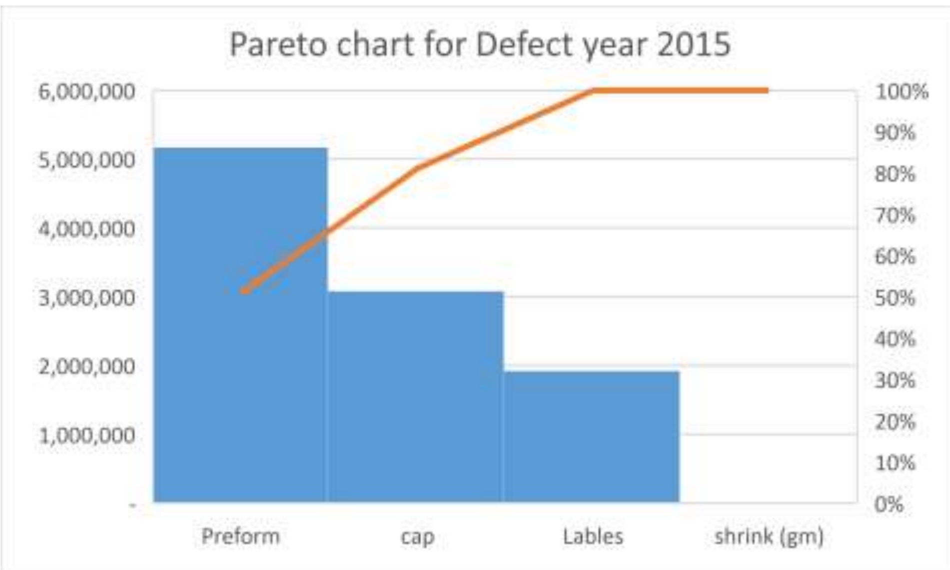


Figure 6: Pareto chart for Defect

Fig 6 reveals the 80% of reject contributor which management need to focus. These are preform, cap and label.

4.6.2 – Down time and machine Availability

Machine availability is a crucial metric for manufacturers, measuring the amount of time a machine actually runs compared to its scheduled runtime. It is one of three key performance indicators (KPIs) used to determine overall equipment effectiveness, which measures the efficiency of manufacturing equipment. In this report, we will discuss the downtime of machines due to various reasons.

The Case company, Aku plc, records downtime in two ways. The first is called VOS (valid other stoppages), which includes planned and unplanned downtime due to uncontrollable conditions such as power interruptions. Table 29 provides details on valid other stoppages. The second type of downtime is operational/technical, as listed in Table 30.

In the Ethiopian Calendar year 2014, the company lost a total of 137 days across all four lines (22.4 days for Line 1, 26 days for Line 2, 21.6 days for Line 3, and 69 days for the jar line). In 2015, 151 days were lost due to valid other stoppages. Similarly, the total downtime due to operational problems was 196 days in 2014 and 193 days in the first nine months of 2015.

Table 29 shows that the highest downtime in the period was due to a lack of packaging materials, with 925 hours lost. Power interruptions were the second highest cause of lost hours, with 722 hours lost in 2015, followed by space shortage with 339 hours.

The space shortage problem indicates that the company is overproducing beyond market demand, which is consistent with the primary data collected and analyzed. Waiting waste due to the purchase of packaging materials and power is the major manufacturing waste, as shown in the downtime analysis data.

In addition, according to Table 29, it is clear that the company has suffered a loss of over 20 million units of production due to VOS. This loss can be attributed to a lack of space and shortage of packaging materials, which are directly linked to a low market demand. It appears that the company is producing more than what the market requires, resulting in an excess inventory.

The management's decision to halt production is often due to the lack of demand in the market. Additionally, power interruptions are another significant cause of stoppages, forcing the company to wait until power is restored.

To address these issues, the company needs to re-evaluate its production strategy and align it with market demand. It should also invest in backup power sources to minimize the impact of power interruptions. By taking these steps, the company can improve its production efficiency and reduce losses due to VOS.

Table 29: Valid Other Stoppage (VOS)2014 and 2015

Description	Line 1		Line 2		Line 3		Jar Line		Total2014	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Power Interruption	31.2	234.7	22.6	238.2	22.6	238.2		11	76.4	722.1
Unplanned Changeover	0.0	22.8	37.2	59.9	47	52.9			84.2	135.6
Storage space, pallets shortage	188.6	288.8	241.7	11.8	216.6	37.6	580.8	1	1227.7	339.2
Luck of packaging materials	204	180.3	203.6	231.2	92.2	513.4	774.5		1274.4	924.9
Inventory Count	14.7	4.7	21.4	1.5	13.5	7.0	28.5	3	77.8	16.2
Machine Installation							222.9		222.9	
Management decision	54.8	62.3	96.5	177.1	127.7	83.5	56.8	1156.6	335.8	1479.5
Project work		4.5								4.54
Total VOS Hrs	493.4	798.1	622.7	719.7	519.6	932.6	1663.5	1171.6	3299	3622
Total VOS days	20.6	33.3	25.9	30	21.6	38.9	69.3	48.8	261	292

Descriptions	**Line 2**	**Line 5**	**Line 6**	**Jar line**	**Total**
Average hourly Capacity	8,500	15,300	11,000	400	35,200
Valid Other Stoppages in Hrs	493.4	623	520	1,663	3,299
Lost product qty that were able to produce in 2014	4,190,500	9,531,900	5,720,000	665,200	20,107,600

Source: Asku management report 2014 / 2015

Table 30: Operational Downtime 2014 and 2015

Operational Downtimes /Hrs/ in a year										
Machine Center	**Line 1**		**Line 2**		**Line 3**		**Jar Line**		**Total Down time**	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Blower	277.8	966.8	831.4	566.9	278.1	370.2	252.0	0.0	1,639.2	1,903.9
Filler	22.2	57.2	59.7	68.2	47.3	47.2	15.5	0.0	144.7	172.6
Labeler	237.5	299.2	319.5	208.0	113.0	352.8	0.0	0.0	670.0	859.9
Conveyor	1.3	5.9	37.1	36.0	46.6	32.1	5.0	0.0	90.0	74.0
Date Coder	**15.1**	14.7	36.0	11.3	56.4	21.5	0.0	0.0	107.5	47.5
Packer	265.7	272.7	189.2	145.0	119.5	254.6	0.0	0.0	574.4	672.3
Palletizer	68.5	0.0	56.1	37.9	59.4	48.4	0.0	0.0	183.9	86.3
Nitrogen	64.8	28.1	11.9	9.8	28.0	80.0	0.0	0.0	104.7	118.0
Utility	82.7	101.5	156.9	55.9	104.9	16.5	47.3	0.0	391.8	173.9
Trolley /Forklift	61.6	5.3	8.7	1.0	10.9	1.5	0.0	0.0	81.2	7.8
Inspection	1.1	0.0	0.0	0.0	0.3	0.0	0.0	0.0	1.5	0.0
Quality	176.3	109.7	126.4	100.0	68.8	63.6	0.0	3.0	371.6	276.3
Water Treatment	96.2	22.5	100.3	104.9	46.3	69.3	54.6	0.0	297.4	196.7
Other/Material & Manpower shortage	10.6	27.0	13.2	2.4	0.2	1.8	16.6	0	40.6	31.2
Total Hours Lost	**1,381**	**1,911**	**1,947**	**1,347**	**980**	**1,360**	**391**	**3**	4,698.6	4,620.4
Total Days lost	**58**	**80**	**81**	**56**	**41**	**57**	**16**	**0.13**	**196**	**193**

Source: Asku management report 2014 / 2015

Table 30," highlights the concerning number of unplanned stoppages experienced by the company. Specifically, the data indicates that machine-related stoppages are causing a significant decrease in machine availability. Upon closer examination of Table 30, it becomes clear that the blowing machine is the main culprit, with stoppages of 1639 hours in 2014 and 1904 hours in 2015. The labeler machine and packer machine also require attention, with down times of 670 and 890 hours in 2014 and 574 and 672 hours in 2015, respectively. Additionally, quality-related problems are contributing to a high amount of downtime, with 372 and 276 hours in 2014 and 2015, respectively. Pareto graph have developed to check the 80% contributor of operational down time as shown on fig 7. By identifying and addressing these areas, the company can work towards reducing unplanned stoppages and increasing machine availability, ultimately improving overall operational performance.

