APPLICATION OF LEAN TOOLS IN FOOD MANUFACTURING INDUSTRIES TO IMPROVE PRODUCTIVITY

BY

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ABSTRACT

Lean manufacturing principles and instruments have been widely applied in food manufacturing companies during the recent past. Already a successful management philosophy. Lean tools were applied in food production process of selected product in this research to identify and implement improvements. The focus is to sanitize the equipment and optimize the food production process with 5S and Value Stream Mapping and enhance overall food manufacturing efficiency and have ongoing productivity by eliminating common bottlenecks. With a focus on the product selected, this study will examine current practices, utilize cutting-edge techniques and provide recommendations for improved overall rate of production.

The main tools used in this study were Value Stream Mapping (VSM) and 5S. VSM was used for mapping accessible current state of the manufacturing process, review inefficiencies and plan for the future state. Meanwhile, 5S was used to keep the working space in order, improve efficiency and discipline of operations. The tools were embraced because they have a proven history in Lean Manufacturing and continuous improvement. The process was measured before the enhancements were implemented to establish a baseline. The process was re-measured after VSM and 5S had been implemented, in order to identify the impact of the enhancements.

Results through support of lean tools enhanced productivity by 6.7% and lead time by 5 minutes. Significant benefit was achieved through the application of Value Stream Mapping together with 5S to improve manufacturing industries. Significant improvement in efficiency, organization and overall productivity was unveiled from the outcomes. The findings indicate the need for formal project management and strategic presentation of lean tools in food manufacturing industry. Improvements in the manufacture process of the selected product is a testimony that 5S and VSM could drive process enhancement.

The research provides practical suggestions to manufacturing practitioners who hope to implement the same changes on their own process. The contribution and novelty of this research is in applying and comprehensive examination of Value Stream Mapping (VSM) and 5S framework to prove their combined effect on increasing efficiency, organization and productivity of the production process of the selected product.

DECLARATION

I am familiar with the rules regulating higher qualifications at Durban University of Technology and understand the seriousness with which DUT will deal with violations of ethical practice in my research. Where I have used the work of others this has been correctly referenced in the thesis and again referenced in the bibliography. Any research of a similar nature that has been used in the development of my research project is also referenced. This thesis has not been submitted to any other educational institution for the purpose of a qualification.

All subsidy-earning outputs (artefacts and publications) from postgraduate studies will be in accordance with the Intellectual Property Policy of the Durban University of Technology. Where patents are developed under the supervision of the Durban University of Technology involving institutional expenditure, such patents will be regarded as joint property entitling the Durban University of Technology to its share, subject to the Durban University of Technology's policy on the Management and Commercialisation of Intellectual Property. I understand that I am expected to publish an article based on my research results. I understand that plagiarism is wrong and incurs severe penalties.

I HEREBY DECLARE THAT THE ABOVE FACTS ARE CORRECT.

STUDENT : **Date: 09/05/2025**

Sibusiso Wiseman Nkosi (22288988)

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CO-SUPERVISOR: **Date:** 09/10/2025

Dr M Moso

DEDICATION

This research paper is seriously devoted to my wonderful wife (Eva) and beautiful children (Okuhle and Ozian) whom did not abandon me and provided me with wonderful sense of spirit and persistence in pursuing this venture, and the author's family (Nkosi's) who inspired and encouraged throughout the research phase, provided strength when I wanted to give up. It is also dedicated to the author's supervisors Prof O.A Olanrewaju and Ms M Moso, who supervised the research, and the author's family and friends who helped and supported me. Finally, the author dedicates the paper to God for having given him the strength, wisdom and health to complete the project.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

RESEARCH OUTPUTS

This section presents publication that have been submitted/ accepted/ published

- S.W. Nkosi, M. Moso, and O.A. Olanrewaju, Application of Lean Tools in Food Production Industries to Maximise Productivity: Value Stream Mapping Application. Submitted to SAJIE Journal in 2025. (Undergoing review).

CHAPTER 1 INTRODUCTION

The chapter will introduce the subject of research, the concepts and definitions (including terms) and the problem. The study's objective will be stated as well as its expected contribution to the area of study. The study research questions will be established and the study scope will be determined. This research conceptual framework of the study will be illustrated, its background, structure and approaches will be briefly explained. Research methodology will be briefly explained by citing literature study, research design and data analysis techniques used. It will also include background of lean manufacturing, Objectives, Significance of the Study, Justification of the methodology and Conclusion.

1.1. COMMON LEAN MANUFACTURING APPLICATION

Lean manufacturing implementation has a confirmed beneficial impact whenever the tools are implemented proficiently in different industries and organization were utilized, now observing the history of lean manufacturing at the time it was born, the response of lean manufacturing can be observed in the Toyota firm, which emerged with the evolution of lean production when Japan lost World War II, when the business was trying to develop means of fostering and implementing low-cost improvement in their business since they were competing with the USA automobile sector [1].

When companies started using lean tools, this altered their mind-set towards growth and waste reduction in order to meet customer needs. There are numerous various tools used in lean manufacturing in an attempt to maximize the use of resources, enhance quality, productivity, and efficiency. Figure 1 below displays some of the lean tools manufacturing companies use in a bid to keep on improving: The best tools are 5S, Kaizen, Kanban, TPM, PDCA, and VSM.

Figure 1.1 Common Lean tools utilized in manufacturing industries

Source: [2]

Lean manufacturing application removes wasted motion from all operations of a corporation, with the objective to achieve good quality at low cost and shorter lead times [2]. As lean manufacturing is committed to removing waste from all operations, it stands out and is highly successful in comparison to other methods. Roughly, waste refers to any operation which adds no value to the customer's life and demands [3], and Mr. Taiichi Ohno of Japan, the individual most responsible for the Toyota Production System, has categorized waste into seven categories [4]. Overproduction compared to the plan, Operator and machine idle time, unnecessary transport, unnecessary processing, Raw material and finished goods inventories, a quality defect, and no motion adds value.

Even though we are discussing lean in terms of where it started with the car manufacturing business, this waste can be applied to any company; these wastes can be applied, for example, in a contact center or logistics operation- this concept is not narrow and specific to manufacturing [5]. Lean manufacturing has evolved to a point where its implementation now requires the simultaneous use of a set of tools and processes, and in the event of any disagreement, it is universal agreement that waste is anything or any event which fails to add value to society or customers.

In past years, some writers Shah and Ward, just to name a few of them, created a list of lean practices, which includes the following: "JIT, total quality management, total preventive maintenance, human resource management, pull, flow, low setup, controlled processes, productive maintenance, and engaged employees". The contribution that the lean philosophy can make in food companies must be considered [6]. It may also be used for enterprises of all sizes, including extremely tiny businesses. Goncharuk, Mahalik, and Nambiar believe that applying lean concepts to the food business can enhance the efficiency of manufacturing operations [7].

It can also eliminate unnecessary costs and meet client expectations [8]. Hence, this research would like to focus on productivity enhancement with the assistance of lean principles and tools, benefits of lean, and lean implementation challenges that other researchers have experienced during the conduct of the same type of research. Value Stream Mapping (VSM) has been the most popular lean implementation approach in recent years.

VSM is an improvement of process flow and waste identification process. VSM enables an organization to chart the whole process in the existing state and in a future planned state of the process [9]. With VSM, anything can be produced as a product, and it is simple to learn VSM and implement it. VSM relies greatly on skills of the person performing it. It is founded on an understanding of basic principles, and the plan to create processes that may be integrated if the right knowledge and vision are not able to be envisioned, then there could be lots of challenges and limitations in VSM implementation.

1.2. LEAN TOOL VALUE STREAM MAPPING AND 5S DEFINITION

Value Stream Mapping (VSM) is a lean management technique that can be utilized to map and analyze the current state process map and design a future state for the series of events that change a product or service from raw material and information into a finished product for customers. One advantage of VSM application is that it has the ability to unveil areas of waste in the processes [10]. It does so by identifying it, thus rendering the companies more efficient and effective, in order to further improve their operations and provide good services or products. VSM is established as a successful

lean manufacturing tool in visualizing and streamlining process flow and material through an organization. VSM is a lean management method to analyze and enhance flow of value to the customer, it maps a picture of the entire value stream from raw materials products or services.[10]

All working process steps are visually mapped out by a team using the VSM process. Next, the group needs to examine each step in a way that will determine those items in the process that can be moved, streamlined, or done away with entirely. Teams need to be asking themselves throughout which steps of their design and construction process are value adding and which steps are not value adding and therefore wasteful. VSM begins at the end and comes backwards to determine what actions are most vital to produce the end product, service, or outcome [10]. The steps in constructing a VSM flow diagram are defined using the following symbols.

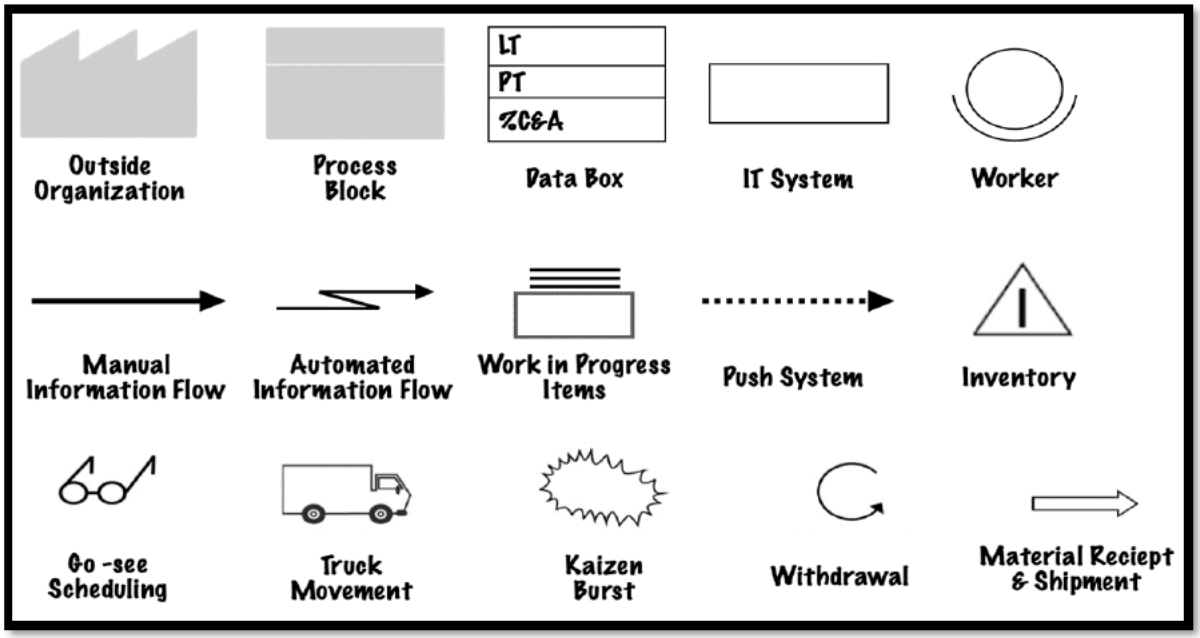


Figure 1.2 The value stream mapping symbols used on processes chat drawing

Source: [10]

1.2.1. VSM SYMBOLS AND DESCRIPTION

The importance of understanding the symbol and when to use each one of them is paramount in designing the VSM processes, this is due to the fact that all of them give its own distinct meaning in the process flow. VSM symbols vary based on regions of

application, but all the symbols used in this type of manufacturing process they fall under these four categories which include process, material, information and general. This symbols might be intricate, but others simply represent their meaning using a layman's term, such as a truck symbol for external shipments and glasses for something to view. Some of the symbols used most frequently with description and the examples on when to employ the symbols in the VSM design process are provided below. The below explains the symbols and will have application examples.

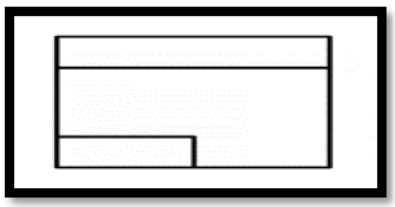


Figure 1.3 Process symbol entity

Source: [10]

Figure 1.3 illustrates how the manufacturing process symbol is used in VSM. For example, procedures such as cutting, stamping, and painting, as well as the little box, reflect an information system employed by the process.

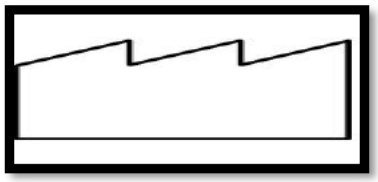


Figure 1.4 External Supplier symbol

Source: [10]

Figure 1.4 is an outside source of material, supplies, or services. The name of the organization should be labelled within the symbol, for example, "XYZ Manufacturing."

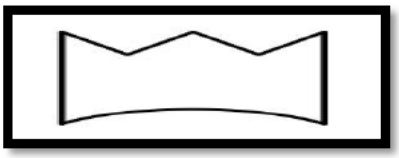


Figure 1.5 Customer symbol

Source: [10]

The point of sale for the plant's production. The name of the organization should be labelled within the symbol, such as Bob's Distribution.

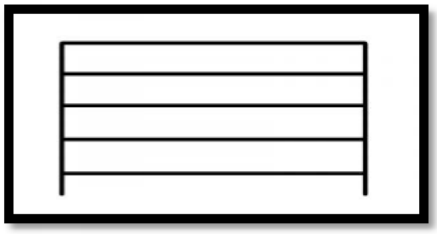


Figure 1.6 Data box symbol

Source: [10]

Figure 1.6 is an Information or data box that detail about a process, department or facility. Example the capturing of lead time, and cycle time in each process

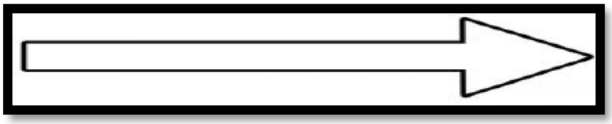


Figure 1.7 Movement of Inventory symbol

Source: [10]

Figure 1.7 depicts an open arrow, indicating the passage of product from one operation to the next.

Figure 1.8 Push Movement symbol

Source: [10]

Figure 1.8 depicts a push movement of commodities originated within the facility rather than being pushed by a client. One example is the flow of a product from one process to another, or the transfer of information from one department to another.

Figure 1.9 Truck shipment symbol

Source: [10]

Figure 1.9 shows a cargo by road or logistics. The symbol above should indicate the frequency of shipments, such as daily activity.

Figure 1.10 Information flow symbol

Source: [10]

Figure 1.10 depicts a basic arrow indicating information flow between processes; for instance, the production control centre connects with every operation.

Figure 1.11 Electronic information flow symbol

Source: [10]

In Figure 1.11, a broken arrow represents the flow of electronic information between processes, such as when the production control centre receives customer orders.

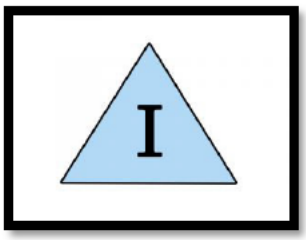


Figure 1.12 Inventory symbol

Source: [10]

A place to store inventory. This typically happens at the beginning and end of the manufacturing process as well as in between processes.

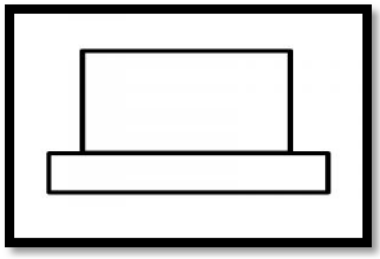


Figure 1.13 Electronic inbox symbol

Source: [10]

The electronic inbox is used to indicate where an electronic order backlog exists.

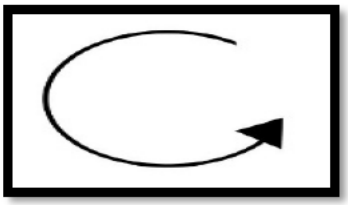


Figure 1.14 Withdrawal symbol

Source: [10]

Used to indicate where a downstream process is pulling from an upstream supermarket.

Figure 1.15 First-in-first-out station symbol

Source: [10]

Used to indicate a “first in, first out” flow of material between processes.

Figure 1.16 Schedule information symbol

Source: [10]

Indicates an information flow or schedule.

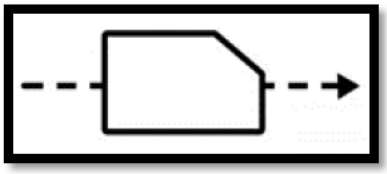


Figure 1.17 Production Kanban symbol

Source: [10]

A kanban card. The card initiates a process to produce a product, and stays with the product from raw material to finished good.

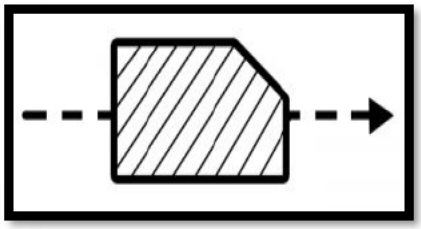


Figure 1.18 Withdrawal Kanban symbol

Source: [10]

A kanban card used for transferring parts from a consuming process.

Figure 1.19 Go-see scheduling symbol

Source: [10]

The process requires a schedule adjustment or confirmation by an operator.

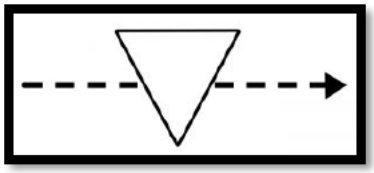


Figure 1.20 Signal Kanban symbol

Source: [10]

Signal kanban indicates when a batch of raw materials has been depleted and a new batch is required.

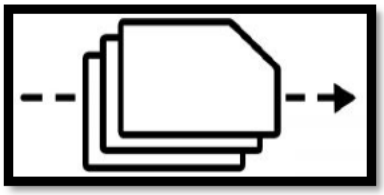


Figure 1.21 Kanban arriving in batches symbol

Source: [10]

Multiple kanban cards moving through the assembly process together.

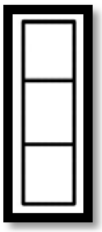


Figure 1.22 Buffer / Safety stock symbol

Source: [10]

A buffer, or an inventory of raw materials intended to compensate for variation within the production times of a process.

Figure 1.23 Load levelling symbol

Source: [10]

A tool to intercept batches of kanban cards and level their volume and mix over time, to smoothen the production process.

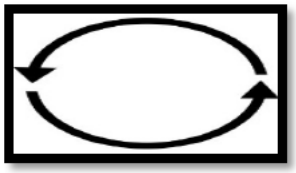


Figure 1.24 Iteration or network symbol

Source: [10]

A symbol placed within a process to show that it requires repetition. Planned repetition is called iteration, whereas unplanned repetition is called rework.

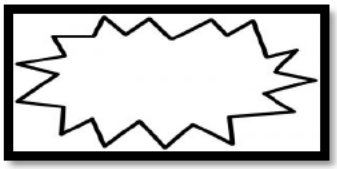


Figure 1.25 Kaizen burst symbol

Source: [10]

The specific type of kaizen activity and any supporting information is noted within the bubble.

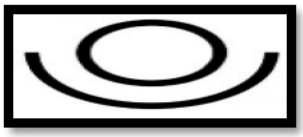


Figure 1.26 Worker / Operator symbol

Source: [10]

Indicates where an operator or worker is required. Operators are not normally shown on the value stream map, but where one needs to be identified for clarity, this symbol is used.

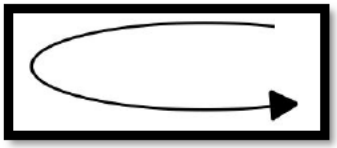


Figure 1.27 Milk run symbol

Source: [10]

Indicates a worker movement to pick up parts, equipment, or supplies.

Figure 1.28 Phone symbol

Source: [10]

Used to indicate expedited information

Figure 1.29 Expedited movement symbol

Source: [10]

Used to indicate expedited movement of materials.

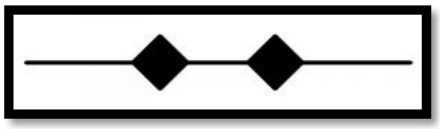


Figure 1.30 Milestone pacing symbol

Source: [10]

Indicates milestones that correspond to specific dates.

Understanding this symbols will offer the convenience of VSM design. To select the use of 5S in Lean Manufacturing it is a system of organization and standardization at workplace. It aims to sort and organize your work area into five steps: Sort (Seiri): Remove unwanted items, Set in Order (Seiton): Setups and positioning of what's important, Shine (Seiso): Clean the work area and maintain it that way, Standardize (Seiketsu): Establish standard procedures, Sustain (Shitsuke): Enhance and upkeep the system [10]. 5S is a simple way of increasing your workplace productivity, safety, hygiene, quality of product, and employee morale. The 5S method is based on lean

manufacturing philosophy, and it can be implemented cost-effectively utilizing the assets that you possess.

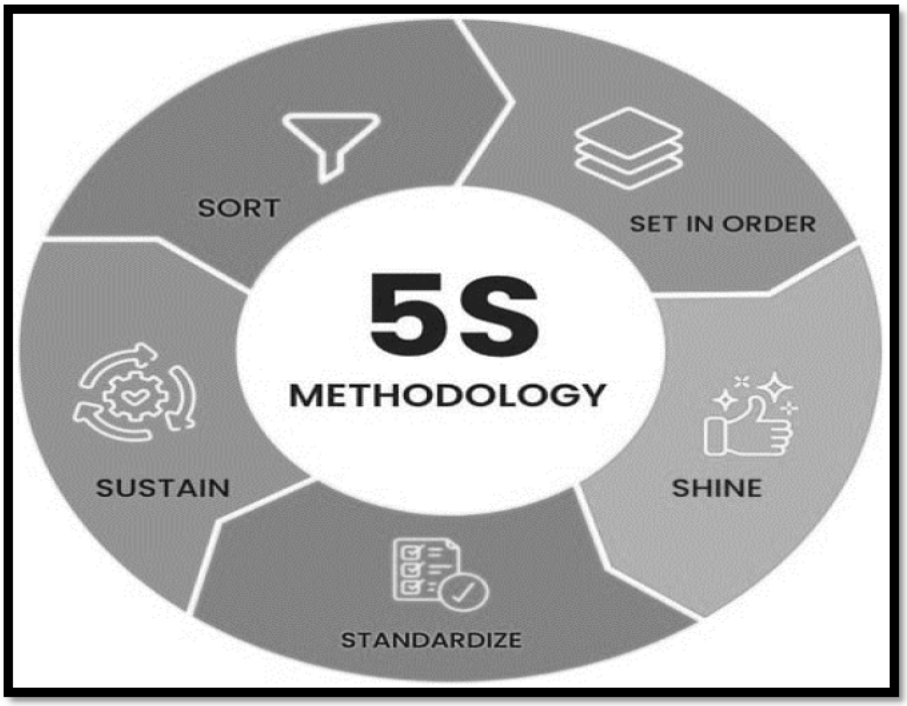


Figure 1.5 Common 5S Methodology adopted in industries

Source: [10]

1.3. COMPONENTS MERGING IN VSM AND 5S APPLICATION

VSM focus on knowing the customer requirement and express the value in his or her view; by visualizing the overall value stream with all operations and activities we therefore recognize all types of wastage, where 5S help in maintaining the space to be clean and in good order, reducing the risk of contamination this improves food safety. It uses a set of symbols and icons that have already been defined to stand for several things in this flow [9]. Among the most vital aspects further information about symbols will be discussed in 1.2. Table 1.1.

