St. Mary's University
School of Graduate Studies
Institute of Quality and Productivity Management

EVALUATION OF MANUFACTURING WASTES AND THEIR IMPACT ON OPERATIONAL PERFORMANCES: THE CASE OF BOTTLED WATER MANUFACTURING COMPANY

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DECLARATION

I hereby declare that the research work which is presented in this thesis titled "Evaluation of Manufacturing Wastes and their Impact on Operational Performances: The Case of Bottled Water Manufacturing." 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.

Tadele Kumie Kassie	______________________ Signature	____________ Date

ENDORSEMENT

This is to certify that the above declaration made by the author is correct to the best of my knowledge.

Dr. Ameha Mulugaeta (Advisor)	______________________ Signature	______________ Date

ACKNOWLEDGMENT

First of all, I would like to thank God for giving me the courage to successfully complete this thesis work. My sincerer thanks goes to also to my advisor Dr. Ameha Mulugeta for his guidance, unreserved and profound support while doing the research work.

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LIST OF ACRONYMS

ASQ: *Americans Society for Quality*

BSC: *Balanced Score card*

FGD: *Focus Group Discussion*

FSSC: *Food Safety System Certification*

ISO: *International Organization for Standardization*

LSS: *Lean Six Sigma*

NVAA: *Non Value Adding Activity*

SIPOC: *Supplier, Inputs, Process, Output, Customer*

TDS: *Total Dissolved Solids*

TPS: *Toyota Production System*

TPS: *Toyota Production System*

VSM: *Value Stream Mapping*

ABSTRACT

Lean is a system all about the reduction of wastes which are significantly contributing to the ineffectiveness and inefficiency of the business entities if not systematically studied, analysed and long term solutions are taken. Waste could come in many different forms. Companies that have not previously been exposed to lean manufacturing tend to have a lot of wastes in their manufacturing processes. The case company, which is a bottled water manufacturer on which this research dealt with was not an exception. This research was conducted to identify the significance of the eight manufacturing wastes and their impact on operational performances of the case company, such as, on quality, delivery time and costs. To validate data through cross verifications, a triangulated measurement systems were employed including survey questionnaire, archival data collection and focus group discussions.

To investigate the magnitude of wastes in processes, the research was conducted in two categories. Category 1 was representing the manufacturing and associated processes and category 2 the support process. A total of ninety five (95) responses were collected and the analysis of data demonstrated significant results on manufacturing wastes. Analysis made on the archival data collected in a period of twelve months has also revealed that significant amount of wastes were existing in the case company in different forms. The third instrument used was focus group discussions. It was designed to identify the root causes of manufacturing wastes and determine their significance to pose risks to the case company. The results obtained were also remarkable in that root causes were multidimensional and significant. The data analysis and conclusions made on these triangulated methods have shown consistency in that wastes were significantly present in both manufacturing and support processes and these wastes were also significantly negatively impacting on the operational performances of the case company. With these significant wastes, it will be very difficult for the case company to ensure business success in a sustainable manner. The researcher, therefore, has proposed short-term and long term solutions that will significantly reduce the eight manufacturing wastes and consequently improve operational performances.

CHAPTER 1: INTRODUCTION

This chapter provides the basic information that triggered the conduct of this research and the questions answered and the objectives met by this research. It also includes the scope of the research, significance and definition of basic concepts used in this Thesis Report.

1.1 Introduction to Lean and Manufacturing Wastes

The concept and its practice was originated from the shop floors of a Japanese auto industry, in particular, Toyota Motor Corporation (TMC) in the late 1950s to early 1960s (Monden, 1983; Ohno, 1988). Lean manufacturing has recently received much attention all over the world. In its history, the term "lean" was first invented by Krafcik (1988) to pronounce a production system that uses fewer resources compared to mass production system. Further, to represent the same aim, the term was again used in a seminal book "The Machine that Changed the World" authored by Womack .P.J. et al. (1990).

Lean is all about the elimination of the eight manufacturing wastes, such as, wastes from producing defects, excessive transportation; excessive inventory; overproduction; excessive waiting; overprocessing; excessive motions; and wastes associated with failure to use the human potentials for the achievement of organizational objectives. The reduction and elimination of these wastes provides the opportunity to establish lean processes, where non-value adding activities are reduced and if possible prevented at all. These efforts will in turn improve the efficiency and effectiveness of a company operations with a resultant effects on quality of the outputs and optimization of the use of resources, Womack .P.J. et al. (1990).

However, in companies where no systematic study was carried out to uncover the sources and the impacts of the eight manufacturing wastes appropriate actions were not taken, these wastes remains to be abundant and manifest themselves in different forms, such as, low product quality, late delivery time, high operation costs, customers' dissatisfaction, and low profit margins.

1.2 Background Information on Bottled Water Manufacturing

In Ethiopia, though bottled water business has started recently, many companies have invested on it. However, the competition has become so fierce. Initially, competitive advantages were taken from increased production volume, price reduction and proximity to large markets.

However, nowadays, those enablers seems to be no longer a competitive advantage as they have been achieved by many of them. However, 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. Those standards are essential, however, their effectiveness is questionable without integrating the concepts and practices of reduction /elimination of manufacturing wastes.

The case company was established in Addis Ababa in 2015 to produce purified bottled and jar water. It has six bottled water and two jar water production lines with a total capacity of producing 120, 000 bottles of water per hour which makes it one of the top 3 competitors in the industry sector. The company has implemented and achieved international certification on quality and food safety management systems based on the requirements of ISO 9001:2015 and FSSC 22000, Version 5.1, respectively.

However, manufacturing wastes were not adequately taken into consideration, where poor factory layout is creating excessive transportation of materials and excessive motion to people in their efforts to complete their routine jobs. Holding of excessive inventories for in case, and due to the push production system, finished products were excessively produced and exposed to deterioration in quality as they were staying longer time in storage. Some of the reasons were the manufacturing waste categories, such as, motion wastes, waiting wastes, overprocessing wastes are not easily perceivable by individuals unless uncovered by research results of this kind. For other waste categories, the company people holds the wrong perceptions, such as, holding large volume of input materials are considered to be a guarantee for ensuring the continuity of the business and overproduction is a measurement criteria for rewarding people.

This research has specifically examined the sources and the negative impact of the eight manufacturing wastes on operation performances, such as, on quality, delivery time and costs. Based on the research findings, appropriate solutions for the mitigation of wastes have been proposed thereby the effectiveness and efficiency of the business of the case company will be improved.

1.3 Statement of the Problem

Manufacturing wastes in any form, in the absence of countermeasures, consumes the organization resources and cripple it ability to compete in multidimensional factors, such as, quality, delivery time, cost, flexibility and productivity. The case company was not an exception in that it was mainly focusing on activities to increasing production volume, setting up product outlets and designing sales strategies in order to increase profitability of its business. However, it was not well aware of the significant presence of wastes and their impacts on operational performances. Some of the wastes were very apparent, such as, unnecessary transportation of input material, for example packaging materials (preforms and caps) were transported from a production facility which is eight kilo meter away from bottled water production site. Significant amount of defects were also identified form these packaging materials due to rough handlings and excessive loading on trucks, where products underneath got deformed and became unusable.

Due to inappropriate factory layout, input materials were also transported by forklifts from the warehouse in remote location to the feeding hopper. As the feeding hopper is located at first floor of a building a forklift had to extend its forks upward, were in some cases the packaging materials fallen back and got damaged. Due to such inconveniences of materials transfer, the forklifts hit and damaged the structures of buildings. Finished products were also transported from production lines to quarantine store and then to the finished products warehouse using forklifts (expensive to purchase, to operate and maintain), where it could have been done by proper alignment of functions and processes, and installation of conveyor belts with appropriate capacity and capability.

Misconceptions held by people within the organization were also contributing to hold excessive inventories. People perceived holding of excessive input materials as a guarantee for continuity of the business. They did not considered the consequences of damages during handling and storage, inventory costs and tied up capita which would affect the cash flow of the company. Due to wrongly established incentive system, people were rewarded for producing excess. Rewording the destructive performances. Excess products need more space. When the designated stores became full, they were stored in non-designated spaces where the products were exposed to cross-contamination. Due to production in excess, products were also stored in long stacking heights were the necks and caps of the underneath products were broken and isolated as defective products. If those defective products have reached the customers, they became leaky and returned back with complaints. One of easily detectable problems was isolation of considerable quantity of defective bottled water by light board inspection.

These wastes were manifested in routine jobs, however, were not seen as significant problems of the business, as their sources and impacts were not studied and made known to the top management so that systematic actions could be taken to ensure its sustainability and profitability.

1.4 Research Questions

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

a) What are the sources of the eight manufacturing wastes?
b) What are the impacts of the eight manufacturing wastes on operational performances?
c) What can be done to mitigate the impacts of the eight wastes in order to improve the operational performances of the case company?

1.5 Research Objectives

The research objectives were formulated based on the introductory information and problem statement that have been described in sub-section 1.2 and 1.3 above.

1.5.1 General Objective

To identify and determine the source and impacts of the eight wastes and propose actions to mitigate the impacts of those wastes on operational performances of the Company.

1.5.2 Specific Objectives

Consistent with the general objective, the following specific objectives were established.

a) To investigate and identify the eight manufacturing wastes and their sources.
b) To investigate the impacts of the eight manufacturing wastes on operational performances of the case company.
c) To propose operational controls for mitigating the eight manufacturing wastes.

Triangulated methods of data collection instruments were used in order to validate the results obtained and ensure that the weakness of a partial instrument is covered by anther instrument employed for this purpose.

1.6 Scope

This research was conducted on a single organization (case study) engaged in manufacturing and sales of purified bottled water. The company is located around Sebeta Town, in Oromiya Regional State.

The research was focusing on studying the sources and impact of the eight manufacturing wastes, namely, defects waste, overproduction waste, waiting waste, wastes associated with failure to use the human potential, transportation waste, inventory waste, motion waste and overprocessing waste on operation performances of the case company. Quality, delivery and cost, were selected to be the operational performance indicators, as these elements were used as a common denominators as performance indicators by researchers, such as, Nordin N. et al. (2016).

This research did not take into account evaluation of the impacts of the eight manufacturing wastes on the business performance of the case company, such as, customers' satisfaction, profitability and sales. The reason for selecting the operational performances was that these performance measures are the primary factors that affects organization performances. It is due to failure in operational performances that organizations suffer from weaknesses in business performances.

1.7 Significance of the Study

As clearly stated in sub-section 1.2 and 1.3 above, the statement of the problem have shown that there existed manufacturing wastes which have consumed resources, but added no value to the customers, and of course to the organization. However, resources in any form wasted adds costs to the company which will ultimately negatively affect its competitiveness. Wastes that has occurred not only add costs to the company, they are also directly linked to the satisfaction of the customers as they are negatively impacting on quality, delivery time and cost. Therefore, the study conducted on manufacturing wastes and the magnitude of their impacts have produced potentials for improvement for the case company and particularly new insights regarding wastes in bottled water manufacturing, such as, overprocessing to unnecessarily remove TDS from bottled water, which is the cause of wastage of excessive water pumped to the factory, of which one cannot afford in a country with sever water stress. The study outputs will trigger action by the government of Ethiopia, standardization body in general and water manufacturing facilities in particular.

1.8 Limitations

Archival data collection instrument was designed to include all the eight manufacturing wastes, however, as data collection started data was not available for overproduction wastes, motion wastes, wastes related to untapped human potential, and inventory wastes as the case company did not capture them at all. However, it should be noted that studies on those waste categories were adequately covered by perceptual data analysis (survey and focus group discussions) made and the conclusion derived were adequate and justifiable.

1.9 Definition of Terms

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 (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 (ASQ).

Operations performance: Operations performance comprises actual outputs of operations strategies employed, which is influenced by operating conditions (such as quality, manufacturing flexibility, lead time, inventory, productivity, and costs) and represents some internal properties of manufacturing system, Nawanir G. (2016)).

Six Sigma: Six Sigma is a method that provides organizations tools to improve the capability of their business processes. This increase in performance and decrease in process variation helps lead to defect reduction and improvement in profits, employee morale, and quality of products or services (ASQ).

Lean Six Sigma: Lean Six Sigma is a fact-based, data-driven philosophy of improvement that values defect prevention over defect detection. It drives customer satisfaction and bottom-line results by reducing variation, waste, and cycle time, while promoting the use of work standardization and flow, thereby creating a competitive advantage. It applies anywhere variation and waste exist, and every employee should be involved.

Impact: to have an influence on something (Cambridge English Dictionary).

Significance: The significance of something is the importance that it has, usually because it will have an effect on a situation or shows something about a situation. (Collins English Dictionary).

CHAPTER 2: LITERATURE REVIEW

This chapter provides discussions on the information collected from various literatures related to the research objectives. The consistency and divergence among various researchers have also been evaluated and included. Lessons learned from the literatures reviewed and the gaps identified have also been made part of this chapter.

2.1 The History of Lean Manufacturing

Lean production system was originated in Japan which was founded by Taichi Ohno an engineer in Toyota, after he studied the concept of Ford Production System (FPS). However, the term "lean" was first introduced and used by John Krafcik, Nordin N. et al. (2016), to describe the Toyota Production System (TPS) established by Ohno. After the Second World War, Toyota realized that they could not afford to invest much due to lack of resources and thus contributed to the birth of TPS. Toyota Production System (TPS) was developed in order to survive in an environment with minimum amount of resources, therefore, its main objective was to reduce waste in every section and step across the production timeline, Wahaba N. et al. (2013). A lean manufacturer typically uses as less of everything (half the inventory, half the defects, half the manpower, time to market and manufacturing space) to become more responsive to customer demand while producing quality products in the most efficient and economical manner, Womack .P.J et al. (1990).

The ultimate goal of implementing lean production system in an operation is to increase productivity, enhance quality, shorten lead times and as well as reducing cost, Khalil A. et al (2013). Therefore, it is crucial to measure the degree of leanness in a production system in order to realize the benefits of lean and ensure whether a production firm has been implementing the right lean practice to improve its performance.

2.2 The Concept of Lean Manufacturing

Facts have clearly indicated that lean manufacturing has significant contribution to the success of companies in Japanese as well as in US. Experts have suggested that high performance depends on establishing a lean manufacturing system that can significantly reduce wastes. Currently, the concept of lean production is being applied across industries located in many countries due to its worldwide acceptance, and its impact on cost, quality, and time, Nawanir G. et al. (2013).

Various studies have concluded that lean production has helped many companies to improve their performance through waste reductions. At the operations level, several studies believed that lean production has become a powerful system in improving operations performance in terms of quality; inventory minimization; delivery; productivity; and cost reduction. Lean manufacturing has also been considered as an effective system to improve business performance in terms of profitability; sales; and customer satisfaction, Nawanir G. et al. (2013). However, studying the impact of manufacturing wastes on business performance was not the scope of the current study.

2.3 The Eight Manufacturing Wastes and Operational Performances

Waste is any activity that does not contribute value to operations. However, value adding activities transform inputs to desirable outputs, Keitany, P. and Riwo-Abudho M. (2014). Wastes are, therefore, directly impacting on the operational performance of organizations where the operational performances in turn impacts on the business performance, such as, customers' satisfactions and profit.

2.3.1 The Eight Manufacturing Wastes

Wastes in lean production was defined as any human activity which uses resources but creates no value. Ohno has identified seven types of waste categories which are also known as Ohno's seven Muda. ILO (2017) has provided clear definition for the seven manufacturing wastes as followings:

Wastes of Overproduction: overproduction is unnecessarily producing more than demanded or producing it too early before it is needed. This increases the risk of obsolescence and increasing the possibility of having to sell those items at a discount or discard them as scrap.

Defect wastes: In addition to physical defects which directly add to the costs of goods sold, this may include errors in paperwork, provision of incorrect information about the product, production of materials to incorrect specifications.

Inventory wastes: Inventory waste means having unnecessarily high levels of raw materials, works-in-progress and finished products. Extra inventory leads to higher inventory financing costs, higher storage costs and higher defect rates.

Transportation wastes: Transportation includes any movement of materials that does not add any value to the product, such as moving materials between workstations. The idea is that transportation of materials between productions stages should aim for the idea that the output of one process is immediately used as the input for the next process. Transportation between processing stages results in prolonging production cycle times, the inefficient use of labour and space and can also be a source of minor production stoppages.

Waiting wastes: Waiting is idle time for workers or machines due to bottlenecks or inefficient production flow on the factory floor. Waiting also includes small delays between processing of units. Waiting results in a significant cost as it increases labour costs per unit of output.

Motion wastes: Motion includes any unnecessary physical movement or walking by workers which diverts them from actual processing work. For example, this might include walking around the factory floor to look for a tool, or even unnecessary or difficult physical movements, due to poorly designed ergonomics, which slow down the workers.

Wastes of overprocessing: Overprocessing is unintentionally doing more processing work than the customer requires in terms of product quality or features – such as polishing or applying finishing on some areas of a product that won't be seen by the customer.

Soliman H. (2017) has provided a clear definition of untapped human potential which came after the seven wastes identified by Ohno:

Wastes of untapped human potential: The loss of human creativity waste exists in any company that doesn't value its people. Toyota provides the best example of a company valuing its employees. When Toyota invests in its leaders, it expects them to develop the other leaders using the skills and knowledge they have learned through the Toyota leadership self-development program.

2.3.2 Operational Performances

Lean production has been frequently implemented at the shop floor and associated with production processes. Hence, deploying non-financial measures, which were not part of the traditional accounting systems, are found to be useful. This concept have suggested that companies which were engaged in lean production were more likely to use non-financial measures to a greater extent rather than the financial measures. Non-financial measures are actually measuring operational performance, which subsequently influences the business performance. Experts in the field have believed that operational performance is influenced by operating conditions and represents performance at each production resource level.

2.4 Issues Related to Investigation of Lean Manufacturing Effect on Organizational Performances in Previous Studies

2.4.1 Introduction

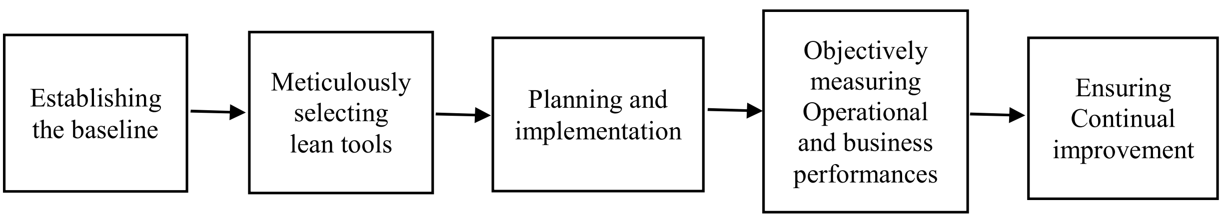
Using Google Scholars and ScienceDirect various literatures were obtained and selected those literatures with a link to the current research problem, questions and objectives. The literatures were reviewed to gain knowledge on what and how other researchers have carried out their researches on the "magnitude and impact of manufacturing wastes on operational performance" and identify the gaps in their researches and design a method to address those gaps in the current research outputs.

2.4.2 Impact of Lean on Operational Performances

In order to achieve the pre-determined objectives, Nawanir G. (2016) explored a bounded system or a case (i.e., lean manufacturer) through detailed and in-depth data collection involving several sources of evidence, such as, interviews, observations, and audio-visuals, documents in order to triangulate the research works so that the reliability of data could be verified and the conclusions derived from it could also be validated. The data analysis have shown that all the lean manufacturing practices were significantly related with all the measures of operational performances.

From Nawanir G. (2016) research works, the following concepts could be mapped in order to provide a logical framework for the effectiveness of lean system.

Fig. 1: Lean Tools Implementation Framework



According to Nawanir G. (2016) lean manufacturing practices must be implemented holistically. Piecemeal adoption is not preferable. The recommendation is in agreement with

Deming (1986) to view the organization processes as interrelated and interdependent components of a system. Because processes are interrelated, it is only through improving all interacting elements that the operational and business performances can be improved.

The holistic implementation of lean manufacturing improves all the measures of operational performances. It is true that the application of appropriate lean tools will immediately improve operational performances, such as, quality, delivery time and costs, and then the resultant effect will be improving the business performances, such as, customers' satisfactions, profitability and sales. This assertion is also in line with the research findings of Uz-Zaman A. (2013) which was stated as "The implementation of inappropriate lean strategy for a given situation can sometimes lead to an increase in waste, cost and production time of a manufacturer". In fact, W. Edwards Deming (1986) called such wrong practices on a system as "Tampering". The strength of the research is that it links between lean tools and operational performances and the contribution of operational performance to the business performance of the studied organization. However, Nawanir G. (2016) could have considered the magnitude of the manufacturing wastes and provide quantitative results which could indicate the level of improvements achieved by implementing lean manufacturing. However, the current research was focussing on the magnitude of each waste in the case company.

Nawanir G. (2016) has also stated that unlike financial performance measures, operational measures usually used perceptual source of data rather than archival source, since there is no such public database which enclose data regarding cost, quality and manufacturing time of every manufacturing firm due to confidential issues. Nordin N. et al. (2016) have indicated causal relationship between lean practices and performance measures. All literatures organized and analyzed by the researchers have supported and had validated the empirical positive impact of lean practices upon operational business performances.

Nordin N. et al. (2016) have further emphasized that lean is a paradigm shift which focuses on the elimination of waste and non-value added activities to achieve higher levels of efficiency, profitability and flexibility and lean operations are characterized by the elimination of apparent wastes reside within the manufacturing processes, thereby facilitating cost reduction. However, the researchers seemed to miss the fact that non-value adding wastes are divided into two categories and one cannot eliminate or attempt to eliminate all categories of wastes. The first category is essential but non-value adding wastes, such as, order processing and fee collection, which we can minimize, not eliminate them at all. The second category is non-essential and non-value adding wastes, such as, defects, overprocessing, excess inventory, etc., which we should minimize or eliminate from the business processes.

Nordin N. et al. (2016) tried to justify that a firm must achieve minimal waste first before able to achieve other performance measures and proved waste elimination as the dependent variable. The researcher have considered waste reduction efforts would result in better performances, which subsequently include lower cost, shorter lead time, more stable quality, lower work-in-process (WIP) and inventory level.

Similar to Nawanir G. (2016) research findings, Nordin N. et al. (2016) have stated that unlike financial performance measures, operational performance measures usually used perceptual source of data rather than archival source since there is no such public database which enclose data regarding cost, quality and manufacturing time of every manufacturing firm due to confidential issues.

Lessons could be derived from Nordin N. et al. (2016) research output that many of the researchers did their researches on perceptual (questioners or interview) rather than collecting data from the archives due to their confidentiality in nature. In addition to confidentiality, the current researcher believed that some companies may not retain those appropriate data at all.

Rasi R. et al. (2015) have made the following discussions: In the first dimension, lean production was positively related with quality. In lean production, product conformity with the specifications begins since the early stage in order to avoid waste and increase the quality. This is because the workers must strictly follow the guidelines, procedure and specifications in producing a product as a way to eliminate the possibility of waste and subsequently the quality of a product will be kept assured. This practise have then affected the delivery (second dimension) as when the production runs smoothly with quality, there was no delay in delivering the product to the customers. The combination of quality product and on time delivery have then affect costs (third dimension). When there is no issue of quality, such as, defects and delivery was on time, there would be no extra cost of reprocessing to replace defect product and send it back again to the customer which in turn saved costs significantly. When there is no complaint from the customer on the quality and delivery, the manufacturing company can create new product since they have more time to improve what they are producing instead of wasting time repairing mistakes that is avoidable. They also can produce more products as everything is as planned. This is the flexibility (fourth dimension) of a manufacturing company which is affected positively from the lean production practise.

Rasi R. et al. (2015) hypothesized that lean manufacturing practice would lead to higher business performance because the central theme of lean manufacturing is to have the right items of the right quality and quantity in the right place and at the right time. This means that waste must be extremely eliminated. Hence, it is believed that lean manufacturing practice encourages higher profits. However, as Nordin N. et al. (2016) did Rasi R. et al. (2015) emphasized the need for elimination of all wastes, however, some wastes are necessary (could be termed as the necessary evils), in that case we can only minimize them.

Rasi R. et al. (2015) findings have shown that the better the implementation of lean manufacturing practices, the better the operational performances. Multiple regression analyses indicated the significant relationships between lean manufacturing practices and operational measures. Furthermore, Rasi R. et al. (2015) emphasized that both lean manufacturing practices and operational measures positively affect business performance. Rasi R. et al. (2015) have identified that not much attention had been paid to investigate the lean manufacturing-performance relationships in the developing countries. Further emphasized that in order to obtain a clearer picture regarding the impact of lean manufacturing practices on performance, investigations in the context of developing countries are substantially required.

Rahman S. et al. (2010) used overall customer satisfaction as a criteria to measure operational performance measure, where customer satisfaction is a criteria for measuring business performance not operational performance measure which is contrary to Nawanir G. (2016).

Balanced Score card was employed to measure the operational and business performances of organizations researched. Therefore, the impact of lean system was measured against KPIs derived from BSC model. The method provides a traditional way of assessing the performance management which have been widely used and considered to be effective. BSC includes both operational and business performance measure, however, the focus of the current research was to measure the impact of wastes on operational performance of the case company.
Suketu Y. et al. (2016) in their literature review have identified the following learnings: A performance management system in a lean context calls for not only a clear system definition – the right metrics, supported by effective tracking and reporting processes, information

technology tools and linkages to financial and other systems – but also the right approach to managing the dynamics of performance hour by hour, shift by shift, day by day, month by month. The people who operate the lean processes must be able to see and understand the critical measures of performance so that they can take the right steps to make high performance an everyday reality.

Suketu Y. et al. (2016) have incorporated leadership performance dimension into a performance measurement system, such as, management commitment and communications, change in management and organisation culture, willingness to learn skill and expertise, employee involvement and trust, supplier relationship and integration of networks, human resource management, performance monitoring, customer involvement, strategy, mission, vision, and financial capability and budget. These performance measure is a new perspective and could be integrated with the BSC measures.

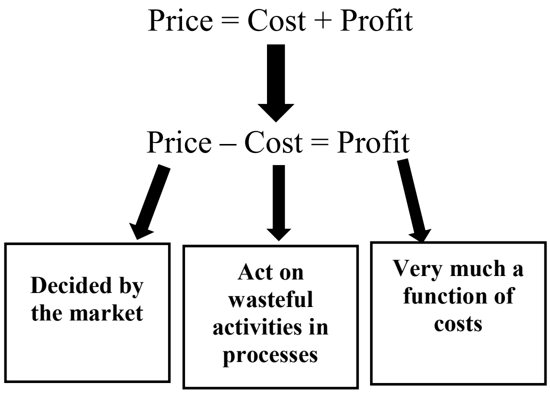
According to Susilawati A. et Al. (2013), BSC provides data of all key indicators at discrete time intervals, and facilitates strategic review that permits formulation of plans to achieve organisational goals. However the BSC cannot view the performance at manufacturing level. In addition, BSC has a weakness to measure long term vision and fails to identify the performance measurement specific level such as employees, suppliers and stakeholder. This assertion is in line with Suketu Y. et al. (2016).

Pal S. (2019) explained that the main objectives of the TPS are to design out overburden (muri) and inconsistency (mura), and to eliminate waste (muda). The researcher further explained that it is also crucial to ensure that the process is as flexible as necessary without stress or “muri” (overburden) since this generates “Muda” (waste). The elimination of Muda has come to dominate the thinking of many when they look at the effects of TPS because it is the most familiar of the three to implement.

According to Pal S. (2019), the goal of empowerment in lean system is based on the idea of showing respect for people. Respect for people extends beyond just the end customer and can include the workers, suppliers, and society. For the end customer, lean strives to maximize value delivery while minimizing waste in the process. Lean aims to maximize human potential by empowering workers to continuously improve their work. Lean leaders facilitate this goal through problem-solving training. They help workers grow professionally and personally, allowing them to take pride in their work.