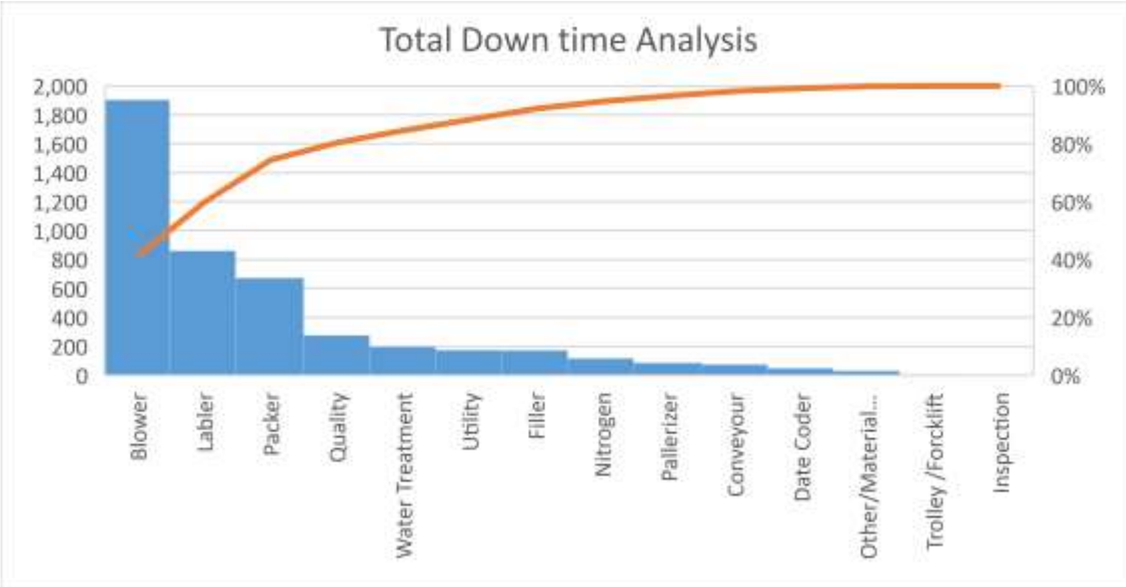


Figure 7: Pareto Analysis of Down time – 2015

4.6.3 –Efficiency Analysis

Efficiency and productivity are two important measures that determine the success of a system. Efficiency measures how well a system is performing in comparison to existing standards, while productivity measures output in relation to a specific input. In simpler terms, efficiency is the percentage of actual output to expected output.

In order to analyze the efficiency and productivity of Asku plc, a case company, nine-month data was collected for the year 2015. Unfortunately, the efficiency of the company was found to be very low, as shown in Table 31. The data collected over the nine-month period revealed that the company was unable to meet its production targets due to various reasons. The total budget for the specified months was 180,031,776 pcs of bottle, but the actual production was only 70,062,758 pcs, resulting in a performance of 38.9%, which is well below the expected level.

The data further revealed that all production lines, including line 1 with an efficiency of 38%, line 2 with 41.9%, line 3 with 37.3%, and Jar line with 34.6%, were not performing well enough to meet the budgeted production plan. This indicates a significant efficiency problem within the company.

The low efficiency and productivity can be attributed to the high materials reject rate and idle times due to operational or non-operational down times. These issues need to be addressed in order to improve the efficiency and productivity of the company.

In conclusion, efficiency and productivity are crucial measures that determine the success of a system. Asku plc needs to address the efficiency problem by identifying and resolving the underlying issues to improve its overall performance.

Table 31: Efficiency analysis of 9 months (July 2022 to April 2023)

Line	Budget pcs	Actual pcs	Variance pcs	Output %	Variance %
1	42,432,000	16,115,008	26,316,992	38.0%	62.0%
2	58,657,248	24,577,538	34,079,710	41.9%	58.1%
3	77,565,728	28,893,766	48,671,962	37.3%	62.7%
Jar	1,376,800	476,446	900,354	34.6%	65.4%
Overall	180,031,776	70,062,758	14,333,783	38.9%	61.1%

Source: secondary data - Asku monthly report

4.7- Factors contributing to the existence of manufacturing waste

There are various factors that contribute to the generation of manufacturing waste within the company. To identify the primary causes, data was collected from respondents through a Likert scale questionnaire. The results of the survey are presented in the frequency table below, providing a detailed overview of the responses. It is crucial to understand the root causes of manufacturing waste to implement effective measures to reduce it. By analyzing the data collected from the survey, we can identify the areas that require immediate attention and develop strategies to address them. This will not only help in reducing waste but also improve the overall efficiency and productivity of the company.

Table 32: Frequency of responses - Factors contributing existence of manufacturing waste

	Indicators of causes of wastes	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Cumulative Agreed
1	Improper planning	2.3	6.8	13.6	59.1	18.2	77.3%
2	Insufficient Training	1.1	6.8	12.5	56.8	22.7	79.5%
3	Power Interruption	4.5	8	20.5	**48.9**	18.2	67.1%
4	Uncertain Market need	2.3	8.0	9.1	55.7	25	80.7%
5	Machine breakdown is the main cause of high rejection	3.4	9.1	14.8	56.8	15.9	72.7%
6	Fail to take dynamic market information	5.7	17.0	17.0	51.1	9.1	60.2%
7	Spare part unavailability	0	3.4	5.7	58	33	**91%**
8	Poor QC of incoming materials	8	20.5	19.3	45.5	6.8	52.3%
9	Absence of Preventive maintenance.	1.1			56.8	42	**98.8%**
10	Assigning staff on wrong position	6.8	21.6	14.8	44.3	12.5	56.8%
11	Unreliable suppliers	8	21.6	22.7	39.8	8	47.8%
12	Poor Internal communication		3.4	4.5	55.7	36.4	**92.1**%
13	Defective materials.	0	1.1	2.3	58	38.6	**96.6%**

Source: Own survey result (2023)

According to Table 32, it is evident that almost all causes for the existence of manufacturing waste are recognized by the company, as indicated by over 50% of respondents. However, the least agreed upon cause is an unreliable supplier, which is understandable since the company purchases most of its raw materials from a sister company and does not face any supplier reliability issues.

The highest response rate of 98.8% is for the absence of preventive maintenance, followed by defective materials with a response rate of 96.6%. Poor internal communication and spare part unavailability also received high response rates of 92.1% and 91%, respectively. Research observations and semi-structured interviews with managers further confirm that the company faces issues related to preventive maintenance due to the unavailability of spare parts locally and the inability to import them due to macroeconomic problems in the country.

The second and third highest agreed upon causes of manufacturing waste are defective materials and uncertain market needs, respectively. Defective materials are typically related to preforms received from the sister company, leading to a high reject rate during the manufacturing process. The respondents also agreed that poor internal communication, insufficient training, and failure to take market needs into account are major causes of manufacturing waste.

During interviews, managers cited poor quality of materials, inadequate incoming inspection of materials, lack of proper maintenance management systems, shortage of skilled manpower, and improper handling of finished products as the main causes of manufacturing waste.

In conclusion, the company needs to address these issues to reduce manufacturing waste and improve overall efficiency. This can be achieved through better communication, training, and maintenance management systems, as well as finding alternative sources for spare parts and improving the quality of raw materials.

4.8- Waste Management

Effective waste management is a critical issue for any manufacturing company. it was noticed a significant accumulation of solid waste that requires prompt removal in the case company "Asku plc”. While the company have implemented proper segregation techniques for plastic bottles and caps, the cost of sorting, packing, and transporting these materials for recycling is quite high. Additionally, managing these waste materials has proven to be a challenging task due to limited resources.

To address this issue, the company have to explore innovative solutions to streamline the waste management processes and reduce costs. Finding sustainable ways to dispose of waste while minimizing environmental impact is crucial. By implementing efficient waste management practices, the company can not only reduce expenses but also contribute to a cleaner and healthier planet. The company should understand the importance of waste management and dedicated to finding practical solutions that benefit both the company and the environment and continue to prioritize this issue and work towards achieving our waste reduction goals.

