Arab American University

Faculty of Graduate Studies

Lean Manufacturing Methodology and its Role in Increasing Productivity and Reducing Costs at To-me Cosmetics Company

By

Fatena Abu Daher

Supervisor

Dr. Ashraf Almimi

This thesis was submitted in partial fulfillment of the requirements for the master's degree in

Quality Management

January-2022

I

Lean Manufacturing Methodology and its Role in Increasing Productivity and Reducing Costs at to-me Cosmetics Company

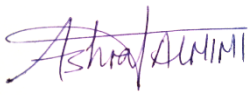
By

Fatena Abu Daher

This thesis was defended successfully on 24 /02 / 2022 and approved by:

Committee members

Signature

1. Supervisor: Dr. Ashraf Almimi 
2. Internal Examiner: Dr. Majeed Mansour 
3. External Examiner: Dr. Nidal Dwaikat 

Declaration

I acknowledge that I have written and developed this Master's thesis entirely, it was created by me as a result of my original dissertation, and I have not submitted it elsewhere to support my application for any other degree or qualification.

Name: Fatena Abu Daher

Signature:

Date:

Acknowledgement

At the outset, I would like to thank the Arab American University represented by the Postgraduate Studies - Quality Management Department for the science and knowledge that it gave me and provided the tools required to achieve this. I also extend my gratitude to my supervisor, Dr. Ashraf Al-Mimi, for his support, advice, and unlimited cooperation during my studies at the university until the presentation of this study.

I also extend my sincere gratitude and thanks to the employees of TUMI, especially the improvement team, for their efforts and support, and I would like to thank the director of the company for his cooperation and support and for giving me the opportunity to implement my project in his company and for providing me with all the necessary information.

This study is dedicated to my life partner, Tariq Iraqi, and my son Khaled, as they are the torch that lit my life and provided me with encouragement and continuous support from the beginning of my joining the Quality Management Program until the completion of this study.

The first and last gratitude to my parents, brother and sisters who instilled in me a love of science and continued pursuing my dreams and goals until my last breath.

Author,

Fatena Abu Daher

Abstract

In today's competitive markets, with increased competition in the labor market, increased demand for industries, increased awareness of customer quality and the need for better efficiency, reduced cost, improved quality, reduced variance and increased productivity, companies have to became more keen on an aspect of continuous improvement. And its adoption as basic standards for organizational culture. Hence, companies tend to use Lean Management System to increase their productivity and improve their business processes with quality, efficiency and effectiveness through the effective application of Lean tools.

This study examines the effect of applying the Lean manufacturing methodology on industrial companies in the cosmetics sector. Furthermore, this study explains how applying this methodology can help beauty product manufacturers make the most of their resources and organize the workplace to become more productive.

The importance of this study stems from the need to improve the productivity of the liquid production line, take advantage of warehouse space and establish a maintenance system in To-me Cosmetics in Ramallah by eliminating waste and reducing variance in order to survive in the rapidly developing world.

Lean Manufacturing Methodology was implemented using a combination of tools such as VSM, 5S and TPM. The current performance in the measurement phase was measured using a VSM, Flowchart, Eight Wastes. The Root Causes of the problems were identified using a cause-and-effect diagram and interrelationships paragraph. The planning and Data were collected through interviews with the company staff and the live observation of

production process data like cycle time and delay time, which was essential to identifying process efficiency and potential improvement opportunities.

Productivity of the fluid line production process is improved by using the first three stages of the 5S concept, the flow chart, and the value flow planning. The results achieved were maintained using the last two phases of the 5S concept, the flow chart, business models, and checklists.

At the end of the optimization efforts, fluid production line productivity and planning were improved reducing the lead time for kitchen cabinet doors production from 2707 minutes to 1096 minutes with improvements in warehouse space utilization resulting in a more streamlined work environment, reducing the number of accidents by 45%. Moreover, inventory management is improved by controlling the procurement and storage of raw materials. The use of TPM also contributed to establishing a maintenance system, reducing wasted time, and controlling maintenance parts and maintenance operations on machines.

This study contributes to the definition of the application of lean management in small and medium-sized enterprises in the Palestinian industry, and confirms the importance of this methodology in improving quality by eliminating waste and reducing variance, which plays a major role in the survival of the Palestinian economy, which faces many challenges.

Keywords: Lean Manufacturing, Value Flow Map, Eight Wastes, 5S, Total Productive Maintenance, Cause and Effect Diagram.

Table of Content

List of Figures

List of Tables

List of Appendices

List of Abbreviations

- VSM: Value Stream Mapping
- 5S: Sort, set in order, Shine, Standardize, and Sustain
- TPM: Total Preventive Maintenance
- CT: Cycle Time
- DT: Delay time
- LT: Lead Time
- ID: Interrelationship Diagram.
- NIS: New Israeli Shekel.
- SMEs: Small-Medium Enterprises

Chapter 1: Introduction

1.1 General Background

Productivity is tacitly improved through quality improvement, and in the current rapidly developing world, there is always an opportunity for improvement that must be exploited in order to survive. This goal can be reached through the Lean manufacturing (LM) methodology, which is considered one of the most important contemporary improvement methodologies.

LM methodology has been adopted among other improvement methodologies such as VSM (Value Stream Map), TPM (Total Production Maintenance), 5S (Sort, Set in order, Shine, Standardize and Sustain) due to the need for the company to organize the work environment and eliminate waste. This is done through the application of LM Tools.

In today's developed world, companies are constantly competing with each other to produce the best quality products, through implementing all tools and strategies to ensure increasing their profits and decreasing their costs at the same time. Decision-makers support the new trends of reducing cost and vis-à-vis increasing their profit, and achieve competitive advantage.

In these times of industrial recession, the world should view these difficult economic conditions as an opportunity to re-engineer and improve operations and operational characteristics towards a robust production method, eliminate unnecessary waste and expenditures while imposing quality at all stages. (Anthony, P., 2018).

On the other hand, today market is more than ever full of stiff competition. There is an increasing demand for different types of products with an enormous number of production

processes, taking into account the industrial need to reduce costs while sustaining quality at the same time. (Philipp Moser& Others 2019)

To achieve this development, a different approach can be taken in manufacturing, which should ensure more efficiency to the production mechanism. Lean Manufacturing (LM) can provide the impetus needed to excel in producing a variety of high-quality products. (Melton, 2005; Womack and Jones, 2003)

LM is today a subject of continuous study and a production system that is adopted by many industries who wish to benefit from the advantages of LM such as improved quality delivered, reduced inventory, elimination of waste.

(Sahar, and others) examined the relationship between LM implementation and improvement in production. They have statistically proven that organization that continuously implement LM will certainly improve their process productivity. They also confirmed that training staff members is essential to the success of LM implementation.

Lean manufacturing is a strategy that focuses on the continuous disposal of all types of waste in the manufacturing processes. These wastes include the well-known eight types of wastes abbreviated by DOWNTIME. More specifically, DOWNTIME includes the wastes of defects, over production, waiting, non-utilized talents, transportation, inventory, motion, and excessive processing.

High levels of productivity ,competitiveness and quality stimulated actions seeking continuous streams, manpower and machinery in the best sequence of activities, aimed at reducing waste in order to add value by setting guidelines called Lean Manufacturing (PASCAL, 2008).

Correa and Vieira (2008), that representation of results that the Lean Manufacturing methodology , which had as precursors Eiiji Toyota and Taihichi Ohno of Toyota

Motor Company has been a recognition of movement in the Western world. The LM became part of the Company competitive strategy, providing productivity improvements whose interest is to increase the availability of resources, reduce costs, reduce waste and increase efficiency.

The scope of implementation of the LM methodology as an improvement methodology takes three to six months through analysis of the factors that hinder increased productivity and reduced costs are identified. The current process is analyzed and improved by identifying the root causes of deficiencies. Ultimately, the study seeks to improve productivity by using various tools in order to maintain gains by installing innovative process improvement elements.

The success of LM implementation is a commitment by senior management that includes resource allocation, employee engagement, and capacity building to improve operations. The research goal is to improve the productivity of the fluid production line, making use of warehouse space, and controlling, following up and documenting the maintenance process.

The results of this research include the participation of employees, reducing the time of the production process, making better use of space, following up on the inventory management system, increasing productivity and reducing costs at To-me Cosmetics Company.

1.2 Problem Statement

It is evident that SMEs are very important for the economy of a country; so it is very important for these enterprises to pay attention to negative influences that affect the survival and contribute to the failure of the enterprise (Nikolic and others, 2018). On the

other hand, (Sing, 2018) concluded that enterprises should control their production processes, identify and eliminate wastes, and continuously improve their productivity, LM has proven to be an effective methodology to achieve these goals.

To-me company-driven environment of current manufacturing systems and the competitive pressure of the global economy are forcing manufacturing firms to become more integrated, flexible and automated in order to increase their productivity at low costs.

To-me company is having trouble improving the production processes and to eliminate/reduce the different types of wastes in every area of the company's production lines, such as excess inventory, excessive movement, poor planning, untapped personnel, unstable production schedules, which lead to a decrease in productivity, efficiency and an increase in costs at To-me Company.

The company also has a limited space to move between materials in warehouses, which negatively affects the progress of the production process due to the existence of an unorganized work environment, a crowded place, thus wasting time and increasing waste. The generated waste that does not add value to the product in company will not just waste materials and work resources, but it will also create material shortages, hinder agendas and workers' energies, create idle time in subsequent workstations and extend manufacturing lead times . Process waste leads to additional equipment and tools, additional manpower, complex material flow, storage Inventory, doubtful quality, missed delivery and lower profits and therefore management does not assist in tactical and strategic decisions.

According to the company’s sales records; the highest demand from the customer is for the liquid line products. The company has low control on the production process of this

line, low control on raw material consumption or storage, lack of machines maintenance, and unidentified wastes and defects. This led to long production period for the liquid line, delay to customer's order, and high cost.

1.3 Questions of the study

In this research, the study is conducted to answer these questions:

1. Will the application of the Lean Manufacturing methodology results in increasing To-me company's productivity and efficiency?
2. Will the application of the Lean Manufacturing methodology results in reducing To-me company's costs?

1.4 Research Propositions:

To examine the effect of implementing Lean Manufacturing methodology on increasing productivity and reducing costs in the To-me cosmetics company, the following propositions are developed:

Proposition 1: Lean manufacturing methodology positively affects the increase of productivity.

Proposition 2: Lean manufacturing methodology positively affects the reduction of costs.

1.5 Significance of the Study

The manufacturing environment has witnessed, in recent years, a radical and significant development in manufacturing systems. As consumers became more demanding and seeking diversification and quality prosperity, and in this competitive environment, the To-me company seeks to develop effective production methods that help in meeting the

diverse requirements of customers, the utilization of available resources effectively and efficiently. The increasing of productivity and competitiveness of the company, the reducing of the costs consumed and the elimination of non-value-added activities along the entire value chain are also sought to be achieved, thus helping the administration make tactical and strategic decisions and Lean may give them stability and protection from crisis. Lean Manufacturing can be used to distinguish between value-added and non-value-added activities and thus serve as a tool for process improvement (Billington, 1999).