Processes: These are usually drawn as the shape of a rectangle and are utilized to signify the various steps or stages of the process. Different rectangles are utilised to signify different processes or operations utilized in the production process of a product or providing a service [12].

Materials Flow: This is presented with the help of arrows. The arrows trace the movement of raw materials, components, and end products from step to step of service delivery or production. Direction and direction of the arrows have important roles in indicating the extent to which materials are moving through the system [12].

Information Flow: Usually depicted in arrows or dashed lines, this element represents how information circulates around the system. This can be orders, instructions, and feedback, which guide the material flow. Where and how information moves and affects the process is important to observe delays or inefficiencies in communication or decision-making. [12]

Data Boxes: Data boxes are filled with information that is relevant for each step of a process after each step of a process. It can include cycle time, wait time, level of inventory, and rates of errors. Measuring such metrics is very important in assessing the success of an individual process step and where it can be improved. [12]

Timeline: At the bottom of the map, the timeline is a simple view of the overall process time in each step of the process and the overall lead time for the entire value stream. The timeline is a useful part of viewing the overall process time and being able to see where time is gained or lost. [12]

1.4. COMPLAINCE WITH THE FOOD AND FEED OF PLANT AND ANIMAL ORIGIN REGULATION ON THEAPPLICATION OF LEAN

The EU directive No 396/2005 establishes maximum residue limits (MRLs) of veterinary drugs and pesticides in food and animal feed. It targets ensuring food and feed products are safe for human and animal consumption and to harmonize the regulation of pesticide and veterinary drug residues in the EU. The legislation also brings into force protections for monitoring and enforcing compliance with MRLs and requires risk assessments to be made before new MRLs can be set (REGULATION (EC) No 396/2005). [13]

1.4.1. ADOPTING ISO 9001 IMPROVE QUALITY PRACTICES

The ISO 9001 is a global quality management system that helps organizations implement and improve their quality management practices throughout the world. It is the most implemented standard for quality management in the world and is designed to

help organizations consistently meet or exceed customer expectations and applicable laws and regulations. The ISO 9001 standard covers a number of quality management processes, including customer satisfaction, leadership, risk management, and continuous improvement. The certification process includes the assessment of the organizations' quality management system and its adherence to the ISO 9001 standard.[13]

ISO 9001 is finding widespread application in manufacturing, health care, and service. Through the adoption of the ISO 9001 standard, organizations are able to minimize Food Safety and Compliance risks by using lean principles of operation in Rapid Product Development with Continuous Improvement in Raw Materials management and Quality monitoring in Commercial Production. Through having a QMS, the company has been able to achieve effective control of their processes, reduce risks, improve efficiency and effectiveness, and deliver high-quality products and services to their clients (ISO 9001:2015) [13]

1.4.2. ADOPTING FSSC 22000 IMPROVE FOOD SAFETY PRACTICES

FSSC 22000 (Food Safety System Certification) is a food safety management system that provides a platform for which organizations can ensure and enhance food safety practices. It is intended to help companies ensure their food products are of good quality and safe, hence reducing the risk of foodborne illness and consumer protection. FSSC 22000 originated from the ISO 22000 standard and incorporates the requirements of other food safety international standards such as HACCP and PAS 220. FSSC 22000 also incorporates additional requirements relevant to the food industry like food fraud prevention and allergen control. Certification entails the evaluation of the companies' food safety management system and how they support the FSSC 22000 standard. After certification, the companies may place the logo of FSSC 22000 on their goods and advertising materials to clearly signify their commitment to food.[13]

1.5. BACKGROUND OF THE STUDY COMPANY

This research was conducted in a food production company, this company was established in 1984 as a part of RCL FOODS' Sugar & Milling business, subsequently Tsb Suiker. The mission of the company was to create the worth of molasses from the sugar production process. The company has grown and evolved into one of the leading

animal feed companies in South Africa. The firm in the case study is based at one of the manufacturing plants in Nelspruit, South Africa. The firm manufactures three types of foods namely: liquid feed, Block licks, and 40kg Protein feed bags. This is the traditional way that has a lot of waste that have sensitive impact overall production efficiency.

To moderate production wastages and increase the production, the firm was willing to embrace lean. Lean production philosophy is one of the focal areas in animal feeds strategy for the future because it can improve the operation and enhance competitiveness in the market. All the employees are not familiar or have little knowledge about lean. Here, the company is seeking to start with a lean implementation process which is simple and affordable. So, the purpose of this study is to study how value stream mapping and 5S principles would be advisable to initiate lean.

1.6. PROBLEM STATEMENT

The firm has seen a 10% increase in downtime over the past two years, leading to significant production delays and overall reduced efficiency. As a result of more downtime, the company production cannot work at consistent production rates, leading to periodic backlogs and delayed deliveries. Long downtimes cause direct loss of working hours, which significantly affects the productivity of our operations and ability to deliver customer orders within time. Higher downtimes translate into higher operational costs.

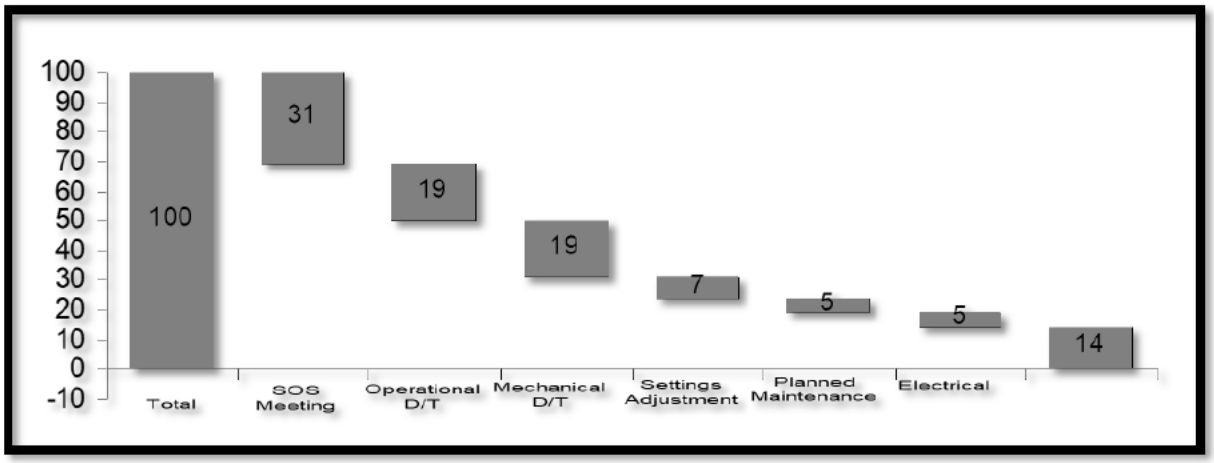


Figure 1.6 Downtime bar chart rate for past 2 years

Figure 1.4 illustrates the total downtime in terms of percentages where's the is 31% lost time in meeting and then the 43% in operational, mechanical and electrical downtime, 7% in start-up and change over settings and 5% in planned maintenance. The increasing downtime has triggered the company to spend heavily on temporary solutions such as outsourcing production, which is proving to be unsustainable. *We are confronted with increased maintenance cost, which is eating into our operational budget, putting pressure on financial resources and decreasing profitability*.

Lean tools like Value Stream Mapping (VSM) and 5S guidelines has remained successfully utilized to maximize efficiency in the food production sector. The implementation of the above strategies enables companies to improve processes, minimize wastage of time, and maximize the rate of production. With the aim of addressing this issue, the current study aims to maximize productivity in the food production sector through lean tools VSM and 5S.

1.7. HYPOTHESIS

By using lean tools 5S Principles and value stream mapping, the food processing industry can achieve increased productivity, better overall equipment effectiveness, and customers' expectations. And Wastes are eliminated by the success of the first four steps: Identifying value, Mapping value stream, building flow, and adopting a pull system

1.8. AIM OF THE STUDY

The purpose of the study is applying lean manufacturing tools in a food manufacturing industries and to improve food manufacturing productivity by increasing productivity and eliminate downtime on production equipment’s.

1.8.1. OBJECTIVES

i. To Optimize work flow efficiency in the food production through application of lean techniques, the 5S principles and Value Stream Mapping.
ii. To eliminate food threats by optimizing machinery cleaning procedures and adhering to ISO 22001.
iii. To improve overall food manufacturing efficiencies and maintain constant productivity rates by eliminating frequent bottlenecks.

1.9. RESEARCH QUESTIONS

i. How the tools Value Stream mapping (VSM) and 5S Methodology would be applied to improve productivity and efficiency in food manufacturing industries?
ii. What impact will the implementation of VSM and 5S have on food manufacturing cleanliness and workflow optimization?
iii. What will be implementing VSM and 5S in food production industries improve food safety compliance?
iv. How implementation of VSM and 5S can eliminate downtime and improve the overall efficiency in food production industries?

1.10. STRUCTURE OF THE STUDY

Chapter 1 Introduction

The context to the research and problem statement are first brought out by this thesis regarding why this research was conducted. The 5S principles and VSM lean tool are then reviewed, from which the research objectives are thereafter formulated.

Chapter 2 Literature reviews

This chapter will discuss how other authors have applied lean manufacturing tool and what they have managed to achieve by applying lean with the aim of exploring how it can be utilized in food production successfully respectively.

Chapter 3 Methodology

Is a plan that outlines how this research was conducted by specifying the research strategy, research design, research strategy employed, and an explanation of the tools used in collecting data?

Chapter 4 Results, and Discussion

The chapter will present Analysis, which addresses observed data analysis and how the data analysis was carried out to reach the results. The chapter will also discuss how the study questions are learned, make recommendations, and present the overall encounters discussion of the findings after applying the approach.

Chapter 5 Conclusions

Based on the findings from the outcome, the researcher will define and explain what can be concluded about the success of the application of lean manufacturing.

Recommendation- the ways that can be utilized for better production.

Chapter 6 References

Sources used in conducting the research.

Appendices

Other materials utilized to complement the research.

1.11. EXPECTED RESULTS OF THE STUDY

This study intentions is to increase the efficiency of food manufacturing firms as well as minimize downtime on production equipment. Once all this has been achieved, this deployment will increase the employee's participation in improvement activities and that will increase the loyalty of the customer which will enhance the company position within the market. The quantifiable measures for measuring outcomes will be reduced lead time, lower defective rate, improved productivity increased customer satisfaction, and cost savings. The implementation time frame for VSM lasting for 6 weeks and 5S lasting for 3 weeks, applying both these lean tools in parallel will take 12 weeks to receive positive feedbacks on the outcomes.

1.12. CONCLUSION

By executing a VSM and 5S, organization can make significant leaps in efficiency, quality and cost savings; by knowing and observing the end-to-end value chain, an enterprise can make smart and timely decisions that enhance its value. This can include reinforcing resources, waste elimination, removal of bottlenecks, and optimizing business outcomes [14]. This is quite a more holistic and integrated effort than just optimizing a single company feed storage. A business is made up of many groups of different functions. VSM can help different teams collaborate towards shared corporate objectives. Once a stream is established, similar jobs become easy to focus on, operations get streamlined, and duplicative work becomes eliminated. VSM enables businesses to find, pursue, and enhance value.

This enables business leaders to focus on improving and make strategic decisions based on well-understood measures. The process of 5S is a technique for increasing productivity and efficiency in the work environment. If you apply the optimal 5S practices, such as implementing 5S in office environments or industrial processes, you can quickly enhance productivity, employee satisfaction, and efficiency. We are all familiar with these ideas, from our grandfathers placing tools just so on Shadow Boards in the shed, to proper cleaning protocols for sensitive equipment in various industries. The 5S ongoing improvement program can uncover tiny gains as much as it can instil the self-discipline necessary in the culture to always strive for better. 5S is an organization improvement method that can be used in any company.

It improves a more organized and effective setting by streamlining processes and removing waste. Where applied appropriately, 5S enhances workplace safety, quality, and efficiency. Therefore, with these seemingly factors enumerated above, the researcher had a reliable friend in improving the food production line through ensuring application of VSM and 5S principle.

CHAPTER 2 LITERATURE REVIEW

This chapter takes a synthesis of literature to understand the lean implementation view in Value Stream Mapping and 5S principles, for an example, lean tools and their application in the food manufacturing industry and lean thinking and its principles which describe lean's root and its value-creating characteristics. A comprehensive review of published literature, sources, on the topics related to the research area is known as this literature review. An overview, the classification, evaluation, and analysis of previous studies and research done the research area, is a review of such literature.

2.1. IMPLEMENTATION OF VALUE STREAM MAPPING (VSM) AND 5S

Application of VSM in food processing industries has been the result of the peculiar features of the food industry, e.g., seasonality, heterogeneity of raw materials, and short shelf life.[16] A demonstration of effective lean implementation in the food manufacturing firm is presented by results [16]. Statically, numerical authors were already in a position to effectively demonstrate use of LM tool VSM in food manufacture and had proved improvement in food productivity. Maalouf, and Zaduminska research was aiming at the expansion of the company production capacity of the main production line and reducing changeover time. Using lean tools VSM, the company succeeded in raising the primary line capacity by 11% and reducing changeover time by 34% [16].

In sync with the findings, [17] confirms that the value added to a product from raw material stage to dispatch and delivery to the customer, organizational attitude towards process improvement, and [14] used VSM tool to reduce waste in a Zimbabwean bread factory, and the author was able to establish and reduce defects by 20%, unnecessary inventory by 18%, and motion by 37%. Value stream mapping, as recognized by Jimenez, is a productive company improvement tool utilized for enabling visualization of the entire manufacturing process, material and information movements, and thus VSM plays a positive role towards areas of improvement identification [18]. Confidential food production also results in wastage reduction of the salvages and scrap types.

Shoba and Subramanya contrasted the use of VSM in lowering the line's scrap rate and lead time [19]. The authors took one step ahead where non-value-added activities were determined, by diagrammed the VSM for the current state. Problems accordingly were fixed using a Cause-and-Effect diagram and Pareto analysis to lower the current scrap rate of 4%. According to [19], a Future State VSM was constructed for the future which projected the decrease in a scrap rate of 0.6% and improvement in the lead time of 11.7%. Other authors such as [20],[21], and [22], in their research report and concede that, VSM methodology is widely used in other non-discrete manufacturing industries and food manufacturing industries.

Khan, Shaikh, and Marri conducted an in-depth and analytical research on lean manufacturing practices used within the pharma industry and indicated the potential application of using VSM in the pharma industry [23]. Like in the case of the other authors, in this article, the authors [17][14] and[19] have written about the vast advantage of using lean practices in some segments of the pharma industry; this is an evidence that VSM can be utilized in any industry and work well. The need to map inter and intra-company value-adding streams has driven the huge interest in reducing food loss and waste such that sufficient food for the rapidly growing population will be ensured.

Womack, and Jones refer to Value streams as the specifics of the businesses that assist in the addition of value to the product or service in question. These were found to be at risk of loss and waste in primary production, processing, storage, food service, and/or consumption [24]. As the basis forms of loss or waste in food, four of the seven lean manufacturing wastes (defect, unnecessary inventory, overproduction, and incorrect processing) were reframed into discarding and loss of nutrients, particularly at the stage of production. Lean manufacturing processes in the agri-food industry are addressed, and lead time is chosen as the relevant performance measure. In addition, VSM was also more suitable for simulation modelling than other lean techniques [25]. Value stream mapping enables understanding and justification of production sequences, the pathway through the process of production is mapped by value stream mapping of the present state.

Rahman, Parvin, and Islam record that subsequent to tracing the production process, and the defects affect, a VSM is scheduled, and an optimization plan is proposed, authors' results indicate that following the deployment of a VSM; the production cycle will reduce by 9.75 minutes to 8.35 minutes which amounts to an improvement in productivity and as a 12% decrease [26]. Furthermore, the writers proved that VSM is a powerful way to diminish production cost and delivery time, and was proposed as a new approach to categorizing operations as unrequired but not value-adding, value-adding, or non-value adding [26]. According to [27], in accordance with the [26] this plan proposed as a new approach to categorizing operations, became more global and was implemented in various contexts. According to authors [28], distinct tools were developed to comprehend varied VSMs and their intersection and use.

The following seven mapping tools recommended for classification were process activity mapping, supply chain response matrix, production variety funnel, quality filter mapping, demand amplification mapping, decision point analysis, and physical structure mapping, along with their respective potential uses [29]. The five lean manufacturing principles were listed by [24], and again significance was placed that VSM must be implemented as the initial step for lean implementation. But the largest wastes in the system were overstocking, defects, incorrect processing, and delivery, and they needed five VSM tools: process activity mapping, supply chain response matrix, quality filter mapping, demand amplification mapping, and decision point analysis [30].

If VSM is applied to map a production line which produces various families of products with various production time and set-up time per production stage and various number of shifts, then it will be ineffective [31]. One was rightly contended that there is always a value stream whenever there exists some product for some customer. The issue is to identify it and rectify it. Value stream mapping (VSM) management is used in any company process exactly the same way and can be implemented big or small.

VSM is used in agriculture food producing factories that manufacture with different production capacity and production time at every production stage. It also includes a potential lean implementation period for the farm or farm production activity that achieves an 80.09% reduction in work-in-process inventory, 50% reduction in finished goods inventory, 82.12% reduction in product lead time, 3.75% reduction in station

cycle time, 6.75% reduction in change over time, and reducing manpower required by 16.66% [32]. Declarative anything which is less than the minimum equipment, effort, material, parts, space, and time needed to generate value to the product as waste. Currently, the outcome of the author had already determined that anything or anything that doesn't generate value are waste, they also taught us that waste exists in the form of anything and anywhere at any point in time [33].

It may be hidden in processes, policies, product and process designs, and operations. Besides this, there were also some other researchers who had the same opinion regarding VSM, aware of the fact that creator of VSM and management systems guru. [34] the author explains that application of this useful tool VSM does not only figure out process inefficiencies, and communication and transactional incompatibilities, but also results in improvement, Value stream mapping applied in accounting for estimating the process costs of a value stream was expanded further. In his article, [35] proves that VSM can be used in many different ways by showing that value stream map data can be utilized to estimate the cost of future and existing state processes and value stream profit-and-loss statement design.

Bhim, Garg, and Sharma suggested applying VSM techniques to determine areas of money drain in the industry balance sheets and implementing the techniques to minimize the cost of running the business in an attempt to save business at the time of recession [33]. Authors, Pavnaskar, Gershenson, and Jambekar, in their view, a suggested link between the issue of manufacturing waste and lean tools has the potential to transform the whole mind-set and culture of doing things while making food [36]. Authors thus conclude that food production organization can chart their manufacturing wastes using the VSM tool. This typology system classifies lean manufacturing tools and measures systematically according to the abstraction level, where the tool is utilized most appropriately in the company, whether management waste or activity waste it is addressing, what type of resource waste it is addressing, and whether it indicates waste, measures waste, or removes waste, or any combination of all the three [36].

As the above-named author Maskell, the diverse usage of VSM [33]. Usage of VSM in description of contemporary beliefs, conduct, and capability among business leaders, described, and with the help of contemporary and future state maps. Emiliani, presents

the failure of most top managers as well as traditional leadership development initiatives [37]. Technical problems are addressed including how to calculate Takt time, where is the supermarket, where can continuous processing flow happen, which process enhancements will be realized, and how to deal with variable product families when mapping job shop operations with a regular VSM were addressed, and further it was clarified that even though it is possible to draw a regular VSM inside job shop operations [37].

Lastly because in operating the job shop future demand cannot be determined, past years' average demand must be used in plotting a particular product family [38]. Xi'an, and Daxue, indicates that use of the VSM tool shall be in the future because of process development of the production process as results also achieved on the author's research. Xi'an further explained that once we have identified areas of improvement and critical path, we improved our primary value stream and another path became critical [39]. We did this process iteratively again and again until we reach the optimal point or the WIP level went below the target level [40]. Overall, researcher Yigit also mentions that VSM is a process that can be implemented in any firm, though this research was designed in mind while considering emerging economies, it may be extended to developed economies [41].

Hans De, argues that VSM can also be utilized in limiting food production loss, the outcomes have wider effects on efforts towards food loss and waste (FLW) reduction and improvement in food and nutrition security. Apart from simulation modeling, which is feasible, and other lean methods like Just-In-Time and 5S, which are improvement tools on a daily basis, also proved VSM-compatible [42]. Implementation of 5S in food processing industries is very important. 5S practice gives good housekeeping and hygiene in the workplace. There are five steps involved in the 5S process: sort, set in order, shine, standardize, and sustain. 5S is a workplace organization method that can be applied to any operation or enterprise, and it is one of the most powerful pillars of visual management [43].

Practice of 5S is intended to implant the discipline of organization, cleanliness, cleaning, standardization, and discipline at shop floor level, Rojasra and Qureshi distinguished between '5S as a philosophy or way' and '5S as a technique or tool' by

contrasting the blueprints created by earlier researchers [44]. Chapman, Kumar, and Gapp, in their discussion, had clarified that proper implementation of 5S can bring the following advantages; efficiency, organization, cleanliness, productivity, and safety in the workplace [45]. Moreover, 5S creates conditions for change for working circumstances and employee values, improved and enhanced problem knowledge that can lead to processes being interrupted in making and actual embodiment by employees of common work; employee flexibility, productivity, quality, safety, and motivation are improved; cost, unproductive time, space and movements are reduced; and breakdown losses and failures are reduced [46].