Table 33: Frequency responses for waste management

	Indicators of causes of wastes	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	Cumulative Agreed
1	Wastes are accumulated for longer period	6.8	13.6	8	58	12.5	70.5%
2	High Cost involved related to waste removal	4.5	14.8	8	59.1	12.5	71.6%
3	Waste disposal is difficult in the company	2.3	9.1	11.4	**59.1**	17	76.1%
4	Waste rejection procedure is inconsistent		6.8	8	56.8	27.3	84.1%
5	Waste is not segregated properly	1.1	1.1	5.7	67	23.9	90.9%

Source: Own survey 2023

Table 33 reveals a concerning issue in the case company - waste removal. 90.9% of respondents, as indicated in the frequency table, agree that the company lacks a waste segregation system. Furthermore, 84.1% of respondents agree that waste removal practices are inconsistent. The researcher observed a significant amount of unsorted waste accumulated in the compound's waste area, primarily consisting of plastic bottles, caps, labels, shrink film, cartoons, and preforms. The company struggles to sort and remove materials promptly due to the high amount of material rejection. PET bottles and preforms are not adequately crushed before disposal, which has a detrimental impact on the environment. The environmental audit conducted by the regional environmental authority office identified these wastes as a risk to the environment and recommended a plan to minimize these risks.

During employee interviews, some stated that the company's waste releases have no impact on the environment because solid wastes are sold to a company specializing in material recycling. In addition, the quality manager mentioned during an interview that liquid waste rejected by the reverse osmosis process at the water treatment plant is treated by a multimedia filtration system and reused for ablution facilities, gardening, cleaning of factory floors and offices, etc.

On the other hand, the case company is dedicated to reducing impact on the environment by utilize lightweight plastics in manufacturing process Furthermore, the company have implemented a comprehensive waste management system that includes the proper disposal of plastic materials such as PET bottles, preforms, and caps. These materials are sorted by type, crushed, and packaged for sale to recycling companies.

However, despite the best efforts, the company have encountered some challenges in waste disposal process. it was noticed a significant accumulation of recyclable waste in the compound that has not been dealt with. Although they have a large corrugated iron sheet room designated for recyclable materials, it is already at full capacity, and materials are being stored outside the room. The current waste disposition practice of the company is after collecting wastes it is moved to area then it is crushed to reduce size during transportation by recycling company. All wastes are sold for the company who are involved on recycling. But due to high rejections of materials the resource available to crush and the quantity was not in balance, the company only having one crushing machine, which is insufficient for the volume of waste produced in the plant. Therefore, high accumulation of waste is observed in the area. The other reason of the accumulation of waste in the compound is due to recycling companies failing to collect the materials on time. Therefore, minimizing the manufacturing waste as defect is very crucial on improving environmental performance.

This accumulation of scrap and defects is unacceptable, and there should be steps to rectify the situation. the company need to explore options to increase the crushing capacity and working with recycling partners to ensure timely collection of materials. Additionally, finding alternative methods for disposing of non-recyclable waste that do not harm the environment. is crucial.

It is crucial for the company to address the waste removal issue and implement a waste segregation system to minimize environmental risks. The company should also invest in resources to sort and dispose of waste promptly. By doing so, the company can reduce its impact on the environment and ensure compliance with environmental regulations.

CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATION

5.1. Summary of Major Findings

This study attempted to examine the effect of Manufacturing wastes on operational performance of bottled water companies in Ethiopia. The study was conducted in a case company Asku plc. To achieve this objective, first the critical success factors of operational performance are being identified then the conceptual model was proposed. This was achieved through a comprehensive literature review. Next the research instrument was checked for reliability and validity. It was concluded that the data collection instrument used for measuring effect of manufacturing wastes on operational performance are reliable & valid. Correlation analysis was done to examine the relationship between Manufacturing wastes & operational performance measures. Finally, regression analysis was performed for estimating the overall model fit & to identify the most predominate manufacturing waste that impact on the operational performance measures. Secondary data also collected from company archives and analyzed.

After conducting a thorough analysis of the questionnaire, it was discovered that the case company is plagued by eight manufacturing wastes that have a significant impact on operational performance. The survey analysis revealed that the mean values for the existence of these wastes were as follows: 4.32 for defects, 4.33 for overproduction, 3.61 for waiting, 4.14 for transportation, 3.76 for excess inventory, 4.23 for motion, 3.55 for excessive processing, and 3.63 for un utilized human potential. These results indicate that all eight manufacturing wastes are present in the case company, albeit in varying forms.

A defect can manifest in various forms, including raw materials, semi-finished materials, and finished goods. Such defects can have a significant impact on operational performance indicators such as cost, quality, delivery time, and efficiency. Upon analysis, it was discovered that the primary source of waste was defects, with a response rate of 96.6%. This was followed by overproduction at 95%, motion at 92%, and transportation at 91%. These wastes have a considerable effect on the operational performance of the company in study by increasing production cost, non-conforming product increased which leads to have complaint from customer as well as increase cost of disposition, also decrease in line efficiency so that the plant will not perform well in terms of targeted production volume.

The effect of manufacturing waste on operational performance is a well-supported finding, as evidenced by secondary data collected from Asku plc. As per the observational data issues with storage space for finished goods, indicating overproduction waste within the company. Furthermore, it was observed that the company had to halt production due to space constraints, causing delays until the area was cleared. Additionally, the company's reject report shows an increase in material rejection rates in the 2015 Ethiopian calendar year compared to 2014, indicating a lack of attention to the issue. Despite the detectability of these wastes in routine work processes, leadership failed to address them due to a lack of investigation into magnitude and impact on operational performance. It is crucial for businesses to prioritize waste reduction efforts to improve operational performance of the company.

According to secondary data, the downtime record reveals a significant amount of time is wasted due to the unavailability of resources such as materials and spare parts. This waiting time is a major source of waste in the company's operations. Additionally, power-related stoppages have a significant impact on performance, and other unplanned stoppages also affect efficiency. Unfortunately, many of these stoppages occur repeatedly due to unaddressed causes. In the budget year of 2015 Ethiopian Calendar (July to April), Line 1 experienced 80 days of downtime, Line 2 experienced 56 days, and Line 3 experienced 57 days due to unplanned stoppages. The blower machine was the primary contributor, followed by the labeler and packer machines.

This study delves into the major causes of manufacturing waste. The survey results indicate that the absence of preventive maintenance is the primary cause, as reported by 98.8% of respondents. Defective materials follow closely behind at 96.6%, with poor communication and unavailability of spare parts at 92% and 91%, respectively.

Regarding waste disposal and management, the survey reveals that a significant amount of solid waste is generated within the company and left un-handled in various areas. The types of waste generated include cardboard boxes, broken wooden pallets, PET bottles, preforms, caps, labeling materials, and plastic shrink films.

The survey also highlights that waste is not being segregated properly, removed in a timely manner, or disposed of consistently. This lack of proper waste management can lead to a negative impact on the environment and the company's bottom line.

5.2- Conclusion

The objective of this study was to analyze the impact of manufacturing waste on Asku Plc's operational performance. To support our conclusions, the researcher done regression, correlation, and descriptive statistics. The findings indicate that Asku Plc's operational performance is negatively affected by eight manufacturing wastes. The correlation analysis revealed that defects and overproduction have a strong relationship with operational performance. Additionally, the regression analysis showed that defects and overproduction are significant predictors of cost performance. Furthermore, defects, overproduction, and transportation are the primary factors contributing to variations in quality. Overproduction and motion are also significant predictors of delivery time. Finally, overproduction, transportation, excess inventory, and motion are the most significant manufacturing wastes that predict efficiency.

The results demonstrate that overproduction has the most significant impact on operational performance, affecting all four performance indicators (cost, quality, delivery time, and efficiency), followed by defects. In general, these manufacturing wastes are positively and significantly correlated with operational performance. It can be argued that they indirectly impact operational performance, leading to increased manufacturing costs, increased non-conformance, increased customer complaints, longer delivery times, and decreased efficiency.

During interviews with managers, it has been determined that the primary cause of high defect rates within the company is due to poor quality materials, inadequate quality control during the inspection of incoming materials, and an insufficient supplier selection process. Additionally, the study has revealed other causes of manufacturing waste, such as the unavailability of critical spare parts for machinery, a poorly managed maintenance system, and dissatisfied and unskilled employees leading to unplanned stoppages due to power interruptions. Furthermore, the study has revealed that waste management, including proper waste disposal, is a significant challenge for the company.