The most terrifying problem manufacturer's face today is how to quickly deliver their products or materials at good quality and low cost. One promising way to tackle this problem is to apply waste-free management principles and techniques.

The focus of the study to reducing the time of the production process, making better use of space, following up on the inventory management system, increasing productivity and reducing costs at To-me Cosmetics Company.

1.6 Objectives of the Study

This research aims at applying different tools of lean manufacturing for the purpose of eliminating the redundant non-value adding activities and wastes at To-Me Cosmetics Company and consequently improving the company's productivity, efficiency and reducing costs.

LM methodology was applied at to-me company in order to:

1. Reduce waste caused by manufacturing processes that do not add value to the final product.

2. Improve productivity and reduce costs.

3. Improve production scheduling and controlling

4. Regulating the production flow, continuous improvement of operations and improving the work site.

5. Increasing floor space and improving its utilization.

6. Improved lead time.

7. Improved inventory management system.

1.7 Limitations of the Study

Projects implemented by the organization involve some uncertain risks. Therefore, the waste-free manufacturing system should be carefully designed to overcome challenges and risks.

Employees may not easily realize the importance of improving and developing the work environment and their career growth, as there is an invisible risk of canceling or not accepting the application of some tools and improvements in the company, resistance to change; reluctance in contributing with suggestions for improvement; lack of motivation; and lack of knowledge of the lean philosophy and its tools.

1.8 Company Profile

To-me cosmetics Company is a Palestinian company. The company was established in 1996. The company started as a beauty education center and sold hair products for the needs of the students enrolled in the center. And through a closer look at the Palestinian market and its increasing demand for cosmetics, the idea of forming the company came out to be the message of the leading company in the world of cosmetics in Palestine to provide local products of high quality, through which the Palestinian market needs to

meet the needs and products of hair and body care, makeup, salon equipment and many more. Other products you sell locally.

To-me Cosmetics is located in the industrial area of Ramallah. The factory employs 30 employees, including department officials and employees.

To-me cosmetics Company is a Palestinian company. The company was established in 1996. The company started as a beauty education center and sold hair products for the needs of the students enrolled in the center. And through a closer look at the Palestinian market and its increasing demand for cosmetics, the idea of forming the company came out to be the message of the leading company in the world of cosmetics in Palestine to provide local products of high quality, through which the Palestinian market needs to meet the needs and products of hair and body care, makeup, salon equipment and many more. Other products you sell locally.

To-me Cosmetics is located in the industrial area of Ramallah. The factory employs 30 employees, including department officials and employees.

(Bayyoud and Sayyad, 2016) defined enterprises with 5-19 employees as a small one and enterprises with 20-99 employees as medium one. They also confirmed that these enterprises can complement large firms if they become more flexible, closer to customer, and having competitive advantage. They also recommended that Government should support these enterprises in many means such as advice about quality control and assurance. Due to lack of these efforts from the government; SMEs should adopt an effective improvement methodology to be able to improve their processes, productivity, and customer retention.

The company owns three production lines which are shampoo, conditioner and semi-solid production line. The company frequently adds new products according to the market need or customer demand.

The company owns approximately 15 machines. The company also produces high quality products as a result of the accumulation of experience and good experience in the process of inspecting and purchasing raw materials and packaging materials.

The company owns three production lines which are shampoo, conditioner and semi-solid production line. The company frequently adds new products according to the market need or customer demand.

The company owns approximately 15 machines. The company also produces high quality products as a result of the accumulation of experience and good experience in the process of inspecting and purchasing raw materials and packaging materials.

1.9 Thesis Structure

To provide a summary of the structure used in this thesis, it is helpful to identify the chapters that make up this paper:

Chapter One: Introduction:

In this chapter, general background is presented, the problem statement is defined, the study questions are stated, the research propositions are developed, the significance of the study is explained, the objectives are determined and limitations to the study are discussed.

Chapter Two: Literature Review

In this chapter, an overview is given about Lean Manufacturing, the history of lean manufacturing is reviewed, the Lean Manufacturing is defined, Comparison between Traditional vs. Lean Manufacturing is provided, data analysis techniques are explained, lean tools and the benefits and previous empirical studies are reviewed.

Chapter Three: Research Methodology

Upon distinguishing between quantitative and qualitative research, the research methodology will explain the way in which data on agile management has been collected, its effectiveness, and the ways in which it is implemented. The stages of the methodology are determined, the tools used in structuring and supporting the arguments for the thesis problem and testing the propositions formulated in the theoretical Chapter are described.

Chapter Four: Results and Discussion

In this chapter, the results are interpreted and explained, the research questions are answered and the research propositions are tested and discussed.

Chapter Five: Conclusions and Recommendations

In this chapter, conclusions are presented, recommendations are provided and some guidance for future researchers is provided.

Chapter Two: Literature Review

2.1 Overview

Lean Manufacturing (LM) has revolutionized the global manufacturing environment at an unprecedented rate. It focused on producing products of high quality, low cost, in the most efficient and economical way possible, combining less human effort, less lead time, less inventory, and less space to become more responsive to customer requests. Lean manufacturing won the hearts of many companies (Albert, 2005).

Continuous improvement is one of the core principles of Lean which is strictly practiced in Lean Plants. Continuous improvement or Kaizen cannot be achieved drastically or over a specific period of time. Instead, small, incremental improvements are made over a long period .A period of time that gradually makes the process better. Some common lean tools are Value Stream Mapping (VSM), Total Productivity Maintenance (TPM), 5S, Kaizen, Kanban, Quality Function Deployment (QFD, and Mistake Proofing (Dale, 2003; Shah and Ward 2007)

The term waste-free manufacturing has been developed to maximize optimization of resources by reducing waste. It was then reformulated in response to the competitive and volatile business environment. Because of the change in the business environment, enterprises are forced to face obstacles and challenges, the organization's survival depends on its ability to respond to these changes and therefore, waste-free manufacturing is the primary driver efficiency for maintaining and sustaining these institutions.

Small-Medium Enterprises (SMEs) are an essential part of national economic and regional prosperity. They have strengthened the ability to generate employment and wealth for the national and regional benefit. The importance of small and medium companies in developing society and their contribution in creating new job opportunities

shows the necessity of helping these companies to improve their operations. SMEs also investigate the possibility of improving its performance and productivity and reducing its costs (Albert, 2005).

2.2 The History of Lean Manufacturing

A waste-free manufacturing approach is an ideal optimization approach that has a major impact on process management. The concept of waste-free manufacturing appeared for the first time in 1990 in the book of James Womack under the title "The machine that changed the world". It is one of the theories that regulate the work environment, reduce waste of materials, maintain the capabilities of employees to respond to what is necessary, to improve production levels and thus improve net total productivity (Pool et al., 2010). The background of lean manufacturing is based on the history of Japanese manufacturing that has been applied around the world in many industries. Taiichi Ohno developed the system at Japanese automaker Toyota, after WW II, Japanese manufacturers faced a shortage of resources, prompting them to search for new ways to cover this deficit. The goal of waste-free manufacturing was to reduce losses during the operation stages (using fewer resources to produce the same outputs that are obtained from the traditional production system), making the organization more flexible to achieve customer satisfaction (Pool et al., 2010)**.** Taiichi Ohno once said that "Waste free manufacturing is all about looking at the timeline from the moment a customer gives us a request to the point where we raise money, we are working to reduce this timeline by removing non-value added waste" (Ohno, 1988)[6**]**

2.3 Definition of Lean Manufacturing Approach

Global competition presents volatile and unstable intense challenges in demand, leaving you looking for a wide variety of opportunities to attract and to be their own customer. In order to succeed and remain in a competitive environment, companies need to find and adopt effective methods of their operations. Companies are looking for new ways to increase value of the products by eliminating unnecessary practices and processes that do not add value to the product. LM (Waste Free) is a systematic approach to waste identification and disposal. The implementation of lean manufacturing system helps organizations to improve quality, reduce lead time, deliver on time, achieve customer satisfaction and exploit resources that increase sales and profits (Upadhye et al., 2010).

Lean Manufacturing is a set of techniques, principles and tools which many organizations or industrial companies choose to implement in order to enhance production efficiency and total customer value while at the same time eliminate waste (Mwacharo, 2013).

The basic idea of Lean Manufacturing is to provide better quality goods to more consumers at low price. In doing so, it ultimately leads society to more prosperity (Melton, 2005).

2.4 Traditional vs. Lean Manufacturing

Implementing waste-free manufacturing is the best way to develop products, employee skills, and benefits of the company's operations results (Abraham et al., 2012). Some of the keys to lean manufacturing are that it takes a whole-process approach, improving the entire supply chain rather than improving part of it, and providing partial solutions without perfect solutions is not enough. It is necessary to see and learn options and opportunities (Paneru, 2011).

The main differences between soft manufacturing and the traditional manufacturing system include a different mindset, where the traditional system considers management the main driver of change, while in agile production everyone has the right to find ways to improve operations. Moreover, waste-free manufacturing solves the problems identified in the traditional manufacturing process by reducing waiting-time, allowing and producing products in the right amount and time, and reducing losses to achieve ideal work, flexibility, and ability to change, and also reduces the time needed to produce various production units, thus responding to customer requests in a way better and bigger. (Hansen & Mowen, 2008)

Waste-free companies can produce products of high quality and less size and put them on the market faster than producers in large quantities, which is driven by the request of the clients, and not produce what you expect to sell, which meets the needs of customers and achieves a competitive advantage. Lean organizations also make twice the quality with twice the product, at half the cost, half the time and space with a small portion of the normal stock of work. Lean management revolves around operating the organization as efficiently and effectively as possible, at the lowest cost and without any waste. (Minju, 2009)

In waste-free manufacturing, the value of a product is determined on a basis the customer really requires and is willing to pay for it (Value-added activities). On the other hand, activities that do not add value, that is, that add unnecessary time and effort are disposed of, this is actually a product shift that matches the customers 'expectations. (Nielsen, A. 2008)

In manufacturing, the generation of waste that does not add value to the product will not only result in waste of materials work resources, but it will also create material shortages,

hinder agendas and workers' energies, create idle time in subsequent workstations and extend manufacturing lead times (Rawabdeh, 2005). Process waste leads to additional equipment and tools, additional manpower, complex material flow, and storage Inventory, doubtful quality, missed delivery and lower profits (Leon, 1999).

The presence of strong competition between domestic and international companies leads companies to shift from the traditional manufacturing system to the lean system, but this transformation requires overcoming some challenges and barriers in order to obtain success. Hence, the successful implementation of a waste-free manufacturing system is based on critical factors such as good management, skills, leadership and experience, as well as an organizational culture geared towards the efficiency of the organization. (Balle, 2005; Chaisorn and Lila, 2011; Nordin et al., 2010).