Marta K. et al. (2015) have explained that an important thing for every organization is to make profit, i.e. to improve the ratio between earned and invested money. This consideration is based on the fact that if resources (money, labour, material, etc.) are used more efficiently, the whole process of making profit and supporting competitiveness of the organization will be enhanced. The organization should therefore try not only to analyse the waste but also to eliminate it with correctly chosen tools and methods. This concept is in line with that the following concept (own compilation).

Fig. 2: Transformed View of the Concept of Cost



According to Marta K. et al. (2015) waste occurs in every enterprise, therefore, workers should constantly search for it and eliminate/reduce it to increase productivity and reduce costs.
Marta K. et al. (2015) have concluded that it is obvious that in today´s competitive environment each organization wants not only to survive, but also to progress and, therefore, it must examine its processes and minimize waste, which may be achieved by application of tools and methods for waste reduction. Waste is everything which does not bring value to the company and it highly contributes to the money spent in vain, therefore, every company has to get rid of all activities, which have negative impact on its effective operation.

2.4.3 Impact of Lean on Reduction of Manufacturing Wastes

According to Chahal V. et al. (2017) in order to eliminate/reduce wastes it is very essential to meticulously select appropriate lean tools tailored to the organization's contexts, followed by effective and efficient implementation. This assertion actually works for any other interventions (systems). Based on Literature study Chahal V. et al. (2017) have established a matrix indicating which lean strategy is best fit to reduce/eliminate the manufacturing wastes.

To collect data, Leksic et al. (2020), have developed questionnaires divided into three segments as follows: Segment 1, people have identified their eight wastes in their processes, Segment 2, the questionnaire was about the implementation of lean tools, and Segment 3, the questionnaires were established to identify improvements achieved (to verify that wastes were reduced as a result of implementing lean tools). Leksic et al. (2020) have identified sources of wastes before lean implementation and researching for effectiveness. 5S and Kaizen are the lean tools most used at the beginning of the lean transition, followed by other appropriate tools.

2.4.4 Identifying the Magnitude of Manufacturing Wastes, Implementation of Lean Tools and Measuring Impact of Lean Tools on Operational Performances

In their literature review, Kazi. A. A. et al. (2013) have indicated that "Incorrect application of lean strategies resulted in inefficiencies of an organization's resources and reduced employee confidence in lean strategies. 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". This assertion is in line with the concept that, though they are engaged in the same business and located on the other sides of the road, organizations situations are quite different, in many cases such companies differ in their internal contexts, such as, the machines they have, the methods they employed, the suppliers they use, the leadership style, the competence of their people.

Kazi. A.A. et. al. (2013) have also concluded that the implementation of inappropriate lean strategy for a given situation can sometimes lead to an increase in waste, cost and production time of a manufacturer. Because of inappropriate selection of lean strategies, changes may cause disruptions in the very process it meant to improve. This finding is in line with the Deming (1986) belief that the tendency to take action, without reason causes more problems than it fixes. According to Deming such actions were termed as "tampering". The act of tampering worsen the company situations instead of improving.

Kazi. A.A. et. al. (2013) had conducted the research before and after lean implementation and were able to demonstrate the impact of lean based on primary and secondary data analysis. Unlike Kazi. A.A. et. al. (2013) many of the literatures reviewed started their research on the impact of lean tools on organizational performance before understanding the current situations.

The weaknesses of this research was that it was limited to assembly line. It was not covering the full scale and the interacting elements to the assembly process, such as, materials supply, inspection, maintenance, the human resource management, transportation, handling and storage, etc. The information derived from such studies couldn't be used as an input to generalize and recommend for other industries in similar or different sectors.

As part of applying Lean Six Sigma, Hassan M.K., (2013) has identified root causes for waste generation by using the fishbone diagram. The 80-20 rule was used to recognize the sub-causes that have the most influence on waste generation using the Pareto chart. The causes were considered in the "improve" phase of the Lean Six Sigma process to be addressed for possible improvement according to the available company resources.

2.4.5 Impact of Manufacturing Wastes on Operational Performances

Brito M. et al. (2020), in their literature review have learned that the Toyota way preaches that the worker is the most valuable resource – not just a pair of hands taking orders, but an analyst and problem solver. The results of the research have shown that the respondents (production workers, managers and executives) answered that the eighth waste is related to the lack of one or more than one of the following components: rewards, recognition, justice, evaluation, motivation, goals, self-esteem, knowledge, and resources.

Mani M. and Gill P. (2019) had developed a questionnaire to collect data to find out the major waste in Indian automobile industry. In the questionnaires the eight lean wastes were listed and respondents were asked to arrange them in the order of major wastage of productivity in their firm. However, the magnitude (the significance) of each waste was not studied where ranking in this regard gives little sense. What if the impact of the eight wastes was low and the researchers were ranking the insignificant wastes?

Generally, the manufacturing system is an input-output model, Wahab et al. (2013). The system receives the input elements and then later undergoes a few processes in the transformation stage. Finally, the desired product is produced in the output stage. Quality and cost of the final output rely heavily on the factors that affect or control the system during the transformation process. The goal is to produce the right product at the right time and with the right cost in order to gain profitability and stay competitive by continuing the sales growth. This concept is in agreement with Pramadona and Adhiutama A. (2013).

The model presented by Wahab et al (2013) has provided the opportunities to look at lean wastes in a holistic approach, including establishing a cause and effect relationship, such as, poor raw material becomes the sources of defects and defective products delays delivery until the issue is resolved with the customer and this in turn deteriorates people motivation which is in line with principle 12, "Remove barriers that robe people of pride of workmanship", Deming (1986).

As explained by Okpala, C.C. (2014) all manufacturing processes either add waste or value to the production of a good or service. To identify and subsequently eliminate wastes, it is pertinent to have a complete understanding of waste and where it exists. Although products and services significantly differ between companies, the distinctive wastes inherent in manufacturing processes are quite similar. For each of the wastes, there is a proven strategy to reduce or possibly eliminate its effect on a company (such as, Cellular Manufacturing, Just in Time (JIT), Total Productive Maintenance (TPM), Value Stream Mapping (VSM), Poka Yoke (Error proofing), Five-S Practice, Single Minute Exchange of Dies (SMED), Takt Time Analysis, Kaizen (Continuous Improvement), Visual Management, and Single Piece Flow) in order to improve the overall quality and performance.

2.4.6 Others

Soliman H. (2017) have asserted that most wastes were created from over productivity and excess inventory issues. However, increasing productivity has never became the source of waste, it is overproduction that has been creating wastes as the extra products are not demanded by the customers and remains to be a waste. Soliman H. (2017) has clearly elaborated on the sources and strategies to remove the waste, cost effects and cost benefit analysis involved in decision making for each category of manufacturing waste.

The facts and figures of the literatures reviewed have indicated that lean manufacturing contributed significantly to the success of the Japanese and US companies, Nawanir G., et al.

(2013). Further explained that high performance depends on creating a lean manufacturing system. Lessons from this article is that because of its high positive impact on operational performance, such as, cost, quality, productivity, flexibility, and quick response, the lean manufacturing system has been diffused across countries and industries. However, the system is not well known in Ethiopian industries due to lack of awareness and in accessibility of rare support institutions. The positive impact of lean manufacturing was of course supported by Rasi R. et al. (2015).

Lewis P. and Cooke G. (2013) in their research have used public sayings in order to substantiate their argument as "you cannot fatten the calf by weighing it" but without measuring the calf's medical status how one can prevent the entire herd from being destroyed due to a disease or infection. Perhaps the underlying lean message should be to ensure that the right entity is being measured.

From the literature reviewed, Lewis P. and Cooke G. (2013) have defined lean as "lean thinking is lean because it provides a way to do more and more with less and less – less human effort, less equipment, less time, and less space – while coming closer and closer to providing customers with exactly what they want". This is in line with the Deming (1986) concept of optimization of a system by managing all components as a system and not as an individual, then synergy comes and output multiplies.

According to Alefari M. et al. (2017) the success of implementation of lean manufacturing relies on several factors, such as, internal factors include top management, training and education, thinking development, employees, working culture, communication, resources and business planning and the external factors customer focus' and government intervention.

"Top management" factor is key in almost all studies, regardless of whether the study was focused on small and medium enterprises (SMEs) or big organizations, or whether the study was focused in specific countries, Alefari M. et al. (2017). The need for top management leadership during the implementation of any management system, including lean is very essential. It is also in agreement with the followings provisions of published documents:

- Top management shall demonstrate leadership and commitment with respect to the quality management system (ISO 9001:2015, Clause 5.1.1);

- Deming's principle 1: Create constancy of purpose for improvement of products and services (Deming 1986);
- Crosby (1979) first of all, management must be committed and dedicated to process improvement and this culture should be passed on to the whole company workforce.

Pakdil F. et al. (2014) have concluded that multiple assessment tools have been designed to measure different and often individual aspects of lean implementation. While some existing studies measure leanness level through perceptual evaluations, other studies utilise a quantitative assessment approach. Using only one qualitative or quantitative approach in lean assessment efforts may create a bias both in practice and theory. While quantitative assessment leads the organisations to an acceptable leanness level, stakeholders' perceptions about leanness level may result in an opposite result. To decrease this possibility, organisations should utilise both perceptual and measurement approaches simultaneously to assess their lean implementation efforts.

According to Pramadona and Adhiutama A. (2013) once the current state of Value Stream Map (VSM) was completed, the realistic future VSM can be created. By analysing the existing wastes (the seven wastes) discussions were made with several managers that relates to the production process. Various modifications through the lean manufacturing approach were developed. This research approach was commendable in that it makes the current process more visible.

According to Arunagiria P. and Gnanavelbabu A. (2014) an average in which each quantity to be averaged is assigned a weight. These weightings determine the relative importance of each quantity on the average. Weightings are the equivalent of many like items having same value involved in the average. The ranking of this major waste states that how the current industrial production systems faced the various types of waste.

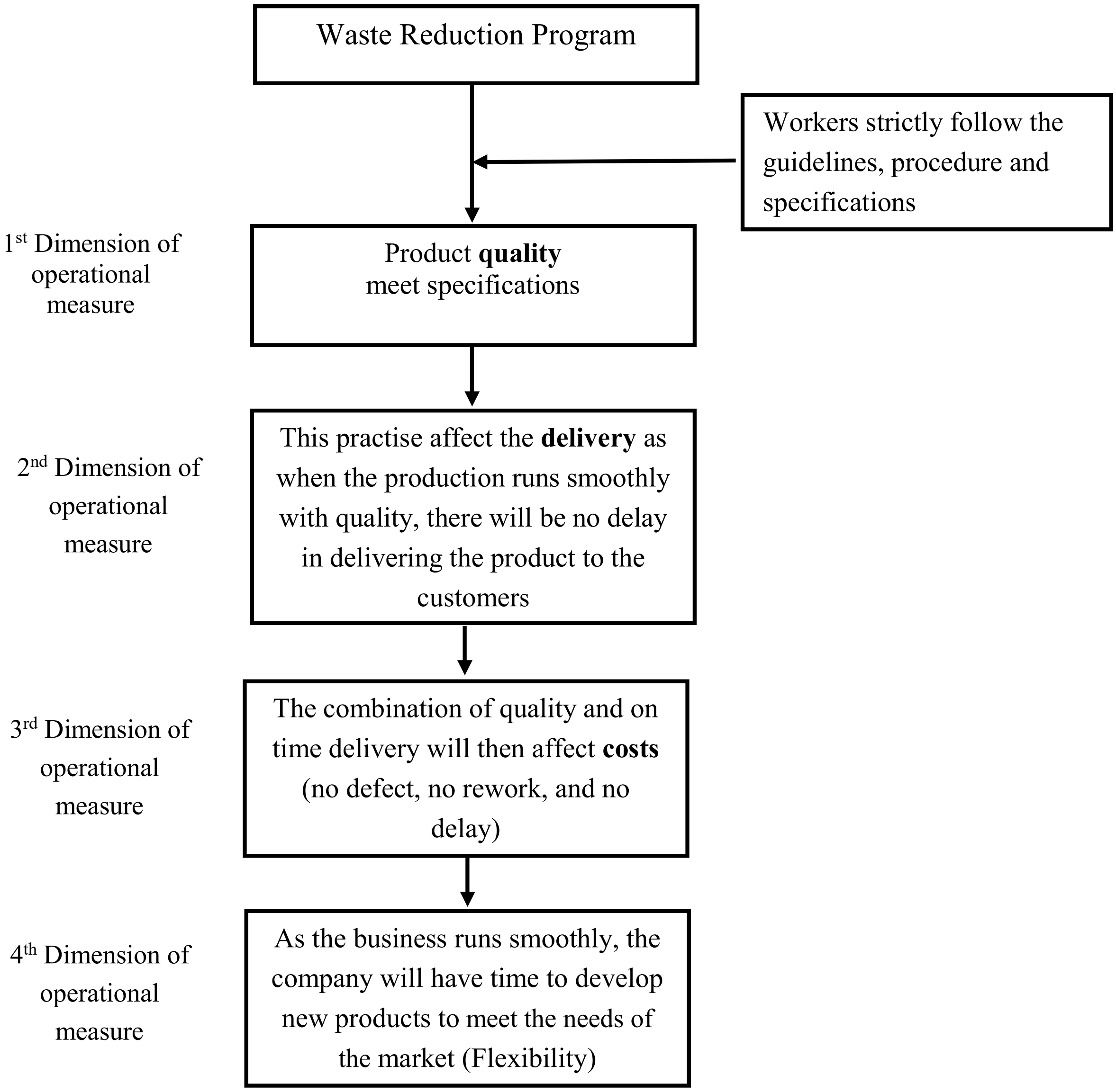
Arunagiria P. and Gnanavelbabu A. (2014) in their results and discussions have pointed out that waste reduction is the major concern in the today's industrial environment. The researchers stated that transportation, waiting time and unnecessary motion were the major wastes that affect the production in the industrial environment covered under their studies. Rathore A. et al. (2015) has explained the research findings as "infeasibility to produce in small batches for efficient utilization of capacity" ---it is a misconception that lean is not applicable in continuous process production facilities. However, the researcher has suggested "Customer satisfaction" and "waste elimination" to be the most important reasons to adopt lean.

Rathore A. et al. (2015) has suggested the following recommendations in order to increase lean implementation:

a) attempts should be made to increase awareness, education and training about lean manufacturing;
b) implementation of VSM can help to identify areas of significant NVAA where large benefits can be recognized;
c) starting with implementation of lean tools which do not involve high expenses and major alterations in equipment, such as, 5S, TPM, visual control, kaizen and "work standardization";
d) exploring possibilities for implementation of lean tools such as Kanban, "pull production," "JIT production" and "production levelling" when product becomes discrete;
e) carrying out benchmarking studies especially functional benchmarking and generic benchmarking to adopt lean manufacturing; and
f) Collaboration with multinational process industries which have implemented lean successfully.

Rasi R. et al. (2015) textual explanations could be illustrated as follows in order to clearly indicate the causal relationship between wastes and organizational performances.

Fig 3: Logical Relationship between Manufacturing Wastes and Operational Performance measures



2.5 Conclusions on Literatures Reviewed

Base on the literatures reviewed, the following conclusions have been established:

a) Literatures reviewed revealed that the researchers were using perceptual data, such as, questionnaires, interviews and focus group discussions. The reasons stated were the confidential nature of archival data.

b) The literatures reviewed were found to be entirely focussing on the impacts of lean tools on operational performances as indicated in Table 1.

Table 1: Categories of Literatures Reviewed

Categories of the Literatures Reviewed	Quantity in %
Impact of lean on operational performances	39.2
Impact of lean on manufacturing waste reduction	7.1
Identifying the magnitude of manufacturing wastes, implementation of lean tools and measuring impact of lean tools on operational performances	7.1
Impact of manufacturing wastes on operational performances	18
Others (Engaged in finding ways to improve processes and products)	28.5

Table 1: indicated that none of the researchers have conducted their researches on the impact of lean wastes on operational performances.

c) From the results of the literatures reviewed, it can be established a common denominator, that quality, delivery time and cost can be used as indicators of operational performances. In addition, not all lean researchers considered the eight manufacturing wastes in their research. Some of them consider only one variable, such as, defect or loss of human creativity and others studied up to thirteen manufacturing waste categories. The selection of variables were dependent on the research objectives.

d) Manufacturing wastes were eating the wealth of the companies, and it is an area where companies need to invest in order to gain multidimensional benefits, such as, cost reduction, cost saving, customers satisfaction, enhancing competitiveness and to clean-up their mind and think lean as well.

e) Wastes are an inherent elements of any company, therefore, lean solutions are applicable to companies while taking into consideration of their contexts.

f) As one size can't fit all, lean solutions should be tailored based on the contexts of the companies.

g) To justify the validity of their research works based on perceptual data, researchers have triangulated their data collection instruments. In addition, respondents were meticulously selected, such as, managers, middle managers and senior exports who were well aware of lean tools and the manufacturing wastes, to ensure truthfulness of data collection processes.

Based on the conclusions established above the following justifications have been drawn up:

- As indicated on Table 1, none of the researchers have conducted their researches on the impact of manufacturing wastes on operational performances. It is, therefore, justifiable that the current study was focusing on the impact of manufacturing wastes on operational performances.

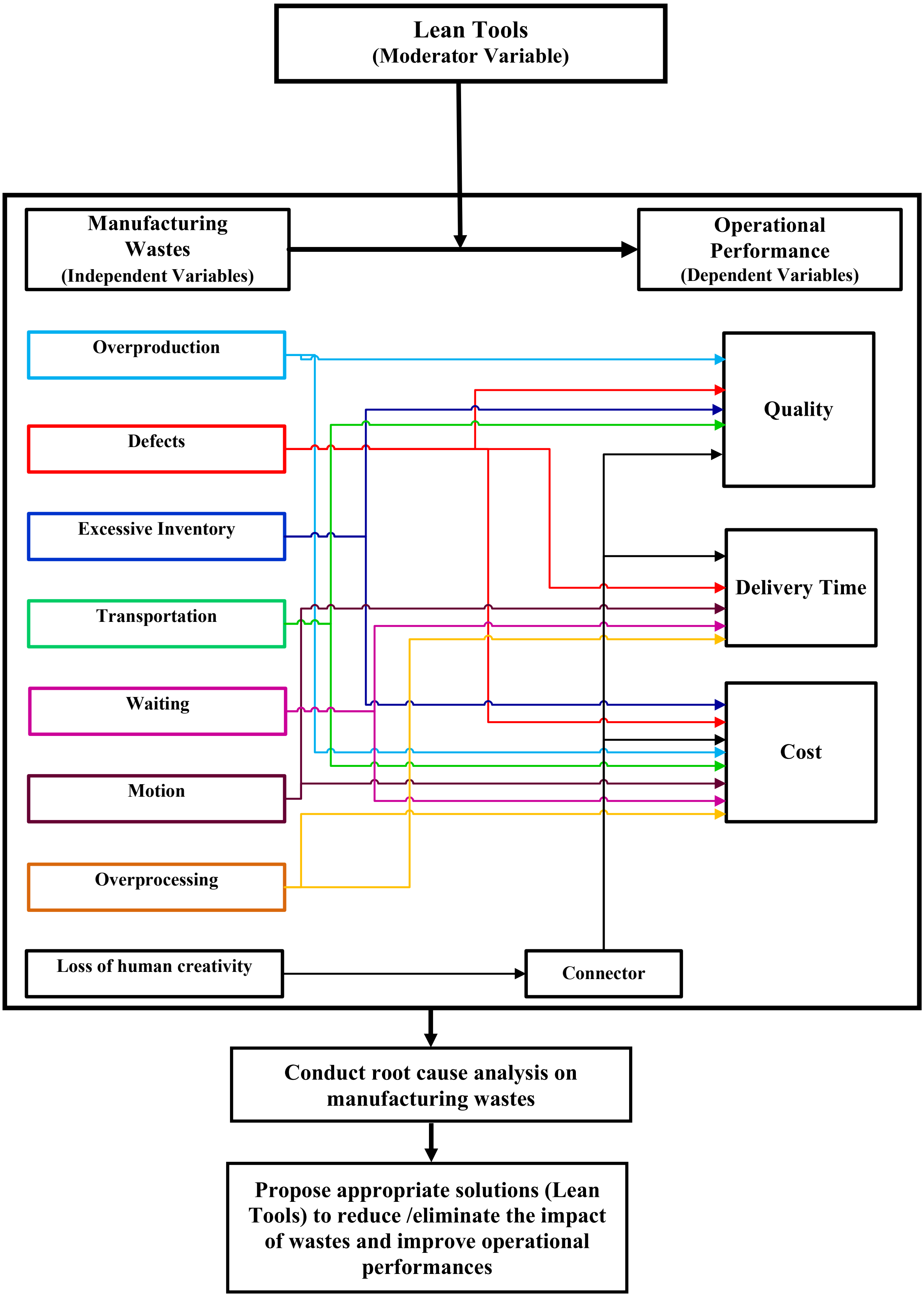
- The previous researches were limited themselves to perceptual data, which did not revealed information about archival data. However, the current research has triangulated perceptual data with archival data. Though it was a challenge, the results obtained revealed valuable information on respondents' perceptions against realities on the ground, such as, overprocessing and transportation wastes.

- To implement an effective lean manufacturing system it is very apparent that adequate justifications should be provided to the industries, especially those in developing countries. Therefore, it is justifiable to study the extent of wastes in the case company and identify the root causes for each category of wastes.

2.6 Conceptual Framework

Based on the information gathered from the literatures reviewed and the analysis made against the research problem, research questions and research objectives the following conceptual framework was established (Fig.4).

Fig. 4: Conceptual Framework



As illustrated in the conceptual framework (Fig. 4), the eight manufacturing wastes (independent variables) are the causes for deteriorating the operational performance (dependant variables) of a company. However, the impact of those wastes can be eliminated or reduced through meticulously selection of appropriate lean tools (moderator variables) and ensuring their effective implementation. However, before embarking for a new waste reduction/elimination program one need to know the current status and identify the significant areas to invest in.

As clearly stated by Uz-Zaman A. et al. (2013), the implementation of inappropriate lean strategy (tools) for a given situation can sometimes lead to an increase in wastes, costs and production time of a manufacturer". In fact, W. Edwards Deming (1986) called such wrong practices on a system as "Tampering". The act of tampering worsen a company situations instead of improving it to a higher level of performance. Therefore, when selecting lean tools, precautions shall be taken to ensure their efficacy in reducing or eliminating manufacturing wastes.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

This chapter has discussed the methods that were employed to collect and analyse data in order to effectively answer the research questions and meet the research questions. Specific procedures were established and deployed for each data collection instruments.

3.1 Introduction

Data was collected from primary and secondary sources in a detailed manner. Triangulation was also applied to ensure the validity of the conclusions to be made based on the research outputs.

3.2 Research Design

The research was a mixed type where both qualitative and quantitative data was used. It was an investigative on single a case company where in-depth data collection and analysis was undertaken to identify and determine the magnitude and the impacts of the eight manufacturing wastes on operational performances. To ensure cross-verification of the effectiveness of data collection instruments triangulated instruments were used. The survey questionnaires and focus group discussions were employed to collect data from primary sources and the archival data collection instrument was used to collect secondary data from archives of the case company.

3.2.1 Data Collection Instruments

- **Survey questionnaire:** A separate five point Likert scale questionnaires were developed for two categories of respondent. Category 1 included production, maintenance, quality and food safety assurance and top management. Category 2 was including marketing and sales, procurement, warehouse management, general service and human resource management. The reason for forming categories was to understand the magnitude and impacts of wastes in different functions of the case company and indicate priority areas for planning of actions. The questionnaires in both categories were prepared in Amharic and English languages in order to eliminate communication barriers and ensure the quality of data collected.

- **The Focus group discussion:** The focus group discussion was designed to identify the root causes for each category of wastes. Members of the focus group discussions were meticulously selected to ensure the quality of data collected. To extract and organize data tools such as, fishbone diagram, 5 WHY, and techniques, such as likelihood and consequence were also used to identify the most significant root causes.

- **Archival data:** Sources of archival data were identified in advance and appropriate forms were designed to collect data in the archives of the case company retained for a period of one year.

3.2.2 Sampling Strategy

The target population, sample size and the sampling procedure used to evaluate the perceptions of the respondents have described as follows:

a) The Target population

The case company has a total of 406 employees working in three shifts. If random samples were taken the required number of samples would have been 196. However, to ensure the quality of data random sampling was not the choice of this research.

b) Sampling procedure

Non-probability, purposive sampling techniques was selected to ensure the quality of data and a criteria was also established to select respondents in each function. To ensure the accuracy of data collected, respondents were selected based on their understanding of the concepts of manufacturing wastes, as proposed by Yeasmin S. and Rahman K.F. (2012) and Rasi R. et al. (2015). Therefore, the researcher adopted the purposive sampling technique, where educational level of the respondents were a minimum of Diploma, 10+3, and Level 4 and above as indicated in Table 5.

For stratified sampling the following sampling formula was considered initially, however, to ensure data quality the educational level of the respondents was the prevailing criteria.

$$n_0 = \frac{z^2 * p(1-p)}{c^2} \quad \text{-----------(1)}$$

$$n_f = \frac{n_0}{1 + \frac{n_0 - 1}{N}} \quad \text{----(2)}$$

Where
n_0 = initial Sample Size
nf = target sample size

Z = Z-values for confidence levels are (1.645 for 90% confidence level, 1.96 for 95% confidence level and 2.576 for 99% confidence level)

p = percentage picking a choice, expressed as decimal 0.5 used for sample size needed

c = confidence interval, expressed as decimal; 0.08 = ±8 N = Population

These equations were developed by Johnson et al. (2009) and Freedman et al. (2007).

Table 2: Data Collection Methods and Instruments for Investigating and Identify the Eight Manufacturing Wastes and their Sources

The Eight Manufacturing Wastes	Triangulated Data Collection Instruments		Target Location
	Perceptual data (Questionnaire)	Archival (Secondary) Data	
1) Defect wastes The preliminary assessment on the case company revealed that defective bottled water, caps, poly sheet and labels were found to be significant, as a result they became the focus of this research.	To identify the magnitude of defects in the targeted functional areas, questionnaires were designed in order to collect appropriate data. The data collected were compared and contrasted with the data collected from archival sources.	Records of defective bottled water and caps retained in Production Department were collected using the predetermined form. Summary of monthly records were collected from archives retained for a period of one year.	During the study, the following functional areas were found to be the target areas for this research as initial data demonstrated significance. • Production Dept. (defective bottled water and defective caps • Sales Dept. (defective bottled water returned from the market and/or during distribution process), however adequate data was not found • Procurement and supply Dept. (receiving of defective preforms and caps), however, data was not accessible.
2) Overprocessing wastes Overprocessing happens in several forms, however, in bottled water manufacturing, reverse osmosis is excessively done in order to remove Total Dissolved Solids (TDS) to the level of 50 mg/l or less, while the Ethiopian Compulsory Standard CES 99:2019 specified TDS to be 1000 mg/l (max), International Bottled Water Association (IBWA) and FDA requires 500 mg/l (max). Due to overprocessing of the reverse osmosis significant amount of water is drained to the environment, excessive energy is consumed and it has also an impact on productivity.	To identify people perception on the significance of overprocessing on reverse osmosis, **a** questionnaire designed to this specific area was distributed and data was collected.	This research has identified the significance of overprocessing of reverse osmosis through evaluating numerical data. Summary of monthly records were collected from archives for a period of one year.	The two departments indicated below were the focus areas for the following reasons: • Production Dept. is the owner of the reverse osmosis process

The Eight Manufacturing Wastes	Triangulated Data Collection Instruments		Target Location
	Perceptual data (Questionnaire)	Archival (Secondary) Data	
3) Transportation wastes During the preliminary factory visit it was apparent that due to inadequate factory and machine layout materials (input materials and finished products) were excessively transported from place to place. This research was focussing on the following main aspects of the processes in order to identify the significance of excessive transportation. • Transportation of packaging materials • Transportation of finished products from quarantine stores to the warehouse.	To identify people perception on the extent of excessive transportation, a questionnaire was prepared and distributed to the main functional areas which have been involved in transportation of materials from place to place.	Records retained on excessive transportation of materials over a period of one year were extracted and registered in a predefined form.	Target functional areas where secondary and primary data collected were the followings: • Production Dept. (transportation of packaging materials, and bottled water within the facility). • Procurement and supply Dept. (transportation of preforms and caps from their production site to bottling site).
4) Inventory wastes Excessive inventories were investigated on input materials, such as, packaging materials and finished products.	People perception on excessive inventories was studied using a questionnaire established for this purpose.	In the case of selling of products to the general market, secondary data were collected from the archives, however, found to be inadequate for data analysis.	Procurement and Supply and Production Departments were the focus areas for the study.
5. Waiting wastes As waiting is a hidden waste in many cases and happens intermittently it is very difficult and time taking to capture all the data required on waiting encountered in all processes. However, the researcher has selected the significant indicators, such as, machines idle time and machines downtime.	Data on people perception on excessive waiting was collected using a questionnaire designed for this purpose.	Archival data was collected on machine idle time and down time as those data were readily available. Data retained for a period of one year was collected in a form established for this purpose.	The following functional areas were targeted for the research • Production Dept. • Maintenance Dept.