In conclusion, the study highlights the existence of manufacturing wastes in the company and the effect on operational as well as environmental performance. The root cause of the significant manufacturing wastes also identified.

5.3 Recommendation

By addressing significant manufacturing wastes, Asku Plc can enhance its operational performance and ultimately increase its profitability. To achieve this, the company may need to consider implementing a more rigorous quality control process for incoming materials, as well as improving their supplier selection procedures. Additionally, they should invest in employee training and development programs to improve their skills and job satisfaction. Finally, the company should prioritize waste management and disposal, perhaps by implementing a more comprehensive waste management system.

Based on the conclusions reached the researcher provides the following recommendations.

- This study has identified that defects are the primary manufacturing waste in the company, which has a significant impact on cost, quality, and efficiency. The major source of these defects is the quality of raw materials. As a result, the researcher recommends that the company work closely with its suppliers to resolve this issue collaboratively. Additionally, consider sourcing raw materials from other reliable suppliers. To address this issue, the management of the company is advised to carefully select appropriate suppliers, develop relationships with selected suppliers when support is necessary, and manage relationships with strategic suppliers. By taking these steps, the company can reduce the occurrence of defects and improve its overall manufacturing process.
- The major cause of defects in finished goods is poor maintenance management systems. To address this issue, it is recommended that spare parts for machinery be made readily available and maintained appropriately. It is recommended to manage inventory of critical spare parts and components for all equipment in the plant. Additionally, implementing a Total Productive Maintenance (TPM) system can help to solve issues related to operational downtime. It is important to note that an inadequate maintenance system is the root cause of various types of manufacturing waste, including defects, over processing, repacking, and motion. By implementing a comprehensive maintenance system, these issues can be effectively addressed and prevented in the future.
- One major issue related to over-processing is the need for repacking products. To address this, the researcher recommends implementing an effective maintenance system for packing machines to ensure that the quality of packaging is not compromised. This can be achieved through routine quality control checks and stopping defects before they require repacking.

Additionally, it is important to avoid de-palletizing processes in the warehouse and manage inventory levels to meet market demand and reduce excess inventory. Another factor contributing to package damage is improper handling of products. To address this, management need to consider providing training for employees in the warehouse and sales routes to ensure proper handling techniques are used.

- Wastes related to transportation of raw materials can be resolved by having mini store near to production so that manual trolley can be used. Recommend to stop transporting finished product to outside store shall be avoided and the company shall think of loading all sales trucks from the factory warehouse.
- In order to minimize waste related to waiting the researcher recommend proper planning and procuring materials needed for production and having an alternative source of power. It is also crucial for the company to address the root causes of the stoppages and ensure the availability of necessary resources. By doing so, the company can minimize waiting time and increase productivity. Additionally, implementing preventative maintenance measures can help reduce the occurrence of unplanned downtime and improve overall equipment effectiveness.
- To address these issues related to waste management, it is recommended that the company implement a comprehensive waste management plan that includes proper segregation, timely removal, and consistent disposal procedures. This will not only improve the company's environmental impact but also increase efficiency and potentially reduce costs.
- Finally, the company shall consider implementing lean manufacturing system using appropriate lean tools as a long term strategy to minimize those wastes. The researcher recommends to implement the below simple lean tools (Table 34) to minimize wastes and improve operational performance.

Table 34: Recommended lean tools for Asku plc

Lean Tool	What is it?	How does it help?
5S	Organize the work area: • Sort (eliminate that which is not needed) • Set In Order (organize remaining items) • Shine (clean and inspect work area) • Standardize (write standards for above) • Sustain (regularly apply the standards)	Eliminates waste that results from a poorly organized work area (e.g. wasting time looking for a tool).
Gemba (TheReal Place)	A philosophy that reminds us to get out of our offices and spend time on the plant floor – the place where real action occurs.	Promotes a deep and thorough understanding of real world manufacturing issues – by first-hand observation and by talking with plant floor employees.
Kaizen (Continuous Improvement)	A strategy where employees work together proactively to achieve regular, incremental Improvements in the manufacturing process.	Combines the collective talents of a company to create an engine for continually eliminating waste from Manufacturing processes.
KPI (Key Performance Indicator)	Metrics designed to track and encourage progress towards critical goals of the organization. Strongly promoted KPIs can be extremely powerful drivers of behavior – so it is important to carefully select KPIs that will drive desired behavior.	The best manufacturing KPIs: • Are aligned with top-level strategic goals (thus helping to achieve those goals) • Are effective at exposing and quantifying waste (OEE is a good example) • Are readily influenced by plant floor employees (so they can drive results)

Overall Equipment Effectiveness (OEE)	Framework for measuring productivity loss for a given manufacturing process. Three categories of loss are tracked: • Availability (e.g. down time) • Performance (e.g. slow cycles) • Quality (e.g. rejects)	Provides a benchmark/baseline and a means to track progress in eliminating waste from a manufacturing process. 100% OEE means perfect production.
PDCA (Plan, Do, Check, Act)	Iterative methodology for implementing improvements: • Plan (establish plan and expected results) • Do (implement plan) • Check (verify expected results achieved) • Act (review and assess; do it again)	Applies a scientific approach to making improvements: • Plan (develop a hypothesis) • Do (run experiment) • Check (evaluate results) • Act (refine your experiment; try again)
Standardized Work	Documented procedures for manufacturing that capture best practices (including the time to complete each task). Must be “living” documentation that is easy to change.	Eliminates waste by consistently applying best practices. Forms a baseline for future improvement activities.
Total Productive Maintenance (TPM)	A holistic approach to maintenance that focuses on proactive and preventative maintenance to maximize the operational time of equipment. TPM blurs the distinction between maintenance and production by placing a strong emphasis on empowering operators to help maintain their equipment.	Creates a shared responsibility for equipment that encourages greater involvement by plant floor workers. In the right environment this can be very effective in improving productivity.
Visual Factory	Visual indicators, displays and controls used throughout manufacturing plants to improve Communication of information.	Makes the state and condition of manufacturing processes easily accessible and very clear to everyone.

5.5 Limitations of the Study

The study utilized a questionnaire as a tool for data collection. It is important to note that the reliability of the study's results is entirely dependent on the effectiveness of the tool's design. However, it is possible that some respondents may have developed biases, leading them to provide misleading data that cannot be entirely trusted to produce reliable results. Furthermore, it is important to consider the sample size and response rate of the study. It is possible that the sample size and response rate were not high enough to draw generalizations about Ethiopia's bottled water industry as a whole.

The results of the regression analysis are also noteworthy. The analysis shows that none of the operational performance is significantly impacted by the three manufacturing wastes of waiting, excessive processing, and underutilized human skill. This is contrary to the results obtained from the literature review on lean manufacturing concepts and the results obtained from the descriptive study and frequency of this research.

5.6 Suggestions for Further Research

The study revealed that out of the eight independent variables of manufacturing waste, only a few had a significant impact on the dependent variables. These variables include defects, overproduction, transportation, excess inventory, and motion. However, to fully comprehend how manufacturing waste affects operational performance, further research is required on the remaining three variables, namely waiting, excessive processing, and underutilized human skill.

Moreover, conducting additional studies on various bottled water manufacturing industries will help to generalize the findings of this study. By doing so, we can gain a better understanding of the impact of manufacturing waste on operational performance and identify potential areas for improvement. It is imperative to note that this research can have significant implications for the manufacturing industry, as it can help companies optimize their processes and reduce waste, ultimately leading to increased operational performance.