With the benefit of ongoing improvement is an apparatus whereby employees at every level in an organization work together actively to provide ongoing incremental improvements to the production process. At some point, continuous improvement brings together the collective knowledge at a company to yield a powerful driving force for ongoing improvement [47]. With having been tested and tried to function in practice by authors Ashraf, Rashid, and Rashid, use of the 5S approach in an actual case study within the food and beverage manufacturing sector warns off encroachment of the local and even global market by new players, threatening the industry to lose its profitable niche [11].

Accordingly, to remove the aforementioned issues, there should be continuous improvement. Improvement was suggested and put into practice on the grounds of 5S for the succeeding two months. Several benefits were achieved, i.e., cost savings, productivity improvement by 38.65%, and reduction in component rejection by 6.1%, because of the proposal of improvement [11]. Findings revealed that 5S is an excellent driver to enhance organizational performance regardless of organizational type, size, production, or service. The Japanese, Jiménez argued, are taking over the world market because they have embraced 5S.

Competency-based training, the author's research indicates, has a wide association with 5S to an incredibly great degree [18]. Matawale, had utilized an interpretative structural modeling-based model to simulate interrelationship among various drivers to lean and agile manufacturing systems [48]. But Authors have other views about 5S, Ghodrati and Zulkifli view 5S as organizational learning, change strategy, and development

strategy [49], while Sweis, view 5S as industrial recipe that distinguishes a company from other firms [50]. Randhawa, and Ahuja have explained in the business transformation stream that to have dedicated employees for implementation of 5S program, top management need to be involved towards practicing 5S among subordinates [51].

Ghodrati, and Zulkifli conducted studies in identifying organizational performance drivers and effectiveness of 5S implementation for performance [49]. Things to be avoided during the execution of 5S in food processing in order to get good results of 5S as stated by Randhawa and Ahuja are as follows: 1. Sort, straighten and Shine other's space, 2. Clean and shine for cleaning the space and not for inspection and safety inspection, 3. Audit and don't maintain anyone's improvement 4. Conduct 5S audits and don't have problem-solving sheets, 5. Believe that the intention of 5S is to improve flow and productivity, 6. Set a target and measure the number of 5S Kaizen events, and yell at someone when they don't meet new 5S standards [51].

Such firms try to adopt both 'total 5S systems' or 'aspects of the 5S' in their routine work but in the form of an informal approach, Process innovation candidates were selected on the productivity effect and barrier they posed to subsequent company strategy: i.e., having more flexible production systems so as to make lower volumes, it could be concluded that 5S philosophy can also be applied to such industries thus making information within this paper applicable to generic food and beverage manufacturers, particularly middle and large-scale firms [52].

5S creates working environment where workers' suggestions and proposals are taken into account. The working environment is created in such a manner that working is enjoyable resulting in satisfaction of workers in work and improved workers' morale to create efficient Kaizen system most critical aspects are workers' cooperation and commitment and strong support from top management [52]. Literature also suggests the integration of KPIs and that of external exchange agents in the control of the progress of outcomes in process improvement [5].

Lean program management for implementation involves team collaboration and oversight of the final implementation of KPIs, the measurements of control should

therefore be carried out in the input process, production process, and output process. Furthermore, it suggests that the use of upstream performance reports and non-financial incentives is essential to the performance of lean manufacturing implementation [6]. Value stream maps (VSMs) are one of the most employed tools by food businesses to identify cross-contamination risks [7] and supply chain food loss and waste critical points [8].

Again, one of the most commonly used techniques is the 5S approach, where cleanliness culture is fostered within organizations so that food wastage due to pollution and spoilage is minimized [7], as also inventory stock [9]. The most important obstacles to enforcing rigorous manufacturing practices are sequential time for cleaning, preparation time that is too lengthy among product families, and product perishability that is too high. All the significant limitations listed by the respondents are specific to the food processing industry nature, i.e., knowledge deficiency, resource deficiency, and low level of employee commitment [10].

Inadequate business culture, leadership, and change attitude need to be included among the barriers too. Vlachos [11], however, uses get the knowledge to prepare top managers to utilize lean tools. Authors of several articles hypothesize that the SPC quality control tool is essential in the food industry because it offers an SPC roadmap that serves as a guidebook for the proper application of statistical process control in the food sector. The roadmap consists of five steps that must be developed by the senior management, steering committee, and action team.

This manual will depict the overall trend of food manufacturing processes to continuous learning for improvement [12]. The -S and -R charts are most frequently used by these firms. Further, the SPC tool recognizes as implementation barriers the unawareness of Statistical Process Control, no quality improvement training, and lack of statistical knowledge and skills. Its application allows for reduced waste, reduced customer complaint, and reduced defect and reprocessing rate [10] [13]. Most importantly, other authors recommend the application of the Hazard Analysis and Critical Control Points system to ensure food safety by monitoring the critical limits of the checkpoints reached on the production line. From the above, it is presumed that the use of lean tools, statistical process control, and the HACCP system in food production is a good starting

point to ensure the quality and safety of industry products for their flexibility and adaptability to different environments and needs, depending on the product, process, and plant layout [14].

In order to obtain successful implementation, some of the observed obstacles by certain writers, e.g., the absence of knowledge, absence of resources' availability, insufficient employees' involvement [11][15], absence of experience, absence of education, and inappropriate training in lean application [16] must be taken into account.

2.2. ELIMINATION OF WASTE THROUGH VSM AND 5S PRINCIPLE

Lean Implementation possesses two types of strategies that are hard and soft practises. Hard practises are highly tool and technique focused. Pavnaskar, in their research, have mentioned that there are more than 100 tools by which lean is executed [36]. Hard lean practises, which are carried out for eliminating the waste, consist of 5s. Kanban and pull production are practises that are used for matching the production to the demand. Kaizen is used for continuous improvement which is also used to eliminate the waste [54].

VSM is also one of those methods which is used to analyze the current state and shape the future state. It helps to make the information flow clear and helps to map the undesirable process and resources used, which eliminates waste directly. VSM helps to demonstrate the material flow and also the information flow that controls the overall material flow [54]. VSM is also a simple and inexpensive lean implementation process. As our research needs the same, reducing wastage, maintaining flow, and enhancing productivity. Thus, only lean tool VSM and the desire to improve it will be mentioned under the hypothesis. As Chiarini defines, "Soft practices concern people and relations, while hard practices refer to lean technical and analytical tools" [55]. Soft lean practises are very important to achieve superior and sustain performance in the long run.

They also argue that companies most commonly fail to implement the technical tools, and unless attention is given to the soft practises, their failure can be triggered [55]. Rother in his book explains some of the most important reasons for lean implementation failure, out of which the most significant individual one is not considering soft lean practises [56]. An example of hard lean practice is VSM upon which this whole research

is based. Author [55] shows examples of soft lean practices such as continuous improvements. It further describes that by employing these soft practices, there is more quality output, better output and ability to generate more competitive advantage. Thus, along with hard technical lean tool application of soft practices is required [55]. The lean concepts aim at the operations which are required but do not add any value as per the customer's view (RNVA-Required Non-Value Added).

They may be required by administrative regulations or technology used. In practice, they are hard to eliminate or even hard to change. The remaining activities that are performed but fail to add any value to the customer are the pure waste (Non-Value Added), and all these activities need to be eliminated. It is ideal if all the processes in a lean organization consist of activities adding value (VA). Papargyropoulou [27] used the example of a Malaysian restaurant to describe the conceptual framework of food waste creation in the hospitality sector. They concluded that food supply, consumption and food waste generation should be analysed jointly in order to reveal information about food waste sources (where, how and why) and to implement case specific measures for food waste prevention targeting the material and socioeconomic drivers of food waste generation.

Another study established the operating policy and procedure of the restaurant and social food consumption culture of consumers as the main drivers of HoReCa food waste [28]. This suggests that prevention of food wastage in these businesses needs to consider working performance, consumer behaviour and practices, and food cooking and consumption behaviour. Clowes et al. [29] carried out research with 114 restaurants and came up with five actions that could result in the eradication of food wastage in restaurants, which are explained comprehensively below: • Measure. A "food waste inventory" enabled sites to identify where and how much food was being wasted so that managers could target hotspots and monitor progress over time. • Involve employees. Kitchen and serving personnel don't usually want to generate food waste but need more guidance and training from managers and owners.

- Reduce over-production. Certain production practices contribute to the culture of over-production. Some examples are batch cooking, casserole trays, and buffets, which are some of the reasons for producing more food than the cook-to-order preparation.

- Assess purchasing and inventory habits. Restaurants wishing to prevent food waste need to review their current purchasing and inventory control habits.
- Recycle food that is leftover. Because customer demand is never predictable, restaurant kitchens will always have leftover food and even wasted food. For such situations, having planning options on hand to recycle these foods safely into something viable can allow the kitchen to make money from this potential waste, or donate to a good cause.

Blum's [24] review of the literature concerning cost reduction of food waste in the restaurant industry found three formats: food waste cost reduction processes, food waste cost reduction methods and food waste reduction measures.

The reasons for food waste in restaurants comprise staff practices like over-preparation (over-production) of food, inadequate storage of ingredients and not utilizing food scraps and trimmings [13], service style and timing, type of menu and reliability of forecast of likely number of diners [30]. All-you-can-eat buffets, specifically were labelled an issue since leftover food from a buffet could not be legally reused or donated due to health code laws. Though food waste reduction is widely recognized by most owners and managers as a method of making their business more profitable, the implementation of some of the most impactful forms of reduction is low [31].

It therefore justifies investigating other lean management methods of minimizing waste in production organizations. Operationally, food waste takes place at three phases of the food service process as follows: pre-kitchen, in-kitchen and post-kitchen [31]. In-kitchen waste is addressed mainly through case studies. Pre-kitchen waste can, however, impact in-kitchen waste, while surplus ingredients can lead to food expiring in the kitchen and materials being wasted. Universally applicable strategies to prevent food wastage are demand forecasting [32] and supply practice management by just-in-time practices and unnecessary stock, serving and storage of perishable food such as machinery and procedure for example first expired first out rule[33], diverting edible leftover [34] to other meal [35], animal feeding [36,37], composting [38], biogas [39], as suitable, customer sensitization to plate leftover problem and behaviour change [18,19,40], Diverting edible leftover to poor consumers [40], local charities, food bank [41].

2.3. FOOD SAFETY COMPLAINCE IN LEAN APPLICATION

Food safety is very important in the literal term as the lives of the consumers are at risk [41]. It is because of this reason that it is extremely critical that foodstuffs supplied at the channels of distribution be in the best state possible so as to be consumed. In fact, levels of quality for food manufactured and/or consumed according to the European Union (EU) levels [42], [43]. By some means, it can be said that available production processes are the result of work and research done towards the end of the nineteenth century in industrial production [44]. Chronological list of the most relevant milestones in the field. Industrial production, at the end of the nineteenth century, was set to produce a huge number of products. The unit cost was supposed to be low, quality check in the backdrop.

Quality control was conducted at the end of the production chain, simply discarding defective products [45]. With this approach, product quality was the responsibility of that final control unit, not of the global production system, as it is understood today. Current EU policies address the issue of food safety in a direction towards guaranteeing proper and standard rates of quality for food manufactured and/or used in the EU [42], [43]. Current modes of production can be assumed to date back to studies and activities towards the latter half of the nineteenth century in industrial production [44]. Sequential exploration of the most relevant milestones within this field. Industrial manufacture at the close of the nineteenth century was focused on manufacturing an enormous number of products.

The unit cost had to be minimal, and background quality checking. In fact, quality checking was being done at the end of the production line, rejecting only defective products [45]. In this way, the quality of the product remained the issue of that last control unit, and not of the world production system, as envisioned now. Karol Adamiecki proposed his schedule at the start of the twentieth century, but posed the problem of coordination of the whole cycle of production. Yet years need to go by before it can be implemented [46]. Production on the chain actually started in slaughterhouses, where the animals were drawn back and forth along the plant by a chain-and-pulley system after they were slaughtered. That is where Henry Ford

originally started thinking about the assembly line [41]. In the early twentieth century, the quality of the process would create the quality of the product.

Whenever the production process deviates from the control parameters, the end product will likely be defective. Statistical process control pioneered by Walter Shewhart with a vision to produce functional products through proper control of the production process [45]. A further step toward such questioning is reached when one knows that the product's quality is not only a factor of production but also of design; properly designed product, the result of properly designed manufacture, has many possibilities of being free of defects. Now, there is a need to take into account the product's quality at the very start of design activities. In design excellence, during the later twentieth century, there was the dominant strategy of design by Gen'ichi Taguchi [47]. The central argument of this strategy is that if one is designing a rugged product, then faulty products won't be made.

By employing this strategy, products and processes are over-designed and thus they carry an "extra cost", which subsequently will be "waste". [41]. During the same period in the twentieth century, total quality control was the new concept that emerged, attributed to Armand V. Feigenbaum [48], whereby product quality is the work of one of the participating departments and the outcome of that gave rise to what became known as concurrent engineering [5]. Kaizen, which is the blending of two Japanese words for "continuous improvement", is a technique that is aimed at addressing continuous endeavour in improving processes and standards in an organization [23]. Continuous improvement is required in order to maintain quality and competitiveness excellence within a highly dynamic market place [42]. Among numerous alternative approaches to improvement, the most widely utilized are ISO 9000 series standards, lean practices, and business excellence models [24]. Whereas all of these methods rely on differing strength and varying application across industries and nations, both 5S and VSM place colossal emphasis on continuous improvement [25].

Whereas both of these concerned techniques take an interest in continuous improvement of organizational performance, they differ in application and direction. VSM is customer satisfaction based and engages all employees in quality activities using analytical and quality tools for constant improvement [25]. The second, 5S, was directed

towards reducing process variation using better cleaning and methods [26]. While such variations particularly in terms of their overall methodology and involvement of workers both approaches share a common issue with problem-solving using a rational process [25].

2.4. SUCCESS FACTORS IN VSM AND 5S APPLICATION IN FOOD INDUSTRIES

Lean is the entire business concept [48,49] and to make a business leaner, it must have been thought of as a system overall [50] what this means is how things really get done, how materials are purchased and how manufacturing gets accomplished, while [51] advocated the consistency of the "sociotechnical system", (technical and social) systems. This is consistent with [52] who stressed lean's socio-technical strategy, and they defined lean based on technical (tools) and social (drawing on people capabilities) factors. Despite such agreement on the need to appreciate lean as a socio-technical system, this paper confines itself to the social elements alone. Critical success factors (CSFs) of a specific improvement program are the program's most essential ingredients and activities, which are under the management's control in an attempt to get the aims goals of the company achieved [53, 54].

For lean manufacturing – CSFs - this implies that if conditions for the factors are not fulfilled; then the success of lean manufacturing implementation has minimal chances of taking place [12]. Therefore, the identification of drivers or reasons behind the lean manufacturing adoption process is a concern of paramount significance for the businesses which are about to embark on a lean manufacturing project [55, 56, 57, 58]. They are lean manufacturing change process drivers or blockers [59, 60, 61, 62]. In order to take on the advantages of lean programs, companies need to be cognizant of CSFs of lean in a manner that they need to be aware of the risk of failure in taking on lean and therefore need to embrace counteractive measures against that risk [17]. Literature review has indicated that although lean practices were being followed in most developing nations in the earlier times, consciousness of its underlying philosophy is not comparable [63].

A recent research [64], of the lean manufacturing literature published from 1996 until the first quarter of 2012 discovered that 14% of the studies had been performed in developing nations and 86% have been carried out from the developed western world. Organisational cultural variation is the greatest threat to organisations embracing lean [65, 66]. [67] Believes organisational culture is the most powerful driving force for formulating strategies for achieving the company objectives. Organisational culture may have a positive or negative influence on the lean activities of the organisation [68, 69]. Before proceeding with the initial step of lean manufacturing, the firm has to change its culture and also that of its staff members [70, 71], as the culture of the company and change management have been identified as a root cause of all failing lean programs [72, 73].

[74] Believe that values, ideologies, and beliefs behind employees' practices and behaviour in an organization are very important in adopting lean. Top management commitment has largely been viewed as a critical enabler [75]. Top management commitment can be stated in terms of formulating clear vision procuring appropriate financial provisioning, and strategic direction [76]. Though lean transformation is largely to be undertaken at the shop-floor level, top management must take the ride for the earliest stages [77]. [78] Have developed empirical results that point to commitment and managerial support impacted positively and negatively on lean initiative implementation activities. In order to augment an organisation lean readiness, one of the activities must be carried out, i.e., internal credible champion [13].

Lean manufacturing champions should ideally be the implementation leader and he/she establishes and heads the lean change steering committee to facilitate best practice transfer across functions. Lean initiative implementation is demanding grass-root support at the organisation level, and it is essential that the lean champion establishes organisation awareness to value the importance of lean at all levels [73]. Having a pilot project program in a way that one can lead an organization towards lean and discover the benefits of lean straight away is usual in literature in most of the situations [79, 77]. Having influence over the employees by giving them chance in a way that one can himself realize the real benefit of lean at an early stage is one advantage of a pilot project [79]. When making the decision on the project, the management must be careful to select successful projects so that the project will have definite benefits [80]. One of the problems of non-acceptance of lean initiative by the workers is the workers are not

adequately educated and trained [81]. With the implementation of the learning culture and simply the utilization of the lean tools, the companies can prosper with improvement.

In an effort to get workers more engaged in a lean programme, the company can have a company suggestion system with some reward in terms of funds for suggestions that lead to process or equipment innovation [82]. In as much as doing the lean, shop-floor employees are more responsible than the rest of the organisation members [83]; the same study has established that 17 lean manufacturing variables are usually performed by shop-floor employees.

Later on, [84, 83, 85] cited the employee participation in the continuous improvement, which increased their autonomy and responsibility. As the top executives constantly oversaw the employees, work blame cultures were developed. This is one of the reasons referred to as having an effect on the willingness and ability of the workers to engage in the implementation of lean practice [86]. Also, [87] found that workers' involvement was influenced by cultural and social natures; workers tend to conform to their managers which resulted in putting workers into a risk-averse culture that was the primary preventive of workers' involvement.

Lean implementation is accompanied by all levels of employees. Hence, there should be an effective process of communication to provide streamlined process flow [89]. Communications can be verbal between people, written report or verbal reporting to a board or as directions transmitted to a team of subordinates [12]. Communications agenda for workforce and management are [89,90, 91].

- Overview of change programme, emphasizing robust business case, how to put into practice and anticipated impact of change.
- Regular communication between implementation team and workforce to catch up with issues or improvement ideas.
- Regular meeting between the lean manufacturing steering committee and the implementation team.

2.5. FOOD SAFETY MANAGEMENT SYSTEM (ISO)

Finally arriving at the implementation of the ISO and/or FSSC 22000 quality management system is gaining an understanding of the ISO 22000 standard and in the

case of FSSC 22000 the worldwide standard developed and advocated by the Global Food Safety Initiative on the basis of current ISO standards FSSC 22000 [92]. All about quality standards is based on the continuous improvement philosophy and is developed with an aim to assist the companies' quality management system. Lean manufacturing has to consider ISO while implementing production in development. The following are good food safety requirements in lean implementation.