<table>
<tr><th rowspan="2">The Eight Manufacturing Wastes</th><th colspan="2">Triangulated Data Collection Instruments</th><th rowspan="2">Target Location</th></tr>
<tr><th>Perceptual data (Questionnaire)</th><th>Archival (Secondary) Data</th></tr>
<tr><td>6. Motion wastes
The researcher has considered the following issues as the targets of the study as they were significantly contributing to motion wastes.
• Excessive motions due to poor ergonomics
• Poor machine layout
• Poor organizational layout</td><td>As excessive motion is one of the hidden wastes, where it is difficult to measure due to lack of appropriate technology and skilled manpower. However, the researcher has measured people perception through the use of questionnaire designed for this purpose.</td><td>Not applicable as the company has never retained records related to motion.</td><td>The following main functional areas were the target for studying motion wastes.
• All functions in the scope of the study</td></tr>
<tr><td>7. Overproduction wastes
The case company is adopting push production system and the water business is profitable only if the company produce continuously in large quantity. This is because the packaging is more expensive than its content, the water.</td><td>People perception on overproduction wastes was studied using a questionnaire designed for this purpose.</td><td>Not applicable, as people never considered overproduction as a waste it was not registered in any form</td><td>Production Department was the focus area to study overproduction wastes.</td></tr>
<tr><td>8. Wastes associated with untapped human potential
One of the hidden wastes is failure to use the human potential for achieving organizational objectives. Failure to exploit the human potential is manifested in many forms, however, the researcher has focussed on the following main data sources.
• Participation in strategic issues of the organization
• People motivation
• Resignation of skilled manpower</td><td>People perceptions on wastes related to untapped human potential were studied using a questionnaire designed for this purpose.</td><td>Archival data on employees' satisfaction, grievance, absentees and turnover were planned to collect, however, they were not adequately available.</td><td>All functions specified within the scope of the study were the focus of study.</td></tr>
</table>

Table 3: Data Collection Methods for Investigating the Impacts of the Eight Manufacturing Wastes on Operational Performances

Activities Undertaken	**Description**
1) Developed a questionnaire to study the impact of wastes on operational performances	The operational performance measures were quality, cost and delivery time
2) Identify data sources	Functional areas where data was collected were the followings • Factory Management • Production Department • Technique Department • Quality and Food Safety Assurance Department • Marketing and Sales Department • General Service • Procurement and supply Department • Warehouse • Human Resource Management Department
3) Determine sample size	To ensure data quality, the criteria used for respondents' selection was educational level. The sample size was determined by the educational. All people with educational level diploma, 10+3, Level 4 and above were selected as a sample.
4) Verify the reliability and validity of questionnaire and improve questionnaire as necessary.	Reliability test on questionnaires was conducted by distributing the questionnaires to 14 participants in category1 and 10 participants in category 2 using Cronbatch Alpha (α) in SPSS software.
5) Conduct validity checks on questionnaires	The questionnaires were given to three experts in the field to provide their opinion on appropriateness, clarity, and comprehensiveness (composition).
6) Distribution of the questionnaire and collecting data.	Once reliability and validity were verified, the questionnaires were distributed to people identified previously. The purpose of data collection was explained on the questionnaire itself.
7) Collecting data as planned.	Data was collected (filled questionnaires) as planned.

Table 4: Data Collection Methods for Proposing Operational Controls for Mitigating the Eight Manufacturing Wastes

	Activities Undertaken	Description
1)	Organize the focus group discussion (FGD) team	The focus group discussion team was composed of 11people selected from: • Factory Management • Production Department • Technique Department • Quality and Food Safety Assurance Department • Marketing and Sales Department • General Service • Procurement and supply Department • Warehouse • Human Resource Management Dept.
2)	Conducting a briefing session to FGD members	The briefing session was conducted to ensure an effective data collection process: Focuses during the briefing sessions were: • Objectives of the research and objective of the FGD; • Working Program; • Rules of the discussions (Rules of Brainstorming).
3)	Conducting root cause analysis and identify significant causes for each waste category	• SIPOC; • Fishbone diagram; • 5WHY techniques; and • To select significant causes likelihood and consequence factors were also employed.
4)	Identify and propose solutions to mitigate/prevent the impact of the eight wastes.	The researcher have proposed appropriate solutions for mitigating manufacturing wastes.

Table 5: Sampling Plan for Survey Questionnaires

S. No.	Functions	Total Number of Employees	Educational level	Sample size	Total
1.	Factory Management	12	Diploma, 10+3, Level 4 and above	12	74 (65%)
2.	Production	125	---do---	28	
3.	Technique	23	---do---	15	
4.	Quality & Food Safety Assurance	82	---do---	19	
5.	Marketing & Sales	55	---do---	10	40 (35%)
6.	General service	26	---do---	6	
7.	Procurement and Property Admin	7	---do---	7	
8.	Warehouse	44	---do---	10	
9.	Human Resource Department	12	---do---	7	
	TOTAL	406	-	114	100%

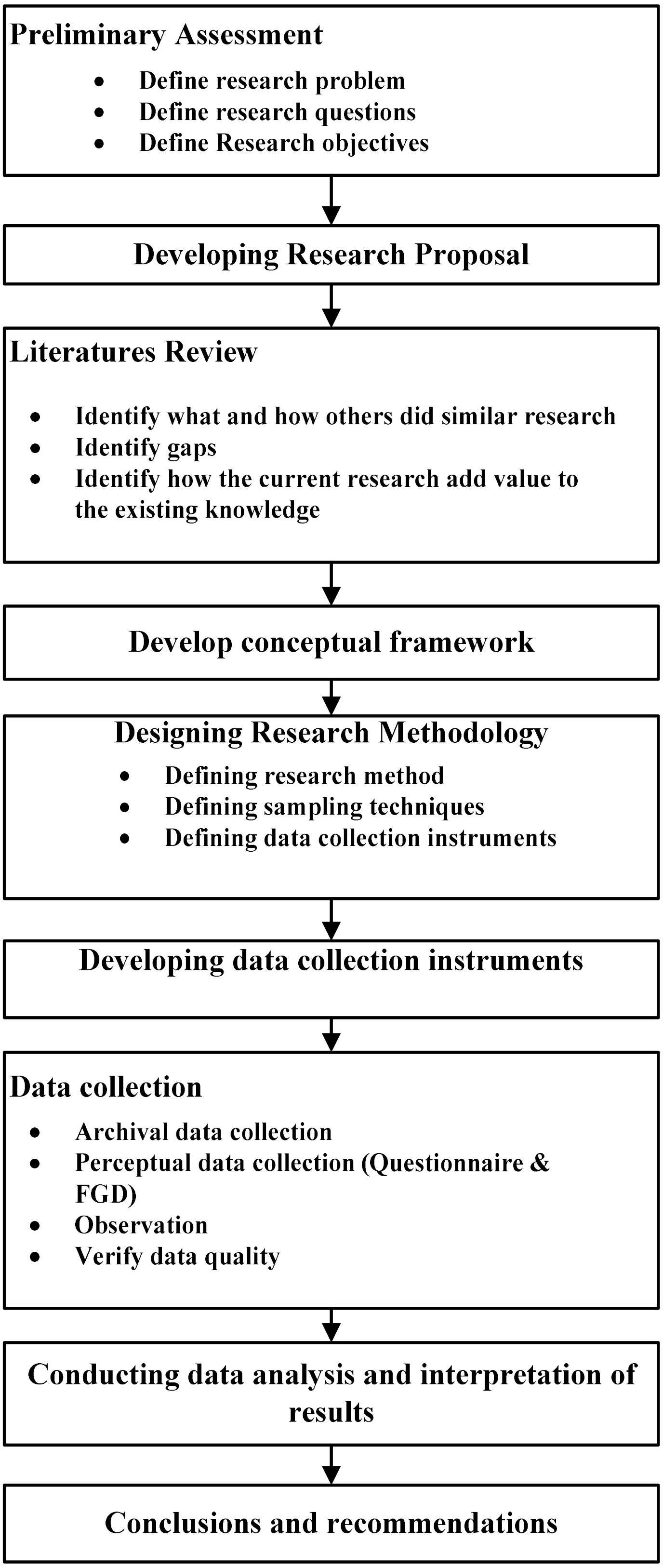
3.4 Analysis of Data

For data collected from primary and secondary sources appropriate statistical tools were used as indicated in Table 6. The outputs of data analysis results were further evaluated against performance measures such as, quality, delivery and cost, Nordin N. et al. (2016) and Okpala, C.C, (2014). SPSS statistics software was also deployed to accurately analyse data collected, such as frequencies.

Table 6: Data Analysis Methods

Research objective	**Data Type collected**	**Data Collection tools**	**Data Analysis tools**
Objective 1: To investigate and identify the eight manufacturing wastes and their sources	1) Primary (Perceptual) data on the eight manufacturing wastes.	Questionnaire method	Frequencies, percentages, mean, standard deviations, Bar charts, and Process Sigma level
	2) Secondary (Archival) data four manufacturing wastes, such as, defect, waiting, transportation and overprocessing. Archival data for the rest of manufacturing wastes was not available.	Data collection on monthly reports available in the archives.	
Objective 2: To investigate the impact of the eight wastes on operational performance.	3) Primary (Perceptual) data collected on the impact of the eight manufacturing wastes on operational performances.	Questionnaire method	
Objective 3: To propose operational controls for mitigating the eight wastes	4) Primary (Perceptual) Data	Focus Group discussion method	Fishbone diagram, 5 WHY, and likelihood and consequence as a measure of significance.

Fig. 5: Overall Research Methodology Framework



3.5 Verification of Reliability and Validity

The consistency of measurement tool employed were verified through reliability checks, based on a pilot test of the questionnaires prior to full-fledged implementation. In the case of validity checks, the questionnaires were revised in order to include valid opinions obtained from experts as indicated on Table 7.

Table 7: Validity Verification of Questionnaires by Experts

Section of the Questionnaire	Previous Contents of the Questionnaire	Comments Issued by Experts	New Version of the Questionnaires
Category of the Likert scale	The Likert scale was organized in four categories as follows: • Strongly agree (1) • Agree (2) • Disagree and (3) • Strongly agree (4)	Experts commented that a 4 point Likert scale forces the respondents to form an opinion, where in some cases they don't have an information about an issue in the questionnaire. It may, therefore, be the source of false information, if not corrected.	The questionnaire categories were revised to be a 5 point Likert scale as follows: • Strongly agree (1) • Agree(2) • Undecided (3) – Newly added • Disagree and (4) • Strongly agree (5)
Part II: Questionnaire # 23	The organization is unable to exploit the human potential due to low motivation of people.	The questionnaire seems to blame the workers for having low level of motivation. However, motivation is created by deliberate, planned and continuous actions of the leadership.	The organization is unable to exploit the human potential due to failure to increase the motivation of its people.
Part II: The Amharic translation for "Waiting"	Excessive waiting/ **ሌላ ስራ እስኪጠናቀቅ ድረስ ስራ ፈቶ መጠበቅ**	Not necessarily, the job in the upstream or downstream may have been completed on time, however, due to poor communication "Excessive waiting" may happen.	Excessive waiting / **ስራ ፈቶ መጠበቅ**
Several sections of the questionnaire	Typographic errors both in English and Amharic versions	Typographic Correction	Typographic corrected versions of the questionnaires were printed and issued to respondents

CHAPTER 4: DATA ANALYSIS

This chapter provides results of data analysis narrating what it means against the research objectives, such as, significance of the occurrence of the eight manufacturing wastes and their impact on operational performance of the cases company. It also provides the root causes for each category of wastes determined by focus group discussions. The summary of findings have also been organized so that the findings could be framed to each research objective established from the outset. Data analysis conducted has also described to indicate whether the outcomes of triangulated instruments support each other.

4.1 Perceptual Data Analysis

Questionnaire method was used to collect data on people perceptions on the significance of the occurrence of the eight manufacturing wastes in processes of the case company. As the name implies, the manufacturing wastes were initially attached to the production processes as they can be easily perceivable and their impacts were apparent. However, nowadays, it is well known that wastes are associated with each and every process, though their type and magnitude is different. That is why this research has considered studying of wastes in two categories. Category 1 included those functions and processes which are directly involved and interacting intensively with the production processes, which was including, the top management, production, maintenance and quality and food safety assurance. On the other hand, category 2 was including, sales and marketing, procurement, warehouse management, general services and human resource management. For the two categories, separate questionnaires were prepared and data analysis were carried out separately in order to clearly understand the magnitude and the impact of wastes in the two areas of the business processes.
Bilingual questionnaires (English and Amharic languages) were used to avoid language barriers and ensure effective communication of questions to respondents. In both categories, selection of respondents were based on educational level to ensure their understanding of wastes, which ultimately ensures data quality.

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.

Reliability Test: Fourteen samples were collected from category 1 and tested for reliability using Cronbatch Alpha (α) and the result was 0.835, which was good (Mohammed, et al) and indicated that the questionnaires used were found to be reliable (consistent) as the acceptable limit is $\alpha \geq 7$. The same test was conducted on ten samples collected from Category 2 and the reliability test result was 0.801, which was acceptable to proceed with the full scale data collection.

Validity check: The questionnaires were given to three experts in the field to provide their opinion on appropriateness, clarity, and comprehensiveness (composition). Prous et al, 2009, have indicated that experts' opinion as a method of validity check on research instruments. The experts have suggested feedbacks to eliminate confusion and divergence of responses from the intents of the study.

Data collection: Seventy four (74) questionnaires were distributed to category 1 respondents and sixty responses (81%) were received, which is acceptable. At the same time forty questionnaires were distributed to category 2 respondents and thirty five responses (87.5%) which is also adequate to proceed with data analysis.

4.1.1 Data Analysis on the Significance of Occurrence of Manufacturing Wastes

The data collected was analyzed using SPSS software and particularly frequency statistics was used to analyse the magnitude of occurrence of the eight manufacturing wastes. The magnitude of occurrence of each of the eight manufacturing wastes have been analyzed as follows:

Defect Wastes

Table 8: Response Results on Defect Wastes

Type of Waste	Sample Category	Indicators of Wastes	Strongly Agree (%)	Agree (%)	Cumulative (Strongly Agree and Agree) (%)	Undecided %)	Disagree (%)	Strongly Disagree (%)	Cumulative (Disagree & Strongly disagree) (%)
Defect wastes	**Category 1**	1) Disposing defective products	26.7	55.0	**81.7**	13.3	3.3	1.7	**5.0**
		2) Reprocessing of defective products	10.0	21.7	**31.7**	33.3	21.7	13.3	**35.0**
		3) Stoppage of production due to defects	26.7	46.7	**73.3**	11.7	10.0	5.0	**15.0**
	Category 2	1) Receiving of defective input materials from incapable suppliers	8.6	42.9	**51.4**	31.4	8.6	8.6	**17.2**
		2) Returning of defective products from the market	14.3	45.7	**60.0**	31.4	8.6	-	**8.6**
		3) Receiving of complaints from the customers due to defective products	22.9	42.9	**65.7**	25.7	5.7	2.9	**8.6**

As indicated in Category 1, Table 8, One of the three indicators used to assess defect wastes in processes was disposal of defective products as defects were not be able to reprocess. As disposal of materials is an indicator of wasted materials, energy and the efforts of machine and the human efforts assigned to do the job. The perceptual assessment conducted in category 1, have shown that the combined result of strongly agreed and agreed was 81.7%, which is significant to impact on the operational performances of the case company. The second indicator was halting the production process due to generation of excessive defective products. The combined results have shown that 71.3% of the respondents confirmed its presence. When processes were halted due to defects, multidimensional negative effects could occur, such as, the defective product itself, loss of production until the problem is fixed, and if the defective products have damaged the machines it involves maintenance costs and creates idle machines and people in the upstream and downstream manufacturing steps. The third indicator used was the incidents of reprocessing of defective products. The results have shown that its occurrence is less than others, however, it cannot be ignored when actions are sought.

As it was done for category 1, three defect indicators were also used in category 2 to assess their occurrence and significance. As shown in Table 8, receiving of complaints due to defective products took the lead, where the combined result was 65.7%. The second significant defect indicator was returning of defective products from the market place with a response rate 60%. The third significant indicator response rate was 51.4%. The results obtained confirmed that defects were not localized in production areas, however, they are also occurring in other processes as well.

Inventory wastes

Table 9: Response Results on Inventory Wastes

Type of Waste	Sample Category	Indicators of Wastes	Strongly Agree (%)	Agree (%)	Cumulative (Strongly Agree and Agree) (%)	Undecided (%)	Disagree (%)	Strongly Disagree (%)	Cumulative (Disagree & Strongly disagree) (%)
Inventory wastes	**Category 1**	1) Excess inventory of products	18.3	41.7	**60.0**	21.7	13.3	5.0	**18.3**
		2) Excess inventory of spare parts	13.3	15.0	**28.3**	56.7	13.3	1.7	**15.0**
		3) Disposition of excess inventory of products	10.0	30.0	**40.0**	23.3	26.7	10.0	**36.7**
	Category 2	1) Purchase and hold of excessive input materials due to economy of scale	2.9	5.7	**8.6**	68.6	20.0	2.9	**22.9**
		2) Holding of excessive products due to poor sales performance	14.3	28.6	**42.9**	25.7	28.6	2.9	**31.5**
		3) Holding of Excessive materials (PPE)	-	8.6	**8.6**	54.3	25.7	11.4	**37.1**

As shown in category 1 Table 9, to assess the extent of occurrence of inventory wastes three indicators were used where excessive inventory of finished products were found to be the most significant (60%) among others. This finding is supported by the focus group discussion results, where push production system and inaccurate market forecasting were the major causes for excessive inventory for finished products. Disposal of excessive products, as it was made based on customers' requirements and bears customer logo takes the second level (40%) indicating the occurrence of inventory wastes. The third inventory waste indicator was excessive spare parts, with the least magnitude of occurrence of 28.3%.

Category 2, Table 9 indicated that holding of excessive products due to poor sales performance takes the highest significant level (42%). As supported by the results of focus group discussions, the case company has expanded its production capacity without increasing the capacity and capability of the marketing and sales functions. Due to mismatching of production and sales capacity excessive products were found in storage. The second and the third indicators of inventory wastes in category 2 have shown less magnitude of occurrences, which was 8.6% each.

Overprocessing wastes

Table 10: Response Results on Overprocessing Wastes

Type of Waste	Sample Category	Indicators of Wastes	Strongly Agree (%)	Agree (%)	Cumulative (Strongly Agree and Agree) (%)	Undecided (%)	Disagree (%)	Strongly Disagree (%)	Cumulative (Disagree & Strongly disagree) (%)
Overprocessing wastes	**Category 1**	1) Overprocessing of reverse osmosis	28.3	36.7	**65.0**	23.3	11.7	-	**11.7**
		2) Excessive monitoring of CCPs and OPRPs	10.0	28.3	**38.3**	36.7	18.3	6.7	**25.0**
		3) Excessive frequent inspection of reliable machines	10.0	30.0	**40.0**	36.7	15.0	8.3	**23.3**
	Category 2	1) Excessive approvals to issue purchase orders to the suppliers	5.7	17.1	**22.9**	51.4	25.7	-	**25.7**
		2) Excessive market promotion of products	2.9	17.1	**20**	20.0	48.6	11.4	**60**
		3) Over sympathetic to employees' in managing their grievances	-	25.7	**25.7**	22.9	37.1	14.3	**51.4**

In Table 10, Category 1, excessive removal of total dissolved solids (TDS) was taken as indicator of overprocessing wastes and the result was found to be 65% which is the highest in this category. As clearly indicated in the results of focus group discussions, each day 30% of the raw water is drained to the environment. Taste less bottled water is wrongly preferred by the market as the essential elements have been removed by overprocessing. The maximum national regulatory limit for bottled water is 1000mg/l, (CES 99:2019), however, the water is overprocessed to reach 50mg/l or less. Instead of perusing the wrong demands of the consumers, the case company could have considered educating the customers in that water with taste is also safe and acceptable. The second and the third indicators of overprocessing were found to be moderately significant which the case company cannot disregard in its improvement actions.

Table 10, category 2 indicated that wastes of overprocessing seems to be less significant, however, significant number of respondents have responded to undecided option of the Likert scale. This might be due to lack of adequate information on the concept of overprocessing. Therefore, this area requires detail assessment when actions are sought. In addition, overprocessing is one of the hidden wastes significantly occurring in organizations where lean manufacturing system has not been implemented.

Transportation wastes

Table 11: Response Results on Transportation Wastes

Type of Waste	Sample Category	Indicators of Wastes	Strongly Agree (%)	Agree (%)	Cumulative (Strongly Agree and Agree) (%)	Undecided (%)	Disagree (%)	Strongly Disagree (%)	Cumulative (Disagree & Strongly disagree) (%)
Transportation wastes	Category 1	1) Unnecessary transportation of finished products	23.3	56.7	**80.0**	8.3	3.3	8.3	**11.6**
		2) Unnecessary transportation of people	18.3	23.3	**41.7**	25.0	28.3	5.0	**32.3**
		3) Unnecessary transportation of broken distribution vans	5.0	18.3	**23.3**	63.7	13.3	-	**13.3**
	Category 2	1) Unnecessary transportation of input materials due to over purchasing of input materials	2.9	20.0	**22.9**	60.0	14.3	2.9	**17.2**
		2) Unnecessarily transporting of finished products due to inappropriate factory layout	8.6	40.0	**48.6**	25.7	17.1	8.6	**25.7**
		3) During recruitment, proximity of candidates residential house were not considered as a result the company transport people from remote locations	8.6	22.9	**31.4**	22.9	37.1	8.6	**45.7**

Category 1**,** Table 11 has revealed that unnecessary transportation of finished products was the most significant indicator of transportation wastes (80%). This finding is supported by results

of the focus group discussions, where poor factory layout have taken the lead to contribute to excessive transportation of materials from place to place. Unnecessary transportation of people was also the second significant indicator (41.7%) caused by failure to assess the proximity of new employees' residential house to the case company in addition to competence requirements. Unnecessary transportation of broken distribution vans back to the organization's own garage remains to be less significant, which accounts only 23.3%.

Among the transportation wastes indicated in category 2, Table 11, unnecessarily transportation of finished products due to inappropriate factory layout found to be the most significant. This finding supports the indicator in catogory1, Table 11. This is because transportation of materials from place to place is easily perceivable by people at all levels. It is tiresome and the cost is painful. That is why people in both categories responded to a large extent than other indicators... However, other transportation waste indicators were found to be less significant.

Motion Wastes

Table 12: Response Results on Motion Wastes

Type of Waste	Sample Category	Indicators of Wastes	Strongly Agree (%)	Agree (%)	Cumulative (Strongly Agree and Agree) (%)	Undecided (%)	Disagree (%)	Strongly Disagree (%)	Cumulative (Disagree & Strongly disagree) (%)
Motion wastes	Category 1	1) Physical fatigue due to excessive motion caused by poor ergonomics	18.3	40.0	**58.3**	5.0	28.3	8.3	**36.6**
		2) Excessive motion due to shared resources	23.3	55.0	**78.3**	10.0	6.7	5.0	**11.7**
		3) Time lost for searching of maintenance tools	16.7	41.7	**58.3**	26.7	13.3	1.7	**15.0**
	Category 2	1) Irretrievability of products from storage created unnecessary motion in search of such products	8.6	14.3	**22.9**	31.4	42.9	2.9	**45.8**
		2) Excessive motions as employees facilities and workstation are at distant locations	-	17.1	**17.1**	11.4	54.3	17.1	**71.4**
		3) Irregular file coding has created excessive motion for searching	5.7	28.6	**34.3**	17.1	31.4	17.1	**48.5**

As shown in Table 12, category 1, "excessive motions due to shared resources" was found to be the most significant source of motion wastes, which accounts 78.3%. Though motion wastes are one of the hidden wastes, the respondents were able to capture and respond its significance in the case company. Poor ergonomics and motions for searching of maintenance tools were also found to be significant, where each of them account 58.3%.

Table 12, category 2 indicated that motion wastes were not as significant as those identified in category1. This might be due to people perception on motion wastes in support services is inadequate or offices are arranged in close proximity. However, irregularities in file coding creating excessive motion for searching of documents could be considered as significant (34.3%), because this problem is still not adequately resolved after implementation of two international management system standards (ISO 9001 quality management system and FSSC 22000, Version 5.1 food safety management system. The other two motion waste indicators could be considered as less significant, however, cannot be totally ignored when action plans are considered for long term solutions.

Waiting wastes

Table 13: Response Results on Waiting Wastes

Type of Waste	Sample Category	Indicators of Wastes	Strongly Agree (%)	Agree (%)	Cumulative (Strongly Agree and Agree) (%)	Undecided (%)	Disagree (%)	Strongly Disagree (%)	Cumulative (Disagree & Strongly disagree) (%)
Waiting wastes	Category 1	1) Waiting due to delayed supply of input materials	30.0	50.0	**80.0**	3.3	13.3	3.3	**16.6**
		2) Waiting to stop production for preventive maintenance	15.0	33.3	**48.3**	28.3	21.7	1.7	**23.4**
		3) Waiting until faulty equipment is fixed	25.0	41.7	**66.7**	16.7	15.0	1.7	**16.7**
	Category 2	1) Delayed foreign purchases due to unavailability of foreign currency	25.7	25.7	**51.4**	45.7	2.9	-	**2.9**
		2) Customers waited excessively due to manual loading of products	20.0	22.9	**42.9**	34.3	11.4	11.4	**22.8**
		3) Waited longer to get decisions on opening of new distributor channels	5.7	22.9	**28.6**	42.9	28.6	-	**28.6**

Table 13, category 1 revealed that among the three indicators of waiting wastes, waiting due to delayed supply of input materials was the most significant indicator with 80% response rate. The second level significant indicator was waiting until faulty equipment was fixed with 66.7% response rate. This problem is connected to the third waiting waste indicator, which is waiting for decisions to stop production for preventive maintenance, with 48.3% response rate. This particular finding is supported by results of focus group discussions in that machines have exceeded preventive maintenance schedule due to delays in decisions. Authorized persons resisted to stop production machine for a brief period for preventive maintenance, however, forced to stop longer time for breakdown maintenance.

Table 13, category 2 indicated that delayed foreign purchases due to unavailability of foreign currency takes the most significant contribution to waiting wastes. Though it seems to be external factor, failure to plan at early stages could also contributed to excessive waiting for input materials. The second significant waiting waste indicator was customers were waiting excessively due to manual loading of products. Manual loading was one factor and the inadequacy of loading docks were another factors for customers to wait longer time until their trucks were loaded. This particular problem does not only dissatisfy the customers, it also decreases the productivity of the sales process. The third indicator in this category could be considered as less significant.