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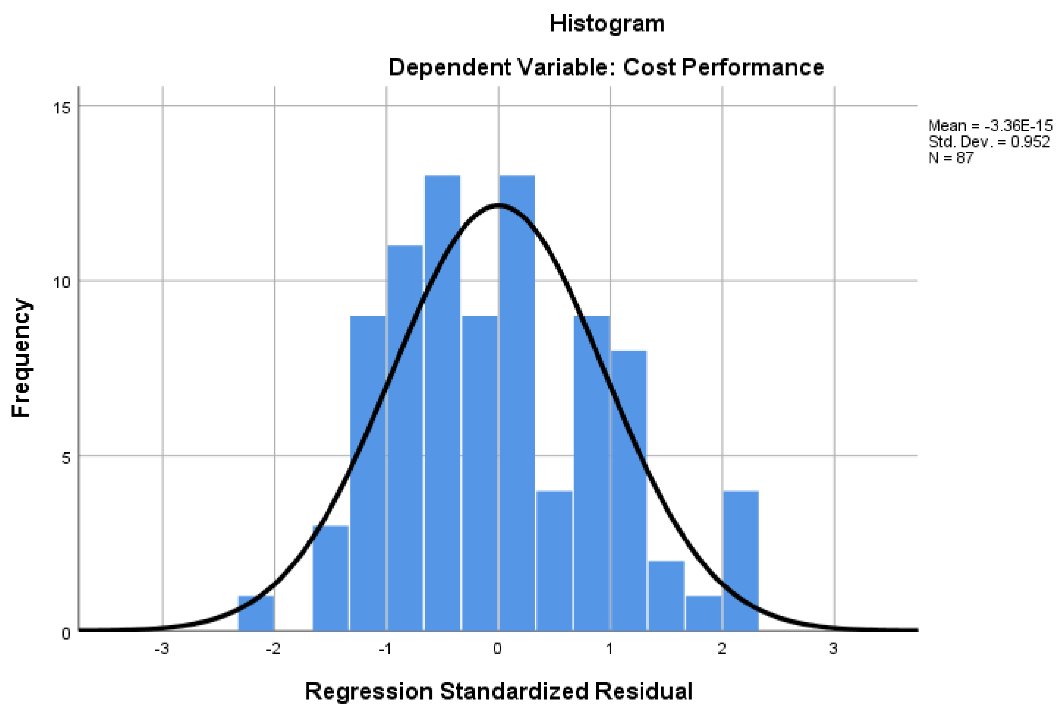
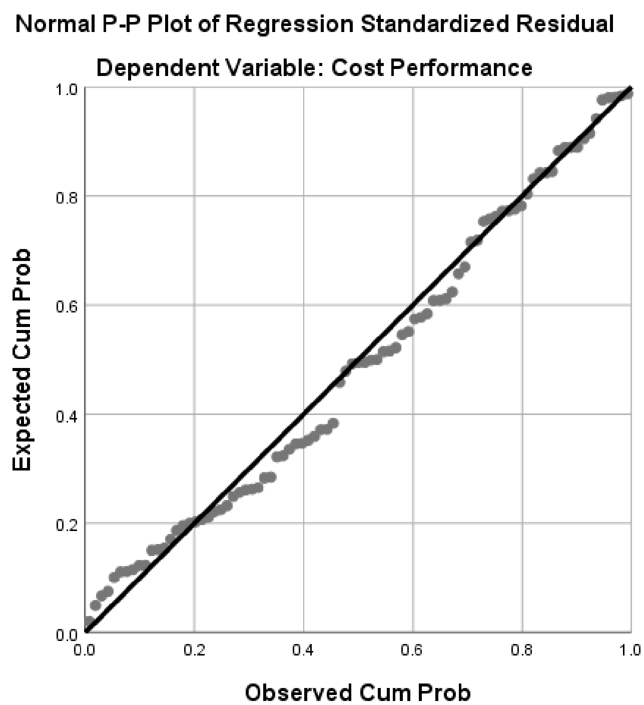
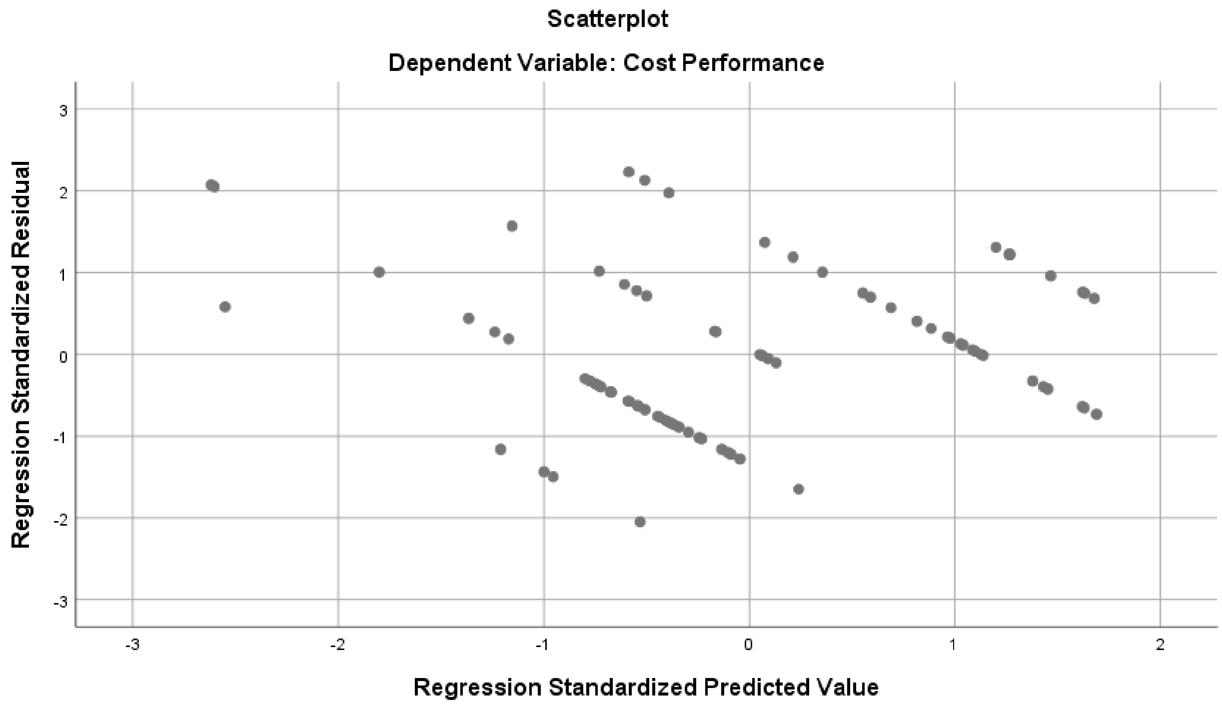
APPENDIX 1 – LINEARITY AND NORMALITY TEST RESULTS