2.5 Lean Manufacturing Tools and Techniques.

Lean Tools are exceptionally important because many companies begin their lean journey by recognizing Lean as a set of "tools" to implement, the whole managerial approach of an organization must be aligned with the lean philosophy but significant consideration must be given to lean tools and techniques for they are the backbone of lean management. A set of lean tools can be implemented to achieve the goals of lean philosophy. Tools and techniques that contributed to achieve the goals of this research include:

2.5.1 Waste Elimination through 5S:

According to Deshpande et al. (2015) 5S originated in the 1980s as a Japanese technology introduced by Takashi Osada. Deshpande et al. (2015) defined the concept of 5S as a methodology for managing the work environment which helps to improve the workplace, human capabilities and thus productivity.

According to (Brady Worldwide Inc., 2008), the Lean management foundation is in line with the Lean philosophy, using the 5S operating model as an essential tool for lean manufacturing, facilitating the establishment of the system and operational stability required by manufacturers to ensure and maintain a lean manufacturing sequence.

(Kumar and Kumar, 2012) The 5S concept improves order and hygiene while providing a safe and comfortable working environment. Although the main objective is to increase productivity and reduce costs, the system aims to eliminate all operations that do not add value, such as time lost in operations. The 5S concept is a vital component of an organization seeking kaizen and a lean manufacturing position with the primary objective of delivering the right product, in the right quantities, to the right customer, at the right time. The 5S concept was envisioned as a philosophy that influences continuous improvements in workplace productivity, quality and safety.

5S is a very good way to help the company boost profits and reduce waste and it is the main tool for running Lean (Ablanedo-Rosas et al. 2010). In a lean Manufacturing system, the 5S model is also a tool for visualizing the obstacles and hindrances of the organization (Hirano, 1995). According to (Dennis and Shook, 2007) the goal of the 5S concept is to achieve organization in the workplace, efficiency while reducing product defect rates and improving safety. Kohfeldt & Langhout (2011) emphasized that the 5 Why method was developed by Sakichi Toyoda in the 1930s to identify manufacturing and production problems,

The 5S application includes many benefits which include: improved hygiene, easier identification of errors, reduced downtime, reduced number of searches, reduced walking and movement, reduced risk of accidents, increased safety, reduced errors,

improved flow, improved space utilization and improved management Visual Workspace (Chapman, 2005). These benefits bring many overall improvements in quality, productivity, delivery, safety, morale, and cost.

According to Osada (1991), 5S is defined as the foundation for a total quality environment, Sort, Set in order, Shine, Standardize and Sustain which leads to the beginning of a comfortable, healthy and productive life for everyone at work.

The 5S tool philosophy is rooted in Japan and is an acronym for five Japanese words with the following meanings:

1. Seiri (Sort): put things in order – to organize them.
2. Seiton (Set in order): make a place for everything.
3. Seiso (Shine): Clean the workplace, maintain its appearance and prevent dirt.
4. Seiketsu (Standardize): define standard work instructions.
5. Shitsuke (Sustain): Continuously maintaining established procedures, making 5S a habit.

2.5.2 Value Stream Mapping:

VSM is the grasp of all the activities required to produce a custom product, and the improvement of the entire process from the point of view of the end user or customer (Emiliani, 2006). The concept of value flow planning means that flexible thinking should not be limited to the boundaries of an individual company, but to consider the full range of activities that are involved in creating and present it value (Kippenbergher, 1997).

Value stream mapping has appeared as the preferred way to implement lean. VSM is a management tool for planning, implementing, managing, sustaining and linking Lean Manufacturing improvements to daily work (Tapping, 2002). It maps information flows

and material flows and that signal and control the material flows. This facilitates the Lean application process by helping to define the steps for value added and eliminating the non-value added steps/waste in a value stream (Lian and Van, 2002).

According to Venkataraman et al. (2014), VSM is defined as a visual tool that helps identify where waste has occurred. VSM is used to evaluate current manufacturing processes and create ideal and future state processes. VSM plots the course of the process in order to identify various factors such as:

-Value-added time (the time taken to produce the final product),

-Non-value-added time (time spent that does not contribute to the production of the final product),

- Cycle time (the time required to perform the operation) and

-Change time (time required to change tool, programming, etc.).

Which helps in identifying and eliminating waste and implementing Lean principles.

A collection of ways to visually display the flow of materials and information through the production process. (Belokar et al., 2012) pointed that the aim of VSM is to identify value-added and non-value-added activities. It is used to determine what is actually happening rather than what is supposed to happen so that we can identify opportunities for improvement, It is also used in process time cycle improvement projects because it shows exactly how the process works with detailed timing of step-by-step activities and is used to analyze and improve the process by identifying and eliminating time spent on non-value-added activities.

VSM is often used in process time cycle improvement projects because it shows exactly how the process works with detailed timing of step-by-step activities. It is also used for

process analysis and improvement by identifying and eliminating time spent on non-value-added activities.

2.5.3 Total Productive Maintenance (TPM):

In 1971, Seiichi Nakajima invented the original approach to Total Productive Maintenance, It can be considered as equipment maintenance that is carried out at the company level and he considered it a productive maintenance system that is implemented by all employees through small group activities (Bakri & others, 2012). It is used to maintain production and to improve the quality of machinery, processes and all other resources by eliminating defects related to equipment and products (Singh & Kumar, 2017).

TPM is a management approach that can be adopted to reduce sudden machine malfunctions as the work progresses (Feld, 2000). It also focuses on equipment maintenance to achieve optimum production without defects, accidents or malfunctions, this improves equipment reliability and efficiency rates by eliminating unnecessary waiting in the process. It is also part of an agile management system that focuses on proactive maintenance and worker engagement to improve equipment and tool efficiency.

According to Card (2016), Taiichi Ohno describes the "5 Whys" technique as the basis of the approach for Toyota, and the heart of the TPS methodology. Asking why five times whenever a problem is found, by repeating why 5 times will explain the nature of the problem and how to solve it. The solution or method is designated as 'one how' and so on 'Five Whys equal One How' and so (5W=1H).

Bakri et al (2012) describe the need for TPM's participation in the manufacturing industry, and focus on maintenance as a vital part of the business. TPM also seeks to engage within

the organization to maximize the effectiveness of production equipment. It involves maintenance and production staff working as a team to reduce downtime and reduce waste in order to improve the quality of the final product.

According to Adesta & others (2018) they summarize TPM eight pillars as follow:

1. Autonomous maintenance: It means ensuring that operators are fully trained in routine maintenance such as inspection, cleaning and lubrication, which puts this responsibility in their own hands and ensures that the machine is always clean and lubricated, and helps identify problems before they fail .
2. Focused improvement :Focuses on developing the work done by machinery and equipment. It also focuses on self-discipline and organizational problems in the workplace (Singh & Kumar, 2017).
3. Planned maintenance :It involves studying metrics such as downtime and historical failure rates and then scheduling maintenance tasks based on expected or measured failure rates or downtime. Where maintenance is divided into four categories: Corrective maintenance, Maintenance Breakdown maintenance ,Preventive maintenance.
4. Quality maintenance: The Japanese Institute of Plant Maintenance defines this as the "quality maintenance preparation activity" of equipment that excludes quality defects based on the basic concept of maintaining perfect equipment to achieve the best product quality (Dawood & Sahib, 2017)
5. Training and the Education : Its goal is to provide operator and maintenance training to help eliminate malfunctions. Dawood & Sahib (2017).

Training needs to focus on: Proactively maintain equipment, identify emerging problems, and implement a proactive and preventive maintenance schedule ,improving skills and knowledge.

6. Safety healthy environment: Maintaining a safe work environment means that employees can perform their duties in a safe place without any health risks, not harmed by development or procedures. It is important to produce an environment that makes production more efficient. This makes this pillar play an essential role in the production sector. Production managers are concerned with security-related functions.
7. Office TPM: (Vardhan & Gupta, 2014) Considered as one of the most important pillars of TPM, it is implemented to simplify office management which requires ensuring the availability of resources in a timely, appropriate and economical ways to perform maintenance activities.
8. Development Management: Deploy new equipment in the shortest possible time by learning from the current system and developing a new improved system. Maintenance improvements are made to independently evaluate systems and equipment (Sivaram & others, 2013).

2.5.4 Root Cause Analysis:

A fishbone diagram (also called an Ishikawa diagram) named after Kaoru Ishikawa, a Japanese quality control statistician, is a tool for identifying the root causes of quality problems (Juran, 1999).

(Watson, 2004) defines a fishbone diagram as an analysis tool that provides a systematic way of knowing the effects and causes that create or contribute to those effects. Also referred to as a cause and effect diagram.

Also known as a method for discovering the root causes of malfunctions or problems in order to identify appropriate solutions. Root cause analysis assumes preventing fundamental problems from occurring and solving them radically and systematically instead of treating the visible symptoms (putting out fires).

(Carmen Nadia Ciocoiu, 2010) stated that the fishbone diagram is essentially a model for the suggestive presentation of the associations between an event (impact) and its multiple causes that occur. A diagram helps team members think in a very systematic way. Some of the benefits of creating a fishbone diagram is that it encourages group participation, helps identify the root causes of a quality problem or characteristic using a structured approach, and identifies areas in which to collect data. Also known as the fishbone diagram and Ishikawa diagram, the cause-and-effect diagram is an effective yet effortless root cause analysis tool used in lean thinking.

2.5.5 Poke-Yoke:

It is the use of any device or automated method that makes it impossible for an error to occur or makes the error clear once it has occurred, implemented so that defective materials are not passed through the production process, This helps ensure zero tolerance for defects, as well as prevents defective items from working their way downstream and causing bigger problems, Less time for employee training, elimination of quality control processes, reduced amount of defects and 100% control over the process (Fisher M., 1999).

2.5.6 Focus PDCA:

is a four-step iterative management method used in businesses to control and continually improve processes and products, PDCA Cycle can help to simplify operations, reduce costs, increase profits, and improve customer satisfaction (Nicholas J.M., 1998).

2.5.7 Kaizen:

A strategy in which employees work together proactively to achieve improvements Incremental and regular production process. Primary focus is on replacing waste activities that do not always add value with value-adding activities, total product improvement and customer satisfaction (Hamrol A., 2015).

2.5.8 Just-in-time Production:

"Bring the right part to the right place at the right time in the right quantity", helps to improve the company's resources such as capital, labor, and equipment. The goal of JIT is to completely eliminate waste in the manufacturing process, by making production rates fully in line with market demand or Takt's time. JIT means making what the market wants, when it wants, using minimal materials, facilities, equipment, human resources and will reduce wastage of storage space (Nahmias, 1997).

2.5.9 Kanban:

Is a signaling system to determine when components, materials or products are needed in the next stage of the manufacturing or delivery process (Kobbacy and Liang, 1999). Kanban facilitates high capacity utilization and high production volume while reducing labor stock and production time in the process.

2.5.10 One-piece Flow Production Systems:

The parts are transported through the step-to-step processes without any work in progress between one piece at a time and a small batch at a time (Lisa Jain, 2020).