Overproduction wastes

Table 14: Response Results on Overproduction Wastes

Type of Waste	Sample Category	Indicators of Wastes	Strongly Agree (%)	Agree (%)	Cumulative (Strongly Agree and Agree) (%)	Undecided (%)	Disagree (%)	Strongly Disagree (%)	Cumulative (Disagree & Strongly disagree) (%)
Overproduction Wastes	**Category 1**	1) Overproduction due to inaccurate market forecasting	11.7	31.7	**43.3**	30.0	21.7	5.0	**26.7**
		2) Overproduction due to unreliable production machines	5.0	23.3	**28.3**	18.3	38.3	15.0	**53.3**
		3) Excessively produced fabricated or modified parts	3.3	8.3	**11.7**	43.3	31.7	13.3	**45.0**
	Category 2	1) Purchase of machines where we can't use their full capacity	5.7	17.1	**22.9**	45.7	28.6	2.9	**31.5**
		2) Sending of excessive products in a single distribution route	8.6	34.3	**42.9**	37.1	11.4	8.6	**20.0**
		3) Deployed excessive labour force to do a particular job	8.6	51.4	**60.0**	20.0	20.0	-	**20.0**

Table 14, category 1, have shown that overproduction due to inaccurate market forecasting (response rate 43.3%), was found to be fairly significant. During the assessment on overproduction wastes, people in some cases got confused as producing over and over is a criteria for rewarding people with materials and/or certificates of recognition. However, the consequences became very clear as people brainstormed to each other in the focus group discussions. Holding the wrong perceptions have forced people to do things the wrong way, which started, somewhere from the top and cascaded down to individuals at the shop floor. Rewarding the destructive elements of the business could worsen the situation instead of getting better and better. The other two overproduction indicators could be considered as less significant, however, actions could be taken after all other significant problems have been resolved.

Table 14, category 2 “deployment of excessive labour force to do a particular job” has been identified as significant with a response rate of 60%. When excessive number of people are deployed in a particular job, people will have no adequate job to effectively contribute to the achievement of company’s objectives. Deployment of excessive human resource will have not only a negative impact on the costs of production or service provision process, but also robs people satisfaction as they are working below their capacity and capability. Sending of excessive products in a single distribution route takes the second significance level, however, the consequence was product return, and increasing defect rates as the products stayed longer time in transportation. The third indicator, purchasing of machines where full capacity was not utilized could be considered as less significant, however, could be considered during updating purchasing of purchasing procedures.

Wastes of Untapped Human Potential

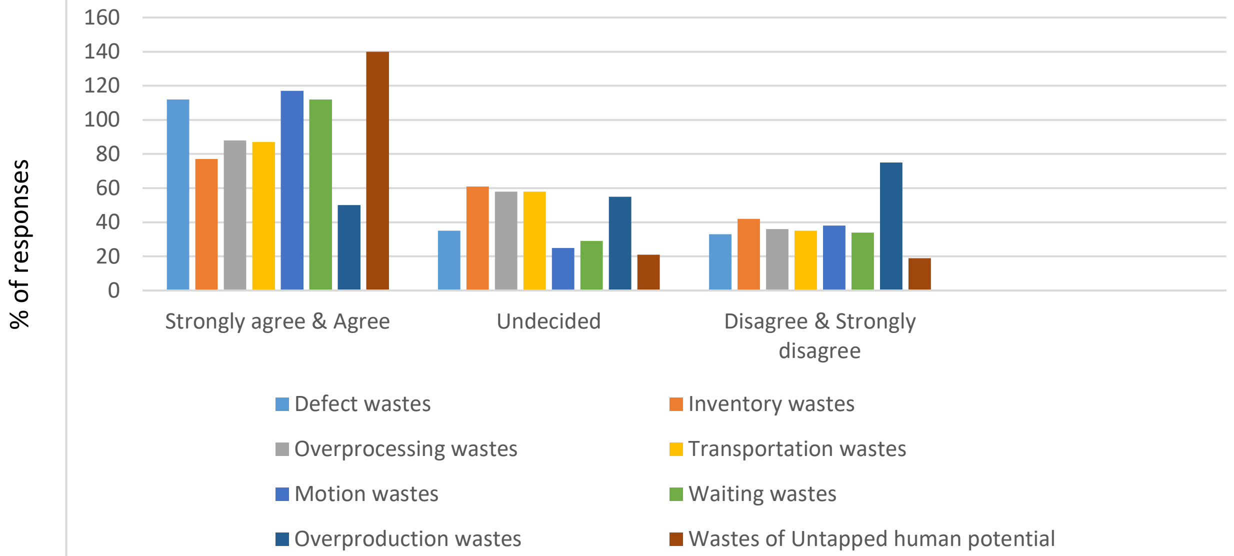
Table 15: Response Results Wastes of Untapped Human Potential

Type of Waste	Sample Category	Indicators of Wastes	Strongly Agree (%)	Agree (%)	Cumulative (Strongly Agree and Agree) (%)	Undecided (%)	Disagree (%)	Strongly Disagree (%)	Cumulative (Disagree & Strongly disagree) (%)
Wastes of Untapped Human Potential	**Category 1**	1) Untapped human potential due to failure to participate people	35.0	46.7	**81.7**	8.3	6.7	3.3	**10.0**
		2) Untapped human potential due to failure to improve people motivation	33.3	48.3	**81.7**	5.0	13.3	-	**13.3**
		3) Untapped human potential due to attrition of skilled workers	13.3	56.7	**70.0**	21.7	8.3	-	**8.3**
	Category 2	1) Untapped human potential due to failure to participate people	14.3	51.4	**65.7**	8.6	25.7	-	**25.7**
		2) Untapped human potential due to failure to improve people motivation	14.3	57.1	**71.4**	2.9	20.0	5.7	**25.7**
		3) Untapped human potential due to attrition of skilled workers	28.6	40.0	**68.6**	14.3	14.3	2.9	**17.2**

As shown in Table 15, category 1 and category 2, wastes associated with untapped human potential were found to be very significant in all the three indicators studied in both categories, where response rates were from 70% to 81.7%. This data analysis result demonstrated that the potentials of the human resource were not effectively exploited for the achievement of the organization's objectives. One of the essential strategy to use the human potential is to enhance their satisfaction. This is in line with the assertions of Brito M. et al. (2020) that "One of the clearest symptoms of deteriorating condition in an organization is the lack of workers satisfaction. The symptoms are hidden behind layoff, work deceleration (speed reduction), and turnover. The symptoms may also be complaints, poor performance, poor product quality, disciplinary problems, and other issues. On the contrary, high work satisfaction is desirable by managers because it can be linked with a positive result that they expect. High work satisfaction is a sign of a well-run organization and is basically a result of effective behaviour management".

Summary of Data Analysis on the Significance of Occurrence of Manufacturing Wastes in the Case Company

Fig. 6: The Significance of Occurrence of the Eight Manufacturing Wastes as Indicated by the Sum of the Number of Responses of the Three Indicators (Category1)



As indicated on Fig. 6: the manufacturing wastes were significantly present in processes of the cases company. Among the sum of responses of the three indicators in each category of wastes, untapped human potential takes the lead followed by motion wastes. However, the response rate to overproduction is the least of all in the graph as overproduction has not been perceived as a waste rather it is the criteria for rewarding people. This misconception should be eliminated through educating people on its consequences of overproduction, (such as, it causes inventory wastes, defect wastes, transportation wastes, and tied up capital) both in theory and in practice.

Fig. 7: The Significance of Occurrence of the Eight Manufacturing Wastes as Indicated by the Sum of the Number of Responses of the Three Indicators (Category 2)

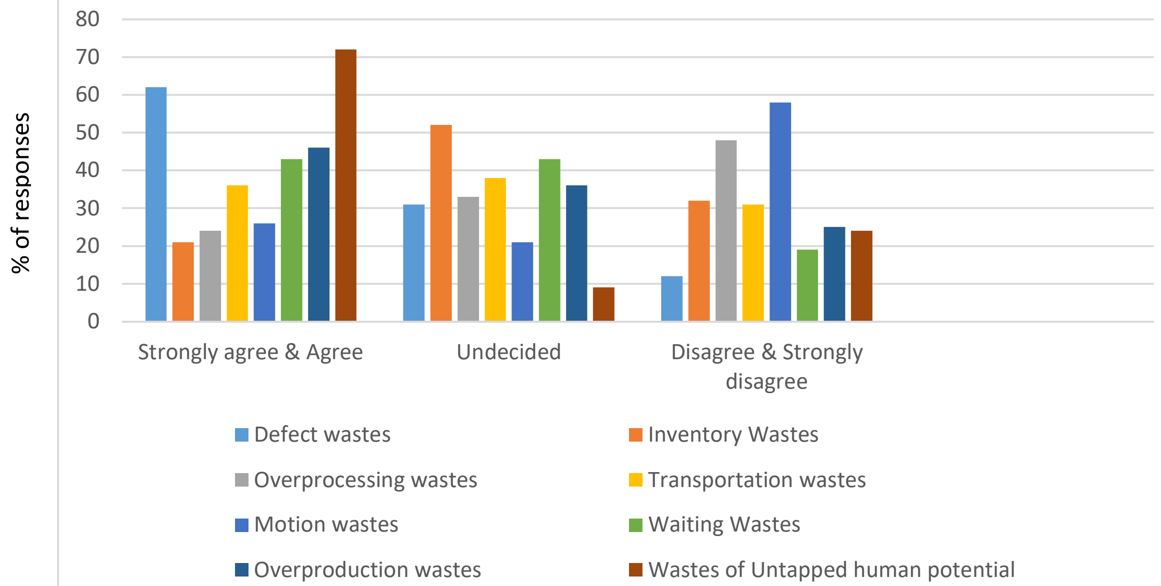
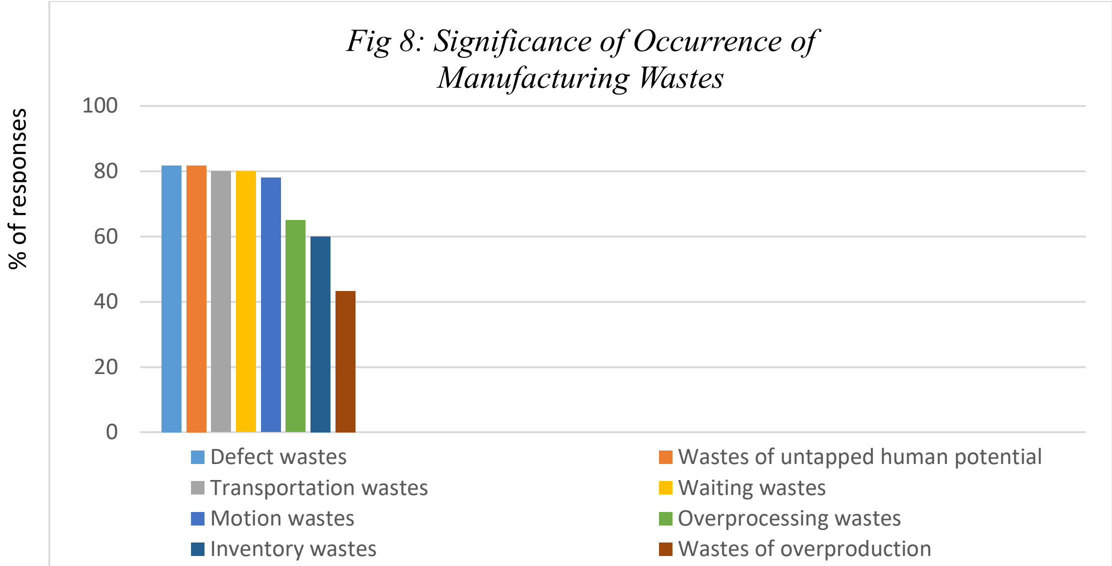


Fig. 7, indicated that, in category 2, untapped human potential was also the most significant cause of wastes. In this regard, data analysis results are consistent and validated that people in the organization have not been effectively involved and felt that they are not contributing a lot for the successes of the organization. Such sentiment would eventually create dissatisfaction and people may also become indifferent to the organization's improvement programs.

In general, the data analysis findings in both categories are summarized as follows:

a) As shown in Fig. 8: The majority of manufacturing wastes in the case company were identified with significant response rates, such as, defect wastes (81.7%), wastes of untapped human potential (81.7), transportation wastes (80%), motion wastes (78%), waiting wastes (80%), overprocessing wastes (65%), inventory wastes (60%), and overproduction wastes (43.3%).



b) The research finding has proven that wastes were associated with every process, though the magnitude is different.

c) The magnitude of manufacturing wastes were higher in production and interacting processes with production (category 1) than those of the support processes (category 2).

d) In the case of support processes (category 2) a considerable number of people have responded to "undecided" category of the Likert scale, such as, for inventory wastes (68.6%), transportation wastes (60%), Motion wastes (54.3%), overprocessing wastes (51.4%), overproduction wastes (45.7%). This might be due to the manufacturing wastes were not adequately known by people in support processes.

e) The responses were fairly distributed among the obvious wastes, such as, defect wastes (81.7%), transportation wastes (80%), waiting wastes (80%), inventory wastes (60%) and overproduction wastes (43.3%) and hidden (non-obvious) wastes, such as, wastes of untapped human potential (81.7), motion wastes (78%), and overprocessing wastes (65%).

4.1.2 The Impact of Manufacturing Wastes on Operational Performances

Quality, delivery time and cost, were selected for this research as operational performance indicators, as these indicators were used as a common denominators by researchers, such as, Nordin N. et al. (2016). However, other researches have used productivity and flexibility as additional operational performance measures.

Quality as Operational Performance Indicator

Table 16: The Impact of the Eight Manufacturing Wastes on Quality

Operational Performance Measures	Sample Category	Performance indicators	Strongly Agree (%)	Agree (%)	Cumulative (Strongly Agree and Agree) (%)	Undecided (%)	Disagree (%)	Strongly Disagree (%)	Cumulative (Disagree & Strongly disagree) (%)
Quality	Category 1	1) Eight manufacturing wastes impacting on producing defective products	23.3	51.7	**75.0**	15.0	8.3	1.7	**10.0**
		2) Due to the eight manufacturing wastes our company is perceived us low quality performer	13.3	36.7	**50.0**	16.7	26.7	6.7	**32.4**
		3) Due to the eight manufacturing wastes our products are not user friendly	23.3	56.7	**80.0**	5.0	10.0	5.0	**15.0**
	Category 2	1) The eight manufacturing wastes negatively impacting on receiving of defective inputs	11.4	60.0	**71.4**	20.0	8.6	-	**8.6**
		2) Due to the eight manufacturing wastes our company is perceived as low quality performer	2.9	45.7	**48.6**	17.1	28.6	5.7	**34.3**
		3) The eight manufacturing wastes have become the causes for customers' complaints	11.4	60.0	**71.4**	20.0	8.6	-	**8.6**

Table 16, Category 1 demonstrated that the eight manufacturing wastes had an impact on quality, such as, products were not user friendly (with a response rate of 80%). This finding was supported by the focus group discussions that lack of user friendly were exhibited by caps were not easily opened by the consumers, rings were removed when the caps were opened, the bottles were not able to stand in their upright position on tables at the time of consumption. Defects on products were the second higher significant indicator with a response rate of 75%. Defects were identified due to leaky bottles, visible suspended solids, and deformed bottles, under filled bottles, missing labels, and missing caps. The third quality indicator was the customers' perception on quality performance of the organization which accounts 50% response rate. The results have clearly indicated that manufacturing wastes were negatively impacting on quality which is one of the significant operational performance indicator of an organization.

As shown in Table 16, category 2, the impact of the eight manufacturing wastes were also significant in support processes, where receiving of defective input materials and customers' complaints each of the indicators account 71.4% response rate. The third quality indicator was customers' perception on the performance of the organization, with a response rate of 48.6%. This indicator was about company image which has a potential to increase if permanent solutions are not taken on the root causes of defective products and customers' complaints.

Delivery Time as Operational Performance Indicator

Table 17: The Impact of the Eight Manufacturing Wastes on Delivery Time

Operational Performance Measures	Sample Category	Performance indicators	Strongly Agree (%)	Agree (%)	Cumulative (Strongly Agree and Agree)	Undecided (%)	Disagree (%)	Strongly Disagree (%)	Cumulative (Disagree & Strongly disagree) (%)
Delivery time	**Category 1**	1) Due to the eight manufacturing wastes we failed to deliver on-time	6.7	55.0	**61.7**	15.0	20.0	3.3	**23.3**
		2) Due to the eight manufacturing wastes we failed to improve productivity	20.0	60.0	**80.0**	10.0	10.0	-	**10.0**
		3) Due to the eight manufacturing wastes we are seen by the customers as Incapable to walk the talk	6.7	30.0	**36.7**	16.7	40.0	6.7	**46.7**
	Category 2	1) Due to the eight manufacturing wastes we failed to deliver on-time	20.0	37.1	**57.1**	11.4	22.9	8.6	**31.5**
		2) Due to the eight manufacturing wastes we failed to improve productivity	8.6	57.1	**65.7**	20.0	14.3	-	**14.3**
		3) Due to the eight manufacturing wastes we are seen by the customers as "Incapable to walk the talk"	5.7	28.6	**34.3**	17.1	37.1	11.4	**48.5**

The data analysis result on the impact of manufacturing wastes on delivery time was found to be significant as indicated in Table 17, category1. One of the indicator was "unable to improve productivity" took 80% response rate. The reason is when the manufacturing wastes are significantly occurring in processes, they interrupt processes until problems are fixed, and this in turn will affect the productivity of processes. If productivity is below expectations, then the company will fail to meet delivery time which will ultimately result in customer complaints followed by attrition of the customers. The second significant indicator was "processes were not able to deliver results to their immediate customers, which accounts 61.7% response rate. The third indicator was about the erosion of customer' confidence that they doubt the organization's ability to meet its promises.

Though it was not significant as category 1, category 2 in Table 17 shows that the eight manufacturing wastes have negative impacted on operational performance of the case company. As indicated in category 1, the negative impact of the eight manufacturing wastes on productivity was the highest significant response rate with 65.7%.

Cost as Operational Performance Indicator

Table 18: The Impact of the Eight Manufacturing Wastes on Costs

Operational Performance Measures	Sample Category	Performance indicators	Strongly Agree (%)	Agree (%)	Cumulative (Strongly Agree and Agree) (%)	Undecided (%)	Disagree (%)	Strongly Disagree (%)	Cumulative (Disagree & Strongly disagree) (%)
Cost	Category 1	1) The eight manufacturing wastes have increased manufacturing or service delivery costs	31.7	51.7	**83.3**	10.0	6.7	-	**6.7**
		2) The eight manufacturing wastes have negatively impacted on our ability to compete with price	11.7	43.3	**55.0**	33.3	8.3	3.3	**11.6**
		3) The eight manufacturing wastes have increased the amount of monitoring and inspection on our products and processes.	11.7	53.3	**65.0**	20.0	8.3	6.7	**15.00**
	Category 2	1) The eight manufacturing wastes have increased service delivery costs	5.7	60.0	**65.7**	14.3	17.1	2.9	**20.0**
		2) The eight manufacturing wastes have negatively impacted on our ability to compete with price	20.0	40.0	**60.0**	17.1	20.0	2.9	**22.9**
		3) The eight manufacturing wastes have increased the amount of monitoring and inspection on our processes	8.6	54.3	**62.9**	31.4	5.7	-	**5.7**

As indicated on Table 18, category 1, cost was significantly negatively affected by the eight manufacturing wastes. Increased manufacturing and service delivery costs took a response rate of 83.3%. Increased monitoring and inspection activities as a result of excessive wastes, has also received a response rate of 65%. The third cost indicator in this category was decreasing competitiveness with price as a result of increased costs of manufacturing and service delivery processes. The data analysis result is in support of theoretical explanations that wastes are directly associated with costs. When it comes to a business entity nothing is wasted without a cost.

As mentioned in Table 18, category 1, the negative impact of the eight manufacturing wastes were also found to be significant in category 2. Their impact was significant in that the response rate of increased service delivery costs (65%), marginal market competitiveness with cost (60%) and increased process monitoring and inspection costs (62.9%).

Summary of Data Analysis on the Impacts of the Eight Manufacturing wastes on Operational Performance

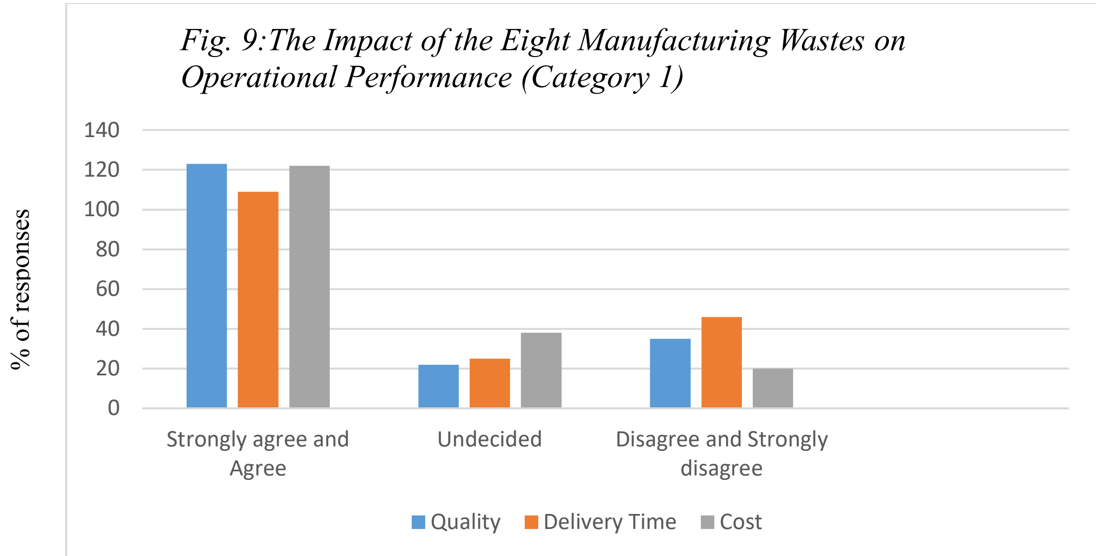
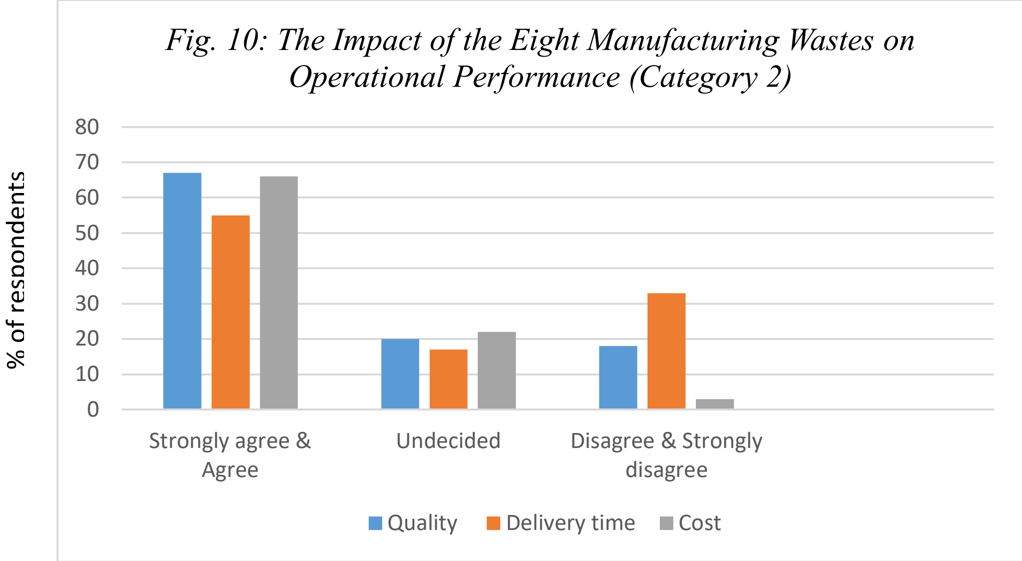


Fig. 9:The Impact of the Eight Manufacturing Wastes on Operational Performance (Category 1)

Category 1, Fig. 9: indicated that the imapct of the eight manufacturing wastes on operational performances of the case company were very significant in all the three operational performance measures. The operationaal performance indicators were manifested themselves through the respondents in a proportionate manner. Therfore, the significant occurerence of the eight manufacturing wastes were proved by their significant imapct on operational performances measures.



Category 2, Fig. 10: revealed that the eight manufacturing wastes were significantly impacting on the operational performances of the case company. As it was observed for category 1, the impacts on indicators were fairly distributed, in that each of them were affected by the eight manufacturing wastes in a proportionate manner. This outcome is in line with the concept that lean manufacturing practices must be implemented holistically, Gusman Nawanir, (2016). This recommendation is also in agreement with Deming (1986) to view the organization processes as interrelated and interdependent components of a system. Because processes are interrelated, it is only through improving all interacting elements that the operational and business performances can be improved.

In general, the data analysis findings in both categories are summarized as follows:

a) The data analysis results have clearly demonstrated that the eight manufacturing wastes were significantly impacting on the operational performance of the case company. This conclusion is supported by evidences of response rate to quality was from 50% to 80%.

b) The impact of the eight manufacturing waste were significant both in main and support processes, however, the magnitude was more intense in manufacturing and associated processes than in support processes.

c) The impact of the eight manufacturing wastes was more intense on cost than quality. This might be due to the costs of reworks, rejects, returns from the market, unnecessary transportation of materials and replacement to sold defective products.

4.2 Data Analysis on Focus Group Discussions

As indicated on Table 19, eleven senior people, who are well aware of processes of the case company were selected. To facilitate the focus group discussions initial briefing session was conducted on objectives of the research, objective of the FGD; rules of the discussions (Rules of Brainstorming), and working program.

The focus group members have discussed on the possible causes of each waste category, and measure their significance based on the likelihood of occurrence and their consequences in the cases company. The scores to each potential cause were assigned based on intense brainstorming, justifications, and finally reached to conclusions based on general consensus. The role of the researcher was facilitating the discussions, and helping them to reach conclusions.

Table 19: Composition of Members of the Focus Group Discussion

S. No.	Functions	Members of the FGD	Educational Level
1.	Factory Manager Office	Factory Manager	1st Degree and above
2.	Production	Production Department Head and one line production Manager	---do---
3.	Technique	Technique Department Head and one Divisional Head	---do---
4.	Quality & Food Safety Assurance	Food Safety and Quality Assurance Department Head and one food Safety Divisional Head	---do---
5.	General service	General Service Department Head and Hygienic and Sanitation Division Head	---do---
6.	Warehouse	Warehouse Manager	---do---
7.	HR Department	Human Resource Department Head	---do---
	TOTAL	11	

Selecting Risk Significance Rating Criteria

To select the most significant causes for target wastes among the lists proposed by members of FGD, rating scales and descriptions for each were established based on a published document as indicated in Appendix 3 to 6.

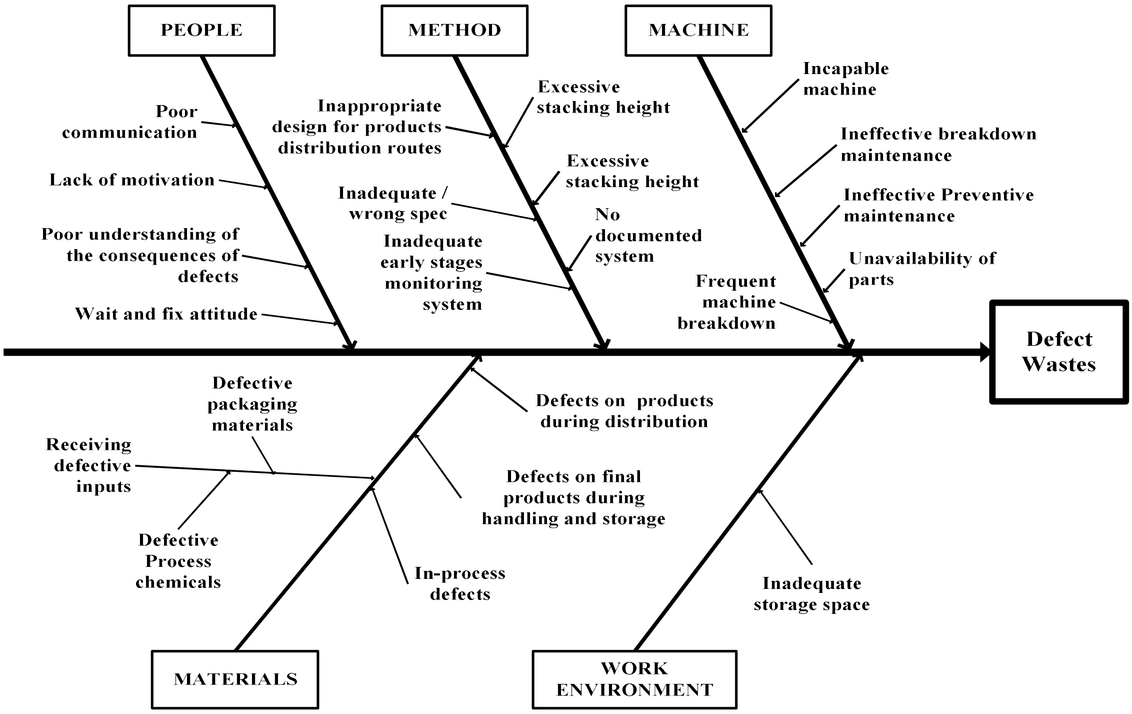
Legends to colour codes

The colour codes on Tables indicates the impact of the identified cause on the specific category of waste.