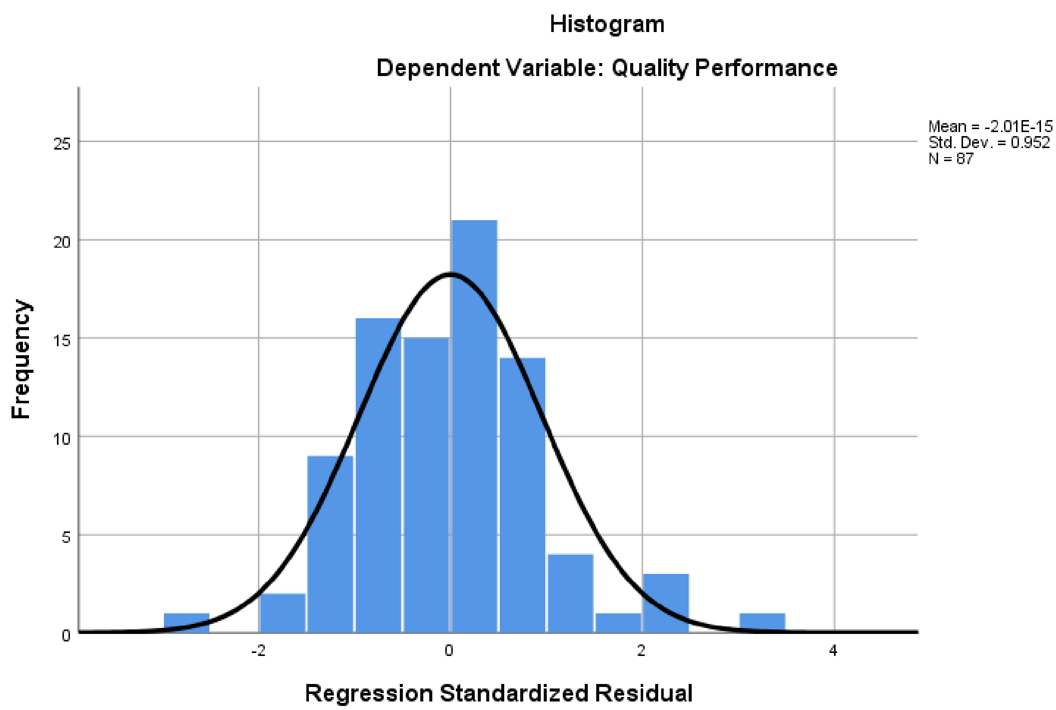
Test for Cost

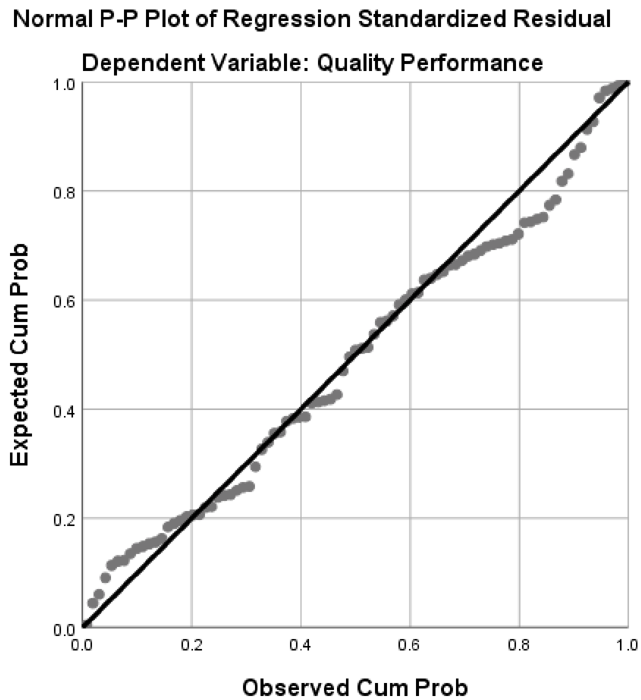


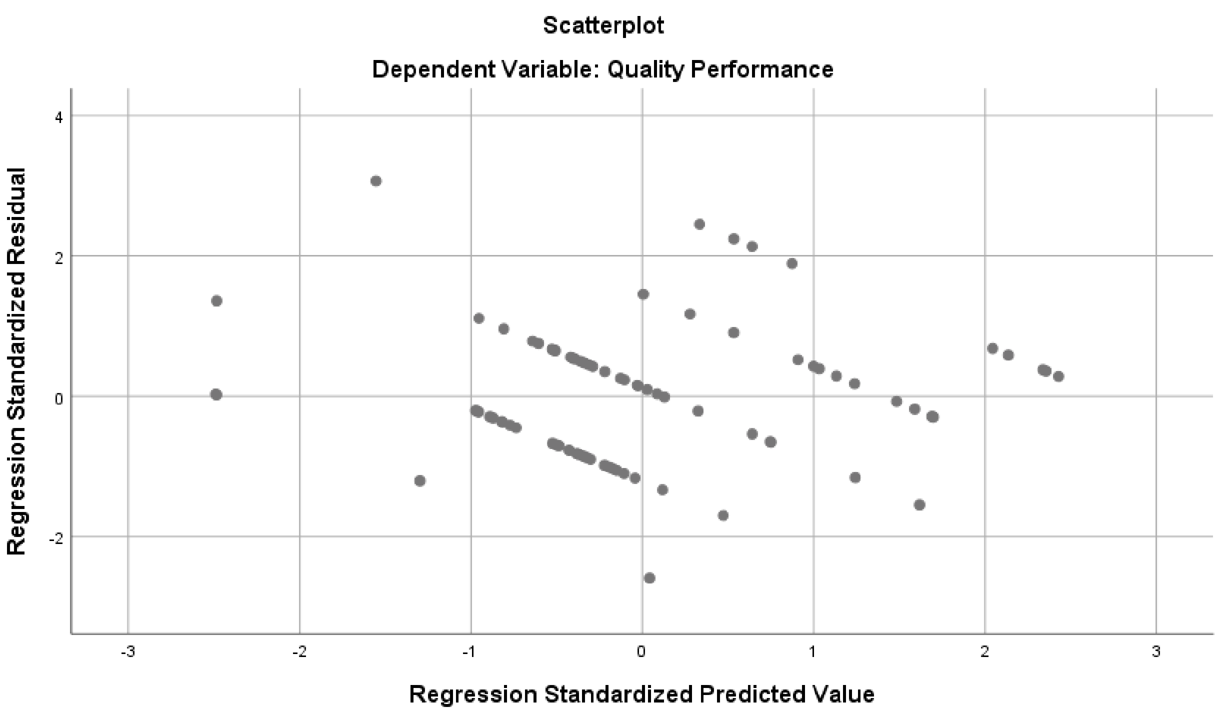




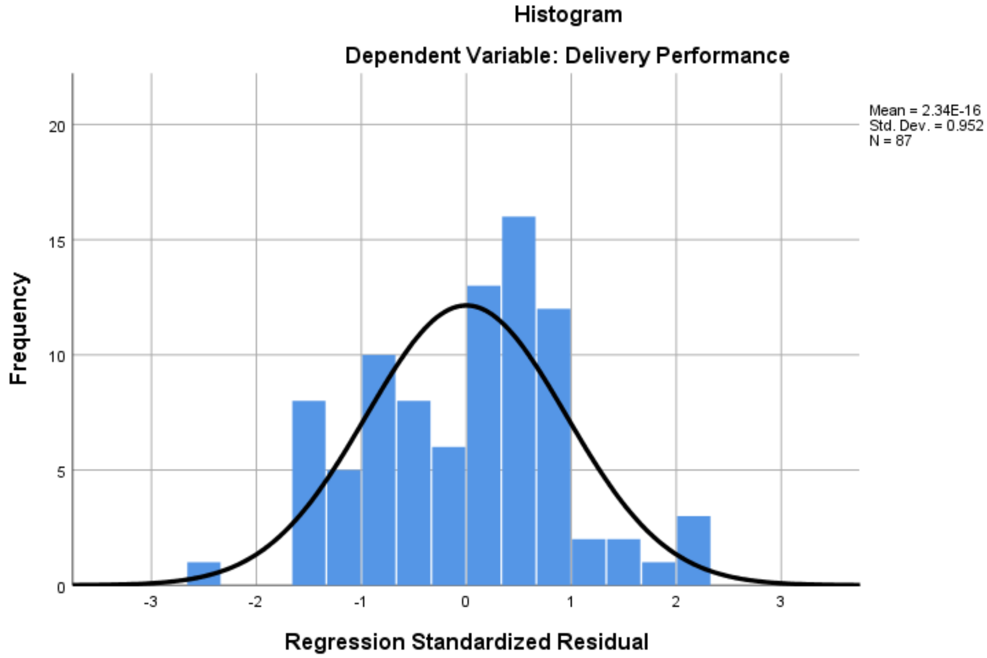
Test for Quality

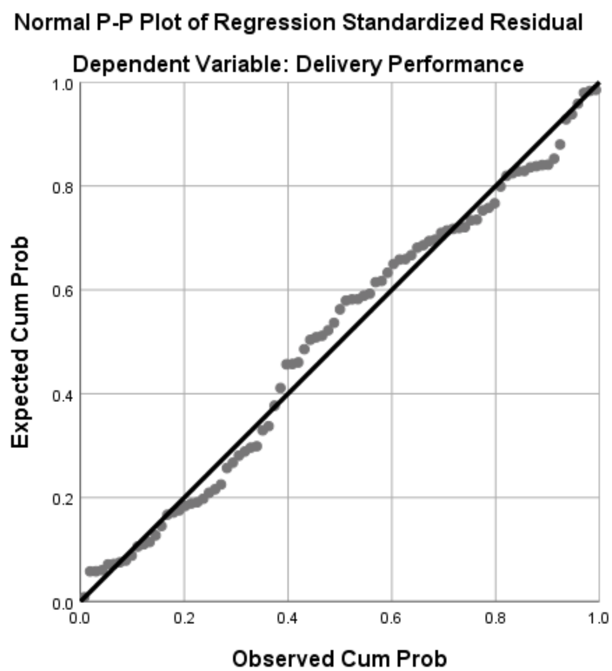


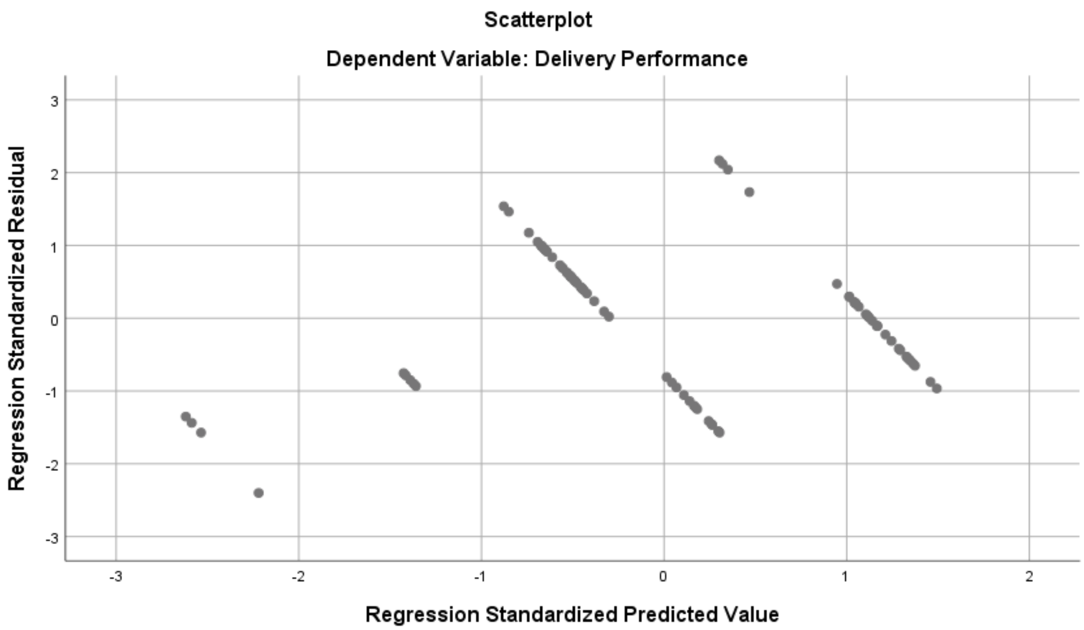

Normal P-P Plot of Regression Standardized Residual
Dependent Variable: Quality Performance
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0


Scatterplot