2.5.11 Pre-Production Planning (3P):

Is an approach to project management, design and process development that creates a more reliable and efficient production process? The approach provides an organized process that helps to improve people, process, and technology by bringing Lean Thinking to factors such as the production process and people employed thus maintaining the production process, facilities and tools to meet customer requirements (Bresko, 2009).

2.5.12 Line Balancing:

Is a production strategy to settle the workload during operations and make production lines flexible to eliminate bottlenecks and excess capacity, also includes matching the production rate to take time. Maximizing production efficiency and reducing the number of workstations is one of the most common objectives of line balancing (Adeppa, 2015).

2.6 The Benefits of Lean Manufacturing

The basic idea of Lean Manufacturing is to increase productivity, improve efficiency, and provide better quality goods to more consumers in low price. In doing so, it ultimately leads society to more prosperity (Mwacharo, 2013).

Therefore, the benefits are multiple (Upadhye et al., 2010):

1. Improved quality of the product: through improved efficiency, improved innovation and quality control that would previously have been wasted.

2. Simplification of manufacturing processes: companies can better respond to fluctuations in demand and changes in the labor market, thus reducing delays and improving delivery times.
3. Employee satisfaction: raise employee morale and confidence, Lean manufacturing not only enhances productivity but also employee satisfaction.
4. Improved profits: Increased productivity while reducing waste and better quality ultimately yields to a more profitable company.
5. Sustainability: Reduced waste and better adaptability making manufacturing processes better equipped to thrive in the future.

2.7 Previous Studies on Lean Manufacturing

Examples of the application of Lean manufacturing principles are becoming clearer. The following paragraphs present some of these examples, it is divided into two parts:

2.7.1 Previous Studies in Industries Similar to To-me Factory

A Study presented by (Ma. Erika R. Laguardia., 2016) which occurred in the Cosmetics Manufacturing's Central Weighing Area, Processing and Packaging Area for Creams, Liquids and Lotions. The aim of this study was to eliminate waste and help companies to achieve shorter time and lower cost, and to improve manufacturing and competitive operations through assessing the level of implementation of the 5S system to get rid of problems in the departments in the Central Weighing Area, and the processing and packaging area. The data were adopted through observations and documentation. The findings showed that the problems (elimination of waste, achieving shorter time and lower cost, improving manufacturing and competition operations) were eliminated by applying 5S system within the company.

In a study carried out by (Borget Alfred Anoye, Adama Ouattara, 2015), a small soap company was suffering the high cost of soap manufacturing. The root and main causes were tracked using PDCA, 5s, and Pareto diagram. As a result, operations were continuously evaluated to improving efficiency, effectiveness and flexibility by increasing production capacity, eliminating the problem of overtime, increasing machine performance, improving worker performance and reduced soap price by 50%, which made the soap company more attractive in the market.

In a study conducted by Singh et al. (2010), the lean implementation process and its benefits to the production industry were discussed. The main tool applied was the value stream map which was created for both the current status and the status after improvements were implemented. The benefits achieved included lead time reduction by 83.14%, processing time reduction by 12.62%, work in process inventory reduction by 89.47%, and reduction in manpower requirements by 30%. Finally, productivity per operator has increased by 42.86%.

In a study by (Shubham Ghushe et al. 2017) which was conducted at a Coir Product Manufacturing Industry, aimed to optimize the use of resources and increase the value of the product by reducing waste (Muda), through the use of agile manufacturing tools and the results were as follows: Kaizen worked to reduce the time required for the operation by two seconds which is approximately 16.69 minutes a day and also increased the safety of workers , through an application Value stream Mapping (VSM) inventory time was reduced by about 5 days, lead time was reduced by 5 days, thus increasing productivity. With the POKA-YOKE application the process time is reduced to 3.5 seconds which is about 29 Minutes a day. It also reduced the chances of errors by the worker.

In a study conducted by (Patel and Thakkar, 2014) for the Indian ceramic processing industry which produces bricks. This case study addressed "minimizing process waste, maintaining proper quality, smooth process flows, controlling, enhancing storage facilities, security, and safety, and saving process cost." The 5S tool was used, as a result, storage partition showed an improvement in space usage by 12.91%, while reducing other process waste such as employee movement, the workplace is more functional than it used to be. This case study also provided the idea that 5S technologies should be examined periodically for the long-term benefits of the company.

Another study by Deshpande & Joshi (2016) presents a Small Indian multi-product (Small-sized) manufacturing company suffered from long manufacturing lead times. By researching the root causes, the company found that additional lead time was necessary due to long setup times and wasted research times. With the successful implementation of 5S it was observed that the setup time was reduced by 6% and the search time was reduced by 18%.

In Singh & Kumar study (2017) they reviewed the main benefits of TPM: improving process and product quality, lowering production costs, improving efficiency, improving employee ownership and achieving customer satisfaction. As final results they concluded that TPM is a technology promised in India to increase organization quality and improve productivity in the manufacturing industry.

In a study by (howdary and George, 2012) lean manufacturing implementation in a pharmaceuticals company, the factory produces a wide range of pharmaceutical or non-pharmaceutical products and is used equally, the company suffers from the huge cost of used space and inability to deliver orders on time, great variety of raw materials with a workforce of only 12 people spread over an area of 10,000 square feet .The 5S tool was

used, as a result, reduction in work in progress material as well as the space that formerly was utilized for such matters, a decrease in the needed workforce and also in the Non-value-added time.

2.7.2 Previous Studies in other Sectors

A study conducted by (Jaiprakash Bhamu,agdish Bhadu, Kuldip Singh Sangwan,2020) at the ceramics industry aims to demonstrate that lean manufacturing can be successfully implemented in a semi-process industry, to reduce wait time, defects, wastage, inventory , processing time, and space, through implementing many tools , such as Kaizen ,5S ,VSM. The findings showed reduction in inventory by 36%, waiting time reduction by 32%, defects reduction by 40.51%, processing time reduction by 1.02%, reduction in manpower by 6.85%, Space creation for further use is 719 m^2, Cost saving of US $ 0.61 million in one financial year, team work and improve employee morale.

In a study carried out by (R. S. Katikar, 2020) on the industry XYZ situated near Pune, India which produces over 60 components and supplies to leading valve manufacturers in India. The company suffers from a relatively high defect of the valve body cap having a large volume. The study aims to improve the quality of the valve body cover components and find out the defects and root causes that cause the malfunction of the large volume valve, continuous improvement of skills of workers, proper handling of materials with appropriate handling device, Regular maintenance of devices, formation of quality circles in each department. Through implementing many approaches, such as Fish Bone diagram, 5S, Kaizen, PDCA cycle. The results showed 74% reduction in total defects was observed due to proper implementation of lean manufacturing, which increased the productivity of machines and workers and reduced defective components.

In a study conducted by (Vatsal Vaghasia, kishan Fuse, 2019) Avval Industries manufactures Anti-locks for Energy meters, the customer's monthly demand for the anti-lock is 22,500 pieces. The main tool applied was the 5S, Single Minute Exchange of Dies (SMED), Kanban, and Value Stream Mapping (VSM). The benefits achieved included, after using Value Stream Map the lead time moved 30 days to 20 days, processing time 309 to 280 seconds, the benefits of the company are achieved by 10% in Lead time and 29% in processing time. After using Kanban System, the finish goods inventory was decreased from 1780 to 794, the benefits of the company are achieved by 55% from reducing inventory space. After using SMED, the smaller anti-lock job decreased from 3 minutes to 5 seconds, the benefits of the company are achieved by 90% to move to the next task. After using 5S the time to implement tasks was reduced from 5 minutes to 1 minute. The number of defective pieces dropped from 50 per day to 10 per day, the benefits of the company are achieved by 40% because decrease number defective pieces. Thus, the results led to reduction in defectives, reduction in inventory, decrease in lead time, increase in profitability and increase in efficiency.

A study conducted by (Yutthaphon Khayankit, Jirapan Liangrokapart, 2018) at the tyre mold plant in Thailand to improve production lines in the manufacturing environment by reducing lead time, processing and setup time in manufacturing environment, that is through implementing many approaches, such as SMED, 5S, VSM, TPM, One piece flow, as a result, this case study addressed reducing lead time by 64.53 percent at the plaster station and by 58.55 percent at the milling station.Process times at the plaster and milling stations were reduced by 6.58 and 69.65 percent, setup times of both plaster and milling stations were reduced by 20.83 and 29.47 percent.

Also, the study conducted by (Brijbhushan, Onkar Singh Bhatia, Vikas Ucharia ,2018) in a precise manufacturer of two-wheel and three-wheel components to improve the existing quality system, increase efficiency and reduce non-conformities through the use of various lean manufacturing tools such as Multiple activity charts, PDCA cycles, cause and effect diagram, Pareto chart, and control chart. The findings showed a better working environment is provided to the workers, rejection was reduced to 12000 ppm from 29000 ppm and reduced the loss of organization in the productivity process from 4.02% to 2.79%. Which improved the process efficiency and can be considered as an evidence of the importance of adopting LM in this study due to its role in speeding production process and faster delivery to customer.

Another study conducted by (Mahmood, K., Shevtshenko, E.,2015) at the Metal Fabrication Company aims to enhance productivity, reduce cost, increase customer value and to reduce waste during production operations, through implementing many approaches, such as Pull System (Kanban), Value Stream Mapping (VSM) and Dedicated Flow. The findings showed a decrease in the inventory level from 1,845 tons to 1,600 tons which lead to a productivity improvement, and the number of inventory days was reduced from 26 to 22 days to accelerate the production process, the researchers concluded that applying waste-free approach achieved 13.3% of productivity improvement. And the same results were achieved in this study by reducing production time and thus improving the productivity.

Sivaram & others (2013) revealed in their study the importance of using the TPM system with ISO 9001 to perform the accompanying model, which is based on eight TPM columns modified into five items of ISO, so as to achieve zero defects, zero crashes and zero accidents. In addition, the implementation of the TPM 9001: 2008 study model

wouldn't affect the quality management system based on the ISO 9001: 2008 standard. On the contrary, it will increase the company's benefits by increasing electrical equipment, health, safety, environmental improvement levels and uninterrupted production. To add to that, the company has an integrated system of both standard TPM and ISO.

A study that was carried out by (Rosnah M.Y. and Othman A., 2012) at a Plastic Molding Division of a SME company located in Malaysia, the plastic molding company is continually striving to increase productivity, reducing inventory and delivery on time using value stream mapping, Kanban pull, and 5S. The results showed total productivity improvement by 15.6%, inventory reduction by 50.6% and increase delivery on time by100% every month.

According to (Patel and Thakkar, 2014), the implementation of 5S and visual management system in the ceramic manufacturing company has improved the inventory system, space utilization, reduced error range and personnel safety, increased machine efficiency and work environment, increased productivity, space utilization, workplace cleanliness, rapid damage reporting and instrument maintenance, ease of inspection, and eliminated the causes of accidents in the company.