2.5.1. QUALITY MANAGEMENT

It is in the last decades when globalization opened up new markets for businesses that consumers' demands have grown as a consequence. Something every consumer can relate to. Product diversity has expanded and consumer choice will likely be quality and word of mouth in addition to the price of the commodity. [92] In recent decades, supplying products of high quality has played a progressively more important part in making the company more competitive. John S. Oakland postulates in his book that "any organization basically competes on its reputation". Quality has many definitions but they share something inherent in common: product characteristics, customer expectations and needs. According to John S. Oakland this would be possible in a sentence; "Quality then is simply meeting the customer requirements". [92]

The dimension of quality will be most significant in the instance of food and medicine. REKO-rings, or as they are named, appeared in Finland in 2013 based on a French model called AMAP. The idea relies on locally produced high-quality foods produced directly by the farmer and offered to the consumer without extra cost on transport and marketing. The buyer can see the quality and is also aware that it flows directly from the manufacturer without flowing through several channels of distribution. There are approximately 130 REKO-rings throughout Finland. [93]

2.5.2. COMMITMENT TO QUALITY

Any implementation of quality system requires the involvement of the management. Oakland states that the CEO of the organisation "should accept the responsibility of and commit to a quality policy in which he/she must really believe". It is required so that this is then communicated in the organisation at all levels. If the CEO himself is not completely committed to the implementation, it will lead to a failed attempt at quality improvement. By example and by transmitting the beliefs to the remaining organisation,

the continuous improvement will be given the right direction towards better quality in the whole organisation. Quality needs to be something visible, audible and tangible. [92]

This case study comes under the food safety policy, which falls under the ISO/FSSC 22000 requirement. The quality policy is the overall requirement of total quality management (TQM) implementation and one that every employee needs to get acquainted with as a sort of guide and mindset in the organization. The policy must be thoughtfully weighed and must, together with continuous improvement, allow for flawless functioning and waste and error elimination. In TQM the following issues must be taken into account when drafting the quality policy; the customer specifications, the ability to meet the customer requirements at a cost, ensuring the suppliers deliver materials of desired quality, ensuring the sub-suppliers share the organisations beliefs, prevention rather than detection, training and education for improving quality in the organisation as well as in sub-suppliers, customer satisfaction measurement and keeping the quality systems reviewed regularly.[92]

By carrying on a little further the policy of quality, there can also be developed by the company a vision and mission statement. The vision is what the organisation wants to be, while the mission is what it actually strives for, what the organisation wants to do. In addition to the vision and mission the core beliefs and values, who we wish to be as, of the organization must be established as well as the purpose, why we exist. An uncomplicated model is demonstrated in Figure 2.1 below. [92]

2.5.3. INTERNAL ASSESSMENT, AUDITS AND REVIEWS

Self-assessment is one of the most important components of the quality management, from time to time one must turn around and review the operations in order to identify the strengths and weaknesses. Self-assessment tools for the operations are many, for

example, group meetings, activity audits and questionnaires, but the most important activities do not change, see Figure 2.1 below. [92]

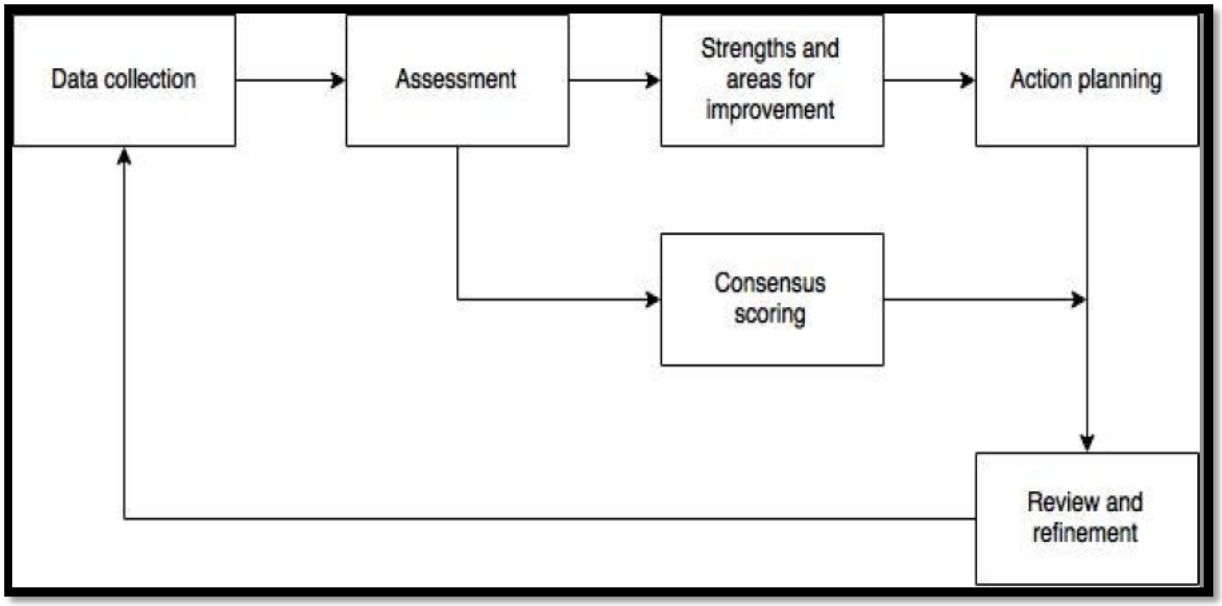


Figure 2.1 Key steps in self-assessment

Source: [92]

There should be audits in each management system to make sure that the system is performing the intended function and audits should be conducted to make sure that the procedures being followed are as efficient as the procedure documented. While carrying out the audits, the findings of the audits should be used. This is because if a process is faulty then it usually means that there are problems after a recorded procedure. Thus, by altering a process it is possible to resolve auditing problems. [92]

ISO 22000 specifically states that management should have documented meeting of review with the food safety team from time to time so that they can compare the challenges and the improvement required. As Oakland puts it, the purpose of a review is to ensure whether the system is delivering what is intended, identify flaws and irregularities in the system, verify management levels, and demonstrate remedial steps required to remove waste or loss, identify potential areas of risk and ensure efficiency of remedial action procedure. There are three forms of audits, the first party, second party and third party audits. The first-party audits are also referred to as internal audits, and as per ISO 22000 application, are performed by an organization on itself. [92]

The staff performing the audit can be staff not included in the being audited systems or by an agent of the third party. Second party audit can be performed by a firm's customer for products it purchases from them to it's or international standards. For example, A produces minced meat and B is a grosser that buys minced meat products from A. B visits A to audit them so that they can be confident in A. Third party auditing process involves a third party organisation which is not covered in any agreement between customer and supplier. Third party auditing typically involves the firm getting certified by receiving a certificate declaring that they are adhering to the requirement of an international standard.[92]

2.6. CONCLUSION

Much was well understood in the context of 5S and VSM, The topic has been of concern to both practitioners and researchers, as evidenced by the huge literature surrounding value stream mapping and its growing application in developing nations and developed nations, where else does unnecessary movement occur? Waste is avoided by streamlining the work environment, reducing downtime, and enhancing quality by constantly maintaining equipment in good condition with operators, making them more accountable for their work environment.

Development of a safe working space by ensuring that it is frequently cleaned and properly maintained. Development of space in your facility by eliminating the unwanted equipment and tools is developed by 5S implementation. Industry, through a case study, attests to the fact that VSM and 5S are highly effective methodology for finding and eliminating different types of wastage.

There is evident literature in determining proper application tools in lean waste management since the key aim of lean manufacturing. With regard to the improvement of productivity and lean tool outputs, other researchers have exhibited evidence feedback with regard to strategies of implementing the relevant lean tool to the relevant research area, Lean tool implementers are generally guided to pilot the lean system without coming up with a method that will also guarantee success factors and determine key performance indicators (KPIs). Benefits of VSM and 5S in food processing firms are self-evident, apparent, and interconnected once the lean manufacturing framework is properly established. Lean implementation in food companies requires the Food safety standard to come into play and hygiene as a mandatory system to be followed by

any organization working in the food sector, while food corporations utilize other systems for the intention of assisting quality management or production optimization.

The approach taken in drawing conclusions in this thesis felt like the course of things. Because the QMS is based on a standard, a literature review was almost required for this type of research. Once again, the training and the ISO/ICT checklist were significant contributions to the standard. However, the first goal is always to ensure the health and safety of products. All of the following solutions, ideas, systems, or processes should be implemented in accordance with HACCP principles. One concept which is not used at all in food processing, but can support a lot of benefits, is Lean Management. Drawing general conclusions in economics makes the conclusion vulnerable. In chapter 3 the approach of this study will be limited to create a combined consensus of success in VSM and 5S to enhance production.

CHAPTER 3 METHODOLOGY

Chapter 3, delineates the decisions taken with respect to testing the relationships in the conceptual model, for example, the sampling, procedure, measures, and the analytic strategy. Methodology chapter also offers a description of the research philosophy adopted, the research strategy used, and the research instruments used in the pursuit towards an objective. It explains the research method used in collecting the research data, for Example, study population, sample and sampling method, data collection procedures, data collection process, administration of survey instrument, and analysis of the data. The chapter will also provide a wonderful appreciation and insight into how the study was obtained. The procedure will first address the research approach and intention. There is also an explanation of the method used to collect the data.

3.1. RESEARCH STRATEGY

A quantitative technique was used for this study based on the purpose and research question. The approach was utilized for the goal of determining the existing manufacturing system and performing VSM. One of the significant reasons for adopting a quantitative was to come up with general conclusions from quantitative analysis and then via data narrow, expand, or specify the quantitative conclusions [92]

3.1.1. OBSERVATION

Observational study data collection was carried out by observing one production line while manufacturing. Observation and taking a good and detailed read of the production process [94] was carried out by witnessing. Process Activity Mapping was utilized for this witnessing observation which facilitated the data gathering in a well-structured technique. All of the phases in the process activity mapping were supplied separately, including the time spent, the number of persons engaged, the equipment used, and even the distance travelled in that process step. These observations allowed the discovery of waste and disturbances. While observing any improvement that had been identified and measured, which enabled the VSM analysis.

3.2. VALUE STREAM MAPPING IMPLIMANTATION STEPS

This future state mapping is an ideal best VSM that eliminates or reduces all the wastes that are found while evaluating the results of the VSM [95]. Also, this ideal state map

can be used for improving and predicting the future production state to optimize the company's future productivity and efficiency. Tyagi, contend that lean tool (VSM) has a drawing process to be adhered to in order to get results [96], in VSM agreements. Steps 1-6 outline the standard VSM process, with steps 7 and 8 adding environmental data to the map to preclude any mis-construction or ambiguity [97].

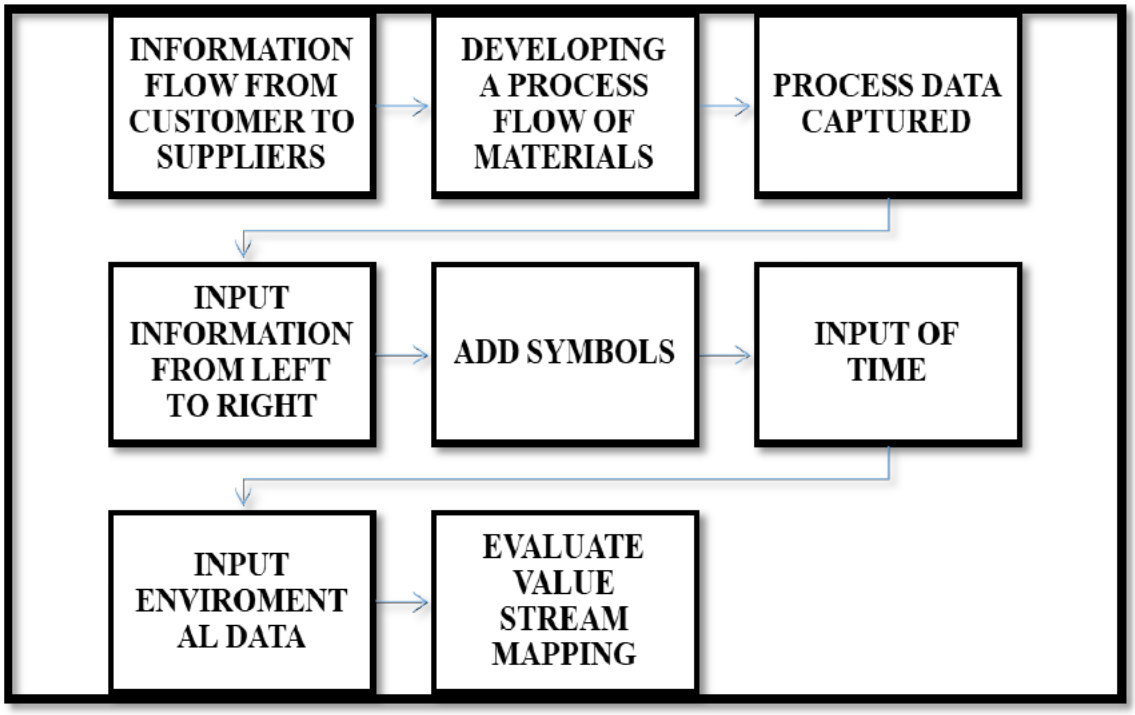


Figure 3.1 Process flow chat of 8 steps adopted to implement VSM.

Source: [97]

As a result, in step 8, the lead time, value-added time, and cycle operation time views were determined in order to improve the manufacturing line's present VSM. It will result in differentiation between the state map before and after the company's improvement and waste reduction efforts are implemented.

3.3. 5S ADOPTION

5S method evolves work floor condition control. It is a daily practice for continuous improvement and reworks the environment for easy work. It encourages efficiency and productivity with flexibility in enhancing the flow of work. 5S is a preventive approach

that pre-empts shop floor accidents; identify good work habits of workers and eliminate wastes in advance [97]. The researcher took these steps to implement the 5S method effectively:

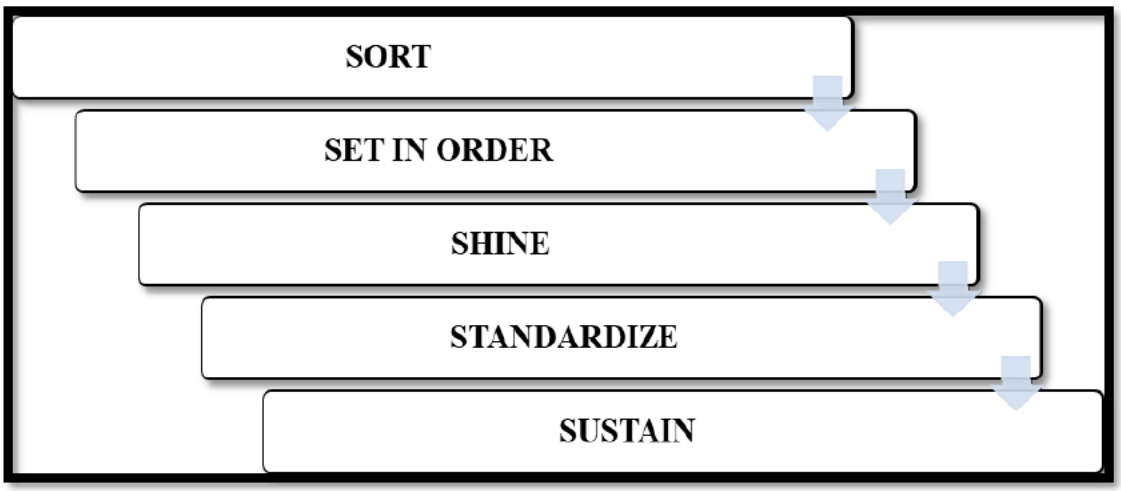


Figure 3.2 The 5S methodology process flow

Source: [97]

Step 1: seiri (straighten up or sorting) – During this stage, the researcher uses red tags to separate the needed tools/ raw materials that are always required to support/ add value production and the unnecessary tools that do not add any value to the production. [97]

Step 2: seito (set in order or put things in order) – The researcher puts tools/raw material into order, by categorizing all things which are common so that they stand in readiness to be utilized when needed. The research makes use of signs and markings such that everything finds its way to the right designated place. [97]

Step 3: seiso (clean up or shine) – The researcher had established a standard cleaning procedure: Maintain the workplace cleanliness. The procedure holds that while in the cleaning time, time will be controlled and that all will engage in cleaning, that with this application, cleaning time will be improved and early start-up achieved.[97]

Step 4: seiketsu (standardize or personal cleanliness) – To ensure that the implementation is successful, the researcher had to develop a habit of staying clean and tidy by preparing a checklist that delegates work to safety representatives. The checklist ensures tasks are done and maintained at optimal level. [97]

Step 5: shitsuke (sustain or discipline) – Follow procedures in the workplace, by developing a check sheet of tasks that need to be completed daily and on a weekly basis. [97]

3.4. FOOD SAFETY HACCP 7 STEPS IN 5S LEAN TOOLS.

The HACCP system is a food industry regulatory standard employed by most developed countries. The system is considered an important vehicle of food safety. The program develops risk assessment necessary and controls appropriate to safe food business practices and public safety protection. It is a platform upon which other higher level food safety and food quality systems were developed after it was established. [98] Creating a HACCP plan requires producing safe food and is a team effort in a food company. A sufficient HACCP plan covers all the areas of the food chain to make sure that food safety hazards are managed and resolved properly for public safety. While the primary objective of a HACCP plan is food safety, it also helps a food business develop its reputation as much as service and quality of approach to ensure the safety of the customers from injurious hazards. [99]

The 7 principles applied in HACCP are as follows:

1. Conduct a hazard analysis.

2. Identify the critical control points (CCPs).

3. Establish critical limits.

4. Monitor CCPs.

5. Establish corrective actions when a CCP is not in control.

6. Establish verification procedures.

7. Establish record-keeping and documentation procedures

1. SEIRI (Sorting) versus HACCP Principles

1S step (Seiri - sorting, selection) of the HACCP system being applied to a list of all potential hazards and a list of all hazard prevention measures (HACCP principle 1).

Sorting can be used to determine the items which can be a source of hazard to the working area. Through their removal, potential hazards can be eliminated to a large extent. [99]

The second HACCP principle 2 is to identify critical control points (CCP) - operations or steps in the process that are especially/critically significant in terms of food health safety. The application of step 1S removes non-relevant items from the work area, which reduces the minimal risk of hazards. It also enables control points and critical control points to be readily identified. HACCP principle 3 is to set goals and tolerance levels for the identified critical CCPs. The parameters should be measurable with set target values. The target values should enable effective elimination or reduction of the hazards to an acceptable tolerance level. Step 1S implementation has no relevance in any useful manner to this HACCP principle. [100]

There are no critical limits in the 5S system - unwanted items are either already at work or have been successfully eliminated. Once CCPs have been identified, a system of monitoring must be implemented HACCP principle 4. Sorting (1S step) helps towards a more organized work area, making more effective monitoring and control of CCPs possible during the manufacturing process. Performing step 1S gives support to the HACCP monitoring system to identify the points at which hazards may arise. Threat occurrence statistics are, as a matter of fact, an element that launches the development of corrective actions HACCP principle 5, like the 5S method, it is the meeting point of the two methods. [100]

The second HACCP principle 6 is to develop verification procedures. Audit is a very common verification tool. Auditing is also included in the 5S method. If the products under suspicion, potentially endangering the health safety of food products, are identified during Step 1S, then both HACCP and 5S monitoring can be simultaneously conducted. This will render a more organized working area and ensure the health safety of food products. As per principle 7, under HACCP management, operation and activities carried out must be recorded and documented. Recordation and documentation must also include sorting (1S principle) and separation of unwanted items and hazards. With the application of the 1S - Sorting principle, it is possible to

eliminate or even minimize unwanted documents and material, sort and apply existing records and documentation on HACCP.

2. SEITON (Systematization) versus HACCP Principles

2S principle includes maintaining an orderly and logical setup of equipment and documents in place. All things and where they are placed must be labeled. Where they are stored, how one could find them, and the way they are stored must be standardized. Rational and systematic and logical arrangement increases efficiency for work. Step 2S will definitely assist in the compilation of lists of hazards (HACCP Principle 1) as it assists in arranging, organizing and marking up articles, equipment and materials on the workplace. Workplace orderliness has the potential not only to define danger, but even preventive in character. Systematization (step 2S) will definitely assist in determining CCPs (HACCP Principle 2). Factory order prevents worker error risks and assists in deciding CCPs in manufacturing. The 2S principle and the 2S principle by themselves enable you to maintain the largest number of CCPs. [99]

2S rule is not applied in determining objective and criticality tolerance levels for each control point (HACCP Principle 3). Determining setting and imposing order in the workplace, and disposal, results in only more focus on setting objectives and tolerance levels for each CCP. On the contrary, application of step 2S can make the CCP monitoring system robust (HACCP principle 4). The organization in the workplace would be improved by the introduction of step 2S, which would further improve supervision and control at key points in production. [99]

Where the issues are already being identified, 2S would be able to assist in locating where there could be potential operational as well as actual issues. And this would assist in identifying how controls must modify the same (HACCP Principle 5). Better workplace organization also assists in monitoring and controlling according to pre-determined standards (HACCP Principle 6). Systematization is also directly related to maintenance of record and documentation (HACCP Principle 7), because by systematization, the convenience in handling documentation and records is achieved through developing a transparent and unambiguous system of document storage and preparation. [99]

3. SEISO (Cleaning) versus HACCP Principles

This is also directly linked to the HACCP system, namely Good Hygiene Practices (GHP). Cleaning is an inspection category whereby equipment and tools are inspected, and even maintaining the employee's personal hygiene clean. 3S step can be of great help in enumeration and an enumeration of hazards (HACCP Principle 1), and in identifying potential hazards of contamination, non-compliance with hygiene law, etc. 3S regular cleaning also aids in reduction of the likelihood of hazards (HACCP Principle 2), and thereby compliance with CCPs tolerance limits (HACCP Principle 3).

The CCP monitoring system that is put into practice (HACCP Principle 4) can be used to also monitor workplace cleanliness and, when there are hazards, find and fix them (HACCP Principle 5), in the course put into effect for the effective working of the HACCP system (HACCP Principle 6), the effectiveness and efficiency of cleaning and preparing the documents and maintaining the records as evidence of their practice can also be ensured. [99]

4. **SEIKETSU (Standardization) versus HACCP Principles**

Step 4S (Seiketsu – standardization) Standardization because of which the employees keep their workplace clean and tidy on a day-to-day basis allows generation of awareness for hazards. Therefore, while enumerating the hazards (HACCP Principle 1), some hazards can be enumerated as potential hazards but will never occur since they are prevented because of practice of tidiness and cleanliness on a daily basis (4S). Standardization also minimizes contamination and risk of hazards, which impacts identification and characterization of CCPs (HACCP Principle 2). Hazard(s) will be covered, but these are possible hazards but not necessarily critical, hence do not have to set limits for these (HACCP Principle 3). [99]

System design for surveillance of such 4S activities should be incorporated into the HACCP system of monitoring (HACCP Principle 4), verification steps (HACCP Principle 6) and record-keeping (HACCP Principle 7). It should be operationally redundant to implement and adjust, but the action can be prolonged to HACCP action (HACCP Principle 5). [99]

5. **SHITSUKE (Self-discipline) versus HACCP Principles**

This habit also meets HACCP system requirements, thus there is a synergy effect between 5S and HACCP. During the hazard listing process (HACCP Principle 1), self-

discipline eliminates hazards by adhering to standards. Practiced good habits and self-control minimize or eliminate the hazards listed above in the CCPs (HACCP Principle 2). The CCP system developed can also be used to monitor and control compliance with standards and inspect the operation of self-discipline (HACCP Principle 4). Developing corrective actions (HACCP Principle 5) is an activity that will continue to encourage employees to exercise self-discipline and enforce set standards.[99]

Developing and applying a verification process (HACCP Principle 6) can also be done for self-checking and testing how effective and efficient the measures undertaken are. The last is documentation and records (HACCP Principle 7) of the activities performed, again this activity can be done in parallel for both HACCP and 5S. [99]

3.5. DATA IDENTIFICATIN AND ANALYSIS METHOD

Data specification is necessary prior to the collection. Because the system utilized in this research is widespread and complex, massive amounts of data are collected. It is extremely necessary to gather and keep only the data which will be of use in this research. Value stream mapping, being the central theme of this research, facilitates value-adding data specification. The data of the thesis is collected from primary and secondary sources. Observation and reading company reports, such as the annual report [16], is the key method of data collection. Secondary data sources for collection are books, literature, journals, and scholarly publications. Secondary data provided data on available literature regarding data collection. Secondary data provided data on available literature related to our study question. The qualitative data is collected from a literature

study. Quantitative data is attained by observation and examination of organizational records [16].