Dependent Variable: Quality Performance
Regression Standardized Residual
Regression Standardized Predicted Value
4
2
0
-2
-3
-2
-1
0
1
2
3

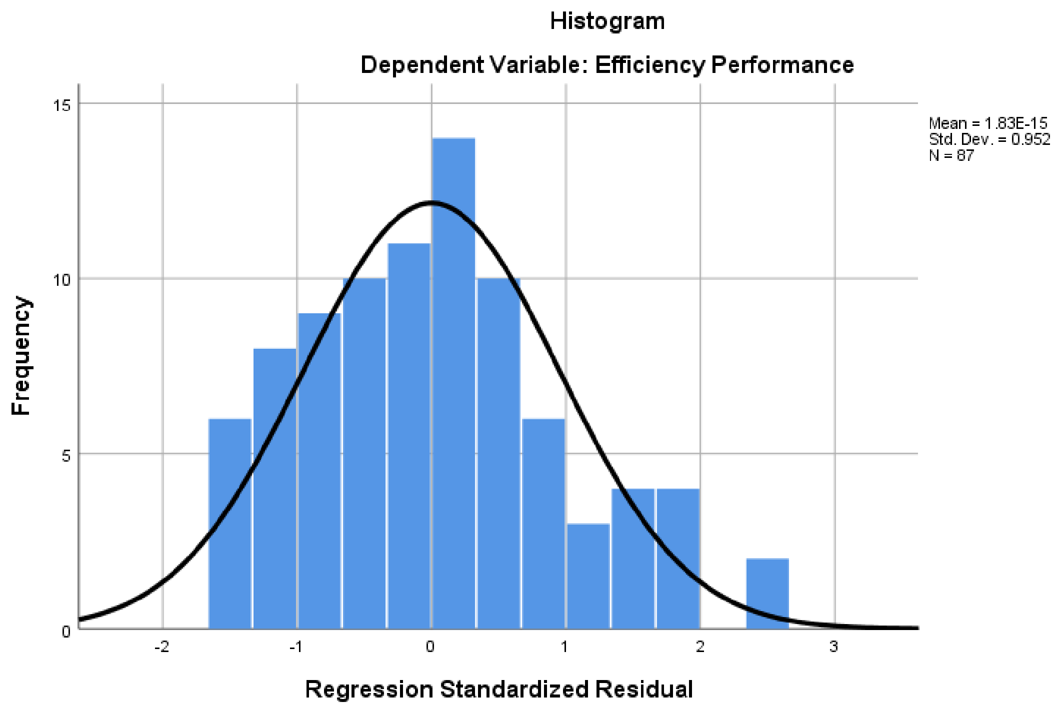
Tests for Delivery Time

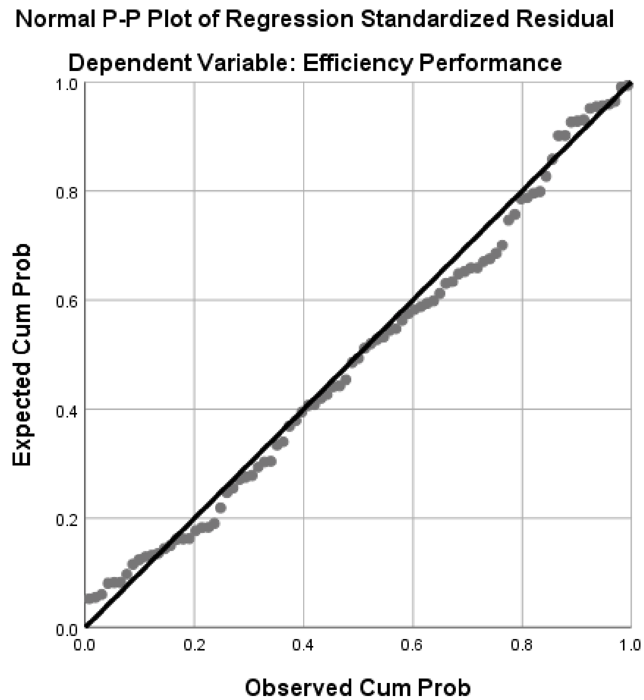


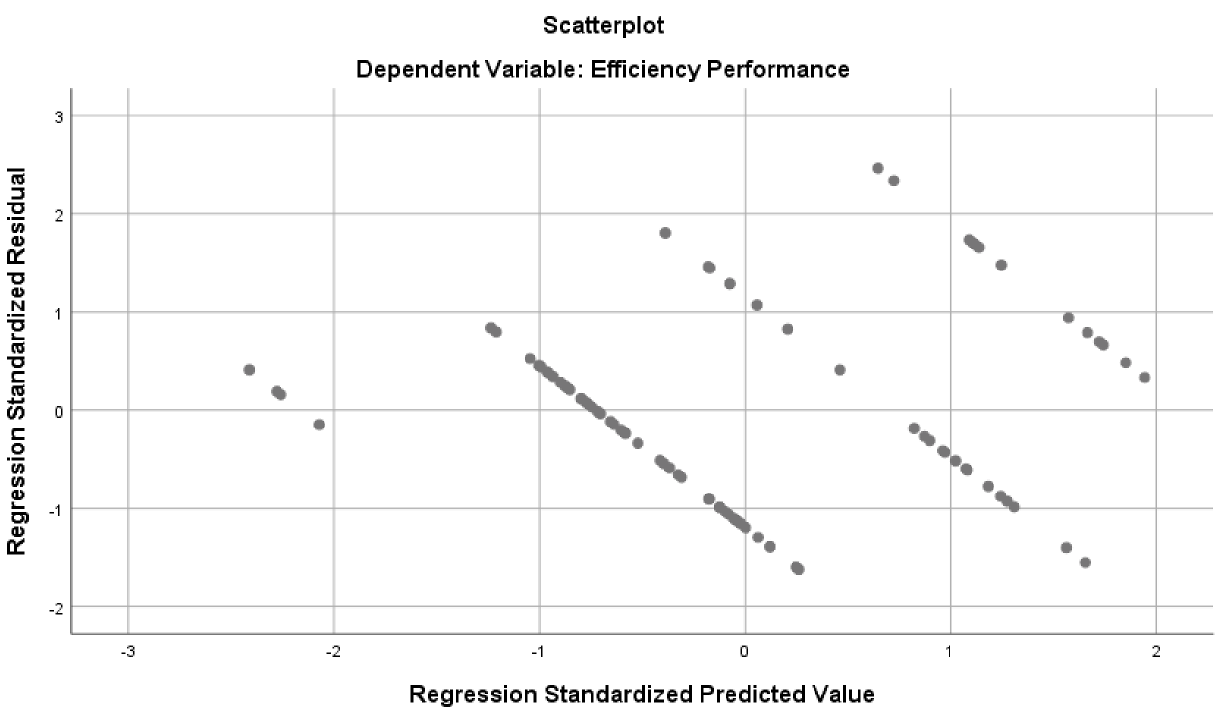




Test for Efficiency




Normal P-P Plot of Regression Standardized Residual
Dependent Variable: Efficiency Performance
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0