In a study by (Goriwondo, et al., 2011), the use of a value stream map to reduce waste in manufacturing for the baking industry in Zimbabwe was presented. The study aimed to use a value-flow map to determine and reduce waste in bread-making and improve the process. The study demonstrated the use of a value flow map to reduce waste in the baking industry and reduce defects by up to 20%, reduce unnecessary inventory by 15%, reduce unnecessary movement by 37%, improve efficiency, and increase production capacity by 15%.

In a study by Moura (2015), LM implementation study was carried out for a tissue paper factory. The production process consists of several steps that require specific machines to prepare and then process the pulp for the production of tissue paper, this process is not flexible. Therefore, the study aimed to reduce waste, improve annual productivity, and enhance competition. The study demonstrated the use of SMED, which resulted in positive results including increase in the productivity time by 1.5 hours which is translated in revenues of almost 150.000 euros.

2.8 Chapter Summary

In this chapter, the adopted methodology, tools and techniques implemented through a review of previous studies and research are explained. Previous studies on the application of LM methodology and its tools confirm the effectiveness of this methodology in improving productivity and space utilization in industrial organizations. All previous studies confirm that the application of flexible management tools significantly reduces different types of waste, enhances production efficiency and reduces cost.

Chapter Three: Research Methodology

3.1 Overview

The implementation of lean manufacturing methodology helps organizations to improve quality, reduce lead time, deliver on time, improve customer satisfaction and exploit resources that increase sales and profits (Upadhye et al., 2010).

The purpose of this research is to apply Lean Manufacturing methodology in To-me Cosmetics in Al-Bireh. Lean management tools that explains the problems from several aspects and help to perform appropriate solutions to reach the targeted improvements were followed in this research.

This chapter explains the quantitative and qualitative research methodology to answer the research questions, the way the data were collected, the tools(VSM,5S ,TPM) used in structuring and supporting the arguments for the thesis problem, testing hypotheses to achieve the objectives and validating the results.

The methodology that was followed consists of three stages:

The first stage consists of studying the current manufacturing system through studying the manufacturing practices within the company and conducting personal interviews with the plant manager, operations director and production officer at To-me Cosmetics Company, to study the current situation and to identify the problems (wastes), collect data within the company through interview techniques and to choose suitable lean manufacturing tools for waste disposal.

The second stage includes studying lean manufacturing tools application and testing its effect on increasing productivity, reducing costs, achieving competitive advantage and making a comparison between the existing manufacturing system and the system using lean manufacturing.

The third stage includes verifying the results and assessing the impact of lean manufacturing on the performance of operations and production at to-me company.

3.2 Qualitative Technique

Qualitative Research is any type of research that produces results that have not been reached by statistical procedures or other quantitative means (Strauss and Corbin 1990).

This technique focuses on collecting participants' perceptions, experiences, and behaviors rather than collecting digital data (Tenny & others, 2017).

It is a non-numerical examination that focuses on an in-depth analysis of assumptions, beliefs, and interpretation of observations, for the purpose of discovering underlying meanings and patterns of relationships (Casebeer and Verhoef, 1997).

Types of data collection include: observations, interviews, group discussion, oral history and analysis of narrative and textual data such as: letters, reports, and films (Carter & Henderson, 2005).

All techniques have their own strengths and limitations, many analogues suggest that quantitative and qualitative techniques should be combined to compensate for their overlapping weaknesses (Kelle (2006).

3.3 Quantitative Technique

Quantitative research is known as a research that explains human problems or phenomena using methods based on mathematics and numerical data, especially statistics, to analyze these data (Yilmaz, 2013)

According to (Pathak et al., 2013), the quantitative approach is based on numbers and can be performed objectively. (Phakiti, 2010 it is derived from quantifiable variables and

factors which result from measurement instruments. It is used to define a problem or address the “what” or “how many” of research question methods and the data used that are comparable on a numerical scale.

After creating the flow chart of the target process, data were collected using the data collection sheet presented in Appendix A, cycle time and lead time were identified in the current status, wastes and non-value-added steps were identified and eliminated using VSM and 5S tools. The new flow chart was developed and implemented after the improvements were done. Data were recollected for this new flow chart and percentage value added was calculated to verify results.

3.4 Data Collection

3.4.1 Interview

Interview is a procedure designed to obtain information from one or more persons through oral responses to oral inquiries, whether structured or unstructured interviews.

According to Saunders and Lewis (2000), the interview research system allows the researcher to be flexible and change direction with the emergence of changes in new data. According to Bryman (2008), semi-structured and unstructured interviews mostly focus on the experience and opinion of the interviewee, with the aim of obtaining rich and in-depth data. Janesick (2010) stated that the main technique of such a method is based on observation, interviews, documents, photos and videos.

Sommer & Quinlan (2018) emphasize the importance of using this technique to help the researcher discover how, what and why it happened in more details than the written records, which helps to provide a good explanation or identify the discrepancy during the work

For this thesis, the main objective of the interviews conducted is to obtain additional information regarding the business and other major issues that hinder the implementation of Lean management in the plant. More data were collected through daily conversations with employees to examine the difficulties that emphasize the lack of principles of lean management.

The interview was conducted in the workplace with approximately 30 workers and department officials inside the factory separately and at different times for a period of time ranging from 15-20 minutes during 6 months during the daily work movement. It also included an interview with the owner of the factory to document the state of the company and listen to the problems from their point of view and how the production process, the problems that hinder their work.

The main objectives of the interviews, meetings and observations are:

1- Understand work environment and the production process.
2- Collect data to identify current performance.
3- Identify opportunities of improvement.
4- Set priorities for improvement.
5- Communicate the work to be done with everyone
6- Ensure that the main purpose is to improve the workplace and that the collected data will not be used for the purpose of performance evaluation of the staff.
7- Verify results of improvements and be able to sustain achievement.

3.4.2 Observation

According to Mahoney and Goertz (2006) ‘It requires that the researcher becomes a participant in the culture or context being observed’. Participant observation requires intensive work for a long period of time in order for the researcher to be accepted as an essential part of the culture. In the end, the observations are guaranteed as a natural phenomenon.

According to Kawulich (2005), a qualitative tool is the systematic description of actions and events in the social environment chosen for the study. Arumugam & others (2012) Observation method helps identify root causes of differences in process output.

Brady (2004) an increase in the number of observations will address more variables and lead to more reliable data.

Antony & Douglas (2012) realized that observation affects the company and the people affected by enhancing employee engagement, improving company learning, and providing employee learning through experience.

For this thesis, the Observations in the company included all manufacturing lines during the company's working hours. The researcher followed the role of the participant and the observer in writing down their daily performance, the work of machines, the arrangement of materials and tools, the ease of access to them and the problems that affect the development and growth of the company were monitored.

Furthermore, the company’s observations included all manufacturing lines during the company’s working hours, which led to the discovery of many problematic matters such as the absence of a clear maintenance system, the lack of easy access to materials for the production process (raw materials, empty cans and labels), unplanned release of workers from one area to another, which leads to delayed performance of liquid production line.

These initial observations were supported by interviews that provided a deeper insight into the work activities.

3.4.3 Data Analysis

Analysis tools such as Value Stream Map, Total production Maintenance, Fishbone Diagram, 5S technique and eight wasters to obtain quantitative and qualitative data, to identify the root causes of problems, to find solutions and apply improvements to make a change to the existing situation in the company.

3.5 Research Tools

Implementation of adequate lean is a basic need in current manufacturing industries, where this research focuses on identifying practices, techniques, or tools for implementing lean in manufacturing to improve productivity. The purpose is to get the right product, at the right quality and at the right time in order to achieve profitability and maintain competition by continuing to grow sales.

In this research, a simple input, process and output model of the manufacturing system is developed with identification of wastes known as seven deadly wastes of lean in order to create awareness of the lean system in manufacturing. Figure 2 presents a system model showing the relationship between lean and waste dimensions. “Muda” is a Japanese word for waste and “Ohno [11]” identified seven types of waste namely: overproduction, waiting, transportation, unnecessary movement, poor handling, defects and inventory. Productivity can be improved by eliminating this waste from the system by effectively implementing simple tools.

Once companies have obtained the main sources of waste, as a result of using tools like Kanban, in time method of production homogeneity, autonomy, Kaizen etc. will help companies to take corrective action to eliminate or reduce this waste (Monden, 1993).

3.5.1 Implementation of Lean Methodology

The goal for any manufacturer today is to reduce costs, increase efficiency and lead times, and eliminate waste while maintaining the highest quality of its products (Tapping, 2002).

3.5.1.1 Value Stream Map:

Value Stream is defined as understanding all the activities required to produce a particular product and optimizing the entire process from the point of view of the end user or customer. Emiliani (1998).

VS is a very important part of the VSM process in documenting the relationships between manufacturing processes and the procedures used to manage these processes, such as production information and production scheduling.

The majority of process planning techniques often only document the flow of the core product, while VSM also documents the flow of information within the system.

Value Stream Management is a process that helps organizations identify and systematically remove non-value-added elements from value.

The goal for any manufacturer today is to reduce costs, increase efficiency and lead times, and eliminate waste while maintaining the highest quality of its products (Tapping, 2002)

The main objective of the VSM implementation in To-me is to improve the performance of the production system. A study was conducted on the existing production lines in the

manufacturing organization. The organization currently has four similar production lines with a production capacity of approx. 80000 monthly. The study identified the liquid production line to apply VSM. The main reason for choosing it among the production lines is that its production was less than the planned production capacity, the demand from the client was very high but the organization was not able to deliver on their clients' requirements. Where the study focused on the liquid production line to improve the overall productivity, performance and quality of the manufacturing line.

3.5.1.2 Total Preventive Maintenance

TPM is an effective way to ensure that there are no defects or failures and to reduce expenses which is a requirement for the success of the company.

According to Adesta et al. (2018), they summarize the eight pillars of TPM as follows:

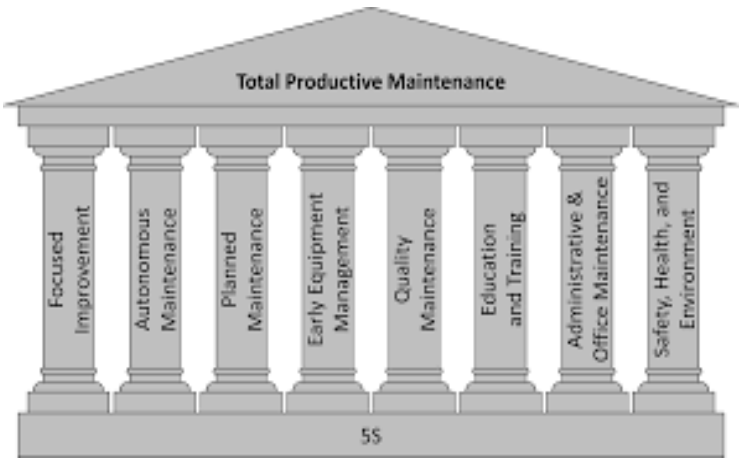


Figure 3-1: A TPM Model with 8 pillars (Adesta et al. , 2018)

This system is based on eight pillars aimed at improving equipment performance by using proactive maintenance to prevent any failure or sudden shutdown, control of equipment parts storage room inventory and maintenance layoffs.