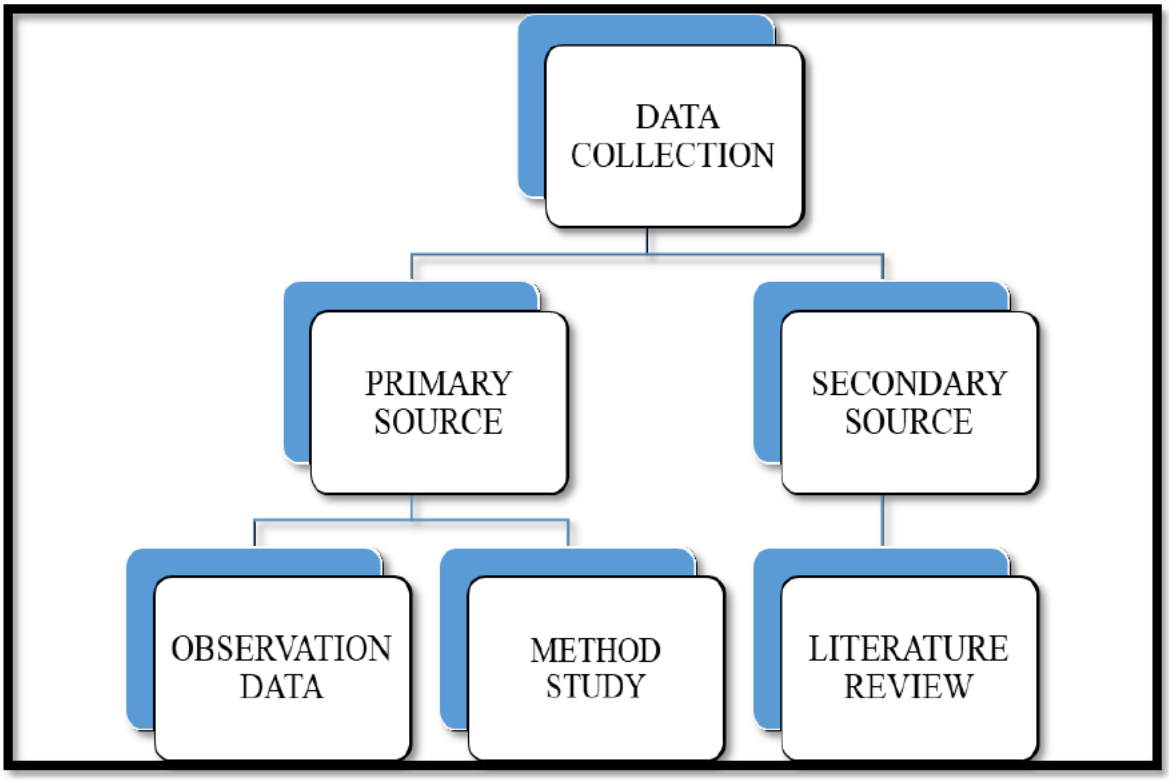


Figure 3.3 Data collection adopted method planning chat

Source: [16]

Our first step to achieve this balance is to make the Takt Time of the customer equal to the operation cycle times of the process. With an operation whose cycle time is more than the Takt Time, we will never be able to give an adequate number of products to satisfy the demand of the customer. This is a scheduled time based on available production time within an interval and the number of products ordered within the same period. [99]

Equation 1 **Takt Time = Total Available Production Time / Demand**

Our second action in determining the balance of the process of production is to compare cycle times across operations. There are two reasons for performing this action. To begin with, this aids us to spot out possible bottle necks in the process. Secondly, this comparison aids us to determine whether and when rebalancing of the process would be required. If operations' cycle times are normally different, short cycle operations will use less resources to the degree that it is costly and foolish. Additionally, it is

undemocratic [100]. In order to be able to respond to questions like, why certain operations need to work full-time and others part-time?

Equation 1 **Lead Time = Pre-Production Time + Production time + Waiting time + Transportation time + Storage time + Inspection time**

In VSM, value-added time (VAT), process lead time (PLT), cycle time (CT) and process cycle efficiency (PCE) are used to calculate for the improvement in the production process.

Equation 2 $\boldsymbol{Value\ added\ time = SUM\ OF\ EACH\ PROCESS\ TIME}$

Equation 3 $\boldsymbol{PLT = Sum\ of\ interchange\ time\ between\ processes}$

Equation 4 $\boldsymbol{PCE}\ \% = \frac{\boldsymbol{VAT}}{\boldsymbol{CT}}$

One thing to keep in mind while doing VSM analysis is whether the process can take care of the demand of the customer or not, and how much the process can cope with increased levels of demand. For this reason, we need to examine the bottle neck capacity, as this will determine the limiting rate of the process [37].

Equation 5 $Over\ capacity = Takt\ time - C/T Bottle\ neck$

3.6. RESEARCH QUALITY

Research validity and reliability are determined by demonstrating them. Both reliability and validity are crucial since they represent the research quality of a study. A combined approach was utilized in this research, with the qualitative strand considering the literature and the quantitative strand considering data from observations and organizational records. The research should differentiate validity from reliability. Reliability is the precision, accuracy, consistency, and dependability of the research outcomes. Quantitative research is more reliable than the qualitative study. It is a quantitative study with more emphasis on observation. The suitability of the data is what validates it [101].

Observation and record data were used in order to ensure the research was of quality. Reliability in this research can be termed as moderate because the research subjects were conducted in an SME firm where transformation occurs very often. Bryman and Bell term reliability as when the outcome of the research is used again or conclusions derived can be repeated again [102]. Since VSM is a continuous process and a circular activity, the same result was achieved whenever VSM was replicated. Also, repeated problems and repeated responses were found during interviewing.

Thus, providing guarantee of moderate reliability to this research. Other than the strength of this research, accounts of all those pieces of information seen and interviewed were disclosed to the manager, so that he may verify whether the gathered data were correct or not. Cause and waste were explored and thereafter empirical findings constructed on observation were compared. Recordings and transcripts were examined and heard numerous times to minimize misconceptions and improve internal validity. To increase the study's reliability and validity, data were gathered through a literature research and observation, as well as interviews with the entire population.

3.7. CONCLUSION

The quantitative underpinning of VSM enables data-driven, strategic decision-making. VSM achieves continuous improvement by quantifying entire value stream performance and identifying flow barriers/process breakdowns. Companies are in a more favourable position to meet their customer's as well as internal needs. Through the use of this method, the study will establish the efficacy of VSM and 5S principle and improvement results that could be attained, the following chapter will outline findings and discussion of data acquisition.

CHAPTER 4 FINDING RESULTS and DISCUSSION

This section strives to depict what results findings achieve within the study research, and it is interested in determining how lean tools, value stream map and 5S principle, contribute to productivity because by minimizing downtime on production tools and in processes, these tools may improve the efficiency and effectiveness of various organizational processes by utilization of VSM and 5S principles. Data analysis from observational studies and Organizational document. The findings provide fruitful information regarding Application of Lean Tools in Food Manufacturing Industries to enhance Productivity. This section will also comprise the observed manufacturing line's process flow, a case business description, value stream mapping, and other data analysis results.

4.1. PLANT PRODUCTION PROCESS

The plant production flow illustrates the primary processes in the company's food manufacturing process. It provides an overview of the most crucial steps of the production process. Several sub-components of the major systems combine and create the final product figure 4.1 below is meant to give the big picture of the process. The company has a simple process flow which is,

- Raw material collection
- Raw material storage Bin filling
- Mixing of ingredients
- Packaging
- Then finally dispatch / Dispatch finished bags

All above production steps, the study will conduct the VSM current State and will recommend the viable effective future state, bellow figure 4.1 will present more detailed aspects for each researched process.

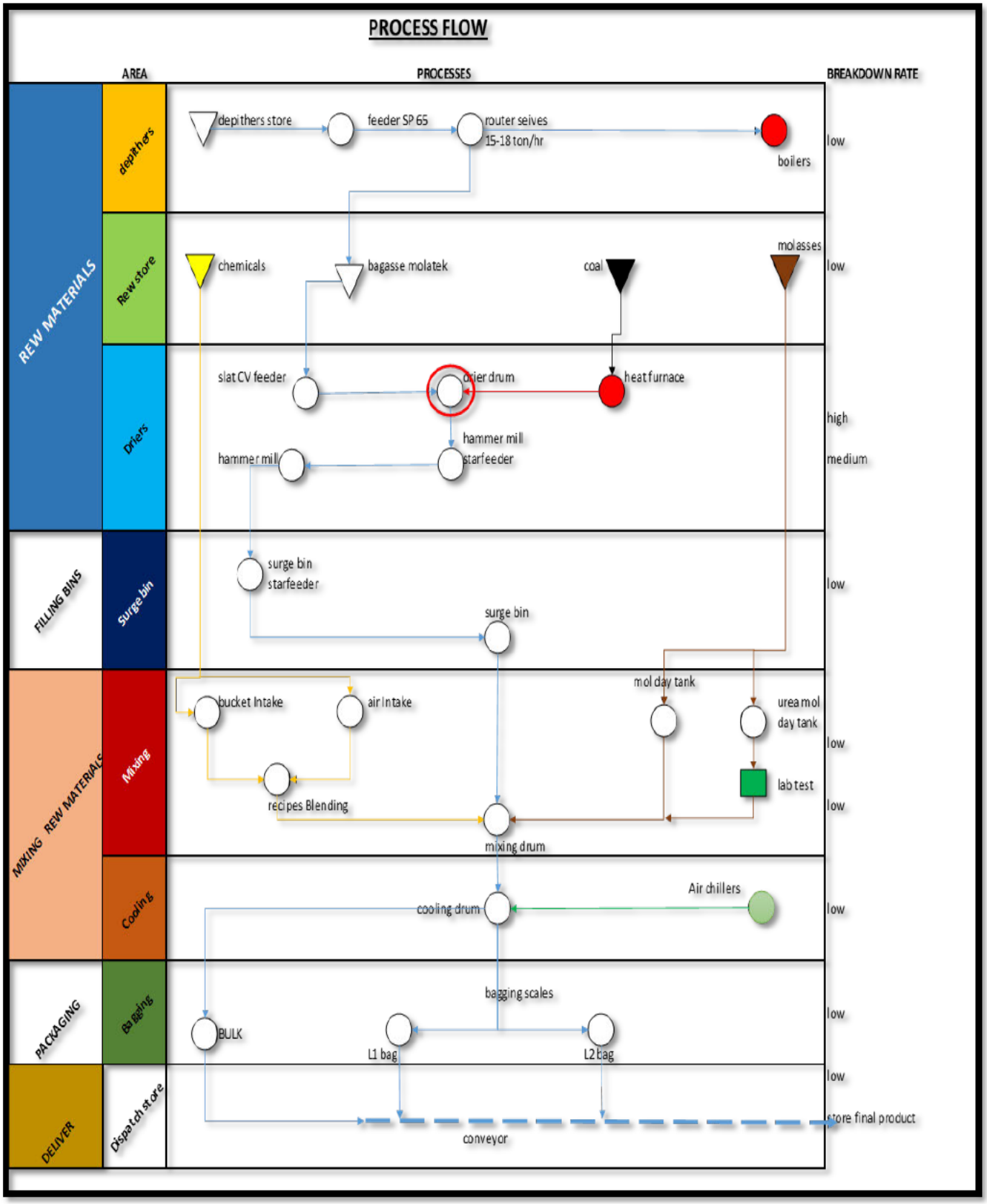


Figure 4.1 Production Process flow in Company x

Source: [100]

The company under investigation process flow is figure 4.1. The raw material regions initiate the food production process from where we acquire the most important factors necessary in setting the production process in motion. The most important factors are bagasse, molasses, and premixed feed chemicals. Bagasse begins at depither plant where there is wet bagasse stored and then proceeds to drying plant, this reduces the surplus moistures on the material after being properly dried the bagasse is then transferred to surge bins which serves as temporary storage of bagasse awaiting utilization.

Simultaneously premixed feed chemicals are removed from procurements store and stored in holding bins awaiting production and molasses to liquid sub tanks. In turn the raw material will be drowned in all bin and tanks to the mixing quad bin, whenever the feed is properly mixed it's then transferred through a curing cooler drams the sent to scales for packaging bags or block press. Though during this process parameters are taken into account to ensure free flowing of the process, PLC and SCADA system are used to facilitate better set up feedbacks from process line and better quality production and more accurate scaling in batched and final packaged product, finally when all the specifications are met then finished product is moved to dispatch stored for sells.

4.2. OBSERVATION TIME STUDY

Below is a brief description of how the process works at Company X from Receipt of orders to delivery to customers. It basically discusses the different phases of food preparation and providing to customers. This research process attempts to add up maximum 10 excursions and calculate the total average time in seconds accordingly and for every process researcher conducts time study. Table 4.1, is observation sheet prepared using Excel to calculate time for every process element to finish a job.

Table 4.1 Time study observation record sheet

Source: [100]

TIME STUDY OBSERVATION SHEET																				
Product code			*Batch plant*	*OPERATION*		*PRODUCT*									*DEPT:*		batch			
				DATE:									0,00		*MACH DESC:*		Entire process			
				Manning Count											*MACHINE No:*		NA			
Operation	Product description	Operator Number	*ELEMENT BREAKDOWN AND DESCRIPTION*		ELEMENT TIMES										CUM			TOTAL		
					1	2	3	4	5	6	7	8	9	10	TOT	AVE	TOTAL	SEC		
place order	1,00	0,1		0	60,00	60,00	60,00	60,00	60,00	60,00	60,00	60,00	60,00	60,00	600,00	60,00	0,132			
				0														0,132		
				0														0,132		
enter order	2,00	0,2		0	60,00	58,00	60,00	61,00	60,00	60,00	60,00	60,00	59,00	60,00	598,00	59,80	0,11			
				0																
				0														0,11		
Material Handling	batch	6,0	Gethering rew materials		120,00	122,00	119,00	121,00	120,00	123,00	120,00	118,00	119,00	120,00	1202,00	120,20	2,93			
																		2,93		
			filling bins		300,00	280,00	290,00	293,00	300,00	297,00	301,00	300,00	298,00	302,00	2961,00	296,10	7,21			
																		7,21		
			mixing product		480,00	480,00	480,00	480,00	480,00	480,00	480,00	480,00	480,00	480,00	4800,00	480,00	11,70			
																		11,70		
			packaging		180,00	189,00	179,00	180,00	185,00	180,00	180,00	182,00	180,00	181,00	1816,00	181,60	4,42			
																		4,42		
			load and dispatch		60,00	60,00	65,00	60,00	62,00	67,00	66,00	61,00	60,00	62,00	623,00	62,30	1,52			
																		1,52		
					Allowance Calculations										BASIC SEC			27,78		
				1,00	Personal	Basic fatigue	Standing	Abnormal position	Lifting	Atmospheric	Noise	Mental Strain	Tediousness	Monotony	% ALLOWANCE					
					5%	4%	2%	0%	0%	0%	0%	0%	0%	0%	STANDARD TIME			30,84		

Time study is a method for measuring work done taken for the purpose of measuring times and working rates for units of a certain job done under specified conditions and for purposes of analysis of data to determine time taken in working at a specified performance level. Table 4.1 is a excel sheet for calculation of allowance factor and standard time, the table contains department name which is batch plant and process description, 10 observation were taken per process with averages. All units of time were in second and converted to minutes. [103]

The following Method and steps was employed for Calculation table 4.1

Step 1: Choose the work to be worked out first. Split work content of work into smallest practicable pieces. Tell the worker, then determine how best to do so.

Step 2: Measure the time for the ideal number of cycles.

Step 3: Compute the average cycle time (CT)

$$\text{Average cycle time} = \frac{\text{Total of cycle times measured}}{\text{Number of cycles measured}}$$

Step 4: Determine the normal time (NT)

Normal time = Average cycle time x Performance Rating

Step 5: The above result can be applied to find the standard time,

$$\text{Standard time} = \frac{\text{Normal time}}{\text{Allowance factor}}$$

$$\text{Allowance factor} = \frac{1}{1 - \%\ \text{Allowance}}$$

4.3. VSM CURRENT PROCESS FLOW

Value Stream Mapping (VSM) is a tool for material and information flow analysis, required to offer a product or service to the final customer.[100] Now there is a trend in the current competitive age to make quality products keeping the voice of customers in mind and supply them at economical prices as well. VSM helps the manufacturers to know about their existing situation and learn types of wastes to avoid or eliminate.[99] VSM facilitates visualization of value, waste, and waste sources of the value stream and hence is a vital tool for manufacturers of any industry type. [100] VSM includes visualization of movement of all the elements and subassemblies through the value stream, for example, production, suppliers, and distribution to the customer. The other significant observation is that VSM can be performed by an individual who is aware of the process but not the factory which produces it [100]. Apart from this, it is necessary to have a careful analysis of every activity in relation to their cycle time, the number of

work stations, the number of workers allocated to a particular workstation, and the activity time between operations which are of no value from the perspective of the customer.[100]

The sum of all the times will allow calculation of the total lead time. General consideration is needed to ascertain inefficiencies and areas of needed improvement, with the goal of enhancing overall efficiency and productivity of the process. The process under analysis here is from thermal treatment through to delivery of the finished product to the customer. [103] The above Current State map depicts how the current state process works, with a pictorial view of all the tasks carried out by the organization from start to finish in order to produce the product.[103]

It is used for mapping the current process and searching for the various wastes in order to improve it. Following an understanding of the basic concepts of VSM, there was a walk-through of the whole process of the example company, from receipt of order to delivery, with their management team, marking information flow and material flow.[103] Before drawing the present state map, material flow and information flow symbols were gathered, which were used to draw the VSM. As the starting point for the present state map, the research boundary must be defined, beginning with client orders and proceeding through to delivery. [103]

According to Langstrand's work, the current state map consists of the current cycle times, change over time, lead times, uptimes, Takt times, and inventories, which are recorded while taking the tour on the shop floor [104]. This current state version must be refined and used as a reference. The current state is utilized to gain a deeper understanding of the entire process. This allows the team to generate better solutions that will pinpoint areas of the process where the organization can improve.[104]

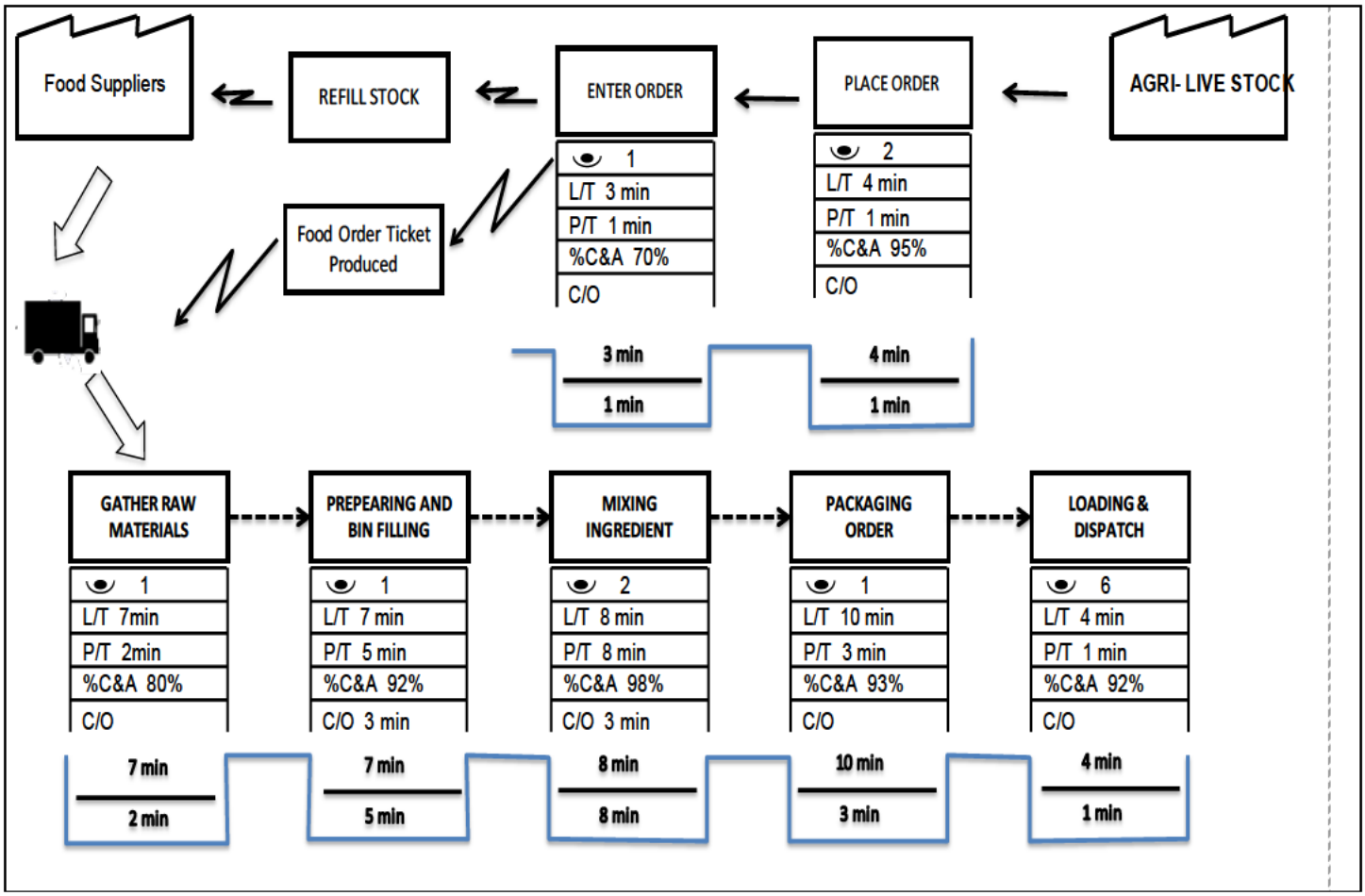


Figure 4.2 The Current state of VSM process flow chat

Source: [104]

4.3.1. Lead time

Now to determine the total lead time, it is determined by summing up the Pre-Production Time, Production time, Waiting time, Transportation time, Storage time, and Inspection time. Here, the lead time is calculated as

Lead time = 7+7+3+8+4+10+4

= 43min or = 2580sec

4.3.2. Process Time

Processing time – Processing time for the single batch here a batch is equivalent to 1 ton of production. Now to find the value add time its total cycle time for all production process which is given below

Process Time = 2+5+1+8+1+3+1

= 21min or =1260sec

4.3.3. The production Change Over time

The duration between the last good piece in one batch and the first nice piece in the next. (Setup time). COT is calculated as follows:

Change Over time = 3+3

= 6min or = 360sec

However, in this case, the changeover is carried out at one-time the change over time will be 3 min.

4.3.4. Takt time

Takt time is the rate at which we must produce in order to meet the needs of the consumer. Takt time is an important metric in any continuous flow (Lean manufacturing) production process, as proved by the VSM study.[100] It is simply the duration in which the consumer requires another unit. To calculate tact time, utilize the Current state map to determine the amount of units needed/transitioning. Calculate this using Equation 1, where the production time is 21 minutes and the customer demand is 200 tons.