Low	Medium	High	Extreme

4.2.1 Root Causes for Defect Wastes

Fig. 11: Fishbone Diagram for Identifying Causes of Defect Wastes



The focus group has discussed on each potential causes of defects and allocated scores in order to determine their significances as follows.

Table 20: Causes of Defect Wastes Significance Determination Matrix

Root causes for Defect Wastes	Likelihood (L)	Consequence (C)	Score (L x C)
PEOPLE			
• Poor internal communication	5	4	20
• Lack of motivation	4	4	16
• Poor understanding of the consequences of defects	3	5	15
• Fix it when it is broken	4	5	20
• Lack of skill	4	5	20
METHOD			
• Inappropriate design for products distribution routes	2	5	10
• Inadequate /wrong spec	1	5	5
• Inadequate early stages monitoring system	4	5	20
• Excessive stacking height	4	5	20
• No documented system	1	5	5

MACHINE			
• Incapable machine	3	5	15
• Ineffective breakdown maintenance (skill and parts)	3	5	15
• Unavailability of parts	5	5	25
MATERIALS			
• Defective packaging materials	4	5	20
• Defective Process chemicals	1	5	5
WORK ENVIRONMENT			
• Inadequate storage space	4	5	20

The focus group has discussed on each potential causes for wastes of excessive defects and allocated scores based on general consensus. Finally, the significance of causes were determined as indicated in Table 20.

The Highest Significant Causes for Defect Wastes

Poor internal communication: During the FGD, inadequate information, wrong information or no information at all were identified as significant causes for defects on products.

Fix it when it is broken attitude: Authorized persons were not willing to stop the production processes for preventive maintenance, because they fear that profit will go down. Maintenance works on production machines were carried out when machine failures were detected. However, before a machine failures were detected a lot of defective products could be produced. In addition, in some cases, when a machine is failed, significant portion of in-process products became defectives, such as, filler, labeller, wrapping, date coding, etc.

Inadequate early stages monitoring system: Lack of monitoring activities at early stage of the production processes have contributed to problems to happen for a long period of time, where excessive defective products were rejected at the final inspection.

Excessive stacking height: Final products were stored in excessive heights, where products in underneath became defective, such as, caps were broken or deformed causing its content to spill, and deformed bottles' shape. Excessive staking heights were also the causes for packed water to fall on the floor which damages the labelling and wrapping ploy sheet and added to the defect categories.

Defective packaging materials: Defective preforms and caps supplied by in-house facility have also contributed to increased defective products, deformed or cracked bottles, and leaky caps.

Unavailability of spare parts: Due to unavailability of spare parts, broken machines were fixed on temporary basis, however, they become the sources of defective products as temporary maintenance could not restore the machines to their intended performance level.

Inadequate storage space: Due to lack of storage space, products were stored in a non-designated and inappropriate areas, where products were exposed to damages and cross-contaminations.

The Second Level Significant Causes for Defect Wastes

Lack of motivation: In some cases due to lack of motivation people loose proper attention to their jobs. As a result machines goes out of control and continued to produce defective products for longer time, such as, leaky bottles, bottles without caps, and packed water without labels.

Poor understanding of the consequences of defects: People past experience, such as, considering defects as a natural phenomenon, consequently they failed to respond when they occur. This is due to lack of understanding of the consequences of defects on the company business performance and to themselves as well. As a result defects have never been dealt with effectively for their reduction or elimination.

Inappropriate design for products distribution routes: In some cases, distribution routes were not meticulously selected, as a result they become the causes for returning defective products, such as, rough and bumpy roads.

Incapable machine: Some machines were incapable to produce the desired outputs, as a result, they become the sources of defects, such as, blower machine, where in some cases the bottles failed to take their intended shape.

Ineffective breakdown maintenance of machines (skill and spare parts): Ineffective machine maintenance have also contributed to machines produce defective products. Ineffectiveness of machine maintenance was mainly caused by lack of skills and unavailability of genuine spare parts.

The rest of the defect causes indicated in Table 20 could be considered as less significant, however, responsibility could be assigned for each cause to follow-up if they exhibit any sign of development.

4.2.2 Root Causes for Waiting Wastes

Fig. 12: Fishbone Diagram for Identifying Causes of Wastes of Excessive Waiting

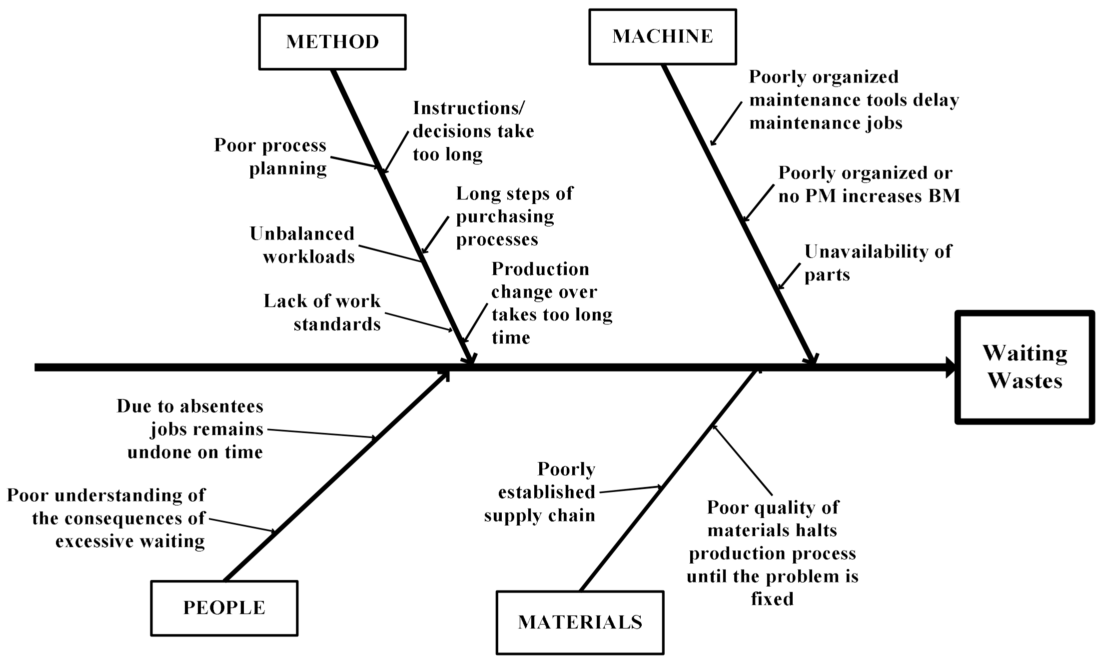


Table 21: Causes of Waiting Wastes Significance Determination Matrix

Root causes for Waiting Wastes	Likelihood (L)	Consequence (C)	Score (L x C)
PEOPLE			
• Due to absentees, jobs remains undone on time	1	4	4
• Poor understanding of the consequences of excessive waiting	4	5	20
• Manpower shortage (Technique & Food safety experts)	3	4	12
METHOD			
• Poor process planning	1	5	5
• Poor process plan implementation	4	5	20
• Unbalanced workloads	1	5	5
• Lack of work standards	4	5	20

• Instructions/ decisions take too long	3	5	15
• Long steps of purchasing processes	5	5	25
• Production change over takes too long time (due to lack of standard)	4	5	20
MACHINE			
• Poorly organized maintenance tools delay maintenance jobs	2	3	6
• Increased corrective maintenance due to absence of preventive maintenance	4	5	20
• Unavailability of parts	5	5	25
MATERIALS			
• Poorly established supply chain	5	5	25
• Poor quality of materials halts production process until the problem is fixed	4	5	20

The focus group has discussed on each potential causes for wastes of excessive waiting and allocated scores based on general consensus. Finally, the significance of causes were determined as indicated in Table 21.

The Highest Significant Causes for Wastes of Excessive Waiting

Poor understanding of the consequences of excessive waiting: The focus group discussions have identified that the consequences of waiting were not clearly understood by people, such as, its impact on productivity, cost and customers satisfactions. It has been considered as part of normal job practice.

Poor process plan implementation: Because process plans were not effectively implemented, excessive waiting was encountered until other jobs gets done. Such as, to collect and organize resources (human resources, input materials, information), and get approvals from the authorized persons.

Lack of work standards: One of the significant source of waiting waste was lack of agreed work standards, as a result people in the upstream process steps do some extra job they think it is appropriate. Though this seemed to be excessive processing, it has also created unnecessary excessive delays to complete other jobs in the downstream jobs.

Long steps of purchasing processes: As the purchasing process holds long steps, it has incurred excessive waiting between interacting functions, such as, multiple reviews and approvals, repeated reminding notes to authorized persons, to collect samples and get tested both in-house and in outsourced laboratories.

Production changeover took too long time (due to lack of work standard): Due to lack of work standards, production changeover took longer time, in some cases, 1.5 hours and in other 15 hours.

Increased corrective maintenance due to the absence of preventive maintenance: Due to the absence of preventive maintenance, the company was exposed to repeated breakdown maintenances which has increased machine downtime. This in turn has increased repeated waiting time for production processes to be commenced.

Unavailability of parts: When machines were broken down for various reasons, it was not possible to carryout prompt maintenance services due to unavailability of spare parts. It took longer time to search spare parts from retail shops. Waiting for spare parts has delayed production processes to commence.

Poorly established supply chain: Suppliers relationship was not adequately established, where in many cases the suppliers failed to meet agreed delivery time. There were situations where the production processes waited longer time until input materials were received.

Poor quality of materials halts production process until the problem is fixed: In some cases poor input materials were arrived at the company premise and were effectively identified by the incoming inspection. However, the decision process on these defective incoming materials took longer time, while the machines were left idle.

The Second Level Significant Causes for Wastes of Excessive Waiting

Manpower shortage (Maintenance Engineers): Due to inadequacy of maintenance engineers and mechanics, there have been repeated incidents that broken down machines were waited for longer time until other maintenance works were completed.

Instructions/ decisions take too long: There were incidents that jobs took longer time to be done due to excessive waiting until decisions/ instructions came from authorized persons, such as, to stop production processes for preventive maintenance and delayed purchasing decision. The rest of the causes for excessive waiting indicated in Table 21 could be considered as less significant, however, responsibilities could be assigned for each cause to follow-up if they exhibit any sign of development.

4.2.3 Root Causes for Inventory Wastes

Fig. 13: Fishbone Diagram for Identifying Causes of Wastes of Excessive Inventory

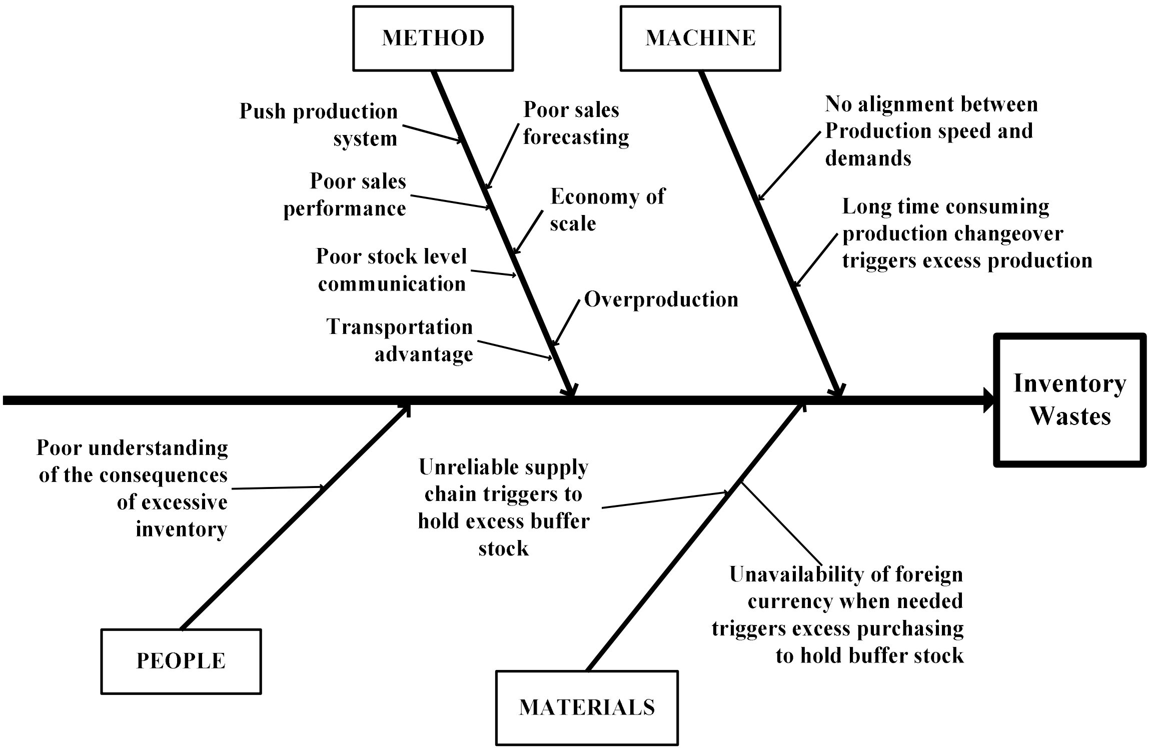


Table 22: Causes of Inventory Wastes Significance Determination Matrix

Root causes for Inventory Wastes	Likelihood (L)	Consequence (C)	Score (L x C)
PEOPLE			
• Poor understanding of the consequences of excessive inventory	1	4	**4**
METHOD			
• Push production system	4	4	**16**
• Poor sales performance	4	5	**20**
• Poor stock level communication	1	4	**4**
• Transportation advantage	1	4	**4**
• Poor sales forecasting	4	5	**20**
• Economy of scale	1	4	**4**
• Overproduction	2	4	**8**
MACHINE			
• No alignment between Production speed and demands	1	4	**4**
• Long time consuming production changeover triggers excess production	1	4	**4**
MATERIALS			
• Unavailability of foreign currency when needed triggers excess purchasing to hold buffer stock	1	4	**4**
• Unreliable supply chain triggers to hold excess buffer stock	1	4	**4**

The focus group has discussed on each potential causes for wastes of excessive inventory and allocated scores based on general consensus. Finally, the significance of causes were determined as indicated in Table 22.

The Highest Significant Causes for Wastes of Excessive Inventory

Poor sales performance: The organization has adopted push production system. Unless machine failure is encountered, it produces as per the target assigned to the production department. However, if in some cases the sales performance goes down, the organization holds excessive finished products to the extent of storing of products in non-designated and inappropriate spaces. Due to over stacking heights products located in underneath got damaged and removed as wastes.

Poor sales forecasting: There were situations where poor sales forecast reports were established and communicated to the production processes. However, due to the inaccuracy of the forecast the organization holds excessive finished products in storage.

The Second Level Significant Cause for Wastes of Excessive Inventory

Push production system resulting in overproduction: The organization has adopted push production system, where all machines operates 7 days a week and 24 hours a day. The marketing and sales function is responsible to sell products through all possible means of strategies. However, if in some cases, the sales performance fails to move products to the market, the organization is forced to hold excessive inventory.

The rest of the causes for excessive inventory indicated in Table 22 could be considered as less significant, however, responsibilities should be assigned for each cause to follow-up if they exhibit any sign of development.

4.2.4 Root Causes for Wastes of Unnecessary Motions

Fig. 14: Fishbone Diagram for Identifying Causes of Wastes of Excessive Motion

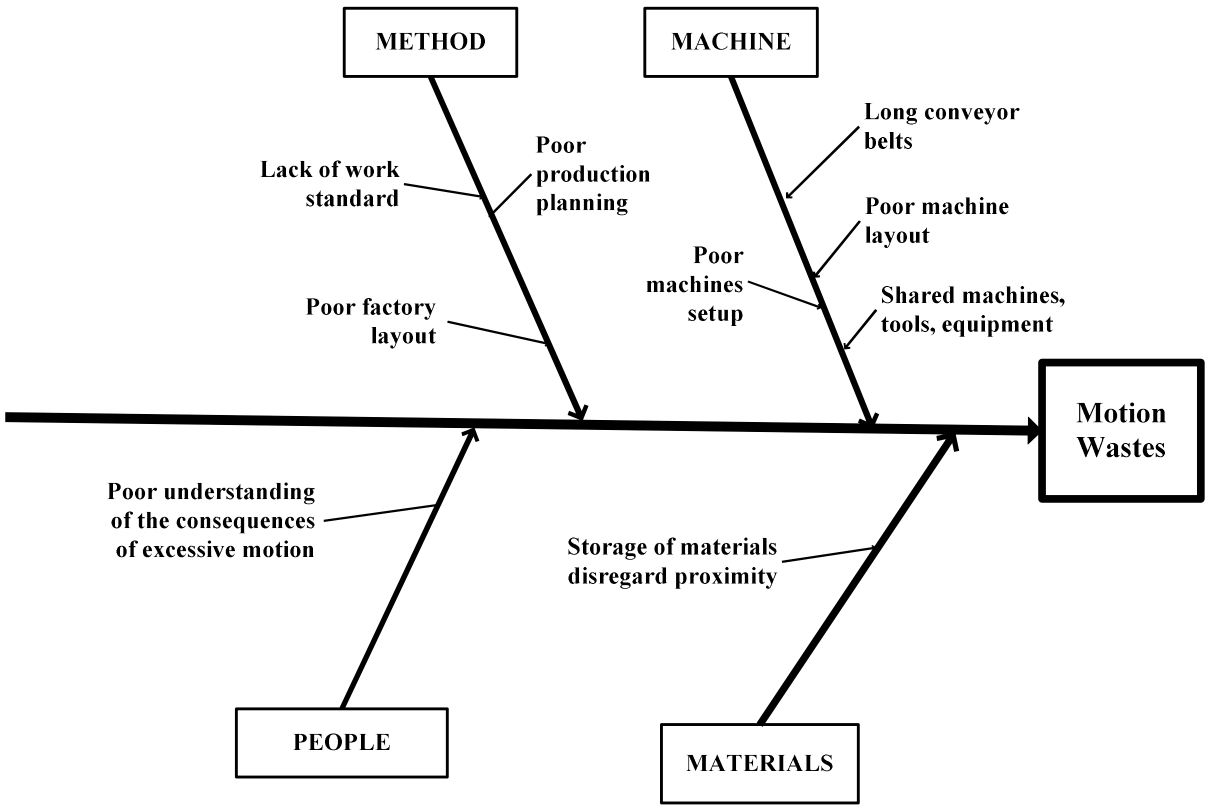


Table 23: Causes of Motion Wastes Significance Determination Matrix

Root causes for Motion Wastes	Likelihood (L)	Consequence (C)	Score (L x C)
PEOPLE			
• Poor understanding of the consequences of excessive motion	2	5	**10**
METHOD			
• Lack of work standard	2	5	**10**
• Poor factory layout (plant 1)	4	5	**20**
• Poor production planning	1	5	**5**
MACHINE			
• Poor machines setup / Poor machine layout (Raw material feeding)	4	5	**20**
• Long conveyor belts	1	3	**3**
• Shared machines, tools, equipment (photocopy machines, printers, welding equipment)	2	3	**6**
WORK ENVIRONMENT			
Ergonomics: failure to keep work closer to the body, bending, twisting, prolonged posture, excessive reaches (excessive stretching), lifting excessive heavy weights, etc.	2	3	**6**

The focus group has discussed on each potential causes for wastes of excessive motion and allocated scores based on general consensus. Finally, the significance of causes were determined as indicated in Table 23.

The Highest Significant Causes for Wastes of Excessive Motions

Poor factory layout (plant 1): The FGD has revealed that poor company layout at plant 1 has contributed to excessive motion wastes.

Poor machines setup / Poor machine layout (Raw material feeding): Machine set up at raw materials feeding section has negatively impacted on excessive motions.

The Second Level Significant Causes for Wastes of Excessive Motions

Poor understanding of the consequences of excessive motion: People were not well aware of the consequences of excessive motion, as a result they were wandering here and there for resources and supports instead of organising in advance through effective planning. People usually went to functional areas to get jobs done where they could have done it through telephone calls, email, telegram, etc. This was due to lack of understanding of the consequences of motion on the company business performance, such as, productivity and cost.

Lack of work standard: One of the causes of motion waste is lack of commonly agreed work standards, as a result people unnecessarily move here and there to do non-value adding jobs, such as, excessive consultation of people in order to avoid accountability, and requested reviews and approvals while the authority was at hand. Though this seems to be excessive processing, it has also created unnecessary excessive delays to complete jobs.
The rest of the causes for excessive motions indicated in Table 23 could be considered as less significant, however, responsibilities could be assigned for each cause to follow-up if they exhibit any sign of development.

4.2.5 Root Causes for Wastes of Overprocessing

Fig. 15: Fishbone Diagram for Identifying Causes of Wastes of Overprocessing

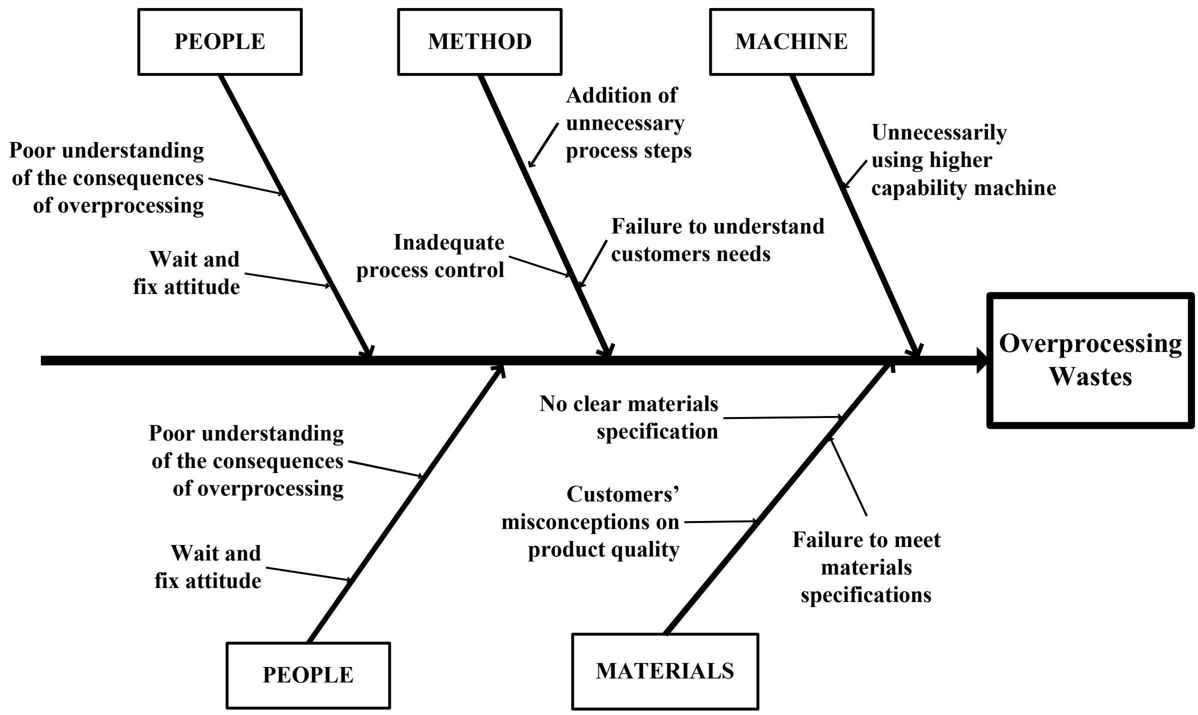


Table 24: Causes of Overprocessing Wastes Significance Determination Matrix

Root causes for Overprocessing Wastes	Likelihood (L)	Consequence (C)	Score (L x C)
PEOPLE			
• Poor understanding of the consequences of overprocessing	2	3	6
METHOD			
• Inadequate process control	2	3	6
• Addition of unnecessary process steps	1	4	4
MACHINE			
• Unnecessarily using higher capability machine	1	3	3
MATERIALS			
• No clear materials specification	1	3	3
• Customers' misconceptions on product quality (RO)	5	5	25

The focus group has discussed on each potential causes for wastes of overprocessing and allocated scores based on general consensus. Finally, the significance of causes were determined as indicated in Table 24.

The Highest Significant Cause for Wastes of Overprocessing

Customers' misconceptions on water quality (Demand for tasteless or low TDS content): The case company was overprocessing the reverse osmosis process to reach TDS limit to 50 mg/l or less, however, the Compulsory Ethiopian Standard CES 99:2019 specified TDS to be maximum of 1000 mg/l and other international standards, such as, International Bottled Water Association and FDA specified TDS to be a maximum of 500 mg/l. This was due to the customers' misconception on the quality of bottled water in that they needed tasteless with light body in their mouth. Instead of educating the consumer's, bottled water manufactures followed the destructive method of production, where due overprocessing 30% of the total volume of water produced was lost to remove total dissolved solids unnecessarily. The rest of the causes for overprocessing indicated in Table 24 could be considered as less significant, however, responsibilities should be assigned for each cause to follow-up if they exhibit any sign of development.