1. Autonomous Maintenance: Train operators in simple daily maintenance tasks such as inspection, cleaning, tightening of loose bolts, lubrication and visual inspections Maintaining tidy and orderly location of equipment. This will help operator's flexibility to work and eliminate the root causes of defects, enhance the sense of responsibility and prevent any sudden failure, so that the work becomes more reliable

2. Continuous Improvement (KOBETSU KAIZEN): Focuses on small improvements and operations, encourages all employees to participate and reduce losses that can reduce efficiency.

3. Planned Maintenance: Focuses on small improvements and operations and encourages all employees to participate.

4. Quality Maintenance: It mainly depends on the 5S to get rid of existing quality problems, take proactive measures. Quality maintenance focuses on the prevention and detection of defects.

5. Early Equipment Management: Focusing on easy access to parts, easy cleaning and lubrication.

6. Education & Training: It aims to train maintenance personnel and make them multi-skilled and to carry out emergency and preventive maintenance.

7. Safety, health and environment (SHE): a safe and healthy environment to eliminate malfunctions and accidents where defective and unreliable equipment poses a threat to the operator and the environment, which negatively affects productivity.

8. TPM in administration: Operations related to administrative functions that will support production, such as order processing.

3.5.1.3 The 5S Phases

The 5S model is an essential tool for Lean management that benefits any organization by creating order and ranking in the workplace for organizing spaces so that work can be performed safely, efficiently and effectively. The system focuses define an organization's approach to its business and to assess organizational capacity in the workplace, on putting everything in place and keeping the place clean, thus making it easier for people to do their jobs without wasting time or risk injury (Chapman, 2005).

5S it is a simple idea that many companies fail to implement: the idea of having everything in its place, a certain amount of material used for what will be used, getting rid of unnecessary things, keeping the status quo clean and striving for improvements. In the event that this can be achieved, many wastes will be disposed of; Satisfaction, safety, satisfaction and efficiency levels increase with time.

5S is implemented in five phases (Antosz K., Pacana A., Stadnicka D., Zielecki W., 2015)

Sort

To get rid of unnecessary tools in the work environment and thus use the space.

The main idea at this stage is to categorize the materials in the site designated for them and remove unnecessary or irrelevant elements.

The team that participated in the implementation of this stage was formed and trained to ensure that the steps and importance of the screening stage are known, as it is necessary for the team to be familiar with the necessary methods to perform this stage in the required manner. Unnecessary materials will be disposed of and stored elsewhere, and consumables will be largely kept close to the place of use.

Pictures will be included to distinguish between the old and new work environment after improvement.

Set in Order

When all unnecessary items are eliminated, the place is organized with the aim of arranging the working environment and process flow.

During this stage, each area is identified with a special sign and a place is allocated for each similar group separately, by installing specialized shelves with visual instructions in order to arrange materials and tools and organize them in an accessible manner. This stage is usually the most time-consuming stage of the entire 5S program.

Shine

This stage consists of cleaning the workplace and maintaining the work area on a daily basis, which helps in identifying any broken tools or machines, redundant items, and factors that harm work safety.

Standardize

This stage involves finding ways to maintain the first three stages. Employees participate in creating a set of standards that will govern the organization, arrangement, and adjustment of the workspace in the future.

This stage explains in detail the correct method to work through instructions and procedures by which the area must be preserved.

Sustain

The goal of this stage is to adhere to the new standards. Workers keep the new rules in place and practice the first three steps every day until it becomes an automatic and acceptable way of doing things. This last stage is often the most challenging. However, without maintaining the new system, all the efforts and costs that went into its establishment will prove fruitless**.**

The system will be sustainable, when order, hygiene and culture become one part of the work habit.

3.6 Chapter Summary

This chapter introduces the adopted methodology of the research and utilized tools to achieve the desired outcomes. Data was collected using interviews, direct observations, and data collection sheets to identify process cycle time and lead time and be able to calculate process efficiency. It also presents the utilized tools in this research like TPM, VSM, and 5S and how it will be utilized to present the current status of the process under investigation and was used to reach the desired outcomes.

Chapter 4: Results and Discussion

4.1 Background

Lean management practices and principles have been widely adopted in many industries, but they are in principle new schools of thought for a factory in Palestine. However, when a factory develops it into a production facility, it becomes necessary to apply these principles in the day-to-day thought and practice of the organization.

This chapter provides insights into the process of revealing the problems of To-me Company and hidden problems inside the factory and during the production process. After conducting gap analysis, it is clear that To-me Company has poor production management system which leads to a decline in productivity, profits, market growth and competitiveness.

The company has three production lines: a liquid production line, a cream production line, and a semi-solid production line. Each line has its own machines, mixers, workers, method and system of work. Divided each line in its own room and separated from the other rooms.

After preparing the flow chart of liquid production line, the VSM was developed for this process after identifying the cycle time and delay time of each process step in order to calculate the process efficiency and identify value added and non-value-added steps in the process.

The warehouse space has been rearranged by applying the 5S tool to organize the work environment. The organization of spaces, stores, and production area will result in better utilization of spaces, lower hindering of movement of workers, less defects, better access to raw materials and production area, and ultimately waste reduction in all of its forms.

The absence of a clear system for managing warehouses is a clear financial burden on the company and a major source of waste and the lack of sufficient space. The organization lacks not only the lack of warehouse management, but also the lack of a position for warehouse administrator, which leads to the consumption of additional time and negatively affects the production process. In addition, there are areas in the warehouse that are ineffective, undefined and not divided by shelves. Regardless of the materials that are spread on the warehouse floor due to the lack of a clear system and policy for controlling and arranging warehouses, the time spent on identifying the quantities available in the warehouses, inventorying them, tracking their operations, easy access to them, and taking them out of the warehouse to the production process consumes a lot of extra time.

The lack of space represents a major obstacle in the course of production operations, regardless of the materials stored on the floor and on top of each other and the presence of other items stored in the wrong place (internal drawers, special samples for the laboratory, maintenance kits and materials for the packaging department, unused tools and mechanisms).

The company also faces another problem like lack of maintenance which delay the flow of production processes, it starts with the worker not distinguishing the names of the machines and his inability to adjust them to the correct weight while filling the product, his lack of sufficient knowledge or experience of the machines, and ends with the lack of spare parts of the production machines, and accordingly, there is a major disruption in the progress of the production process as planned.

4.2 Data Collection

Data were collected in this research through interviews and direct observation by the improvement team.

In this research, data were collected in a quantitative and qualitative manner. The quantitative method is based on the accounting system, and the qualitative method is based on observations and interviews with employees.

In this research, the plant manager, warehouse manager, maintenance officer, operations officer and related workers were involved in the data collection process.

4.2.1 Interview

Interview is a data collection method; specific questions are used to clarify hidden problems affecting the company.

The main advantage of interviews stems from their capability to offer a complete description and analysis of a research subject, without limiting the scope of the research and the nature of participants' responses (Collis & Hussey, 2003)

The researcher conducted personal interviews with the plant manager, general manager, warehouse and maintenance and operations managers and other involved workers to collect the required data and discover the real hidden problems in the company. The data collected were documented immediately after each interview, although the interviews were somewhat structured and specific topics and questions were asked, and the information was taken directly to make a record.

Ten employees were interviewed to give the opportunity to share most of the individual opinions of internal stakeholders and be able to collect the required data that will help in revealing the problems under investigation.

4.2.1.1 Interview with the Company Manager

While conducting an interview with the general manager of the company, many difficulties were noted that confirm the lack of principles of lean management in the organization.

The company is suffering from low productivity and inability to meet customer delivery time, which resulted in financial losses and waste of time due to the inability to proceed as planned. Accordingly, the management system was weak, the workers controlled the work according to their opinions, and there was no sequencing in the production process or the ability to commit to advanced planning because of the many things that hinder the production process from the time taken to deliver the boxes and raw materials to the end of time it takes to deliver the order to the customer.

Also, the operations manager cannot report the time allotted for the delivery of the order with the required specifications and quality, and in order for the production process to be efficient, the delivery of materials for the process, the preparation of the machines and the sequence of the process must also be well organized.

In view of the reality of the existing situation of insufficient capacity to prepare materials for the production process due to the limited and unorganized space for stores and the difficulty in finding materials and taking them out of their place to prepare them for the production process, which hinders the ability to fulfill promises and deliver the order on the date agreed upon with the customer, and the manager has crossed his great dissatisfaction with this problem and the losses it left behind and the weakness of the ability to keep pace with competition in the labor market

He also complained about the lack of maintenance system in the company, which is important to prevent sudden breakdowns of machines. The main problem is the lack of a

person responsible for maintaining and supervising the machines and following up on their work. On the other hand, the company has a storage cabinet for tools and spare parts, which includes some maintenance parts, empty boxes and damaged boxes, and it is also easy for any worker to access them and take what he needs. Also, there is no employee responsible for receiving, disbursing, create inventory lists, and record maintenance work on machines.

The lack of maintenance resulted in faulty filling of the products which will require rework, delay customer order, and sometimes returned orders from customer.

There is another problem facing the company, which is the receipt of the boxes for the packing process that are dirty and need to be re-scanned and sterilized to become suitable for the production process, due to the lack of a competent warehouse official to carry out his tasks in the required and correct manner. Therefore, the company today is threatened if it cannot overcome these problems.

We exchanged a dialogue about the role of Lean management, which the company clearly and tangibly lacks, and the importance of applying its tools to improve the existing situation, arrange the work space, increase the efficiency of the production process and organize it, and thus bring about important changes to increase the company's financial returns.

4.2.1.2 Interview with the Employees

Interviews were conducted with ten employees in order to expand knowledge and gain clearer and more valuable insights into the current situation in the production process.

It was noticed during interviews with the employees that they all suffer from instability at work as they move in between more than one production line within a short time. They

also feel that they are burdened with the existing work volume, the lack of space for warehouses, and the repeated work due to defective machines and dirty boxes, which doubles the work and consumes a lot of time at the expense of other products and the lack of exploitation of work spaces. The employees also feel that the process will become easier if there is a regular, correct and documented inventory process which will facilitate the process of ordering the necessary raw materials.

They also complained about the time wasted in the process of cleaning cans of dust that occurred during the storage process in warehouses, which doubles the work time and delays the production process.

With regards to the frequent breakdown of the machine during work, the employees complained about their inability to put a fixed caliber to fill the product, as the employee is forced to change the caliber more than once, and sometimes it is poured on the employee and he is forced to change his clothes.

4.2.2 The Observation Method

Observation is more than just seeing, as evidenced by the famous quote by Sherlock Holmes D. Watson: "You see but you don't observe" (Conan Doyle, 1891).

Visibility is a necessary but not sufficient condition for monitoring, and the observed information must be in a reportable form for any decisions. (Machamer, 1970).

Arumugam, Antony & Douglas (2012) found that observation influences people and the company by improving company learning, enhancing employee engagement, and providing employee learning through experience.