Scatterplot
Dependent Variable: Efficiency Performance
Regression Standardized Residual
Regression Standardized Predicted Value
-3
-2
-1
0
1
2
3

APPENDIX 2: QUESTIONNAIRE

St. Mary's University Graduate School

Institute of Quality and Productivity Management

Dear Respondent;

This Survey questionnaire is for a research on how manufacturing waste affects ASKU plc's operational performance. Greetings, Sir/Madam I attend St. Mary's University to pursue a Master in Quality and Productivity Management (QMP). The following research is part of my QMP study and was conducted for purely academic purposes. The purpose of the research is to find out the current and existing major sources of waste, their impact on the operational performance of the company, and put forward recommended and suggested solutions to minimize the quantities of waste and their impact on operational performance. All the Information collected through the questionnaire will be used only for contribution to knowledge and kept secret/confidential. Please ensure that you mark all the given statements otherwise incomplete responses.

To this end, we kindly request that you answer the following short questions regarding the stated objective. It will take no longer than 20 minutes of your time. Your response is of the utmost importance to me. Therefore, your genuine, honest, and prompt response is available input for the quality and successful completion of the project research paper.

General Instruction

- There is no need of writing your name.
- In all case where answers options are available, please make mark(X) in the appropriate place.

PART 1: General Information

Instruction: Please, put tick mark (√) in the box provided against your choice

Gender: Male ________________ 2. Female: _____________

Age: 18-- 25 ☐ 5-30 ☐ 31-35 ☐ -40 ☐ ove 41 ☐

Qualification Diploma ☐ First Degree ☐ Masters ☐

Marital status: Single ☐ Married ☐ Divorce ☐ Widowed ☐

Working experience in ASKU PLC 1-5 ☐ 6-10 ☐ 11-15 ☐

Above 15 years ☐

Current position in the company

Operator ☐ Supervisor ☐ Quality control ☐

Mechanic ☐ Head / Manager ☐ Senior professional ☐

PART TWO: Likert scale questions

After you read each of the statements, evaluate them in relation to your organization, and then put a tick mark (√) under the choices you prefer as your priorities.

Where 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree

I	Sources of manufacturing wastes	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
	Defect					
1	Preform , cap and bottle reject from the line is very high					
2	Finished products rejects is high					
3	There are times QC department give order to stop the line due to occurrence of defect					
	Overproduction					
4	We experienced overproduction due to inaccurate market forecasting					
5	Due to overproduction, there was a problem with storage space					
6	Over production creates high rejection in store due to long storage and product deterioration.					
	Waiting					
7	There are cases where the plant stops operation while it awaits raw material supplies.					
8	The production process frequently experiences unplanned disruptions					
9	Preventive maintenance and changeover took longer than expected.					
	Transportation					
10	The plant layout is poor, resulting in unnecessary transportation of materials from store to production and from production to warehouse.					
11	There are situations where the operation is delayed due to transportation-related problems (bringing materials from the supplier).					
12	There is unnecessary transportation of finished products to other store (Yehule Gebeya)					

	Excess inventory					
13	The company holds excess inventory of raw materials.					
14	Finished product inventories are high during the non-pick season.					
15	Due to the large inventory level, difficult to implement FIFO					
16	Due to prolonged storage, products at the warehouse are damaged (dusted, pack-damaged, etc.), and they are rejected.					
	Motion waste					
17	Machines and equipment are not designed in a way to reduce motion (walking, lifting, reaching, bending, stretching, and moving).					
18	In most cases, looking for spare parts for machinery takes too long, resulting in time loss due to tool boxes not being placed near the machine.					
19	A considerable amount of time is lost by travelling here and there due to shared resources					
	Excess processing					
20	There are situations where the warehouse is de-palletize the product to free up space in the store.					
21	The firm does a lot of repacking operations since the goods was handled incorrectly during loading and unloading.					
22	Excessive monitoring physicochemical parameters of finished products hourly by QC where they have never been found outside of the limit.					
	Unutilized human skill					
23	The company fails to utilize employee potential due to poor motivation.					
24	In some areas, personnel are not assigned to the right place, which prevents them from using their skills properly (the right people are not assigned to the right place.					
25	Employees and Managers are not participating in strategic undertaking which results failure to utilize human potential.					

II	**Effect of manufacturing waste on operational performance**					
	Cost					
20	Cost of production increase due to manufacturing cost					
21	Competitiveness with price in the market is affected negatively as a result of increased costs of manufacturing					
22	Inspection and monitoring process is increased deploying excess manpower					
	Quality					
23	Complaint from consumer increases due to high amount of non-conforming product on package.					
24	Due to Manufacturing wastes our product preference is less in the market					
25	Manufacturing waste have effect on generating non-conforming product.					
	Delivery time					
26	Delivery time is negatively affected by high amount of Manufacturing waste					
27	Product delivered to customer is not timely					
	Machine downtime and maintenance time is prolonged and affect product delivery time					
	Efficiency					
28	Plant Efficiency is low due to the eight manufacturing waste					
29	Due to the manufacturing wastes Employee performance and productivity become low					
	Due to high material defect most of the time we do not meet our target production volume					
III	**Major Causes of high Manufacturing Waste**					
30	Improper planning is the major cause of excess inventory in the company.					
31	Frequent power fluctuations can directly affect production capacity.					

32	Uncertain market needs and inadequate forecasting are the main causes of the company's high levels of overproduction.					
33	High production waste is mostly caused by equipment failure (unplanned downtime)					
34	Spare unavailability is the cause for high downtime					
35	Poor quality control at incoming inspection is the main reason for the high defects in materials.					
36	Absence of preventive maintenance is the main reason for high wastage on production.					
37	Assigning staff in the wrong position and insufficient training are the reasons for high defects.					
38	Unreliable suppliers are the main cause of waste in the company.					
IV	**Waste Management and Removal**					
39	Wastes are accumulated in the compound for longer periods due to the difficulty of the rejection process.					
40	There are high costs involved in disposing of the waste produced by the company					
41	It is very difficult to dispose of waste because of the unavailability of the waste area.					
42	Waste rejection procedure is not consistent					
43	Wastes are not segregated properly based on the type before discarded.					

APPENDIX 3 – INTERVIEW QUESTIONER AND OBSERVATION CHECKLIST

Interview questions

1- What types of wastes are majorly observed in the organization from the eight manufacturing wastes?

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2- What is the main challenge of waste minimization in the company?

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3- What do you think is the main cause of high materials and finished product rejection in the company?

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4- what activity are being done to make the plant productive?

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5- What type of action you recommend to reduce wastes in the company?

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6- What is the impact of the waste generated in the company on the environment?

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7- How is the waste in the company addressed / removed?

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Observation Checklist

This checklist is intended to help the researcher to check the manufacturing facility practice in terms of managing wastes

1. Compound (Facility)

- Cleanliness of the compound
- Waste collection Bins availability and management
- Traffic movement
- People Motion in the compound
- Waste Collection area
- Type of wastes in the compound and how they are segregated
- Waste removal practice and process

2. Production Plant

- Production layout
- How workers perform their job
- Material rejection from production process
- Maintenance activates

3. Raw Materials and packaging materials Store

- Storage condition of raw materials
- Quantity in store
- Store lay out
- How they manage FIFO

4. Finished Goods Store

- How does products stored
- Palletization and de-palletizing activities
- Product Handling during loading and unloading
- Any other activates performed in warehouse

5- QC Laboratory

- What QC checks performed in the laboratory
- The frequency of tests
- The number of QC personnel's in the lab
- General laboratory layout and distance from production processes