4.2.6 Root Causes for Wastes of Overproduction

Fig. 16: Fishbone Diagram for Identifying Causes of Wastes of Overproduction

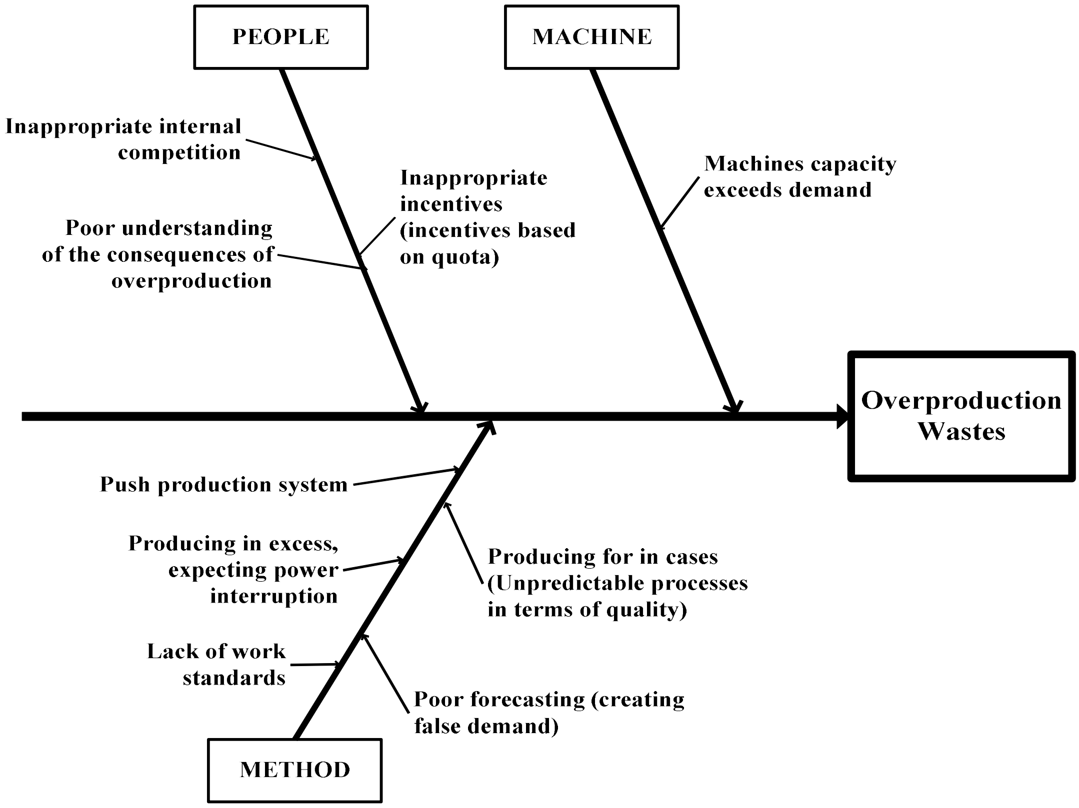


Table 25: Causes of Overproduction Wastes Significance Determination Matrix

Root causes for Overproduction Wastes	Likelihood (L)	Consequence (C)	Score (L x C)
PEOPLE			
• Inappropriate internal competition	1	3	3
• Poor understanding of the consequences of overproduction	4	5	20
• Inappropriate incentives (incentives based on quota)	1	3	3
MACHINE			
• Machines capacity exceeds demand	1	3	3
METHOD			
• Push production system	4	5	20
• Producing in excess, expecting power interruption	1	3	3
• Lack of work standards	3	5	15
• Producing for in cases (Unpredictable processes in terms of quality)	1	3	3
• Poor forecasting (creating false demand)	4	5	20

The focus group has discussed on each potential causes for wastes of overproduction and allocated scores based on general consensus. Finally, the significance of causes were determined as indicated in Table 25.

The Highest Significant Causes for Wastes of Overproduction

Poor understanding of the consequences of overproduction: The focus group discussion has identified that the negative consequences of overproduction has never been thoroughly thought by actors of overproduction, such as, internal transportation costs of excess products from place to place, damages as a result of handling and storage, and in the case of custom made products unable to sell as products bear the customers logo.

Push production system: The case company has adopted push production system, where all machines operates 7 days a week and 24 hours a day. The marketing and sales function is responsible to sell products through all possible means of strategies. However, if in some cases the sales performance fails to move products to the market, the organization is forced to hold excessive finished products in storage.

Poor forecasting (creating false demand): Due to lack of expertise, in some cases the case company has created inaccurate demand and communicate to the production process. However, as the forecasting was inaccurate, the sales strategies could not sell products as expected. Consequently excess amount of products remains to be in storage.

The Second Level Significant Cause for Wastes of Overproduction

Lack of work standard: One of the causes for overproduction was lack of approved work standards (while maintaining flexibility), as a result, people failed to know what to produce, how much and when to produce. Therefore, the prevailing norm was produce as far as inputs are available and machines are working, where the resultant effect was overproduction.

The rest of the causes for overproduction indicated in Table 25 could be considered as less significant, however, responsibilities should be assigned for each cause to follow-up if they exhibit any sign of development.

4.2.7 Root Causes for Wastes of Unnecessary Transportation

Fig. 17: Fishbone Diagram for Identifying Causes of Wastes of Transportation

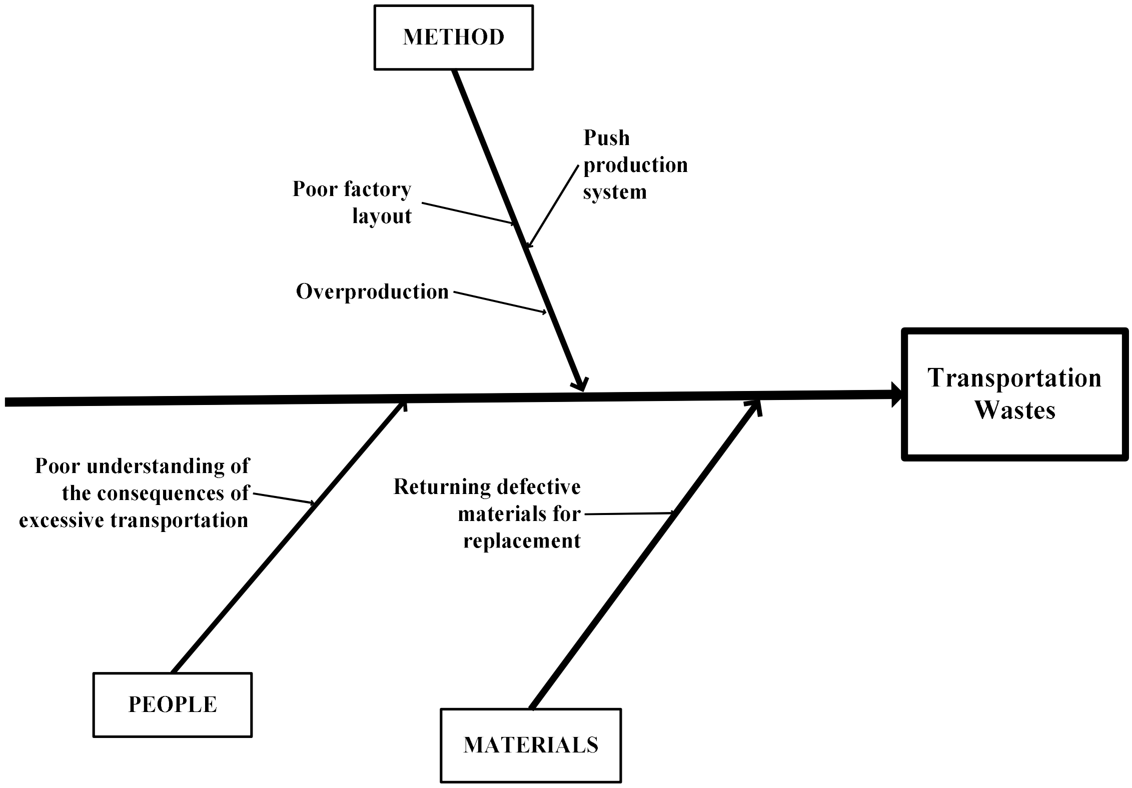


Table 26: Causes of Transportation Wastes Significance Determination Matrix

Root causes for Transportation Wastes	Likelihood (L)	Consequence (C)	Score (L x C)
PEOPLE			
• Poor understanding of the consequences of excessive transportation (lack of cost benefit analysis)	1	3	**3**
METHOD			
• Poor factory layout	4	5	**20**
MATERIALS			
• Internal materials transportation	**3**	**5**	**15**

The focus group has discussed on each potential causes for wastes of transportation and allocated scores based on general consensus. Finally, the significance of causes were determined as indicated in Table 26.

The Highest Significant Causes for Wastes of Unnecessary Transportation

Poor factory layout: Poor factory layout has contributed to excessive transportation of materials from place to place, such as, input materials transportation from warehouse to feeding hopper using forklifts, transportation of finished products (bottled water water) from products quarantine room to finished products storage warehouse, and transportation of preforms and caps from production site to bottled water manufacturing site which is 8 km away.

The Second Significant Cause for Wastes of Transportation

Internal materials transportation: Internally materials were excessively transported from one location to the other due to overproduction and poor machine layouts. For example, at plant 2, finished products were transported by forklifts and loaded to a lift and then moved to the ground floor where the storage space was located and then removed from the lift by a forklift and transported again to the designated space.

Poor understanding of the consequences of excessive transportation (lack of cost benefit analysis) indicated in Table 26 could be considered as less significant, however, responsibilities should be assigned to follow-up if it exhibits any sign of development.

4.2.8 Root Causes for Wastes of Untapped Human Potential

Fig. 18: Fishbone Diagram for Identifying Causes of Wastes of Untapped Human Potential

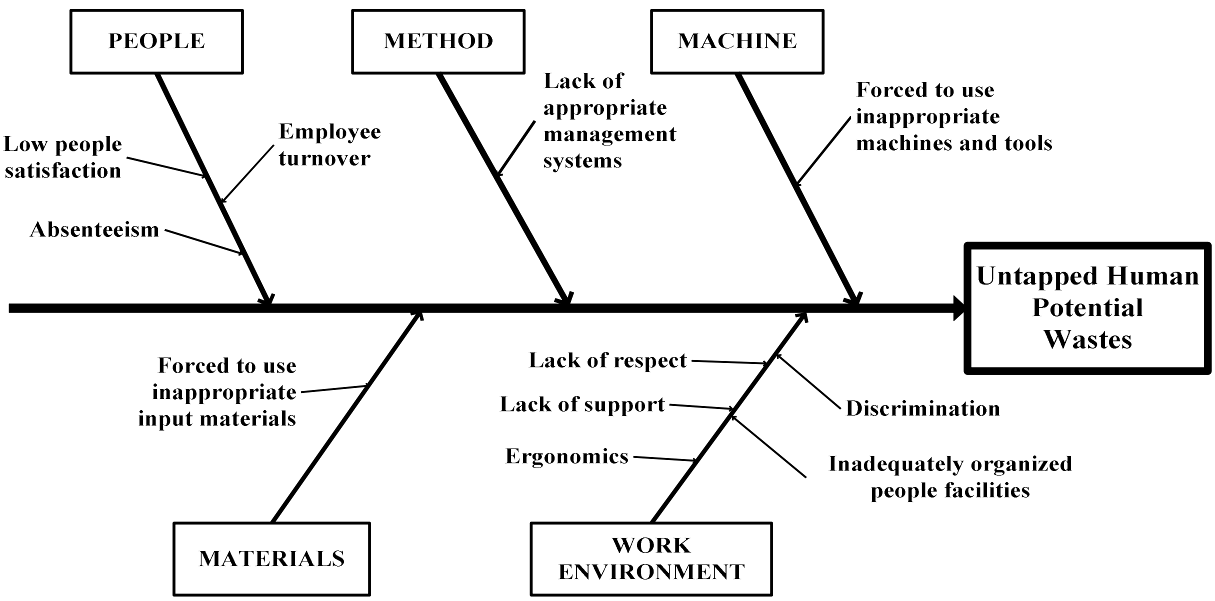


Table 27: Causes of Wastes of Untapped Human Potential Significance Determination Matrix

Root causes for Transportation Wastes	Likelihood (L)	Consequence (C)	Score (L x C)
PEOPLE			
• Low people satisfaction	3	5	15
• Absenteeism	3	3	9
• Employee turnover	2	4	8
METHOD			
• Lack of appropriate management systems	3	5	15
MACHINE			
• Forced to use inappropriate machines and tools	1	3	3
MATERIALS			
• Forced to use inappropriate input materials	4	5	20
WORK ENVIRONMENT			
• Lack of respect	1	5	5
• Lack of support	2	5	10
• Discrimination	1	5	5
• Inadequately organized people facilities	3	5	15

The focus group has discussed on each potential causes for wastes of untapped human potential and allocated scores based on general consensus. Finally, the significance of causes were determined as indicated in Table 27.

The Highest Significant Cause for Wastes of Untapped Human Potential

Forced to use inappropriate input materials: In some cases people were forced to use poor input materials, such as, preforms and caps, which resulted in defective products in the production processes. The situation has created poor workmanship, which had a negative impact on people motivation. Lack of motivation in turn negatively affects to fully utilize people potential for the achievement of the organization objectives.

The Second Level Significant Causes for Wastes of Untapped Human Potential

Low people satisfaction rate, absenteeism, employee turnover, lack of adequate supports to perform jobs and inadequately organized facilities people have also significantly contributed to failure to use people potential (knowledge and skills).

The rest of the causes for untapped human potentials indicated in Table 27 could be considered as less significant, however, responsibilities should be assigned for each cause to follow-up if they exhibit any sign of development.

4.3 Archival Data Analysis

4.3.1 Defect Wastes

Table 28: Archival Data, Defects on Products

Month	Total produced	Defective bottles	Defective caps
Apr 2020	8,982,584.00	191,634.00	123,900.00
May 2020	7,049,795.00	188,310.00	110,050.00
Jun 2020	7,375,554.00	178,762.00	118,600.00
Jul 2020	8,551,290.00	140,977.00	103,207.00
Aug 2020	11,769,414.00	175,511.00	145,550.00
Sep 2020	7,560,210.00	114,432.00	85,912.00
Oct 2020	6,887,310.00	134,000.00	135,000.00
Nov 2020	10,545,834.00	359,735.00	200,900.00
Dec 2020	8,656,992.00	214,485.00	80,000.00
Jan 2021	7,534,314.00	108,587.00	208,587.00
Feb 2021	6,188,610.00	186,399.00	135,000.00
Mar 2021	8,478,774.00	218,384.00	65,000.00
Sum	**99,580,681**	**2,511,216**	**1,511,706**

The data was collected from archives retained from April 2020 to March 2021 and organized in Table 28. To analyse the significance of the defects, the Sigma level of the production processes was calculated and analyzed as follows.

Using the Process Sigma level calculator the following results were obtained:

Opportunities: 99,580,681
Defects: 4,022,922
DPMO: 40,398.6190
Defects %: 4.04
Yield %: 95.96
Process Sigma: 3.25

The analysis made on defect wastes has revealed that the case company was operating at 3.25 Process Sigma level, which is significantly lower level of performance in terms of process improvement and elimination of wastes. This finding is consistent with perceptual data analysis results.

The case company could make a choice on the appropriate sigma level (Table 29) based on the cost benefit analysis made before implementation of the improvement program. The move towards excellence could be done step by step instead of trying a leap at once. For example, if 4 Process Sigma level is adopted, the yield will reach 99.38% (without defect), and the number of defects will be reduced from 40,398.6190 per million opportunities (current performance level) to 6,200 per million opportunities (the target).

Table 29: Process Sigma Level (Source: Peters S. et.al, (2002), "The Six Sigma Way, Team Field Book")

Sigma Level	**Defects (or Errors) Per Million Opportunities (DPMO)**	**Yield (or Produced or Delivered) Correctly (%)**
1	691,500	30.85
2	308,500	69.15
3	66,800	93.32
4	6,200	99.38
5	230	99.977
6	3.4	99.99966

4.3.2 Wastes of Overprocessing

Table 30, Total Dissolved Solids (TDS) Removal to Reach 50 mg/l or Less

Month, Data Collected	Total Quantity of Water Produced (in Litre)	Total Quantify of Water Discharged to remove TDS excessively (in Litre)	Quantify of Water Discharged to remove TDS in %
April 2020	16,875,782	5,062,735	30
May 2020	9,879,556	2,963,867	30
June 2020	9,750,321	2,925,096	30
July 2020	11,656,048	3,496,814	30
August 2020	18,234,100	5,470,230	30
September 2020	9,039,993	2,711,998	30
October 2020	7,846,101	2,353,830	30
November 2020	11,634,893	3,490,468	30
December 2020	9,256,638	2,776,991	30
January 2021	8,186,827	2,456,048	30
February 2021	12,841,192	3,852,358	30
March 2021	20,671,988	6,201,596	30
TOTAL PER YEAR	**145,873,439**	**43,762,031**	**30**

As indicated on Table 30, The case company was overprocessing the reverse osmosis process to reach TDS limit 50 mg/l or less, however, the Compulsory Ethiopian Standard CES 99:2019 specified TDS to be a maximum of 1000 mg/l and other international standards, such as, International Bottled Water Association and FDA specified TDS to be a maximum of 500 mg/l. Excessive removal of TDS is due to the customers' misconception on the quality of bottled water that they preferred tasteless with light body in their mouth. Instead of educating the consumer's, bottled water manufactures followed the destructive method of production, where due to overprocessing 30% of the total volume of water produced is lost (discharged to the environment). However, it should be noted that the TDS content of the raw water of the case company is on average 210 mg/l, which is far below the regulatory limit (1000 mg/l).

A document published by World Health Organization (WHO) in 2003, with document number WHO/SDE/WSH/03.04/16 stated the following facts about Total dissolved solids (TDS).

Identity

Total dissolved solids (TDS) is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulfate, and nitrate anions.

Organoleptic properties

The presence of dissolved solids in water may affect its taste. The palatability of drinking water has been rated by panels of tasters in relation to its TDS level as follows: excellent, less than 300 mg/litre; good, between 300 and 600 mg/litre; fair, between 600 and 900 mg/litre; poor, between 900 and 1200 mg/litre; and unacceptable, greater than 1200 mg/litre. Water with extremely low concentrations of TDS may also be unacceptable because of its flat, insipid taste.

As stated in the above statements, excessive removal of TDS lowers the quality of taste in addition to excessive wastage of the natural resource.

4.3.3 Wastes of Unnecessary Transportation

Table 31, Transportation Wastes

Month, Data collected	**Quantity Transported (in bundle)**	**Resource deployed for transportation**			**Distance covered by vehicles (km)**
		Number of Forklifts (other equipment) deployed	**Number of people assigned to manage transportation vehicles**	**Total wages assigned to those people per month**	
April 2020	12,232			45,000	734
May 2020	9,756	4	9	45,000	585
June 2020	8,200			45,000	492
July 2020	10,207			45,000	612
August 2020	12,138			45,000	728
September 2020	19,623			45,000	1,177
October 2020	8,493			45,000	510
November 2020	11,818			45,000	709
December 2020	9,829			45,000	589
January 2021	8,498			45,000	509
February 2021	5,998			45,000	360
March 2021	9,986			45,000	599
Total	**126,778**	**4**	**9**	**540,000**	**7604**

As indicated in Table 31, finished products (bottled water) were first transported to the quarantine area and stayed there for twenty four hours for the ozone (disinfectant) to decompose in the water so that it becomes harmless to the consumers. After twenty four hours the same quantity of bottled water is transported to another warehouse where it is dispatched to the customers. As indicated in the Table 31, unnecessary internal transportation of products from place to place has incurred excessive wastes, such as, four forklifts were purchased and deployed for unnecessary transportation. Forklifts are an expensive equipment to purchase, to maintain and to operate. The four forklifts were unnecessarily travelled a total of 7,604 kilometre per year. One can imagine how much input materials were consumed by the forklifts. Nine people were assigned to perform unnecessary transportation of finished products from quarantine to finished products warehouse. A total of 45,000 Birr was paid to this people in the form of salaries. However, this cost did not include other costs, such as, canteen subsidies, laundry services, medical services, transportation services, etc. Those wastes could have been significantly minimized by proper alignment of processes and work places and transporting materials from production to storage areas through the use of conveyor belts. Products could also pass their quarantine period in the same warehouse.

Transportation of input materials

Packaging materials (preforms and caps) production facility is about 8 km away from the water manufacturing facility and a vehicle transports packaging materials on average 3 times a day and 7 days a week. The vehicle covers 336 km round trip per week. In addition to transportation costs, the company was experiencing costs of loading and unloading, and the packaging materials got defective due improper handling during transit.

4.3.4 Wastes of Excessive Waiting

Table 32: Wastes of Excessive Waiting

Month, Data collected	Machine idle time (In hours)	Machine downtime (in hours)
April 2020	154.5	263
May 2020	159.35	668.95
June 2020	279.9	521.2
July 2020	453.2	403.8
August 2020	202.3	705.2
September 2020	72	324.8
October 2020	164.97	238.2
November 2020	269	356
December 2020	354	322
January 2021	160	295
February 2021	138	445
March 2021	88	629
Total	**2495.2**	**3172.1**

To study wastes associated with excessive waiting machine idle time and machine downtime were taken as indicators. As shown in Table 31, idle time seems to be excessive, however, because bottled water production is a continuous process and when a single machine gets broken down all other machines in the upstream and downstream becomes out of function until the problem is fixed, and this will escalate the total idle time. However, the total downtime indicated was excessive in that downtime is registered for each machine that was out of function due to failure. As explained previously in this paragraph, the bottled water production is continuous, and when a single machine fails to operate all other machines along the line becomes idle. With this assumptions, the company processes were out of function for 4.4 months a year. However, it should be noted that the company has six bottled water and two jar water production lines. This finding is supported by both analysis results of survey and focus group discussions that machine breakdown is excessive as preventive maintenance was not carried out according to schedules.

4.4 Summary of Main Findings

4.4.1 The Significance of Occurrence of Manufacturing Wastes in the Case Company

The first part of the survey questionnaire and the archival data collection and analysis were designed to identify the presence and determine the significance of the eight manufacturing wastes in order to address the research objective 1. The data analysis results in this regard have shown that the eight manufacturing wastes were significantly present in the case company and justified as follows:

a) Defect Wastes: The survey results have shown that (Table 7) defects were significantly present in both manufacturing and support processes, with a response rate of 81.7% and 65.7% respectively. This findings were also supported by the archival data analysis results on the company's "Process Sigma Level". The company was operating at 3.25 Process Sigma Level where the Defect Per Million Opportunities (DPMO) was 40,398.6190. In support of the significant existence of defect wastes in the case company, the focus group discussions have identified the followings as the most significant root causes for defects:

- Poor internal communication.
- The attitude of fix it when it is broken.
- Lack of skill to operate processes.
- Inadequate early stages monitoring system.
- Excessive stacking height of products in storage.
- Unavailability of spare parts.
- Using defective packaging materials.
- Inadequate storage space.

As stated by Nawanir G. (2016) it is important to warrant that products being passed to the subsequent workstation is high in quality, no defect, no reject, and conforms to the required specification. Nawanir G. (2016) further explained that "In terms of quality, we strive to ensure that each process does not receive, process and dispatch any defect to subsequent process. So, there is an imperative role of quality control starting from suppliers up to vanning process. In every single process, from receiving up to vanning, quality must be strictly controlled. Each process should ensure that no defective items are processed and delivered to subsequent process." However, this research has identified that defects were occurring significantly in manufacturing and support process. Thus, by implementing lean system it is appropriate to reduce the magnitude of wastes in processes of the case company and ensure improvement of operational performances.

b) Inventory Wastes: The response rate for inventory wastes by category 1 (Table 9) was significant (60 %), however, the response rate for category 2 was comparatively less significant with a response rate of 42.9%. The results indicated that a significant number of inventories were in hold in category 1 than in category 2 (the support processes). As demonstrated by focus group discussions, the perception held by people in category 2 on holding excessive inventories was not considering the consequences. They believed that holding large quantify of input materials were considered as a guarantee for business continuity and overproduction (the cause of holding excessive inventory) was considered as one of the most acceptable practices, where people are rewarded when they managed to achieve it. Supporting the significant existence of inventory wastes in the case company, the focus group discussions have identified "poor sales performance and poor sales forecasting" as the most significant root causes for excessive inventories.

According to Nawanir G. (2016) producing based on customer orders, no more and no less, may encourage having inventory in a very minimum level, even zero inventory. It is certainly different from a push system, which requires a certain amount of stock. However, this research has revealed that the case company was experiencing problems of excessive inventory both in input materials and finished products due to the misconceptions held by people that excessive inventories guarantees uninterrupted business transactions.

c) Overprocessing Wastes: The data analysis results have shown that overprocessing is a significant waste in manufacturing processes of the case company, with a response rate of 65% (Table 1). This finding was supported by the archival data analysis results where 30 % of the water pumped to the factory was wasted (drained back to the environment) due to overprocessing of reverse osmosis to unnecessarily remove total dissolved solids (TDS) to 50 mg/l or less, while the national compulsory standard requires TDS to be 1000 mg/l, maximum. Supporting the significant existence of overprocessing wastes in the case company, the focus group discussions have identified "customers' misconceptions on product quality (bottled water)" as the most significant root causes for overprocessing wastes.

According to Arunagiria P. and Gnanavelbabu A. (2014), every process in the manufacturing operation is often assumed to be value adding. This leads individuals to overlook processes as a source of waste. In reality, many processes are unnecessary. The Authors further explained that streamlining or eliminating processing steps that add no value can dramatically speed up an operation and reduce costs. In assertion of the findings of the above Author, Chahal. V and Narwal (2017) have stated that when an extra work happens on work piece or machine to avoid rejection or for perfect working, it is inappropriate/overprocessing, which is very pricey sometimes. It also time and money consuming which divert workers behaviours. In line with findings of those researchers this research has also identified overprocessing wastes, such as, excessive removal of TDS, excessive monitoring and inspection of stable processes and reliable machines, excessive review and approval steps for suppliers which may retard the speed of processes and add operational costs. As proposed by Arunagiria and Gnanavelbabu (2014), the solution is to eliminate those wastes and enhance the efficiency of processes.

d) Transportation Wastes: Transportation wastes due to poor factory layout were found to be significant with a response rate of 80% (Table 10). The response rate for transportation wastes obtained from support process was also significant (48.6%). This finding is supported by archival data analysis where forklifts (expensive to purchase, maintain and operate) unnecessarily travelled a total of 7,604 kilometre per year from production site to the warehouses and the vice versa. Nine people have also been assigned permanently to perform the unnecessary transportation of finished products. In addition, packaging materials (preforms and caps) production facility is 8 km away from the water manufacturing facility and a vehicle transports packaging materials on average 3 times a day and 7 days a week. The vehicle covers 336 km round trip per week and approximately 13, 056 km per year. Supporting the significant existence of transportation wastes in the case company, the focus group discussions have identified "poor factory layout" as the most significant root causes for excessive transportation wastes.

Soliman H. (2017) explained that transportation waste involves all material movements from the supplier to the customer. It adds more cost on the product and could affect external customers directly, causing a delay in orders delivery. Most of transportation problems in plant facilities are subjected to the layout of the plant and production style. This involves the distance between the process steps, the distance between the machines inside each workstation, how close the workstations and machines are to the tools, how far the inventory warehouses are from the production facilities, and how far the other service departments, such as, the maintenance workshops, are from the production lines. Soliman H. (2017) further explained that this usually involves the cost of the transportation equipment like forklifts, cost of operators driving those equipment, safety risks due to using forklifts in the working areas, labour wages, cost of resources, the risk of product deterioration during the handling process, and the effect of delays on the customer. In agreement with those findings, this research has identified significant wastes associated with this transportations, such as, unnecessary transportation of products from production site to warehouses, transportation of maintenance technicians from remote locations for emergency maintenance, and transportation of packaging materials from own facility located 8km away.

e) Motion Wastes: Though motion is one of the hidden wastes, it was effectively perceived by the respondents in category 1 (Table 11) and their response rate was significant (78.3%). However, comparatively motion wastes were found to be less significant in support processes, with a response rate of 34.3%. Supporting the significant existence of motion wastes in the case company, the focus group discussions have identified "poor factory layout and poor machines setup" as the most significant root cause for excessive motion wastes.

According to Okpala C.C. (2014) the waste of movement or motion is the unnecessary movement of persons in the shop floor without the addition of any value on the products or services thereby leading to wastes of time and efforts. These avoidable movements occur because of badly organized layout, low standard processes, poorly trained workforce and bad process design. Motion is associated with ergonomics as it is observed in all cases of running, walking, jumping, bending, lifting, stretching and kneeling. All these motions are wastages as they don't only cost money but also stress and wear-out to the equipment, machine and persons. In line with this findings, the current study has identified significant motion wastes due to poor ergonomics, shared resources, poorly organized materials and tools in storage, and poor alignment of workstations to employees' facilities, such as, rest rooms, canteen, and lockers.

f) Waiting Wastes: The response rate for waiting wastes were significant in both manufacturing and support functions, with response rates 80 % and 66.7%, respectively (Table 12). This findings were also supported by archival data analysis results, where machine downtime and idle time was 3,172.1 hours and 2,495.2 hours per year, respectively. In support of the significant existence of waiting wastes in the case company, the focus group discussions have identified the followings as the most significant root causes for waiting wastes:

- Poor understanding of the consequences of excessive waiting.
- Poor process plan implementation.
- Lack of work standards.
- Long steps of purchasing processes.
- Production changeover took too long time (due to lack of work standard).
- Increased corrective maintenance due to the absence of preventive maintenance.
- Poorly established supply chain.
- Poor quality of materials halts production process until the problem is fixed.