While Cohen, Manion & Morrison (2007) confirmed that observation is a powerful tool to focus on situations by asking a set of questions to monitor activities and events, and it

also helped the researcher to reveal problems and their priorities, like any tool that the researcher should plan when using it.

The monitoring process included all manufacturing lines in the company and during the usual working hours from 8:00 am to 4:00 pm, through which the current situation of the company was assessed by monitoring the movements of workers, their performance of daily work and how tasks are distributed to them.

Semi-regular interviews were conducted, random questions were asked and notes were taken without affecting the production process. This step was necessary to discover the problems that occurred during the work, and to know the sequence of the production process and the time wasted through it, and to discover the problems that affect the development and growth of the company.

4.2.3 People Involvement

After conducting interviews and collecting feedback, an improvement team was formed which included employees from all departments to ensure high participation, which is extremely important to the success of the LM implementation. The improvement team members were trained on how to use LM tools and the importance of applying them and participated in all activities. The objectives of this study was explained to all other employees and informed of the necessity and importance of its implementation and how it would facilitate and organize their work and improve the productivity.

Improvement team members have been assigned tasks that will contribute to the development and improvement of the production process, the use of space and the handling of machines.

4.3 Data Analysis

The main objective of data analysis is to find meaning in the collected data, which enables the researcher to extract knowledge to make correct decisions about the existing situation in the factory. The following are tools used for both data collection and analysis:

4.3.1 Flow Chart:

Flowchart is a tool for visualizing the characteristic steps of a process in sequential order. The main idea is to include all steps that are critical to the process. The flowchart is also used to visualize the process that cannot be seen in Lean.

In order to understand the process of producing liquid cosmetics products, the improvement team draw the flow chart of this process through direct observation from beginning to the end.

The flow chart is presented in figure (4-1):

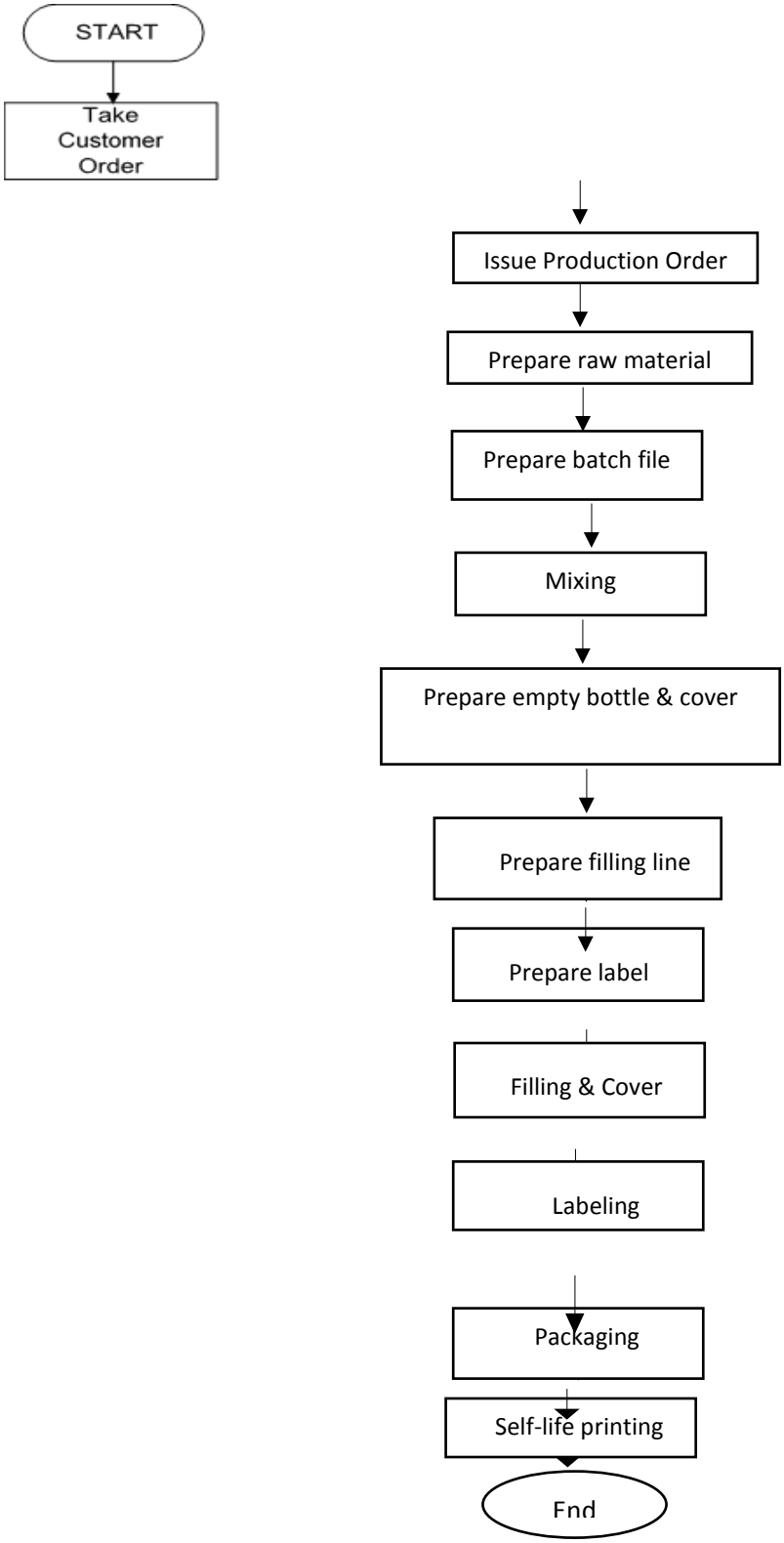


Figure 4-1: Flowchart for the process of producing liquid cosmetics products

The production process of a product in a Liquid Production Line consists of the following steps:

- Take customer order: this step is done by phone, or in writing on blank paper without using any forms.
- Issue production order: the collected order is added to a week production plan without identifying delivery period.
- Prepare raw material: the production officer informs the workers to collect the raw material from stores. He names the raw material for each worker to collect according to production formula that is considered top secret and is not show to the workers. This lead to long delay in collecting raw material since it is collected in many stages. The final stage is identifying the required weight of each material.
- Prepare batch file: in this step the production officer prepares the quantity to be produced, the name of the product, the product code, and the serial number (Lot).
- Mixing: to collected material is mixed in the mixing machine for around 90 minutes. The mixture remains in the mixer for around three days to get rid of the foam.
- Prepare empty bottles and covers: the bottles and covered are prepared to be filled with the mixture.
- Prepare filling line: the mixture is transferred to the filling line automatically, then the filling line is calibrated, and the empty bottles and covers are brought to the area of filling line.
- Prepare labels: labels are prepared to be stacked on the bottles.
- Filling and covering: the workers fill the empty bottles and cover it.
- Labeling: the workers stick the labels on the bottles manually and sometimes automatically. And the expiry date is printed on the bottles.

- Packaging: the bottles are sorted in cartons, product label is printed on the carton, and then sent to stores.

  The final product is sent to show room in a different location outside the factory area.

4.3.2 Eight Wastes

The main objective of Lean thinking remains the focus on eliminating waste at all stages, functions, and areas within the system. It is necessary for organizations to understand the nature and size of their waste and how to eliminate it, to work towards creating a lean and successful organization (Taylor & Brunt, 2001). Initially, the Lean application should start by recognizing the sources and types of waste in the system.

The 8 wastes according to Jeffery Liker (2004) are listed below:

1. Motion – Excessive movement of materials and people which leads to unnecessary work and fatigue.
2. Transportation – Moving resources such as, inventory, tools and finished products from one place to another without adding any value to the product, any unnecessary movement is classified as waste.
3. Non-utilized people – Failure to exploit the full potential of employees.
4. Inventory – Overproduction of materials or finished products that need to be stored.
5. Defects – Reworking the product to correct defects (Defect means a waste of processing, effort and time, causing rework, scrap and incorrect information).
6. Over production – Production of more materials and finished products than demand.
7. Waiting – Time taken or lost waiting for the previous process step to be delivered.
8. Excess processing – Business that consumes resources and effort but does not add any value to the customer.

After clarifying and defining the eight wastes, the improvement team created a table of the eight wastes, which shows the defect in the production processes as shown in the table (4-1):

Table 4-1 Eight Wastes of Liquid Production Lines

Process		DOWNTIME							
Step #	**Process Step**	**Defects**	**Overproduction**	**Waiting**	**Non-utilized Talent**	**Transportation**	**Inventory**	**Motion**	**Excess processing**
1	Take customer order			✓					
2	Issue production order			✓					
3	Prepare row material			✓					
4	Prepare batch file			✓					
5	Mixing			✓					
6	Prepare filling material	✓		✓		✓	✓	✓	
7	Prepare label			✓		✓		✓	
8	Prepare filling line			✓				✓	
9	Filling & cover	✓		✓				✓	
10	Labeling			✓					
11	Packaging								
12	Shelf life printing								
13	Storage								

Waste reduction is a major concern in today's industrial environment. The eight wastes table above shows that movement, transportation, waiting and inventory time are the four main wastes that greatly affect the efficiency of the production process and the availability of floor space.

- Take customer order: Defects occur because the customer's order is taken orally without documenting it, writing the quantities, and reviewing the order with the production and warehouse officer before confirming the order.
- Issue production order: defects occur since there is no form to include quantity and specifications. Long waiting occurs due to lack of production scheduling, lack of stock check of raw material to cover order quantity, and lack of confirming delivery period to customer or production officer.
- Prepare raw material: Delay occur due to unlabeled raw materials and unorganized storage are, workers have to move many cartons or barrels to reach the required material. Additional delay occur since the workers are informed verbally what to collect from the store since the production formula is top secret. Defects occur due to repetitive movement of raw material from one place to another to collect and required ones. While high motion occurs due to unorganized stores and lack of raw material list to be collected.
- Prepare batch file: long waiting occurs since the batch file prepared after preparing the raw material.
- Mixing: delay occur because the raw material step takes a long time on many stages.
- Prepare empty bottles & covers: defects, waiting, transportation, extra or less inventory and high motion occur due to unidentified quantity of bottles and need of bottles pickup on many stages, in addition to lack of required quantity in near stores and lack of clean store area where dust is found on the bottles and covers.
- Prepare label: waiting, motion, and transportation occur since the labels are not prepared with the bottles and not all of them are stored in one place. Then the required quantity is not identified which may result in extra or less labels prepared.

- Prepare filling line: waiting occur due to long time required to get rid of the foam of the mixture and delay in preparing empty bottles and labels which requires high motion to bring missing items to filling area.
- Filling & covering: defects occur in less or extra filling due to estimated calibration. Waiting occur due to less number of bottles, unlatching covers for these bottles, machine malfunction due to lack maintenance, and mixture spilling due to fault calibration.
- Labeling: waiting occur due to lack of stock check of available labels before this process step, and due to preparing less number of required labels.