$\boldsymbol{Takt\ time}$ = (8hr*60) / 200 ton

= 2.4 min/ton or = 144sec/ton

For simple processes such as this one, the process time and the cycle time are equal, so it is easy to handle. We may assess process efficiency by dividing the value-adding time (process time) by the entire lead time.

$\boldsymbol{Process\ efficiency}$ = $\Sigma Process\ time$ / $\Sigma Lead\ time$

= 21/43

= 0.488 *100

= **48.8%**

$\boldsymbol{Over\ capacity}$ =$Takt\ time - C/TBottle\ neck$

=2.4 – 8

= 5.6min*60

= **336sec**

4.4. THE PROPOSED FUTURE STATE

A future state map will demonstrate how the company should operate in order to get the greatest competitive advantage through the use of VSM [103]. The future state map will also indicate potential for improvement at each phase that would have a substantial impact on the overall manufacturing system, which would subsequently be adopted, resulting in a leaner production process [103]. On figure 4.3 is the future state suggested to enhance productivity. Considering the VSM packaging had more Lead Time now, we will implement steps that will reduce the time on packaging to improve the process and decrease downtimes.

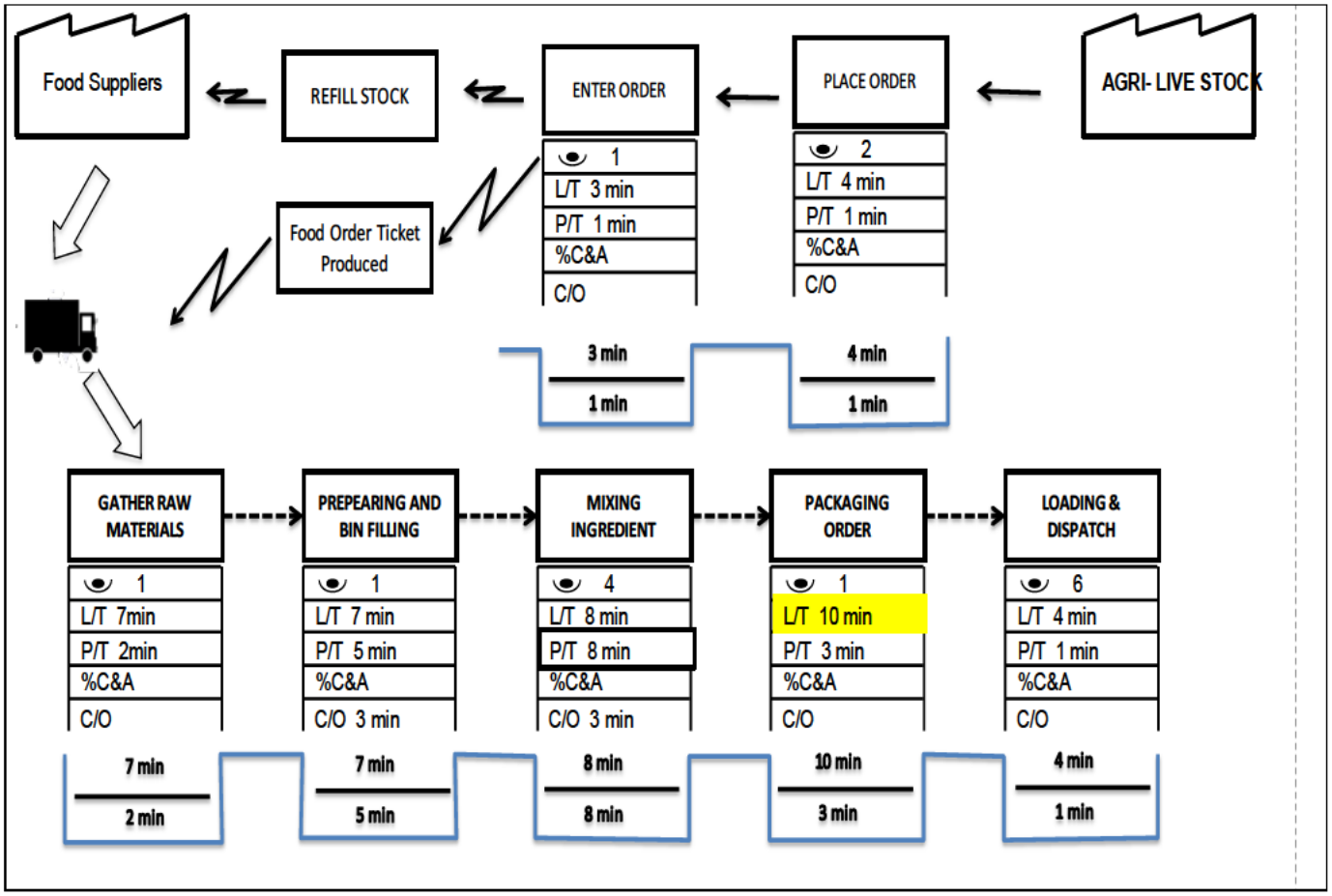


Figure 4.3 The future state of VSM

Source:[104]

4.4.1. ELIMINATION OF NON VALUE ADDING ACTIVITY'S

After identifying that the packaging process is the partial area with higher L/T, the researcher zoomed in on the process to collect more data with regard to reducing the high L/T. table 4.2, below shows how the process had been compromised by this listed non-value-adding activity in the listed three months of study, although currently most of the activities need a long-term plan to be eliminated to zero. The time in the table are in hours, for example on May 2024 unplanned production stops where **107.4** hours.

Table 4.2 Non value adding activity time study

Source: [103]

Non value adding activitys	May-24	Jun-24	Jul-24
Unplanned production stop-Lines	107,4	52,6	2,7
Chokes	29,8	13,6	0,7
Rawmaterial shortage	3,2	1,7	0,1
Shortage of People	5,5	0,1	0,1
No Bags	0,0	0,0	0,0
Insufficient Bagasse supply	65,0	35,3	1,7
Quality	3,8	2,0	0,1
Planned Maintenance stops -Lines	0,0	0,0	0,0
SAP Shedules	0,0	0,0	0,0
Planned Maintenance stops	0,0	0,0	0,0
Unplanned Maintenance stops -Lines(Breakdowns)	132,8	52,7	3,1
Electrical	85,9	38,2	2,1
Mechanical	46,9	14,5	1,0

The bar chart below Figure 4.4, shows that in 3 months the researcher determined that there is a high value of unplanned maintenance stoppages during packaging (electrical and mechanical), followed by planned line stopping which is one of the activities that is off control. Now the researcher will focus on eliminating the chocks on the

manufacturing line. With 5S practices, we were able to pin out some of the issues that resulted in chocks during the production see Appendix A.

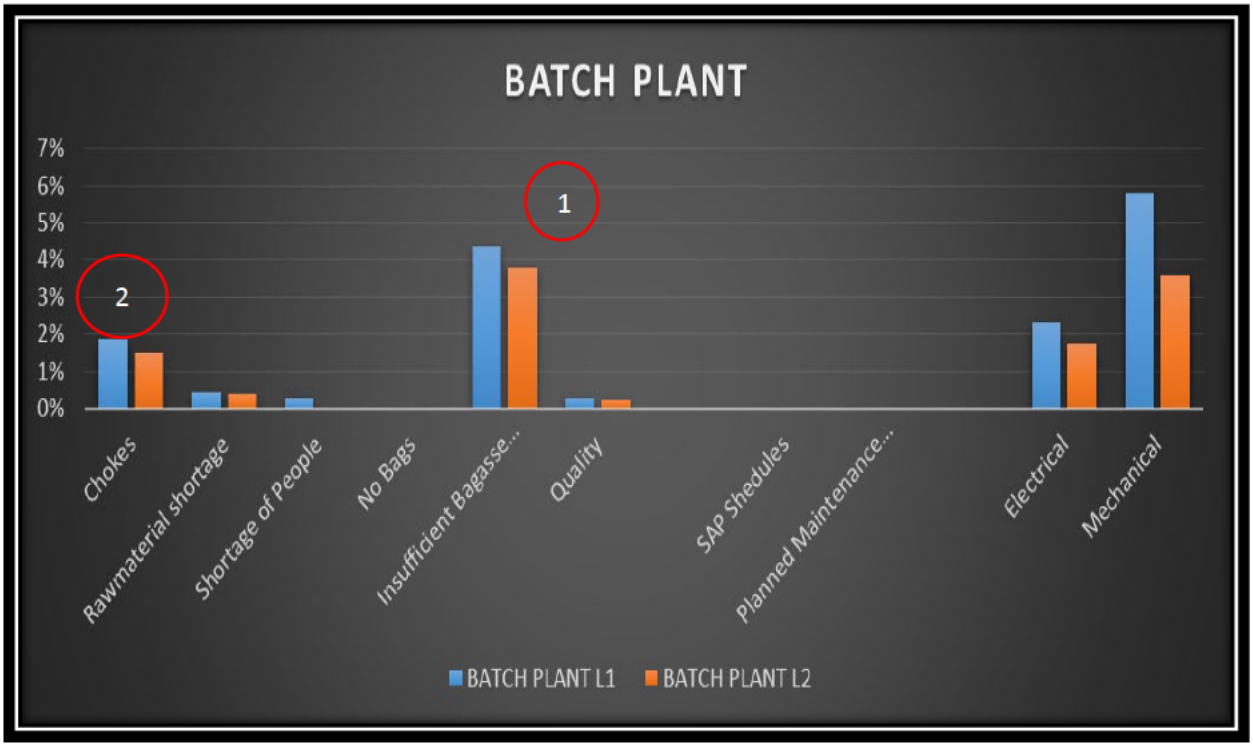


Figure 4.4 Non value adding activity graph percentages

Source: [103]

4.4.2. 5S IMPLEMENTATION TO IMPROVE VALUE STEAM MAPPING PROCESS FLOW

Application of 5S has historical show a positive results in improving any production line now this results will demonstrate the 5S application with VSM to improve productivity of the company production line. To ensure that every team member understood the 5S project a trial use demonstrated in one of the production offices for every individuals to observe the results obtain in just a short period of 5S.

4.4.2.1. 5S DEMONSTRATION STEPS IN MANAGEMENT OFFICE.

This was assigned to Unit Coordinator and Zone owner to implement in-house 5S training courses within the organization as per the 5S Training planner and guidebook. 5S Zone Standards training was also implemented. The whole set of training documents

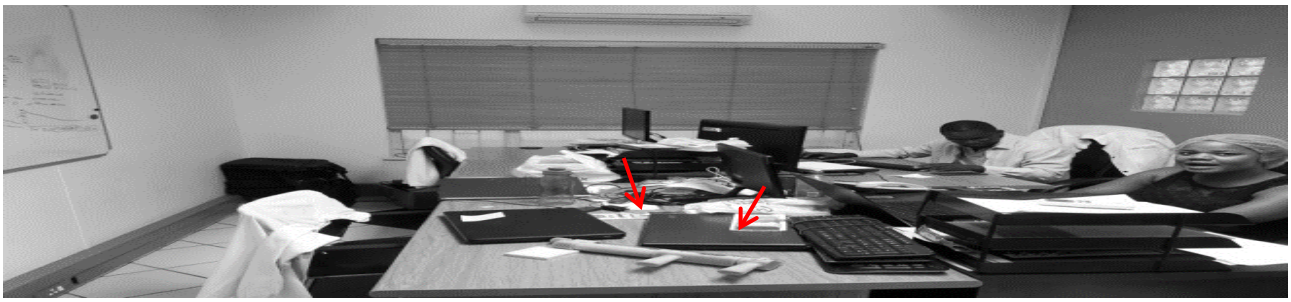
i.e., planner, attendance list and guidebook were retained on file and displayed during internal/external audits. This exercise has made the gates ajar for the elimination of doubts at the grass root level workers. They are the one who don't only know problems but also solutions. Through intervention of trainings, the company got the twin benefits, cost cutting at the shop floor and sense of belongingness among workers.

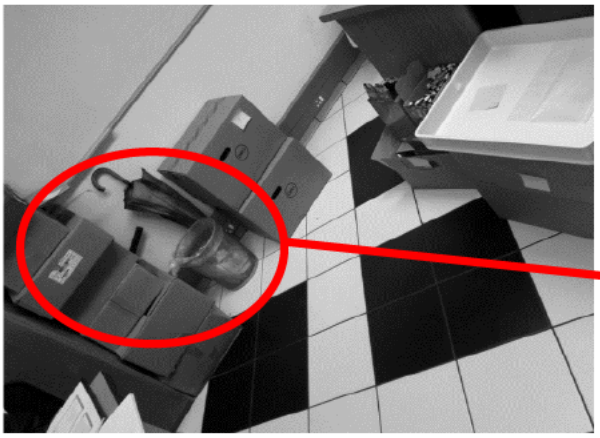
Thus, created a win-win scenario. The benchmarking using the tool 5S was very successful since we had to sort things and dispose of machines of all the redundant tools and sanitize the machines and working area. What you read below will demonstrate how we go about the implementation of 5S. This is the project that was initiated in the company's office as a pilot 5S implementation area, it has the objectives of improving order and cleanness, Working environment and climate, Quality, and Allow effective maintenance. Budget Cost of the project R0

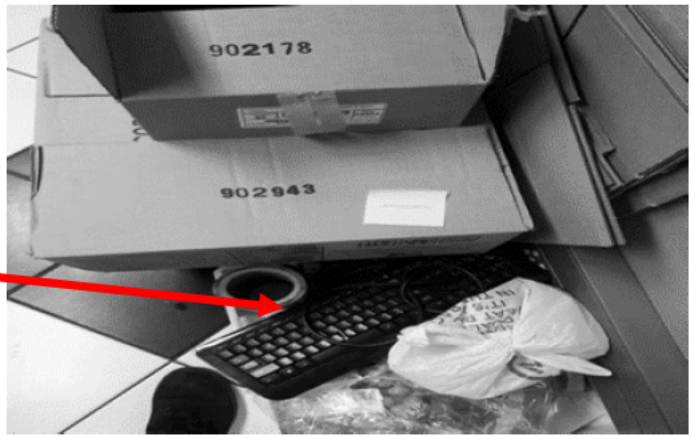
Project results. Start date: 27/03/2023 - End date: 30/03/2023 - Duration time: 3 days

Table 4.3 5S trail and training for studied area

Source: [99]

SORTING

• Observe and identify areas of improvements. • Communicate before rearranging.
SET IN ORDER



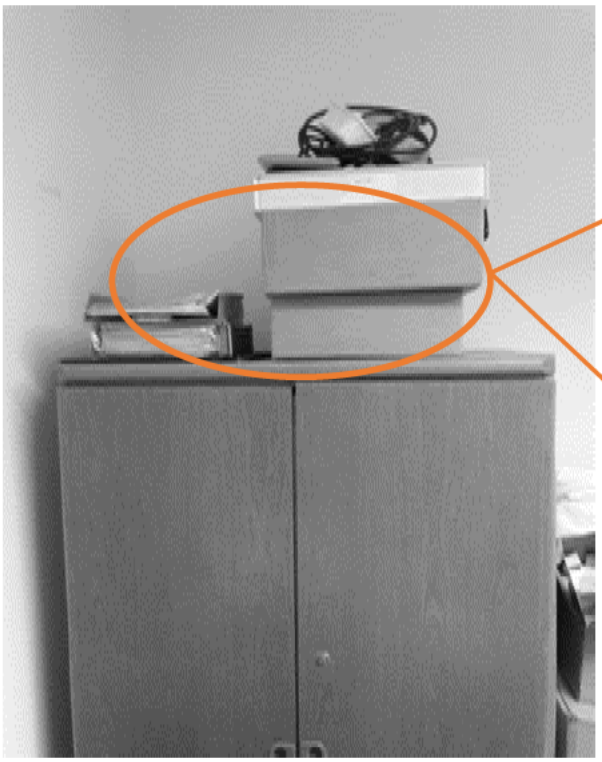


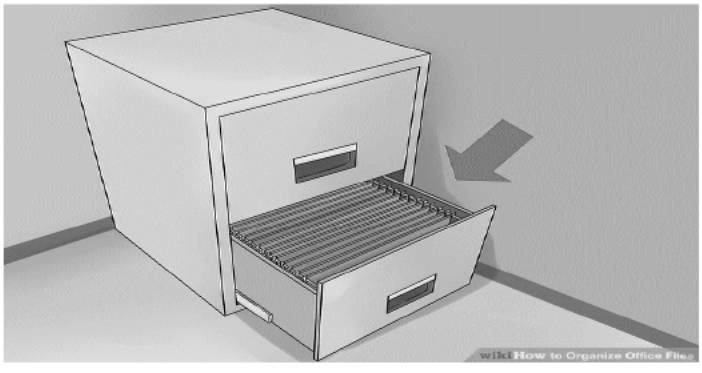
- Label or red tag items to remove.
- Consider key 1 check list developed.

This level of 5s has helped the trainees identify areas for improvement as well as select the equipment not needed as shown above using a red arrow, those are some of the things not needed

- Make workflow smooth and easy.
- Clearly wipe off dust and check any unwanted items.

SHINE





- Common things put in a same box and label what is in side.
- Visible lines to indicate path ways. Marking areas (using colours per area).

The shine step above work should be done on a regular basis.

STANDARDISE

- At this level, we preserve the first three S.
- Conduct a 30-second test (ask for the necessary tool after setting up the order).
- Create control sheet plans and signs.
- Create a work framework that integrates new practices into regular routines.
- Ensure everyone understands their roles for sorting, organizing, and cleaning.
- Use images and visual controls to maintain proper order.
- Regularly review the progress of 5S implementation with audit checklists.

Checklist

The table where designed and used to maintain the necessary activities that should be done daily which are set to be at least 15 min per day.

SUSTAIN

- One-point lessons.
- Also known as "do without being told" and refers to training and discipline.
- Training is a goal-driven process. Its resulting feedback is required monthly.
- Demonstrate self-discipline by keeping daily tasks neat and organized. Make it easy to locate and get important materials).
- Maintain order by ensuring all standards are followed and heard.

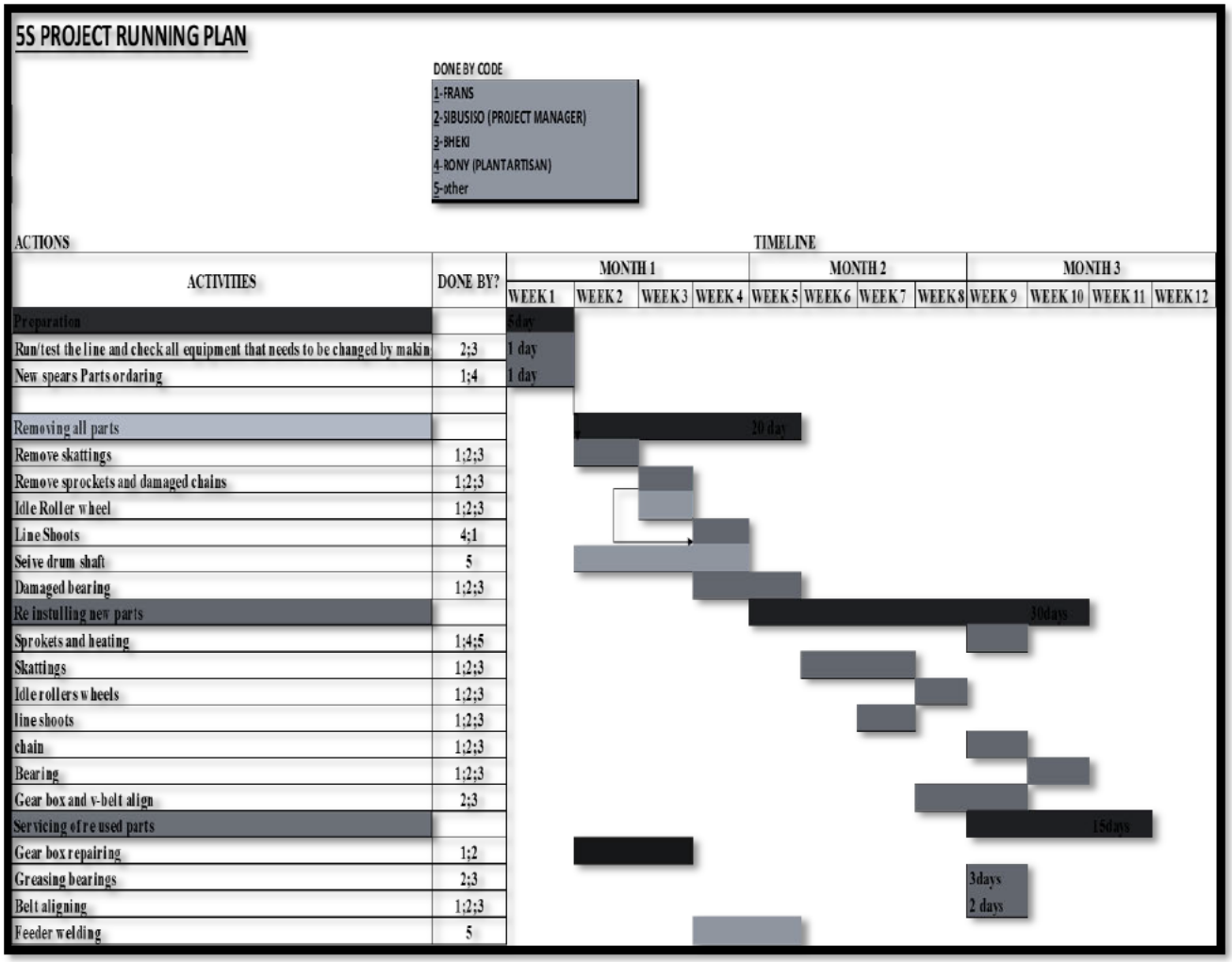
4.4.2.2. SUCCESSFUL 5S IMPLEMENTATION PLANNING

Before the project begin, a plan was develop to ensure proper flow and clear allocation of responsibility in participants during the 5S run project, bellow is an excel sheet that allocate activities that are required and estimated date of completion for each activity. This project will run for 12 weeks to ensure more sustainable results. The project

planning become a success and good guide in obtaining improvement in the production line.

Table 4.4 Project Running plan

Source: [97]



4.4.2.3. STEP 1 OF 5S - SORTING

Round up some front line staff and 5S ambassadors to sort together. Sorting is best done when you can assemble a group identify, define criteria, sort and relocate. Now we set definite criteria for what is not necessary in terms of usage frequency, how applicable they are to our operations at the moment, and condition. You could think of sorting items as figuring out what's required for everyday operations. Ask whether an item is essential for the work being done in that area. If not, consider removing it.