In Okpala C.C. (2014) research findings it was explained that the waste of waiting is the idle time that occurs when co-dependent events are not synchronized. This is because of the process of manufacturing is reliant on the procedures that occurs downstream and upstream. According to Lantech (2013) the wastes of waiting in manufacturing process are bottlenecks in time usually broken machinery, lack of trained staff, shortage of materials, inefficient planning, or as a result of the six other manufacturing wastes. The findings of this research was also matching with Lantech (2013) and Okpala, C.C. (2014) that waiting wastes were significant and were manifested in different forms, such as, delayed materials supply, waiting for decisions to stop production machines for scheduled preventive maintenance, waiting until faulty equipment is fixed, delayed foreign purchases due to unavailability of foreign currency and the customers waited due to manual loading of products onto their trucks.

g) Overproduction Wastes: Overproduction wastes were found to be significant (Table 1), both in category1 and category 2 where the response rates were 43.3% and 60%, respectively. The response rate for overproduction is higher in support processes than the manufacturing process. Supporting the significant existence of overproduction wastes in the case company, the focus group discussions have identified the followings as the most significant root causes for overproduction wastes:

- Poor understanding of the consequences of overproduction.
- Push production system.
- Poor forecasting (creating false demand).

As stated by Okpala C.C (2014), overproduction is at a variance with the basic principles of waste reduction as the excess product ties money down and accrues the cost of maintenance and storage. Soliman H. (2017) has also asserted that making more products than is actually needed or over the capacity of the selling department is a waste of money in enormous rates. The losses are the costs that have been spent to make this products plus all the inventory losses. Even if these products are going to be sold later, there is still a problem with the return on investment of the used raw materials and the other resources that have been expended to make this product. This research findings are also in line with Okpala, C.C. (2014) and Soliman H. (2017) that overproduction wastes were manifested in actual production processes due to push production system and poor market forecasting. Overproduction was also the sources of other wastes in the case company, such as, excess inventory, defects on products due to excessive staking height, transportation waste due to lack of storage space.

h) Wastes of Untapped Human Potential: Wastes associated with failure to use the human potential were also fund to be significant in both categories, Category 1, 81.7% and category 2, 71.4% (Table 14). Supporting the significant existence of wastes associated with failure to use the human potential in the case company, the focus group discussions have identified that "forcing people to use inappropriate input materials" was the most significant root cause for failure to use the human potential (knowledge and skill).

Brito M. et al. (2020) have conducted a research to answer a research question that "Why do workers do not use their full talent?" The respondents (production workers, managers and executives), answered that the eighth waste is related to the lack of one or more than one of the following components: rewards, recognition, justice, evaluation, motivation, goals, self-esteem, knowledge, and resources. In line with these findings this research has identified that the case company failed to exploit the human potential due to failure to participate people in strategic issues, resignation of knowledgeable and experienced people, and failure to improve people motivation.

4.4.2 The Significance of the Impact of Manufacturing Wastes on the Operational Performances of the Case Company

The second part of the survey questionnaire was designed to investigate the impact of the eight manufacturing wastes on the operational performances of the case company. This study was particularly designed to achieve research objective 2. The results of the data analysis in this regards have shown that the eight manufacturing wastes were significantly negatively impacting on the operational performance indicators, such as, quality, delivery time and costs. The negative impact of the eight manufacturing wastes on quality was significant with a response rate of 80% in category 1 and 71.2% in category 2. For delivery time the response rate was 80% in category 1 and 65.7% in category 2. The response rate for cost was 83.3% in category 1, and 65.7 % in category 2.

In addition to justifying the achievement of research objective 1 and 2, it is worth to mention the following findings of the data analysis.

a) The research finding has proven that wastes were associated with every process, though the magnitude is different.

b) The magnitude of wastes was higher in production and interacting processes (category 1) than those of the support processes (category 2).
c) In the case of support processes (category 2) a considerable number of people have responded to "undecided" category of the Likert scale, such as, for inventory wastes (68.6%), transportation wastes (60%), Motion wastes (54.3%), overprocessing wastes (51.4%), overproduction wastes (45.7%). This might be due to the concepts of manufacturing wastes were not adequately known by people in support processes.
d) The impact of the eight manufacturing wastes were significant both in main and support processes, however, the magnitude is more intense in manufacturing and associated processes than in support processes.
e) The impact of the eight manufacturing wastes were more intense on cost than quality. This might be due to the costs of reworks, rejects, returns from the market, and unnecessary transportation of materials.

4.4.3 Operational Controls for Mitigating the Causes of the Manufacturing Wastes of the Case Company

The third instrument was focus group discussions used to identify the root causes of the eight manufacturing wastes. Focus group member were selected meticulously to ensure the validity of information gathered. Initially, the focus group constructed a fish bone diagram, where the waste category being the effect and the various contributing factors as the causes for the effect. The Team evaluated each cause and assigned a point in order to determine its significance. The focus group discussions not only identified the root causes for each category of wastes but also justified the significant existence of the eight manufacturing wastes. as indicated in section 4.2 of this Thesis Report.

4.4.4 The Significance of the Impact of Manufacturing Wastes on the Operational Performances of the Case Company

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i) The impact of the eight manufacturing wastes were significant both in main and support processes, however, the magnitude is more intense in manufacturing and associated processes than in support processes.
j) The impact of the eight manufacturing wastes were more intense on cost than quality. This might be due to the costs of reworks, rejects, returns from the market, and unnecessary transportation of materials.

As a cross-verification, data analysis was made on mean and standard deviations (Appendix 1 and Appendix 2) and the results have demonstrated consistency with data analysis made using frequencies and percentages.

4.4.5 Operational Controls for Mitigating the Causes of the Manufacturing Wastes of the Case Company

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CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

This chapter provides information on the conclusions made based on the data analysis results and the research objectives. It also includes the proposed solutions to the case company to be implemented in short-term and long-term time span so that wastes are reduced or eliminated consequently operational performances are improved.

5.1 Conclusions

This research was realized as a case study in a bottled water manufacturing company where wastes, such as, unnecessary transportation of input materials and finished products were evident. Significant amount of defective bottled water was also isolated by light board inspection at the end of the production lines. The presence of these wastes were easily perceivable in a day to day work processes, however, they were not able to capture the attention of the leadership as their magnitude and impacts on operational performances were not studied and well known. These wastes, therefore, triggered the conduct of this research to identify the perceivable and hidden manufacturing wastes and their impacts on operational performances so that improvement actions could be taken based on decisions originated from objective evidences.

This study contributes towards the understanding regarding the potential effects of manufacturing wastes on operational performances which will intern impact on the business performances of the case company. It was indicated that wastes were significantly present in different forms, consuming the organization benefits and with a potential to negatively impact on its ability to compete in the market places due to failures to achieve quality and delivery time and, of course, unable to reduce unnecessary costs. The research has identified significant results, such as, "failure to exploit the human potential" took the lead among all other waste categories in both production and support processes. This suggests that the case company needs to adjust its leadership style and install appropriate system to dig out the human wisdom from within and use it for reducing and eliminating the rest of the seven manufacturing wastes. In addition, "overprocessing of the reverse osmosis" was unnecessarily removing total dissolved solids (TDS) to 50 mg/l or less, where this value was far below the regulatory limit, 1000 mg/l. Excessive removal of TDS has become the cause for wasting of 30% of the raw water pumped to the production lines. It was a huge wastage for the company and for the Country as well, suffering from water stress. The research has also identified that the case company was operating at a defect level of 4.04%, where a significant amount of products (40,399 bottles of water) were rejected in every one million opportunities.

Those identified wastes had significant impacts on operational performances of the business, such as, quality, delivery time and cost. The operational performances in turn would negatively affect the business performances, such as, customers' satisfaction and profit. For Example, when the organization fails to meet product conformity with agreed specifications, defect becomes apparent (in this case 4.04%). If the defective products pass all the control processes and reach the customers, they become the causes for customers' complaints, product return and liability for business damages. On the other hand, to fix the causes of defects, the production process is halted and a significant amount of time is elapsed until it begins again. More frequent stoppage of the production process will affect productivity, delay deliver time and escalate operation costs. As no waste manifests itself without a cost, it is, therefore, very essential for the case company to take appropriate solutions to improve the existing situations. However, this can never happen without the commitment of the top management and active involvement of people at all levels.

5.2 Recommendations

Based the research findings and the conclusions made, the eight manufacturing wastes have significantly occurred and it was very apparent that these wastes were also significantly impacting on the operational performances of the case company. It is, therefore, appropriate to systematically address those problems so that wastes are reduced or eliminated to an acceptable level. Therefore, the researcher has proposed the following short-term and long-term solutions as indicated below.

5.2.1 Short-Term Solutions

Immediate solutions should be taken on those root causes of wastes where no excessive investment is required, such as:

1) Overprocessing of reverse osmosis (excessive removal of TDS) could be halted through appropriate strategies. By doing so, 30% of ground water pumped to the factory will be saved from unnecessary disposition. This effort is supported by national and international standards.

2) Internal transportation of input materials and finished products by forklifts could be replaced by conveyor belts.
3) Wastes associated with overproduction could be stopped through educating people on its consequences and establishing a communication system between the case company and the dealers so that appropriate information on their demand could be effectively obtained.

4) Preventive maintenance plan could also be established and be implemented as it is the cause of multiple wastes, such as, waiting, wastes, defects, and motion wastes due to unorganized maintenance services.

5) Prioritized category of wastes based on their magnitude of occurrence and impact on operational performances has been presented in Appendix 9 to indicate the focus areas during panning of actions for their mitigation.

5.2.2 Long-Term Solutions

The long term solutions for reducing or eliminating wastes is possible only through the application of Lean Six Sigma (LSS) integrated with the existing quality and food safety management systems. The researcher has synthesized the following model organized around the Deming's PDCA Cycle (Fig. 18).

Fig. 19: Proposed Lean Six Sigma Implementation Model

PLAN

- Gather adequate information on manufacturing wastes and LSS
- Brainstorm and obtain top management commitment
- Establish a project plan for LSS implementation including adequate budget
- Assign project leaders and project team members
- Receive adequate training on LSS concepts, development and implementation methodologies
- If necessary arrange external assistance

DO

- Conduct gap assessment on the current practices
- Establish process maps and characterize current performance
- Select appropriate LSS tools
- Establish /revise organizational structure, policies, principles, procedures, instruction and specification so that LSS requirements could be translated into action.
- Establish and implement improvement objectives (such as, reduction of waste and variation)
- Establish operational controls so that wastes are prevented in day to day operations
- Conduct awareness trainings on the new documented system
- Institute team work
- Enhance communication
- Provide support and motivate implementers
- Monitor ongoing progress and take improvement actions

CHECK

- Conduct periodic assessment against requirements
- Train and conduct internal audit
- As appropriate conduct external assessment/audit
- As appropriate conduct internal and external laboratory tests on products
- Conduct management review and verify the adequacy, effectiveness and suitability of the LSS system

ACT

- Identify root cases for problems identified by the “CHECK”
- Plan and implement appropriate solutions
- Verify the effectiveness of actions taken and as appropriates take additional actions
- Identify and organize lessons learnt and communicate to all internal stakeholders
- Recognize success when it is achieved

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APPENDICES

Appendix 1: *Mean and Standard Deviations on the Significance of the Eight Manufacturing Wastes (Category 1 and Category 2)*

1) Defect Wastes (Category1)

Statistics

		Disposing defective products	Reprocessing of defective products	Stoppage of production due to defects
N	Valid	60	60	60
	Missing	0	0	0
Mean		1.9833	3.0667	2.2000
Std. Deviation		.83345	1.17699	1.10162

Defect Wastes (Category2)

Statistics

		Receiving of defective input materials from incapable suppliers	Returning of defective products from the market	Receiving of complaints from the customers due to defective products
N	Valid	35	35	35
	Missing	0	0	0
Mean		2.6571	2.3429	2.2286
Std. Deviation		1.05560	.83817	.97274

2) Inventory Wastes (Category1)

Statistics

		Excess inventory of products	Excess inventory of spare parts	Disposition of excess inventory of products
N	Valid	60	60	60
	Missing	0	0	0
Mean		2.4500	2.7500	2.9667
Std. Deviation		1.09583	.91364	1.17843

2) Inventory Wastes (Category 2)

Statistics

		Purchase and hold of excessive input materials due to economy of scale	Holding of excessive products due to poor sales performance	holding of Excessive materials (PPE)
N	Valid	35	35	35
	Missing	0	0	0
Mean		3.1429	2.7714	3.4000
Std. Deviation		.69209	1.11370	.81168

3) Overprocessing wastes (Category1)

Statistics

		Overprocessing of reverse osmosis	Excessive monitoring of CCPs and OPRPs	Excessive frequent inspection of reliable machines
N	Valid	60	60	60
	Missing	0	0	0
Mean		2.1833	2.8333	2.8167
Std. Deviation		.98276	1.06033	1.08130

3) Overprocessing Wastes (Category 2)

Statistics

		Purchase of machines where we can't use their full capacity	Sending of excessive products in a single distribution route	Deployed excessive labour force to do a particular job
N	Valid	35	35	35
	Missing	0	0	0
Mean		3.0571	2.7714	2.5143
Std. Deviation		.90563	1.05957	.91944

4) Transportation Wastes (Category1)

Statistics

		Unnecessary transportation of finished products	Unnecessary transportation of people	Unnecessary transportation of broken distribution vans
N	Valid	60	60	60
	Missing	0	0	0
Mean		2.1667	2.7833	2.8500
Std. Deviation		1.09183	1.19450	.70890

4) Transportation Wastes (Category 2)

Statistics

		Unnecessary transportation of input materials due to over purchasing of input materials	Unnecessarily transporting of finished products due to inappropriate factory layout	During new employees' recruitment, proximity of candidates residential house were not considered as a result the company transport people from remote locations
N	Valid	35	35	35
	Missing	0	0	0
Mean		2.9429	2.7714	3.1429
Std. Deviation		.76477	1.11370	1.14128

5) Motion Wastes (Category1)

Statistics

		Physical fatigue due to excessive motion caused by poor ergonomics	Excessive motion due to shared resources	Time lost for searching of maintenance tools
N	Valid	60	60	60
	Missing	0	0	0
Mean		2.6833	2.1500	2.4167
Std. Deviation		1.29525	1.02221	.97931

5) Motion Wastes (Category 2

Statistics

		Irretrievability of products from storage created unnecessary motion in search of such products	Excessive motions as employees facilities and workstation are at distant locations	Irregular file coding has created excessive motion for searching
N	Valid	35	35	35
	Missing	0	0	0
Mean		3.1714	3.7143	3.2571
Std. Deviation		1.01419	.95706	1.22097

6) Waiting Wastes (Category1)

Statistics

		Waiting due to delayed supply of input materials	Waiting to stop production for preventive maintenance	Waiting until faulty equipment is fixed
N	Valid	60	60	60
	Missing	0	0	0
Mean		2.1000	2.6167	2.2667
Std. Deviation		1.08456	1.04300	1.05552

6) Waiting Wastes (Category 2)

Statistics

		Customers waited excessively due to manual loading of products	Waited longer to get decisions on opening of new distributor channels	Purchase of machines where we can't use their full capacity
N	Valid	35	35	35
	Missing	0	0	0
Mean		2.7143	2.9429	3.0571
Std. Deviation		1.25021	.87255	.90563

7) Overproduction Wastes (Category1)

Statistics

		Overproduction due to inaccurate market forecasting	Overproduction due to unreliable production machines	Excessively produced fabricated or modified parts
N	Valid	60	60	60
	Missing	0	0	0
Mean		2.7667	3.3500	3.4333
Std. Deviation		1.07934	1.14721	.94540

7) Overproduction Wastes (Category 2)

Statistics

		Purchase of machines where we can't use their full capacity	Sending of excessive products in a single distribution route	Deployed excessive labour force to do a particular job
N	Valid	35	35	35
	Missing	0	0	0
Mean		3.0571	2.7714	2.5143
Std. Deviation		.90563	1.05957	.91944

8) Wastes of Untapped Human Potential (Category1)

Statistics

		Untapped human potential due to failure to participate people	Untapped human potential due to failure to improve people motivation	Untapped human potential due to attrition of skilled workers
N	Valid	60	60	60
	Missing	0	0	0
Mean		1.9667	1.9833	2.2500
Std. Deviation		1.00788	.96536	.79458

8) Wastes of Untapped Human Potential (Category 2)

Statistics

		Untapped human potential due to failure to participate people	Untapped human potential due to failure to improve people motivation	Untapped human potential due to attrition of skilled workers
N	Valid	35	35	35
	Missing	0	0	0
Mean		2.4571	2.4571	2.2286
Std. Deviation		1.03875	1.14642	1.11370

Appendix 2: Mean and Standard Deviations on the Impact of the Eight Manufacturing Wastes on Operational Performance (Category 1 and Category 2)

1) Quality as Operational Performance Indicator (Category 1)

Statistics

		Eight manufacturing wastes impacting on producing defective products	Due to the eight manufacturing wastes our company is perceived us low quality performer	Due to the eight manufacturing wastes our products are not user friendly
N	Valid	60	60	60
	Missing	0	0	0
Mean		2.1333	2.7667	2.1667
Std. Deviation		.92913	1.18417	1.06033

1) Quality as Operational Performance Indicator (Category 2)

Statistics

		The eight manufacturing wastes negatively impacting on receiving of defective inputs	Due to the eight manufacturing wastes our company is perceived as low quality performer	The eight manufacturing wastes have become the causes for customers' complaints
N	Valid	35	35	35
	Missing	0	0	0
Mean		2.2571	2.8857	2.2571
Std. Deviation		.78000	1.05081	.78000

2) Delivery Time as Operational Performance Indicator (Category 1)

Statistics

		Due to the eight manufacturing wastes we failed to deliver on-time	Due to the eight manufacturing wastes we failed to improve productivity	Due to the eight manufacturing wastes we are seen by the customers as Incapable to walk the talk
N	Valid	60	60	60
	Missing	0	0	0
Mean		2.5833	2.1000	3.1000
Std. Deviation		.99646	.83767	1.11538

1) Delivery Time as Operational Performance Indicator (Category 2)

Statistics

		Due to the eight manufacturing wastes we failed to deliver on-time	Due to the eight manufacturing wastes we failed to improve productivity	Due to the eight manufacturing wastes we are seen by the customers as "Incapable to walk the talk"
N	Valid	35	35	35
	Missing	0	0	0
Mean		2.6286	2.4000	3.2000
Std. Deviation		1.28534	.84714	1.15809

3) Cost as Operational Performance Indicator (Category 1)

Statistics

		The eight manufacturing wastes have increased manufacturing or service delivery costs	The eight manufacturing wastes have negatively impacted on our ability to compete with price	The eight manufacturing wastes have increased the amount of monitoring and inspection on our products and processes.
N	Valid	60	60	60
	Missing	0	0	0
Mean		1.9167	2.4833	2.4500
Std. Deviation		.82937	.92958	1.03211

3) Cost as Operational Performance Indicator (Category 2)

Statistics

		The eight manufacturing wastes have increased service delivery costs	The eight manufacturing wastes have negatively impacted on our ability to compete with price	The eight manufacturing wastes have increased the amount of monitoring and inspection on our processes
N	Valid	35	35	35
	Missing	0	0	0
Mean		2.5143	2.4571	2.3429
Std. Deviation		.95090	1.12047	.72529

Appendix 3: Lessons Learned from the Literatures Reviewed

Author	Lessons Learned
Nawanir G. (2016)	Lean manufacturing practices must be implemented holistically. Piecemeal adoption is not preferable. The recommendation is in agreement with Deming (1986) to view the organization processes as interrelated and interdependent components of a system. Because processes are interrelated, it is only through improving all interacting elements that the operational and business performances can be improved. The holistic implementation of lean manufacturing improves all the measures of operations performance. Unlike financial performance measures, operational measures usually used perceptual source of data rather than archival source since there is no such public database which enclose data regarding cost, quality and manufacturing time of every manufacturing firm due to confidential issues.
Nordin N. et al. (2016)	Similar to Nawanir G. (2016) research findings, Nordin N. et al. (2016) have stated that unlike financial performance measures, operational measures usually used perceptual source_of data rather than archival source since there is no such public database which enclose data regarding cost, quality and manufacturing time of every manufacturing firm due to confidential issues.
Rasi R. et al. (2015)	To ensure the accuracy of data collected, respondents were selected based on their understanding of the concepts of lean manufacturing and their active involvement in the implementation processes, such as, • Manager, • Head of director, and • Other middle and top management positions in production who were familiar with lean manufacturing activities and performance, such as, senior manufacturing engineer and lean manufacturing implementer.
Rahman S. et al. (2010)	The participants of the survey holds middle and senior management positions. This approach is in agreement with the method used by Rasi R. et. al. (2015), which provides the opportunity to generate valid results.
Sharma V. et al. (2015)	Balanced Score card (BSC) was employed to measure the operational and business performances of organizations researched. Therefore, the impact of lean system was measured against KPIs derived from BSC model.
Suketu Y. et al. (2016)	The researchers have incorporated leadership performance dimension into a performance measurement system, such as, management commitment and communications, change in management and organisation culture, willingness to learn skill and expertise, employee involvement and trust,

	supplier relationship and integration of networks, human resource management, performance monitoring, customer involvement, strategy, mission, vision, and financial capability and budget. These performance measure is a new perspective and could be integrated with the BSC measures.
Pal S. (2019)	According to Pal S. (2019), the goal of empowerment in lean system is based on the idea of showing respect for people. Respect for people extends beyond just the end customer and can include the workers, suppliers, and society. For the end customer, lean strives to maximize value delivery while minimizing waste in the process. Lean aims to maximize human potential by empowering workers to continuously improve their work. Lean leaders facilitate this goal through problem-solving training. They help workers grow professionally and personally, allowing them to take pride in their work.
Chahal V. et. al. (2017)	According to Chahal V. et al. (2017) in order to eliminate/reduce wastes it is very essential to meticulously select appropriate lean tools tailored to the organization's contexts, followed by effective and efficient implementation.
Leksic et al. (2020)	The researchers have identified sources of wastes before lean implementation and researched for effectiveness after lean implementation.
Uz-Zaman (2013)	• The implementation of inappropriate lean strategy for a given situation can sometimes lead to an increase in waste, cost and production time of a manufacturer". In fact, W. Edwards Deming (1986) called such wrong practices on a system as "Tampering". • 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". This assertion is in line with the concept that, though they are engaged in the same business and located on the other sides of the road, organizations situations are quite different, in many cases such companies differ in their internal contexts, such as, the machines they have, the methods they employed, the suppliers they use, the leadership style, the competence of their people, etc.
Wahab et al. (2013)	The model presented by Wahab et al. (2013) provides the opportunities to look at lean wastes in a holistic approach, including establishing a cause and effect relationship, such as, poor raw material becomes the sources of defects and defective products delays delivery until the issue is resolved with the customer and this in turn deteriorates people motivation which is

	in line with principle 12, "Remove barriers that robe people of pride of workmanship", Deming (1986).
Okpala, C.C. (2014)	To identify and subsequently eliminate wastes, it is pertinent to have a complete understanding of waste and where it exists. Although products and services significantly differ between companies, the distinctive wastes inherent in manufacturing processes are quite similar.
Alefari M. et al. (2017	"Top management" factor is key in almost all studies, regardless of whether the study was focused on small and medium enterprises (SMEs) or big organizations, or whether the study was focused in specific countries.
Jimenez G. et al. (2019)	Jimenez G. et al. (2019) have developed the following research method which could be adopted in the present research works: • Step 1 was process characterization • Step 2 was identification of waste or MUDA • Step 3 was improvement proposals under lean tools
Pakdil F. et. al. (2014)	The researchers have concluded that multiple assessment tools have been designed to measure different and often individual aspects of lean implementation. While some existing studies measure leanness level through perceptual evaluations, other studies utilise a quantitative assessment approach. Using only one qualitative or quantitative approach in lean assessment efforts may create a bias both in practice and theory. To decrease this possibility, organisations should utilise both perception and measurement approaches simultaneously to assess their lean implementation efforts

Appendix 4: Identified Gaps from the Literatures Reviewed

Author	Identified Gaps
Nawanir G. (2016)	The researcher could have considered the magnitude of the manufacturing wastes and provide quantitative results which could indicate the level of improvements achieved by implementing lean manufacturing.
Nordin N. et al. (2016)	The researcher stated that lean is a paradigm shift which focuses on the elimination of waste and non-value added activities to achieve higher levels of efficiency, profitability and flexibility. However, the researchers seemed to miss the fact that non-value adding wastes are divided into two categories where one cannot eliminate or attempt to eliminate all categories of wastes. The first category is essential but non-value adding wastes, such as, order processing and fee collection, which we can minimize not eliminate them, and the second category is non-essential and non-value adding wastes, such as, defects, overprocessing and excess inventory, etc., which we should minimize or eliminate from the system of the business.
Rahman S. et al. (2010)	Some of the lean practices proposed by Rahman S. et al. (2010) can't be prescribed for all industry type for the following reasons: • Reducing production lot size can't be applied in a continuous production system, which would increase production costs, such as, heavy metal industries. • Focusing on single supplier can't be applied in a sellers' market situation and in situations where suppliers are unreliable. • Reducing inventory to expose manufacturing, distribution and scheduling problems. This recommendation is difficult to apply in situation where foreign currency is not easily available or available after a long queue. Organizations prefer to purchase big volume of products. Otherwise, companies will become out of stock and remains to be idle. That is why they prefer to own a buffer (excess) inventory to minimize the risk of being out of stock (out of business). • Using new process equipment is not always feasible for the sake of implementing lean tools. Instead, it is appropriate to ensure the capacity and capability of equipment through preventive maintenance and implementation of the concept of Muri. • The recommendation to eliminate all wastes is not feasible as some wastes are necessary but non-value adding, however, they

	are important to complete the jobs. Therefore, we should strive to minimize them not to eliminate. • Rahman S. et al. (2010) used overall customer satisfaction as a criteria to measure operational performance measure, where customer satisfaction is a criteria for measuring business performance not operational performance measure which is contrary to Nawanir G. (2016).
Uz-Zaman A. (2013)	The weaknesses of this research was that it was limited to assembly line. It was not covering the full scale and the interacting elements to the assembly process, such as, materials supply, inspection, maintenance, the human resource management, transportation, handling and storage, etc. The information derived from such studies couldn't be used as an input to generalize and recommend for other industries, in similar or different sectors.
Mani M. and Gill P. (2019)	Mani M. and Gill P. (2019) had developed a questionnaire to collect data to find out the major waste in Indian automobile industry. In the questionnaires the eight lean wastes were listed and respondents were asked to arrange them in order of major wastage of productivity in their firm. However, the magnitude (the significance) of each waste was not studied where ranking in this regard gives little sense. What if the impact of the eight wastes was low and the researchers were ranking the insignificant wastes?

Appendix 5: Measurement Scales for Severity of Risk (Source: Peters S. et.al, (2002), "The Six Sigma Way, Team Field Book")

Rating Scale	**Consequence**
	Effects if it happens
5	Illness to customer or employee. Be illegal. Huge loss of input materials/products
4	Makes product or service unfit for use. Significant loss of input materials/products Cause extreme customer/employees dissatisfaction. Major impact on productivity Major loss of revenue
3	Cause a major performance loss to products. Medium loss of input materials/products Cause a loss of performance that is likely to result in a complaint by the customer Causes employees dissatisfaction Medium impact on productivity Medium loss of revenue
2	Cause a minor performance loss. Minimum loss input materials/products Cause a minor nuisance to customers/employees Low impact on productivity Minor loss of revenue
1	Be unnoticed and have only minor effect on performance. No loss of input materials/products Be unnoticed and not affect performance. No impact on productivity No loss on revenue

Appendix 6: Likelihood of Occurrence (Source: Peters S. et.al, (2002), "The Six Sigma Way, Team Field Book")

Likelihood of Occurrence		
Rating Scale	**Likelihood of Occurrence**	**Time Period**
5	Frequent	More than once or more per day
4	Probable	Once or more per week
3	Occasional	Once or more 2 weeks to a month
2	Moderate	Once or more 2 months to a year
1	Unlikely	Has not occurred in the last two years and beyond

Appendix 7: Overall Risk Rating (Source: ANSI / ASSE Z690.3-2011, Risk Assessment Technique)

Risk Score	Risk Rating	Likely Response
1-4	Low	• No immediate response required. • Risk ownership may not be allocated. • Could be excluded from risk monitoring activities. • An infrequent re-evaluation of risk.
5-10	Medium	• Regular monitoring and re-evaluation of potential risk and any factors that may increase consequence or likelihood occurrence. • Allocate accountability for responding to risk to individual responsible for overseeing risk treatment/s as resources/ circumstances permit.
11-19	High	• Develop risk response strategies as part of risk management and operational processes. • On-going monitoring of risk and progress of risk response or treatment plans. • Allocate accountability for responding to risk to individual responsible for overseeing risk treatment/s.
20-25	Extreme	• The immediate escalation of risk to senior management/ executive for prioritized response and treatment plan development. • Incorporate management of risk into established strategic governance and operational processes. • Allocate accountability for responding to risk to individual responsible for overseeing risk treatment/s.

Appendix 8: Risk Matrix (Source: ANSI /ASSE Z690.3-2011, Risk Assessment Technique)

		Severity				
		Negligible (1)	**Low (2)**	**Medium (3)**	**High (4)**	**Extreme (5)**
Likelihood	**Frequent (5)**	5	10	15	20	25
	Probable (4)	4	8	12	16	20
	Occasional (3)	3	6	9	12	15
	Moderate (2)	2	4	6	8	10
	Unlikely (1)	1	2	3	4	5

Appendix 9: Prioritized category of wastes based on their magnitude of occurrence and impact on operational performances

Waste Category	**Survey Results Response Rate**		**Results of FGD (Sources /root causes of defects)**	**Archival Data Analysis**	**Priority Level for planning of actions**
	Category1	**Category2**			
1) Defect Wastes	81.7%	65.5%	• Fix it when it is broken. • Lack of skill • Poor process monitoring • Defective packaging	• 4% defect • Process sigma level:3.25	1
2) Inventory Wastes	60%	42.9%	• Poor sales performance • Poor sales forecasting	• Data was available	3
3) Overprocessing Wastes	65%	42.9%	• Misconceptions on product quality	• 30 % water loss	1
4) Transportation Wastes	80%	48.6%	• Poor factory layout	• Forklifts travelled 7604 km/year • Vehicles travelled 13,056 km/year	1
5) Motion Wastes	78.3%	34.3%	• Poor Factory layout • Poor machines setup	Data Was not available	2
6) Waiting Wastes	80%	66.7%	• Increased corrective maintenance due to absence of preventive maintenance • Poorly established supply chain • Poor quality of materials halts	• Machine downtime 3,172.1 hours /year • Idle time was hours 2,495.2 hours per year	2
7) Overproduction Wastes	43.3%	60%	• Poor understanding of the consequences of overproduction. • Push production system. • Poor forecasting (creating false demand).	Data Was not available	3
8) Wastes of Untapped Human Potential	81.7%	71.4%	• Use of inappropriate input materials	Data Was not accessible	2

Appendix 10: Survey Questionnaire

Manufacturing and Service Delivery Wastes Assessment Questionnaire
በማምረትና በአገልግሎት አሰጣጥ ሂደት በሚከሰቱ ብክነቶች ላይ የሚካሄድ ጥናት መጠይቅ

<u>PART ONE፡ General Information / ክፍል አንድ፡-አጠቃላይ መረጃ</u>

Please put an “X” mark in the boxes provided. / እባክዎ በሳጥኑ ውስጥ የ“X” ምልክት በማስቀመጥ አጠቃላይ መረጃ ይስጡ።

Gender /ጾታ Male/ወንድ ☐ Female/ሴት ☐

Education/የትምህርት ደረጃ ፡- Diploma, 10+3, Level 4 /ዲፕሎማ፣ 10+3፣ ደረጃ 4 ☐

Degree and above /ዲግሪና ከዚያ በላይ ☐

Years of Work Experience፡- 0-5 ☐ 6 –10 ☐ 0 -15 ☐ above 15 / ከ15 በላይ ☐
የሥራ ልምድ

Date of this form was filled / ቅጹ የተሞላበት ቀን ________________________
Date of returning of the filled form፡ <u>within 3 days</u> / ይህ ቅጽ ተሞልቶ ተመላሽ የሚሆንበት ቀን፡- <u>በ3 ቀን ወስጥ</u>

<u>PART TWO:</u> Extent of Occurrence of the Eight Manufacturing Wastes (Contains twenty four Questionnaires)
<u>ክፍል ሁለት፡-</u> ስምንቱ የብክነት አይነቶች የመከሰት ሁኔታ (ሃያ አራት መጠይቆች አሉት)

<u>Instruction /መግለጫ</u>

Please provide your perception on the manufacturing wastes listed in the Table below by putting an “X” sign on the space provided. Your accurate response will help to identify opportunities to minimize and/or prevent the manufacturing wastes. Please also fill the QUESTIONNAIRE in a calm situation and thoughtful state of mind, not in hectic situations. No need to write your name on this Questionnaire.

እባክዎ ከዚህ በታች በሰንጠረዡ ላይ በተገለጹት ብክነቶች ላይ ያለዎትን ግንዛቤ በተሰጠው ክፍት ቦታ ላይ X” ምልክት በማስቀመጥ ይግለጹ:: የሚሰጡት ትክክለኛ መልስ ብክነቶችን ለመቀነስ ወይም/እና ለመከላከል የሚያስችሉ መልካም እድሎችን ለመለየት ያስችላል:: በተጨማሪም እባክዎ መጠይቁን በተዋከበ ሳይሆን በተረጋጋና በጥሞና ለመሙላት በሚያስችል ከባቢያዊ ሁኔታ ያከናውኑ::

በዚህ መጠይቅ ላይ ስም መጻፍ አስፈላጊ አይደለም::

Statement / ዓረፍተ ሃሳብ	Rating Scales/ መመዘኛ ደረጃዎች				
	Strongly agree / በእጅጉ እስማማለሁ (1)	Agree / እስማማለሁ (2)	Undecided / መልስ መስጠት ይቸግረኛል (3)	Disagree / አልስማማም (4)	Strongly disagree / በእጅጉ አልስማማም (5)
A) Defects /እንከኖች					
1) There were incidents that due to defects we rejected semi-processed or finished products. **በእንከን (የጥራት መስፈርት ባለማሟላታቸው) ምክንያት በማምረት ሂደት ላይ የነበሩ ወይም የተጠናቀቁ ምርቶችን ያስወግድንባቸው አጋጣሚዎች ነበሩ።**					
2) There were incidents that we reprocessed products returned from the market due to defects. **በእንከን ምክንያት ከገበያ የተመለሱ ምርቶችን እንደገና ያዘጋጀንባቸው አጋጣሚዎች ነበሩ።**					
3) Based on test/inspection reports, there were occasions where we gave an order to stop the production processes due to occurrence of successive defects on products. **በኢንስፔክሽንና በላቦራቶር ፍተሻ ሪፖርቶች መሰረት በምርቶች ላይ እንከኖች በተደጋጋሚ በመከሰታቸው የማምርት ሂደቶች እንዲቋረጡ ተእዛዝ ያስተላለፍንባቸው አጋጣሚዎች ነበሩ።**					
B) Excessive Inventory/ ከሚፈለገው በላይ ወይም በማያስፈልግ ጊዜ በክምችት የሚያዙ ንብረቶች					
4) In some cases we held excessive inventory of finished products more than needed by the customer. **ደንበኞች ከጠየቁት በላይ ምርቶችን አምርተን በክምችት የያዝንባቸው አጋጣሚዎች ነበሩ።**					
5) Due to changes in technology, there were incidents where we held excessive spare parts and other input materials intended to be used for the maintenance works. **በማምረቻ መሳሪያዎች (ቴክኖሎጂ) ለውጥ ምክንያት ጥቅም ላይ ሊዉሉ የማይችሉ መለዋዎጫዎችንና ሌሎች የጥገና ግብአቶችን በክምችት የያዝንባቸው አጋጣሚዎች ነበሩ።**					
6) In some cases we destroyed or use excessive inventories for internal consumptions as they were exclusively produced according to customer' specification. **ከሚፈለገው በላይ የተመረቱ ምርቶች በደንበኞች መስፈርቶች መሰረት በመዘጋጀታቸው ለሌሎች ደንበኞች መሸጥ ባለመቻላችን ያስወገድንባቸው ወይም ለድርጅታችን ፍጆታ ያዋልንባቸው አጋጣሚዎች ነበሩ።**					

Statement / ዓረፍተ-ሃሳብ	**Rating Scales/ መመዘኛ ደረጃዎች**				
	Strongly agree / በእጅጉ እስማማለሁ (1)	**Agree / እስማማለሁ (2)**	**Undecided / መልስ መስጠት ይቸግረኛል (3)**	**Disagree / አልስማማም (4)**	**Strongly disagree / በእጅጉ አልስማማም (5)**
C) Overprocessing / አባካኝ በሆነ መልኩ ከሚያስፈልገው በላይ መፈጸም					
7) We are overprocessing the reverse osmosis process to reach TDS limit 50mg/l or less, however, the Compulsory Ethiopian Standard CES 99:2019 specified TDS to be maximum 1000 mg/l and other international standards, such as, International Bottled Water Association and FDA specified TDS to be maximum 500 mg/l. የታሸገ ውሃ የቲ·ዲ·ኤስ· (TDS) ይዞታ 50 ሚ·ግ·/ሊ ለማድረስ ሲባል የሪቨርስ ኦስሞሲስ ንኡስ የስራ ሂደትን ከሚገባው በላይ እናከናውናለን። ይሁንና አስገዳጁ የኢትዮጵያ ደረጃ CES 99:2019 ቲ·ዲ·ኤስ· ቢበዛ 1000 ሚ·ግ·/ሊ፣ እንዲሁም አለምአቀፍ የታሸገ ውሃ አምራቾች ማህበርና የአሜርካ የምግብና መድሃኒት ተቆጣጣሪ ኤጀንሲ 500 ሚ·ግ·/ሊ እንዲሆን ወስነዋል።					
8) We do excessive monitoring on some CCPs and OPRPs every 20 minutes, where they have never been found outside of the limit for the last 3 years. Such monitoring programs could have been extended to every one hour or two depending on the risks they involved. ላለፉት ሶስት አመታት ምንም አይነት መስፈርት አለማሟላት አጋጣሚ ባልታየባቸው ወሳኝ የምርት ደህንነት መቆጣጣጠሪያ እርከኖች ላይ (CCPs and OPRPs) አባካኝ በሆነ መልኩ በየ 20 ደቂቃው ክትትልና ቁጥጥር እናደርጋለን። ክትትልና ቁጥጥሩን በአንድ ወይም በሁለት ሰአት ልዩነት ማካሄድ ይቻል ነበር።					
9) On some reliable production machines, we have been unnecessarily doing daily or weekly inspection where they have not changed status in one year or more which could have been extended to quarterly or biannual depending upon the criticality of that piece of machine. ላለፈው አንድ አመት ወይም ከዚያ በላይ ምንም አይነት ጉድለት ባልተከሰተባቸው አስተማማኝ መሳሪዎች ላይ አላስፈላጊ ሳምንትዊ ወይም ወርሃዊ የኢንስፔክሽን ተግባራት ይካሄድባቸዋል። በእንደነዚህ አይነት አስተማማኝ መሳሪያዎች ላይ በየሩብ አመቱ ወይም በመንፈቅ አንድ ጊዜ የእንስፔክሽን ተግባራት ሊካሄዱ ይችሉ ነበር።					

Statement / ዓረፍተ-ሃሳብ	Rating Scales/መመዘኛ ደረጃዎች				
	Strongly agree / በእጅጉ እስማማለሁ (1)	Agree / እስማማለሁ (2)	Undecided / መልስ መስጠት ይቸግረኛል (3)	Disagree / አልስማማም (4)	Strongly disagree / በእጅጉ አልስማማም (5)
D) Unnecessary Transportation /ያለአግባብ ንብረቶችን ከቦታ ቦታ ማጓጓዝ					
10) Due to poor factory layout, considerable amount of resources have been lost during unnecessary transportation of finished products from place to place. **በድርጅቱ የስራ ክፍሎች አደረጃጀት ጉድለት ምክንያት ያለአግባብ ምርቶችን ከቦታ ቦታ በማጓጓዝ ሂደት የድርጅቱ ጊዜና ንብረት እየባከነ ይገኛል።**					
11) There were incidents where we transported senior mechanics, chemists and other experts from their homes when there were manufacturing problems during the night shifts. The senior mechanics and chemists could have been assigned at the night shifts on permanent basis. **በማታው ፈረቃ በማመረት ሂደት ላይ ችግሮች ሲፈጠሩ ሲኒየር መካኒኮችን፣ ኬሚስቶችንና ሌሎች ባለሙያዎችን በርቀት ከሚገኘው ቤታቸው የምናጓጉዝባቸው አጋጣሚዎች ነበሩ። ሲኒየር መካኒኮችንና ኬሚስቶችን በቋሚነት በማታው ፈረቃ መመደብ ይቻል ነበር።**					
12) We unnecessarily transported broken distribution vans back to our facility for maintenance works where it could have been done in a nearby outsourced garage. **በአቅራቢያ በሚገኝ ጋራዥ ማሰራት ሲቻል የተበላሹ የምርት ስርጭት መኪኖችን ወደ ድርጅቱ አጓጉዘናል።**					
E) Unnecessary Motion / አላስፈላጊ የሆኑ ከቦታ ቦታ የሚደረጉ የስራ እንቅስቃሴዎች					
13) We encountered physical fatigue due to excessive motion resulted from poor management of ergonomics, such as, failure to keep work closer to the body, bending, twisting, prolonged posture, excessive reaches (excessive stretching), lifting excessive heavy weights, etc. **የስራ ማከናወኛ መሳሪዎችና የሰራተኞች ቁመና የተጣጣመ አለመሆን እንዲሁም ስራዎችና የሰዎች ጉልበት ተመጣጣኝ ባለመሆኑ ስራ ለማከናወን የሚያደርጉት አላስፈላጊ እንቅስቃሴ አካላዊ ድካምን በቀላሉ በማስከተል ላይ ይገኛሉ። ለምሳሌ፣ የሚከናወኑ ስራዎች ለሰውነት የቀረቡ አለመሆን፣ አጎምብሶ ለረጅም ጊዜ ስራን ማከናወን፣ ስራን ከልክ በላይ ተንጠራርቶ ማከናወን፣ ስራን ወደ ቀኝና ወደ ግራ እየተጠማዘዙ ማከናወን፣ ከአቅም በላይ የሆኑ እቃዎችን ማንሳት፣ መሸከምና ማጓጓዝ።**					

Statement / ዓረፍተ-ሃሳብ	Rating Scales/መመዘኛ ደረጃዎች				
	Strongly agree / በእጅጉ እስማማለሁ (1)	Agree / እስማማለሁ (2)	Undecided / መልስ መስጠት ይቸግረኛል (3)	Disagree / አልስማማም (4)	Strongly disagree / በእጅጉ አልስማማም (5)
14) A considerable amount of time is lost by travelling here and there due to shared resources, such as, maintenance tools, computers, printers, photocopiers, telephone line, etc. **በጋራ የምንገለገልባቸውን ለምሳሌ እንደ የጥገና የእጅ መሳሪያዎች፣ ኮምፒዩተር፣ ፕሪንተር፣ ፎቶኮፒ ማሽን፣ የመሳሰሉትን ለመጠቀም የምናደርገው ከልክ ያለፈ ከቦታ ቦታ ምልልስ የድርጅቱን የስራ ሰአት እያባከነ ይገኛል።**					
15) Due to lack of maintenance tools handling system, we experienced spending quite a lot of time by searching here and there due to irretrievability. **የጥገና መሳሪያዎች አቀማመጥ በስርዓት ባለመደራጀቱ ምክንያት ለስራ ሲፈለጉ በቀላሉ ማግኘት ስለማይቻል በፍለጋ ብዙ ጊዜ የሚባክንባቸው አጋጣሚዎች ነበሩ።**					
F) EXCESSIVE WAITING / ስራ ፈቶ መጠበቅ					
16) There were incidents of excessive waiting due to delayed supply of inputs, such as, process chemicals and packaging materials. **የግብአቶች አቅርቦት ማለትም ኬሚካሎችና ማሸጊያዎች በመዘግየታቸው ምክንያት የማምረት ሂደት ለተራዘመ ጊዜ የተቋረጠባቸው አጋጣሚዎች ነበሩ።**					
17) In some cases we waited for longer time for preventive maintenance works until we got instructions/decisions from authorized persons to stop the production process. **በእቅድ መሰረት በማምረቻ መሳሪያዎች ላይ የመከላከያ ጥገናዎችን ማካሄድ እንዲቻል መሳሪዎቹ የማምረት ሂደት እንዲያቋርጡ ለምናቀርባቸው ጥያቄዎች ስልጣን ከተሰጣቸው አካሎች ውሳኔ እስኪሰጥ ድረስ ስራ ፈተን የምንጠብቅባቸው አጋጣሚዎች ነበሩ።**					
18) There were incidents where considerable amount of time was lost until faulty equipment were fixed. **ተበላሽተው ስራ ያቋረጡ መሳሪያዎች እስኪጠገኑ ድረስ ስራ ፈተን የጠበቅንባቸው አጋጣሚዎች ነበሩ።**					

Statement / ዓረፍተ-ሃሳብ	Rating Scales/መመዘኛ ደረጃዎች				
	Strongly agree / በእጅጉ እስማማለሁ (1)	Agree / እስማማለሁ (2)	Undecided / መልስ መስጠት ይቸግረኛል (3)	Disagree / አልስማማም (4)	Strongly disagree / በእጅጉ አልስማማም (5)
G) Overproduction / ከሚፈለገው በላይ ማምረት ወይም ውጤት ማዘጋጀት					
19) We experienced overproduction due to inaccurate market forecasting. በተሳሳተ የገበያ ትንበያ ምክንያት ከሚፈለገው በላይ የምርት መጠን ያመረትንባቸው አጋጣሚዎች ነበሩ።					
20) We experienced overproduction for in case due to unreliable processing machines. በብቃት ማነስ እምነት በማይጣልባቸው የማምረቻ መሳሪዎች ምክንያት ተበላሽቶ የሚመረትና የሚወገድ ምርት ሊኖር ይችላል በሚል ስጋት (ማሚያ የሚሆን) ከሚፈለገው መጠን በላይ ምርት ያመረትንባቸው አጋጣሚዎች ነበሩ።					
21) There were occasions where we produced modified and fabricated parts in our workshop more than required. በድርጅታችን ወርክሾፕ ከሚያስፈልጉን በላይ መለዋወጫዎችን ያመረትንባቸው አጋጣሚዎች ነበሩ።					
H) Untapped Human Potential / የሰራተኞችን እምቅ አቅምና ችሎታ አለመጠቀም					
22) The organization is not able to exploit the human potential in achieving its objectives due to failure to participate its people in its strategic undertakings. ድርጅቱ ሰራተኞችን በስትራቴጂዊ ጉዳዮች ላይ ባለማሳተፉ ምክንያት እምቅ አቅማቸውን ለድርጅቱ አላማ ስኬት ማዋል አልቻለም።					
23) The organization is unable to exploit the human potential due to failure to improve motivation of people. ድርጅቱ የሰራተኞችን የስራ ተነሳሽነት ባለማሳደጉ ምክንያት እምቅ አቅምና ችሎታቸውን ለድርጅቱ አላማ ስኬት ማዋል አልቻለም።					
24) The organization is not able to exploit the human potential due to continuous resignation of experienced workers. ልምድ ያካበቱ ሰራተኞ በየጊዜው ስራ በመልቀቃቸው ምክንያት እምቅ አቅማቸውን ለድርጅቱ አላማ ስኬት ማዋል አልቻለም።					

PART THREE: The Impact of the Eight Manufacturing wastes on Operational Performance (Contains Nine Questionnaires)

ክፍል ሶስት፦ ስምንቱ የብክነት አይነቶች በአፈጻጸም ላይ የሚያሳድሩት ተጽእኖ (ዘጠኝ መጠይቆች አሉት)

Instruction/መግለጫ

To respond to the nine questionnaires indicated below, please consider the eight manufacturing wastes listed under this instruction and then link to your Company existing situations. Please put an "X" sign on the space provided .

እባክዎ ከዚህ በታች የተገለጹትን ስምንቱን የብክነት አይነቶች እንደገና ያስተውሉ፣ ከዚያም ከድርጅቱ ተጨባጭ ሁኔታ ጋር አዛምደው ከዚህ በታች የሚገኙትን ዘጠኙን መጠይቆች በትክክል ይሙሉ። እባክዎ ሃሳብዎን በተሰጠው ክፍት ቦታ ላይ የ"X" ምልክት በማስቀመጥ ይግለጹ።

The Eight Manufacturing Wastes /ስምንቱ በአሰራር ሂደት ላይ ሊከሰቱ የሚችሉ የብክነት አይነቶች

1) **Wastes of defects & reprocessing. / የተከሰቱ እንከኖችና እንከኖችን ለማረም እየተከናወኑ የሚገኙ ተግባራት እያስከተሉ የሚገኙት ብክነት።**
2) **Wastes of excess inventory. / ከሚፈለገው በላይ ወይም በማያስፈልግ ጊዜ የተከማቸ ንብረት እያስከተለ የሚገኘው ብክነት።**
3) **Wastes of overprocessing. / ከሚፈለገው በላይ በመፈጸም ወይም እሴት የማይጨምሩ ተግባራትን በማከናወን እየተከሰተ የሚገኘው ብክነት።**
4) **Wastes of excess transportation. / በደካማ የሥራ ቦታ አደረጃጀት ምክንያት እቃዎችን ከቦታ ቦታ ማጓጓዝ እያስከተለ የሚገኘው ብክነት።**
5) **Wastes of excessive motion. / በስራ አፈጻጸም ሂደት የሚደረጉ አላስፈላጊ ከቦታ ቦታ እንቅስቃሴዎች እያስከተሉ የሚገኙት ብክነት።**
6) **Wastes of excessive waiting. / ስራ ፈቶ መጠበቅ እያስከተለ የሚገኘው ብክነት።**
7) **Wastes of overproduction. / ከሚፈለገው በላይ ማምረት/ውጤት ማዘጋጀት እያስከተለ የሚገኘው ብክነት።**
8) **Waste of untapped human potential. / የሰራተኞችን እምቅ አቅምና ብቃት አለመጠቀም እያስከተለ የሚገኘው ብክነት።**

Statement / ዓረፍተ-ሃሳብ	**Rating Scales/መመዘኛ ደረጃዎች**				
	Strongly agree / በእጅጉ እስማማለሁ (1)	**Agree / እስማማለሁ (2)**	**Undecided / መልስ መስጠት ይቸግረኛል (3)**	**Disagree / አልስማማም (4)**	**Strongly disagree / በእጅጉ አልስማማም (5)**
A) Quality / ጥራት					
25) Individually or in combination, the eight manufacturing wastes have been impacting on generating non-conforming outputs. **በአመራረት ሂደት የሚከሰቱ ስምንቱ የብክነት አይነቶች በተናጠል ወይም በጥምረት የጥራት መስፈርቶችን የማያሟሉ ውጤቶች እንዲከሰቱ ተጽእኖ እያሳደሩ ይገኛሉ።**					

Statement / ዓረፍተ-ሃሳብ	Rating Scales/መመዘኛ ደረጃዎች				
	Strongly agree / በእጅጉ እስማማለሁ (1)	**Agree / እስማማለሁ (2)**	**Undecided / መልስ መስጠት ይቸገረኛል (3)**	**Disagree / አልስማማም (4)**	**Strongly disagree / በእጅጉ አልስማማም (5)**
26) Because of the eight manufacturing wastes, the customers have perceived our company as low quality performer. **በአመራረት ሂደት የሚከሰቱ ስምንቱ የብክነት አይነቶች በድርጅታችን ላይ በፈጠሩት አሉታዊ ተጽእኖ ምክንያት ድርጅታችን በደንበኞች ዘንድ ዝቅተኛ ጥራት አከናዋኝ መስሎ እንዲታይ አድረገዋል።**					
27) Individually or in combination, the eight manufacturing wastes have been impacting on our products not to be user friendly, such as, not easy to open. **በአመራረት ሂደት የሚከሰቱ ስምንቱ የብክነት አይነቶች በተናጠል ወይም በጥምረት ምርቶቻችን ለአጠቃቀም ምቹ እንዳይሆኑ አድርገዋል። ለምሳሌ ክዳን በቀላሉ መክፈት አለመቻል።**					
B) Delivery Time / የማቅረቢያ ጊዜ					
28) Individually or in combination, the eight manufacturing wastes have been negatively impacting on our ability to deliver results to the customers (internal or external) as per agreed schedules. **በአመራረት ሂደት የሚከሰቱ ስምንቱ የብክነት አይነቶች በተናጠል ወይም በጥምረት ስምምነት በተደረሰባቸው እቅዶች መሰረት ውጤቶችን ለውስጥ ወይም ለውጭ ደንበኞች እንዳናቀርብ ተጽእኖ አድርገዋል።**					
29) Individually or in combination, the eight manufacturing wastes have been negatively impacting on delivery time, consequently we are unable to improve our productivity. **በአመራረት ሂደት የሚከሰቱ ስምንቱ የብክነት አይነቶች በተናጠል ወይም በጥምረት ስራችንን በእቅድ መሰረት እዳናከናውን ተጽእኖ በማድረግ ምርታማነታችንን እንዳናሻሽል አድርገዋል።**					

Statement / ዓረፍተ-ሃሳብ	Rating Scales/መመዘኛ ደረጃዎች				
	Strongly agree / በእጅጉ እስማማለሁ (1)	Agree / እስማማለሁ (2)	Undecided / መልስ መስጠት ይቸግረኛል (3)	Disagree / አልስማማም (4)	Strongly disagree / በእጅጉ አልስማማም (5)
30) Individually or in combination, the eight manufacturing wastes have been negatively contributing and be seen by our customers as "incapable to walk the talk". **በአመራረት ሂደት የሚከሰቱ ስምንቱ የብክነት አይነቶች በተናጠል ወይም በጥምረት የምርት የማቅረቢያ ጊዜ እንዳናሟላና በደንበኞች ዘንድ እንደ እምነት የማይጣልበት ድርጅት እንድንታይ አድርገዋል።**					
C) Cost/ወጪ					
31) Individually or in combination, the eight manufacturing wastes have been impacting on increased manufacturing or service delivery costs. **በአመራረት ሂደት የሚከሰቱ ስምንቱ የብክነት አይነቶች በተናጠል ወይም በጥምረት ለማምረቻ ወይም ለአገልግሎት አሰጣጥ ወጪዎች መጨመር ተጽእኖ አሳድረዋል።**					
32) Individually or in combination, the eight manufacturing wastes have negatively impacting on our ability to compete with price. **በአመራረት ሂደት የሚከሰቱ ስምንቱ የብክነት አይነቶች በተናጠል ወይም በጥምረት ባሳደሩት አሉታዊ ተጽእኖ ምክንያት የማምረቻና የአገልግሎት አሰጣጥ ወጪዎች ከፍተኛ በመሆናቸው በዋጋ የመወዳደር ብቃታችን ላይ ተጽእኖ አሳድረዋል።**					
33) **Because of the negative impacts of the eight manufacturing wastes, costs of monitoring and inspection on production and related processes have increased from time to time.** **በአመራረት ሂደት የሚከሰቱ ስምንቱ የብክነት አይነቶች የፈጠሩት አሉታዊ ተጽእኖ በማመረቻና ተዛማጅ የስራ ሂደቶች ላይ የምንካሂዳቸው የክትትልና ፍተሻ ተግባራት ወጪዎች ከጊዜ ወደ ጊዜ እንዲጨምሩ አድርገዋል።**					