Measure frequency of use. Frequently used items should be made easily accessible, while occasional need items may be stored in less accessible places. Identify duplicate items and whether all are needed. Duplicate items are a waste of space and should be

removed. Establish each item's purpose. If the purpose of a thing cannot be determined or cannot be perceived to have any use, it is on the chopping block. Make sure to retain only what is necessary for safety or regulatory purposes and keep them in good storage. There is no regulatory- or safety-related item which must be eliminated. Plan for future requirements, but do not overstock simply because future requirements are unpredictable. Strike a balance between existing needs and future applications.

Involve the individuals using the space in the sorting. They will likely know what they require for work and can provide valuable feedback. Go through each item in the workplace, separating them into essential (used daily for work) and not essential (outdated, seldom used). Sort items into "Keep," "Discard," or "Reallocate" piles according to the established criteria. Dispose of outdated materials in an appropriate manner or move them to off-site storage areas that are not part of the immediate working environment.

Materials to be relocated in groups should be moved to storage places, out of the immediate working area but as near as possible in case of need. Such storage areas should be clean, labelled, and easy to get to. This keeps the workspace uncluttered and facilitates ease of retrieval whenever necessary. Ensure proper disposal, which can be recycling, donation, or appropriate waste disposal according to company policy and environmental regulations. Maintain records of products disposed of, together with the reason for disposal. This record assists in tracking progress and making future-informed decisions.

4.4.2.4. STEP 2 OF 5S - SET IN ORDER

Begin with an evaluation of the current layout and organization of the workplace. Decide how things are currently organized and identify inefficiencies or safety risks. Consult frontline employees to design an effective layout. Consider workflow patterns, item frequency of use, ergonomics, and safety standards. Develop basic guidelines for positioning items by frequency of use, workflow sequence, and ergonomics. Allocate some space for different types of items. What to keep in mind when doing this is to keep things within easy access and within arm's length, with no excessive bending or stretching. Arrange things in such a way as to keep safety risks to a minimum, placing heavy or dangerous items safely and securely in storage.

Maximize the use of space through proper placement of materials in a systematic way without jamming or obstruction. Rearrange the workplace according to the set standards. Position high-frequency items in convenient locations, high-frequency tools at arm's reach, and low-frequency items in far locations. Use visual indicators such as color-coded labels, signs, or floor markings to show item location, storage, or direction of workflow. It assists in organizing and guiding productive movement within the work area.

4.4.2.5. STEP 3 OF 5S - SHINE

Before starting to clean, gather cleaning materials required—cleaning chemicals, equipment, safety gear, and waste disposal. Develop a cleaning routine that is suitable for the specific requirements of your workstation. Daily quick brushings and weekly deeper cleanings will keep it clean without disrupting operations. Move everything out of the area to have a clear and obstruction-free cleaning route. Cleaning should start from the top and work down to prevent re-contamination of surfaces already cleaned. Use the correct cleaning products and equipment for the different surfaces and equipment. Pay particular attention to the frequently missed areas such as corners,

shelves, and the rear of equipment. Look for signs of wear, damage, or potential safety hazards while cleaning. [99]

Figure 4.5 CLEANING AND INSPECTION

Source: [99]

Once the sanitizing process of the area is done, organize equipment, material, and tools in a logical sequence. Utilize visual signals like color-coding or labelling for reference and pickup. In 5S this step the check were performed and marked where caution is required, the following figure 4.6 and 4.7 shows results pre and post the project and comments on what improved and compliance with the safety standards.

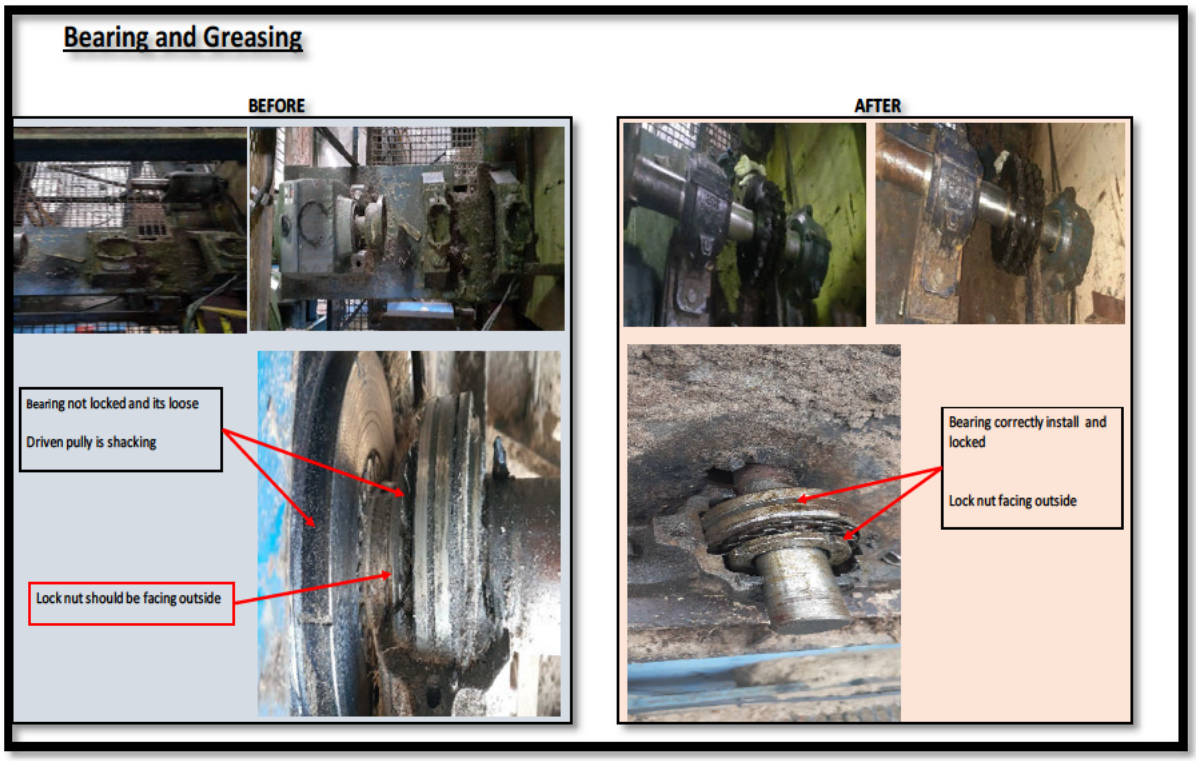


Figure 4.5 Before and after changing bearings and greasing

Source: [99]

Now to ensure that all objective are achieved with productive result all moving parts required bearing check and replacements or broken components. In this case some bearing were found not to be fitted appropriately and already lost their running value

time, this resulted on speed lose in the machine and motor faulty trips. Fig 4.6 shows why regular cleaning of plant is important and how that would improve plant productivity, and in order to increase flow of raw material new rollers were also installed in a properly maintained area. [99]

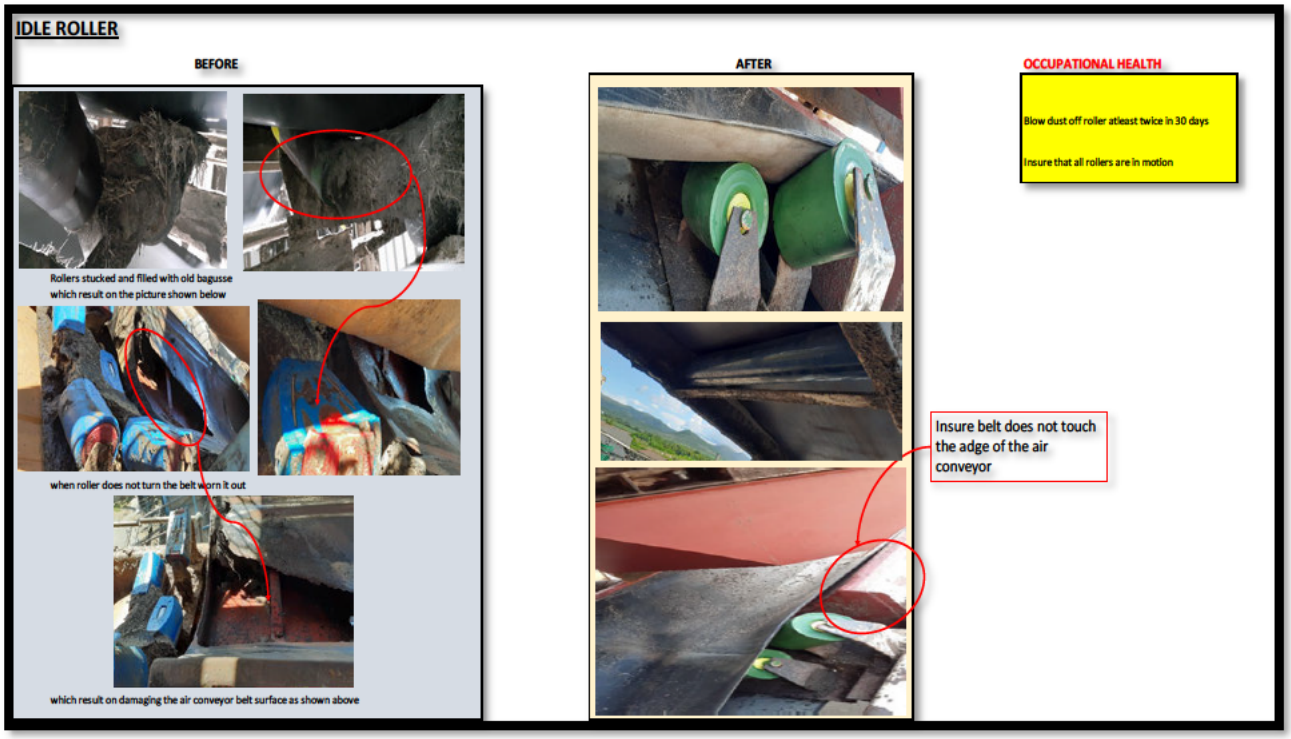


Figure 4.6 Cleaning and replacing damaged rollers

Source: [98]

4.4.2.6. STEP 4 OF 5S – STANDADIZEDING AND CULTURE DEVELOPING

Establish Clear Standards by creating step-by-step instructions on how to complete each step of 5S. Provide guidance on the level of organization, cleanliness, safety, and visual indicators. Establish Standardization Procedures by Demonstrating step-by-step instructions on how to perform each step of 5S, Provide training and material to give people clarity on and adherence to these steps. Policies were formulated in such a manner that an organisation can attain the objectives laid down. The following objectives were taken into consideration while applying the project in the Zone. The objectives are the end to a plan whereas policy is the means and manner taken to achieve each objective. Each Objective worked for one or the other S to identify zone owner for the storage space (S5).

To evaluate the safety & hygiene needs to prevent pilferages & thefts. (S3, S4, S5). To establish the procedure to be followed on raw material received by store keeper. (S4, S5). To make the recovery process of store items effective. (S2, S5). To introduce FIFO to prevent loss of materials. To establish the disposal plan for expired & rejected material (S1, S5). To establish and reinforce 5S in the zone. (S5)

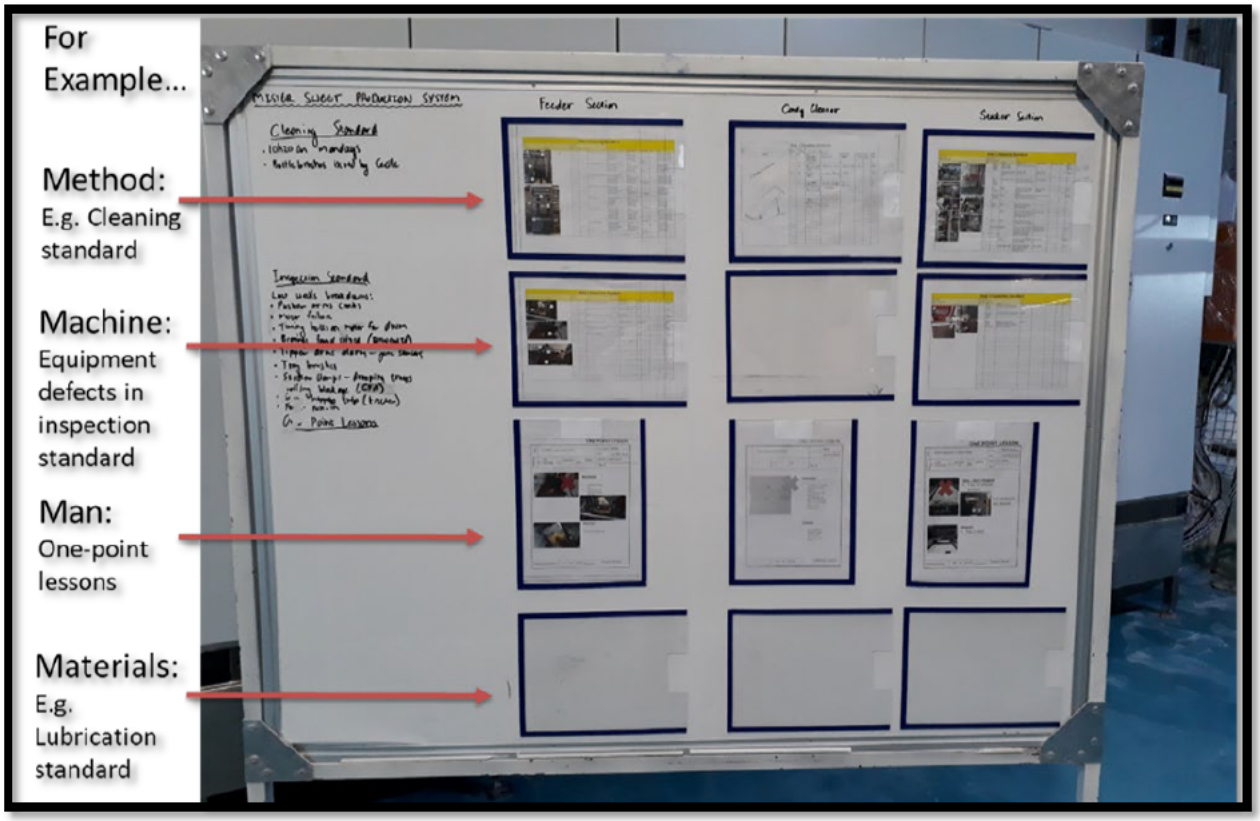


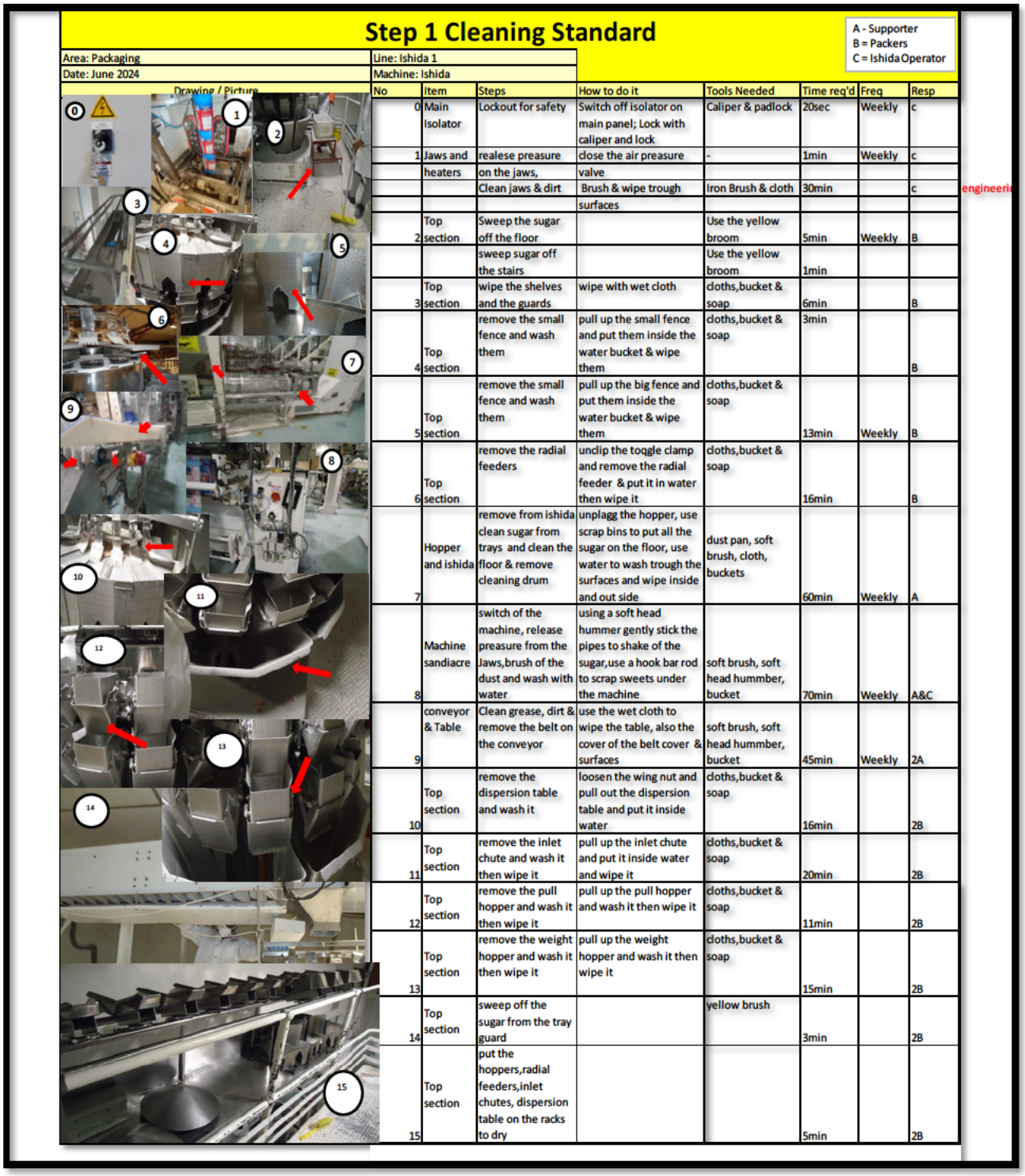
Figure 4.7 The 5S principle Sustain white Board

Source: [98]

Table 4.3, is one such criterion set that requires monitoring to avoid wastage of time and maximize equipment efficiency. The white board will display the process to be followed to ensure standards of hygiene in compliance with food safety and HACCP and it will also indicate the possible future equipment breakdowns that can be detected through inspection, this will also inform the online maintenance schedules for this includes lubricating and dust cleaning of moving parts. Apply visual cues such as colour coding, signposting, and labelling to quickly identify materials, equipment, and some locations. Visual cues should reflect standardized process and expectations. There has to be regular auditing to assess conformity to standardized practices. Gather feedback and data to identify areas of need and standardize adjustments accordingly. Standardized procedures and guidelines must be written to access them easily. Make adjustments or modifications in standards promptly and effectively to all the stakeholders.[98]

Table 4.5 Demonstration of equipment cleaning standards

Source: [98]



Step 1 Cleaning Standard

A - Supporter
B = Packers
C = Ishida Operator

Area: Packaging
Line: Ishida 1
Date: June 2024
Machine: Ishida

Drawing / Picture

No	Item	Steps	How to do it	Tools Needed	Time req'd	Freq	Resp
0	Main Isolator	Lockout for safety	Switch off isolator on main panel; Lock with caliper and lock	Caliper & padlock	20sec	Weekly	c
1	Jaws and heaters	realese preasure on the jaws,	close the air preasure valve	-	1min	Weekly	c
		Clean jaws & dirt	Brush & wipe trough surfaces	Iron Brush & cloth	30min		c
2	Top section	Sweep the sugar off the floor		Use the yellow broom	5min	Weekly	B
		sweep sugar off the stairs		Use the yellow broom	1min		
3	Top section	wipe the shelves and the guards	wipe with wet cloth	cloths,bucket & soap	6min		B
4	Top section	remove the small fence and wash them	pull up the small fence and put them inside the water bucket & wipe them	cloths,bucket & soap	3min		B
5	Top section	remove the small fence and wash them	pull up the big fence and put them inside the water bucket & wipe them	cloths,bucket & soap	13min	Weekly	B
6	Top section	remove the radial feeders	unclip the toggle clamp and remove the radial feeder & put it in water then wipe it	cloths,bucket & soap	16min		B
7	Hopper and ishida	remove from ishida clean sugar from trays and clean the floor & remove cleaning drum	unplagg the hopper, use scrap bins to put all the sugar on the floor, use water to wash trough the surfaces and wipe inside and out side	dust pan, soft brush, cloth, buckets	60min	Weekly	A
8	Machine sandiacre	switch of the machine, release preasure from the Jaws,brush of the dust and wash with water	using a soft head hummer gently stick the pipes to shake of the sugar,use a hook bar rod to scrap sweets under the machine	soft brush, soft head hummber, bucket	70min	Weekly	A&C
9	conveyor & Table	Clean grease, dirt & remove the belt on the conveyor	use the wet cloth to wipe the table, also the cover of the belt cover & surfaces	soft brush, soft head hummber, bucket	45min	Weekly	2A
10	Top section	remove the dispersion table and wash it	loosen the wing nut and pull out the dispersion table and put it inside water	cloths,bucket & soap	16min		2B
11	Top section	remove the inlet chute and wash it then wipe it	pull up the inlet chute and put it inside water and wipe it	cloths,bucket & soap	20min		2B
12	Top section	remove the pull hopper and wash it then wipe it	pull up the pull hopper and wash it then wipe it	cloths,bucket & soap	11min		2B
13	Top section	remove the weight hopper and wash it then wipe it	pull up the weight hopper and wash it then wipe it	cloths,bucket & soap	15min		2B
14	Top section	sweep off the sugar from the tray guard		yellow brush	3min		2B
15	Top section	put the hoppers,radial feeders,inlet chutes, dispersion table on the racks to dry			5min		2B

4.4.2.7. STEP 5 OF 5S – SUSTAIN AND NORMALIZING

Normalizing phase comprises the "Sustain" and "Standardize" steps since they are concurrent steps to attain standards and take advantage of opportunity for improvement. After designing your 5S program and rationalizing the workstation, you will establish materials through which you standardize the process. [98]

- Standardization gives consistency and uniformity to organizational work practices, processes, and visual controls organization-wide, leading to increased efficiency, safety, and long-term payoffs.
- Sustain is how you make your standardization initiative happen

Figure 4.8 CLEANING PROTECTIVE PERSONAL EQUIPMENT

Sustain entails creating habits, routines, and practices that ensure the established levels of cleanliness, order, and efficiency are sustained. It entails creating a mind-set among the employees to follow the 5S principles at all times, incorporating it into organizational culture. Sustenance of 5S principles requires constant reinforcement, training, monitoring, and continuous improvement activities to prevent backsliding and to ensure positive changes become permanent in the work environment. Far and away, the most important element in maintaining 5S is regular audits see appendix B.

4.4.2.4. APPLICATION OF VSM AND 5S ENSURES THE STUDY SUCCESS

Application of lean tools VSM and 5S has been successful on this study by increasing productivity efficiency in food production through:

- Elimination of random Breakdowns

- Reduction in time between failures in pieces of equipment
- Reduction in Ongoing maintenance costs
- Less Consumer complaints about late delivery and food contamination
- Increase in efficiency: 38% (2022) to 60% (2024)
- Improved food safety by FSSC 22000 and ISO 9001

See, appendix A for an overall picture of what was accomplished with the results of 5S throughout research. It is necessary to follow and maintain improvement on this whiteboard of complaints and standards henceforth. All were eagerly quiet to be a part of revolution and standard elevation and culture creation. Tangible and intangible rewards were palpable. Most importantly, pride and belongingness were visibly apparent.

Internal Audit Scores, Productivity and Efficiency greatly increased due to effective planning of space management and participation of all employees. Normal and abnormal wastages were regulated. Accident-free working condition developed due to effective demarcated gangways and fire evacuation routes and fire assembly point. Morale of workers was maximum because they were actively engaged in the project.

Their merit was taken into consideration; they were put into action and achieved net gains by the management and were rightfully rewarded according to internal reward and award policy structure. Team had also taken part in National CII 5S Excellence Award under FMCG sector surpassing their peers with their intelligence work. Similarly, they exhibited their work at Quality Circle Forum. Their good deeds and positive thinking resulted in productive outcomes of achievement.

4.4.2. FUTURE IMPROVEMENT AFTER VSM

Considering the calculation after changes are implemented, the results show that

21min=1260 sec, and also Mentioned above the $Takt\ time$is given by, (8hr*60) / 200 ton = 2.4 min/ton=144sec/ton. By elimination of chocks in the production can improve the production process. In the packaging process the **Lead time**= current state – future state = **10min- 5min= 5min**.

The improved, **Lead time** = 7+7+3+8+4+5+4

= **38min= 2280sec**.

So, now to identify the process efficiency by:

$\textit{Process efficiency}$ = $\Sigma Process\ time / \Sigma Lead\ time$

= 21/38 = 0.553= **55.3%**.

4.4.3. DISCUSSION

In this part of the dissertation, the results and conclusions of the research with the issues that were encountered and how they were addressed and other author's views. This part also includes the improvement recommended and suggested. Productivity of the company is now improved anonymously with some of the operators struggling to accept the new way of doing things. The goal of this report was to get rid of the factors that cause the operators to fail to hit the target established on a daily basis. The 5S system forces the companies to tighten control measures that aim to eliminate wastage in the manufacturing process and enhance a company's bottom line in general. This is done via product improvement and services and even cost savings. But the author had also advised that all the operators should be punctual and should observe all the unnecessary movements. It also advised that all the equipment used should be in good condition at all times.

4.4.3.1. INCREASE PRODUCTIVITY IN THE PROCESS

Because of the exceptional production boom, this study states that the lean mode of operation may be initiated through the technological application of VSM. Manufacturing has increased from 48.8% to 55.3% of items each shift. The question now is how this rise in production was accomplished, and if the case firm will be able to maintain this quick increase in output. Yes, this company will be able to increase productivity because it has received that many customer orders, which equates to productivity improvement, as well as the fact that management intends to produce approximately 85% of products per shift because they anticipate that many customer orders.

Respond to the question on how productivity grew by 6.5% as a result of flaws in their present processes, resulting in a lack of effective planning and management. By

employing VSM, segregating the assembly into stages, and standardizing various processes, all non-value-added activities and wastes were nearly eliminated while maintaining the flow. This enabled the achievement of the goal production, i.e., the influence of lean concepts and VSM implementation.

4.4.3.2. SUCCESSFUL REMOVAL OF PRODUCTION WASTE

As previously indicated in the data analysis, VSM eliminated a significant amount of waste. Womack also believes that eliminating waste is beneficial to an organization's efficiency and product quality [64]. The elimination of all of these wastes in case companies not only boosted efficiency and product quality, but also aided in the maintenance of continuous flow and proper usage of space, staff, and stocks. VSM is easier to implement since these wastes are efficiently eliminated. This research was able to reduce all waste (non-value-adding operations) while also increasing productivity significantly. Therefore, keeping these in view, this study asserts it is achievable and a good idea from a technical perspective for a firm to adopt a lean approach to working when the case firm does not possess explicit knowledge about lean.

CHAPTER 5 CONCLUSION

The researcher concludes the research. Reacher summarizes the primary findings in order to make assertions about the study's aim and objectives, motivation, and findings. This section will explain the study's implications and make recommendations for future research, as well as evaluate the study's limitations and potential areas for future research. The conclusion will emphasize the study's contribution to the current body of knowledge on the application of lean technologies such as VSM and 5S.

5.1. STUDY CONCLUSION

Presently, in the rapid globalization and technological advancements, the customers of the day want products that are good quality but less expensive. With this growing demand, the traditional modes of production are not in a position to cater to this new threshold level of customer demands. Thus, in the present competitive world economy, there is a greater need to adopt new manufacturing processes so that one can deliver a great product within a shorter duration of time and at lesser cost so that every firm can compete. Lean manufacturing is a proven technique of creating a competitive edge. For an organization to adopt lean, its employees must know about lean.

This dissertation, thus, is a case study of a firm ready to embrace Lean. Though there are varied methods of embracing lean, in this study, only the implementation of Value Stream Mapping (VSM) has been examined due to the benefit it proffers. VSM has been applied in research for which data were gathered through observation and the organizational document [35]. Waste was eliminated and disposed of after VSM implementation, hence enhancing productivity, reduced idle time, lead time, and cycle time [100]. It also eliminated other issues and challenges and discontinued them in VSM implementation. According to the study questions, it is confirmed that VSM is a beneficial strategy to adopt lean means of operation from experience and understanding of lean manufacturing.

To provide such evidence on the application and use of VSM from the methodological as well as organizational point of view was established. Two strips of evidence for VSM use from the technical point of view are enhanced productivity and efficient eradication of wastage. Support and management buy-in and willingness and acceptance to change

and support and management buy-in and acceptance and willingness to change are two indicators in support of the study's findings on adoption and implementation of VSM from an organizational perspective.

The report shows that the management requires a committed and dedicated workforce with specific responsibilities. The top management must be in a position to provide resources needed and incur some of the initial costs of defining the line. The transition of moving from traditional manufacturing to productive approaches is an organizational change. Hence, the organization anticipating lean implementation with the help of VSM must have well-defined goals, priorities, and should be aware of the benefits of lean. Moreover, through this study it is revealed that theoretically the company can make some sort of productivity improvement and the VSM output will be at least 29.7% wastages removed which will get the company to 85% efficiency.

This study also encountered a number of issues such as supplier and external consultant issues. These issues and hindrances need to be pinpointed and removed. This study proposes the implementation of soft lean techniques first and then VSM. This study also recommends the company to conduct training and workshops on lean in order to successfully deploy VSM. The study uncovered that certain areas in the region under study were creating waste and should be enhanced. Lean Manufacturing methodologies such as Value Stream Mapping (VSM) and 5S were utilized in the project. From the analysis performed, it was realized that Successful Implementation of a Project: The research proved effective implementation of Lean Manufacturing tools in a food company. This reality serves to prove the adaptability and application of Lean principles to unusual manufacturing sectors for making food, which is diverse in being involved with unusual issues pertaining to hygiene, safety, and regulation.

Identification of Production Bottlenecks: Through observation and analysis with the aid of the Value Stream Mapping tool, the stage of packaging was determined to be the production bottleneck. It was the point of bottleneck in the process that was preventing overall efficiency. Through identification of this phase, it was realized where the effort for optimization is needed to be utilized. There were also other variables that could be optimized which were found, and this served to demonstrate the full diagnostic capability of VSM.

Reduction in Number of Employees and Inventory The project activities saw a significant cut in the number of employees required and the inventory levels. This was achieved by eliminating inefficiencies in the process steps and workflow optimization. Levels of inventory decreased straight away to decreased holding costs and waste caused by perishable goods. In addition, fewer manpower needs with no losses in terms of output indicate effective operations and human resource usage. Cost Savings and Work Culture Improvement: These process improvements translated to cost savings each year, which could be reinvested within the company for future development or other strategic goals. Furthermore, ergonomic and work culture change were substantial. Improved work conditions don't just enhance employees.

5.2. ACADEMIC CONTRIBUTIONS

The writers can draw on their expertise in industrial engineering and management. The article provides readers with a concise introduction to the tool Value stream mapping on the basis of 5S principles, as well as an overview of how the tool can be applied and what elements of the tool can be used as a starting point for a company that is ready to implement lean but lacks any knowledge about it. This dissertation shall serve as the bridge to further studies on the application of value stream mapping to lean implementation in a small business. However, as previously mentioned, this study provides the way for firms who want to make the transition from a traditional manufacturing approach to a better one. It assists in acquiring an understanding of the factors for success in change implementation, the leadership function and management's awareness of the results. The study also cites numerous criteria, challenges, and barriers to be considered before applying VSM to implement lean in an organization that is new to it.

5.3. THE FUTURE WORK

As described above, this thesis is the foundation for an organization wanting to implement lean through VSM. Where VSM was conducted manually, that did not have any limits. Simulation can be used in future research to obtain accurate readings and results. This study considered only VSM, whereas other lean tools can be used in the future to assist a company in implementing lean practices. This study emphasized hard lean practices with less regard to the significance of soft practices, which are essential

in implementing lean in an organization. Future studies might be able to explore soft practices. As the study was on a single case study, it created issues with external validation. Repeating the same studies in multiple companies or a number of case studies will contribute to more external verification and use of results.

This study can be utilized as a starting point for more studies on the application of lean and VSM in an uninformed organization. There are not many articles composed concerning this, so more study is needed in order to encourage small businesses to add lean and VSM to their production systems. It would be great to discuss if other studies in this field have reached the same or different conclusions.

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APPEDIX A

APPLICATION OF 5S

ENVIRONMENT

- **Improved tool selection time**
- **Area is more Safe to work**
- **Scape are removed**

AREA	BEFORE	AFTER
WORKSHOP AREA ✓ Workshop spares are not packed on shelves		
PALLET STORE AREA ✓ Pallets are not correctly placed		

EQUIPMENT

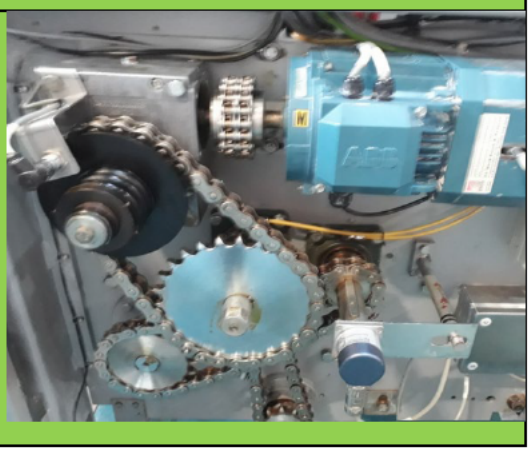
- **Elimination of random Breakdowns**
- **Time between failures**
- **Ongoing maintenance costs**
- **Cleaning time: 7 hours to 4 hours / wk**
- **Decrease in Consumer complaints**
- **Increase in Efficiency: 38% (2022) to 60% (2024)**

UNMANNED WEIGHBRIGE

- ✓ Area was not cleaned.
- ✓ Boom gates are damaged.

CONVEYOR SYSTEMS

- ✓ Conveyor mechanism are not cleaned which results spillage of raw materials.
- ✓ dirt was getting into motor and chain panel, now cleaned to prevent bearings and chains from breaking and creating unplanned downtime



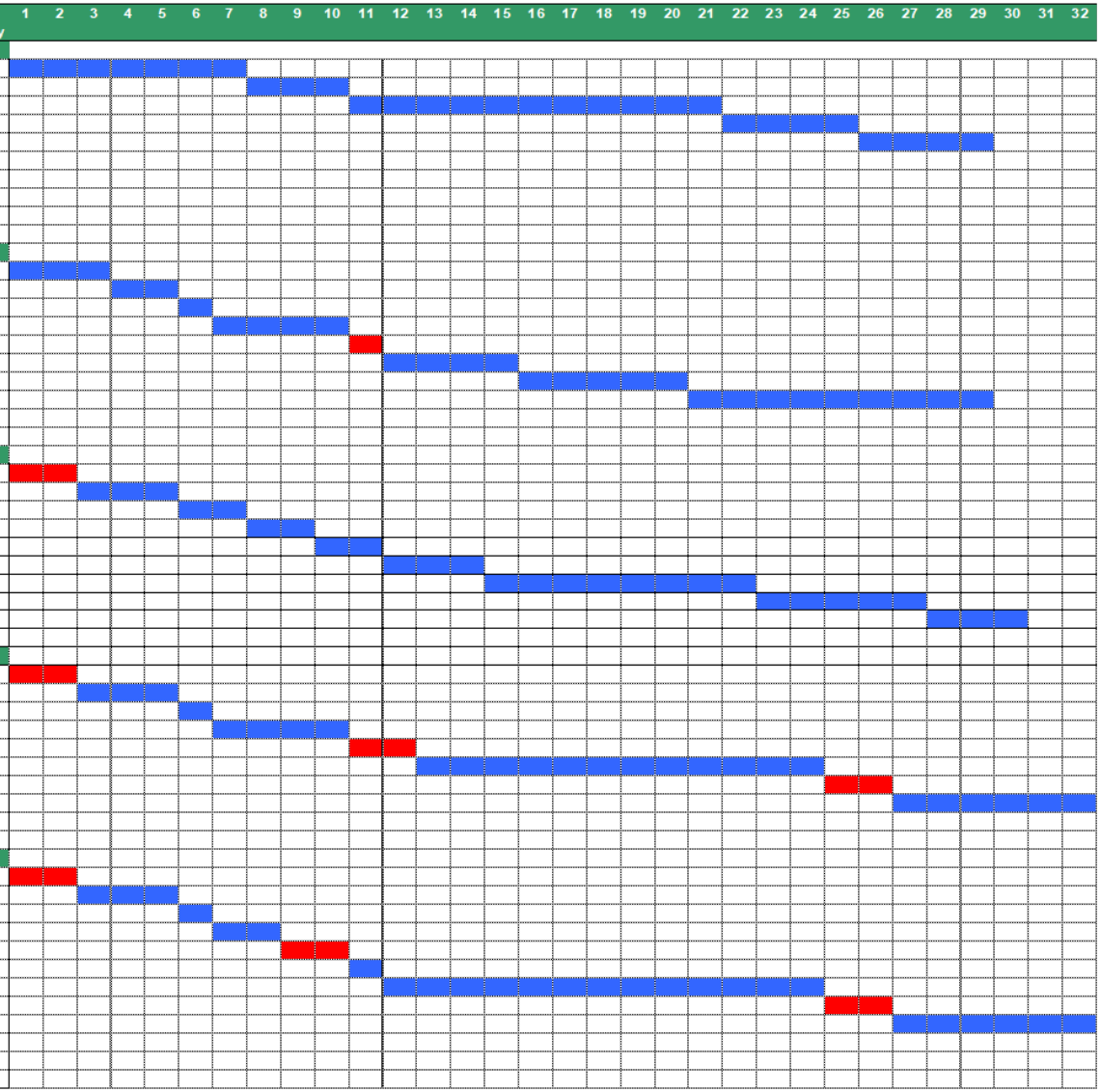
APPEDIX B

5S analysis

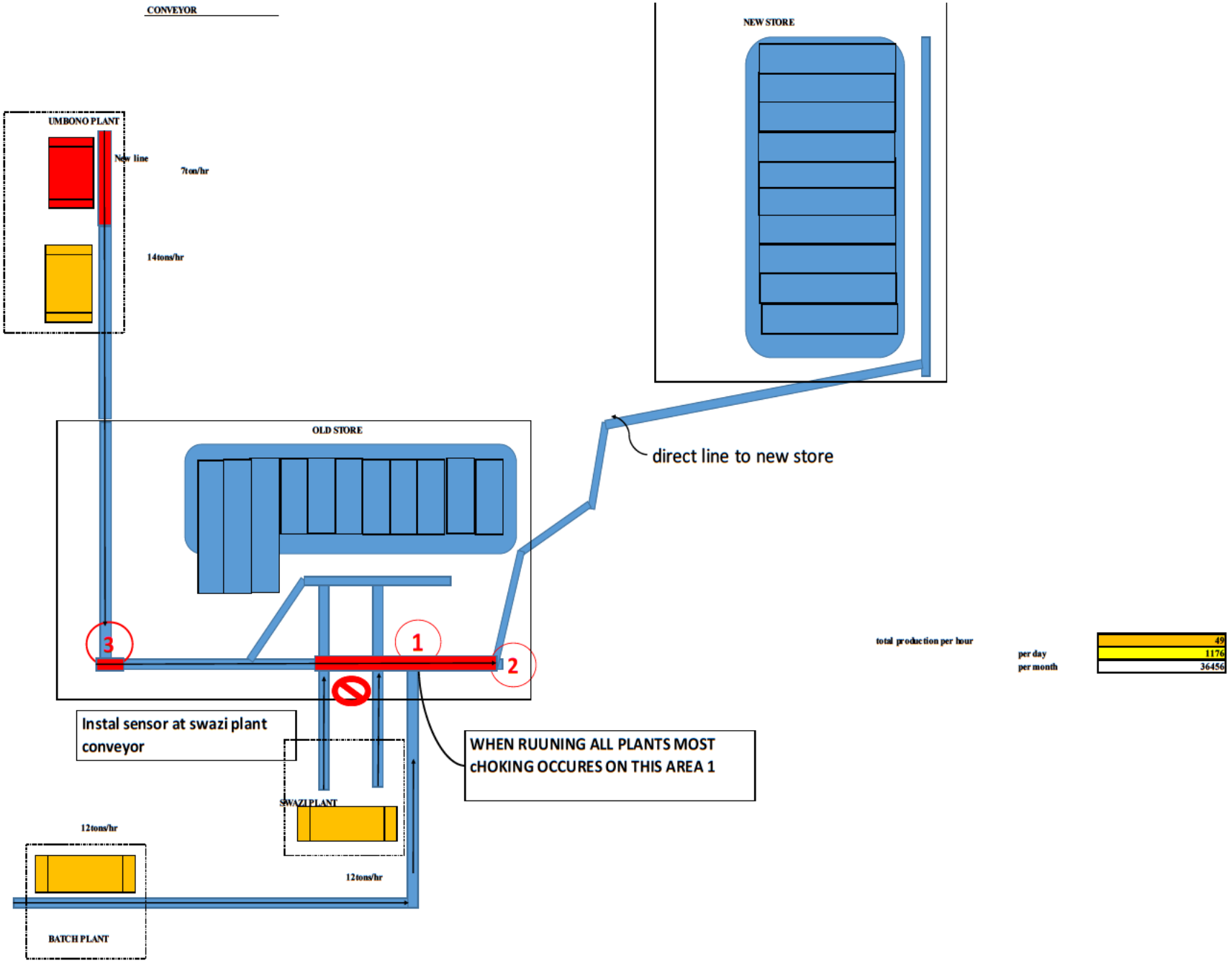
Basic information:		
Observed by	sibusiso	
Date		
From:	To:	
Area	production	
Each cell is	1	Minutes

Activity Categories	
Activity	Category
Working/C	1
Cleaning	2
Break/Sea	3

#	Activity Description	Time	Start	Category
	Operator 1			
1	Upper belt cleaning with air	7	0	2
2	Sweep	3	7	2
3	Upper belt cleaning with air other side	11	10	2
4	Sweep	4	21	2
5	Tray empty	4	25	2
5			29	
5			29	
5			29	
5			29	
5			29	
	Operator 2			
1	Clean the belt	3	0	2
2	Cleaning with air the belt	2	3	2
3	Clean the belt	1	5	2
4	Cleaning with air the belt	4	6	2
5	Loitering	1	10	3
6	Clean the belt	4	11	2
7	Cleaning with air the belt	5	15	2
8	Sweep	9	20	2
8			29	
8			29	
	Operator 3			
1	Give information to the other worker	2	0	3
2	Clean the belt	3	2	2
3	Cleaning with air the belt	2	5	2
4	Clean the belt	2	7	2
5	Cleaning with air the belt	2	9	2
6	Clean the belt	3	11	2
7	Cleaning with air the belt	8	14	2
8	Clean the belt	5	22	2
9	Sweep	3	27	2
9			30	
	Operator 4			
1	Listening to the other worker	2	0	3
2	Clean the belt	3	2	2
3	Tray empty	1	5	2
4	Clean the belt	4	6	2
5	Loitering	2	10	3
6	Sweep	12	12	2
7	Loitering	2	24	3
8	Clean the belt	6	26	2
8			32	
8			32	
	Operator 5			
1	Listening to the other worker	2	0	3
2	Clean the belt	3	2	2
3	Tray empty	1	5	2
4	Clean the belt	2	6	2
5	Loitering	2	8	3
6	Sweep	1	10	2
7	Clean the belt	13	11	2
8	Loitering	2	24	3
9	Clean the belt	6	26	2
9			32	
9			32	
9			32	
Total			32	



APPEDIX C


CONVEYOR
NEW STORE
UMBONO PLANT
New line
7ton/hr
14tons/hr
OLD STORE
direct line to new store
3
1
2
Instal sensor at swazi plant conveyor
WHEN RUUNING ALL PLANTS MOST cHOKING OCCURES ON THIS AREA 1
SWAZI PLANT
12tons/hr
12tons/hr
BATCH PLANT
total production per hour
per day
per month
49
1176
36456