Potential quick wins: the spotted quick wins are to perform the preparing raw material step and preparing batch file in parallel. Also, the predation of empty bottles, labels, and filling line will be performed in parallel. This will reduce the delay and the motion in these steps and will also lead to less defects and transportation.

4.3.3 Production Process Data Collection

The production process data were collected by live observation by the optimization team for the Liquid production line, the cycle time and delay time of each process step were collected using the data collection sheet.

Table (4-2) Efficiency Data for Current Status of Liquid Production Line:

Process step	**AVG CT(minute per square meter)**	**AVG DT(minute per square meter)**	**AVGLT(minute per square**	**%VA = CT/LT %**
Prepare raw material	350	220	570	61
Mixing	200	216	416	48
Prepare batch file	20	228	248	8
Prepare empty bottle & cover	150	1400	1150	13
Prepare label	13.1	96	109,1	12
Prepare filling line	70	240	310	22
Filling & cover	180	180	360	50
Labeling	190	200	390	48

After collecting the process data, the improvement team calculated the process efficiency as follows:

CT= cycle time

DT= delay time

LT= Lead time

LT=CT+DT

%VA= percentage value added of the process which measures process efficiency.

%VA = ∑CT's/∑LT

= (1173.1 / 2707.1)

= 43 %

The low efficiency is due to long lead time in this process.

4.3.4 Value Stream Mapping

VSM is an analytical method, based on the level of details available that adds value to a product or service. It highlights not only process deficiencies, contact and transaction mismatches, but also clues about improvement (Rother and Shook, 1999).

An important objective of the value flow diagram method is to identify opportunities for improvement in a future and short period of time.

An important part of the VSM process is to control the relationship between manufacturing processes and the controls used to manage them, such as production scheduling and information.

Most process planning techniques only document the flow of the core product, while VSM documents the flow of information within the system. VSM is about eliminating waste wherever it is and making work flow (Singh et al., 2009).

The improvement team was trained on the VSM process and prepared the map presented in figure (4-2):

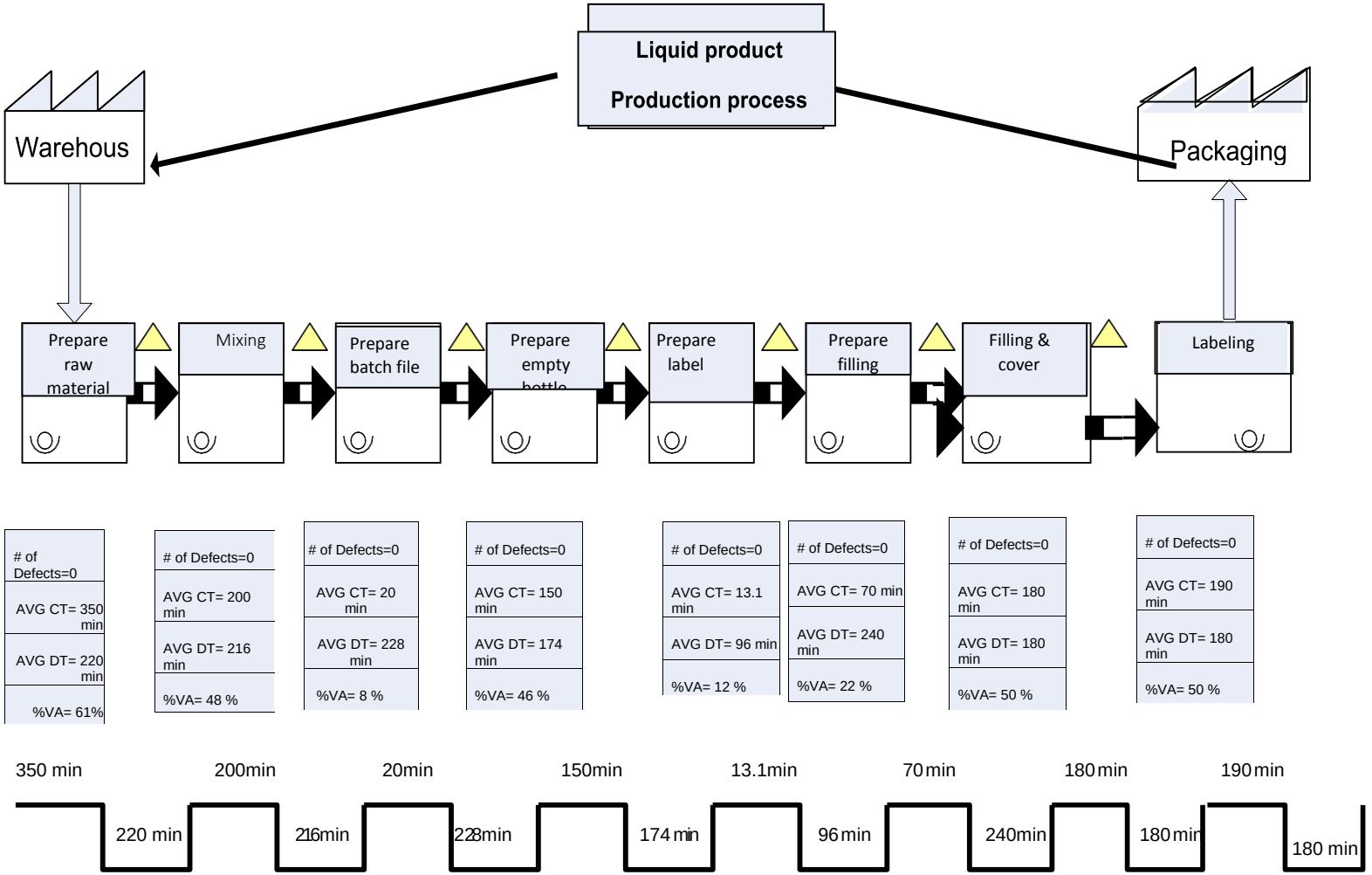


Figure 4-2 Value Stream Mapp of Liquid product Production process

To calculate the efficiency of the process, the sum of the sum of cycle times is divided by the sum of lead times, where the total lead time equals the sum of all cycle times and delay times.

%VA (process efficiency) = ∑CT's/∑LT

= (1173.1 / 2707.1)

= 43 %

4.3.5 Cause & Effect Diagram

The fishbone diagram and analysis typically assist to uncover all the symptoms of any business problem by evaluating the causes and sub-causes of one particular problem. It is also termed as "Cause-Effect analysis" for that particular reason. In a typical fishbone diagram the targeted problem has been put on the head of the diagram and the causes are put as the bones and then smaller bones are created as the resemblances of the sub-causes. Ultimately after completion of the diagram it is a comprehensive evaluation of the causes of the main problems and also reveals the root causes as well. (Bose, 2012).

The diagram shows a model of the association between the problem and its potential causes based on the five main categories of investigation into the causes of problems: machines, process, manpower, material and management. The improvement team prepare the cause and effect diagram presented in figure (4-3):

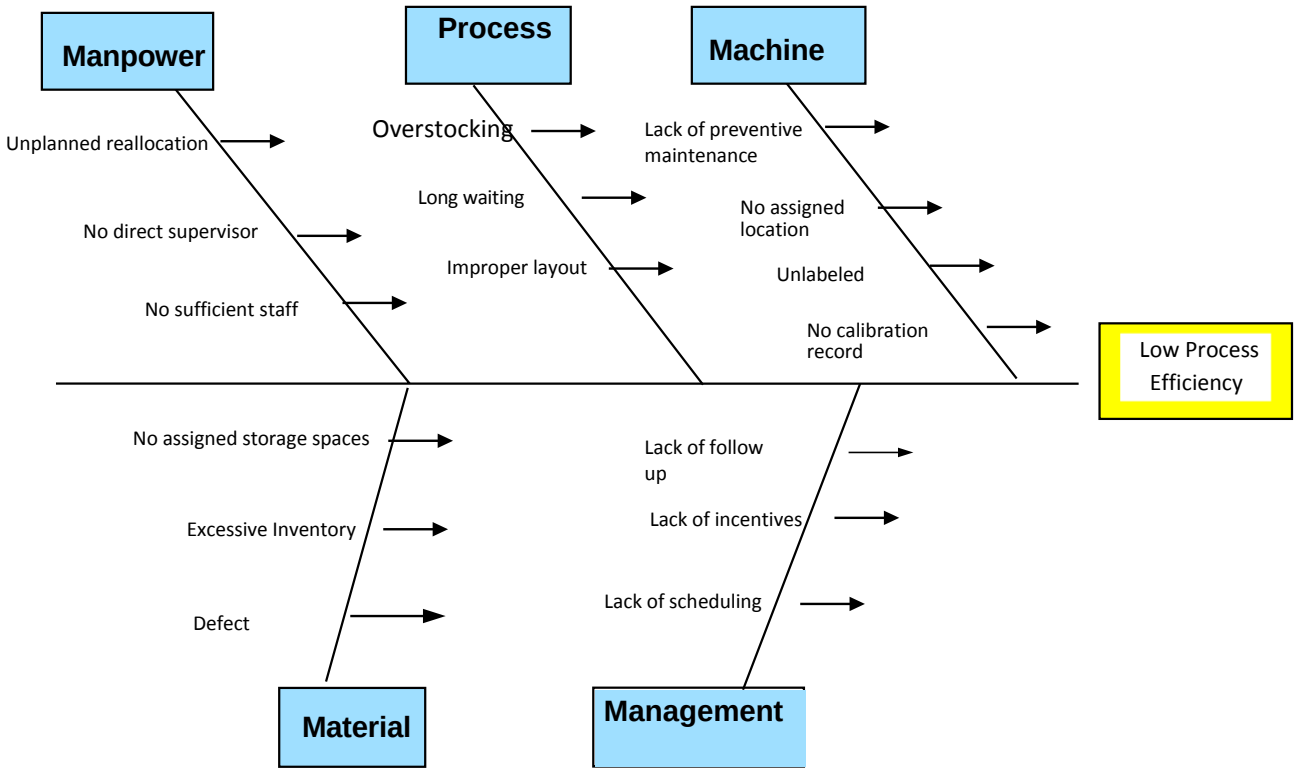


Figure 4-3 Cause and Effect Diagram (Fishbone Diagram)

After completing the identification of potential causes in the cause and effect diagram, the improvement team identified the root causes of the problem using the interrelationship diagram.

According to Dogget (2005) it is a graphical tool to illustrate the various relationships between processes, factors, or other aspects. The Interrelationships Diagram (ID) helps identify, categorize and analyze cause and effect relationships to identify the root causes among all critical issues so that the underlying factors are likely to be an effective part of the solution. The arrows plotted between the factors represent a relationship.

Outgoing arrows represent a causal relationship and incoming arrows represent an effect relationship, both arrows are counted for each potential cause (factor), the higher number of arrows for each factor indicates if it is an effect or a cause. If the number of outgoing

arrows is higher than incoming ones then the factor is considered as a cause, and if the number of incoming arrows is higher than the outgoing ones then the factor is considered as an effect.

The improvement team prepared a diagram of the interrelationships as presented in Figure (4-4):

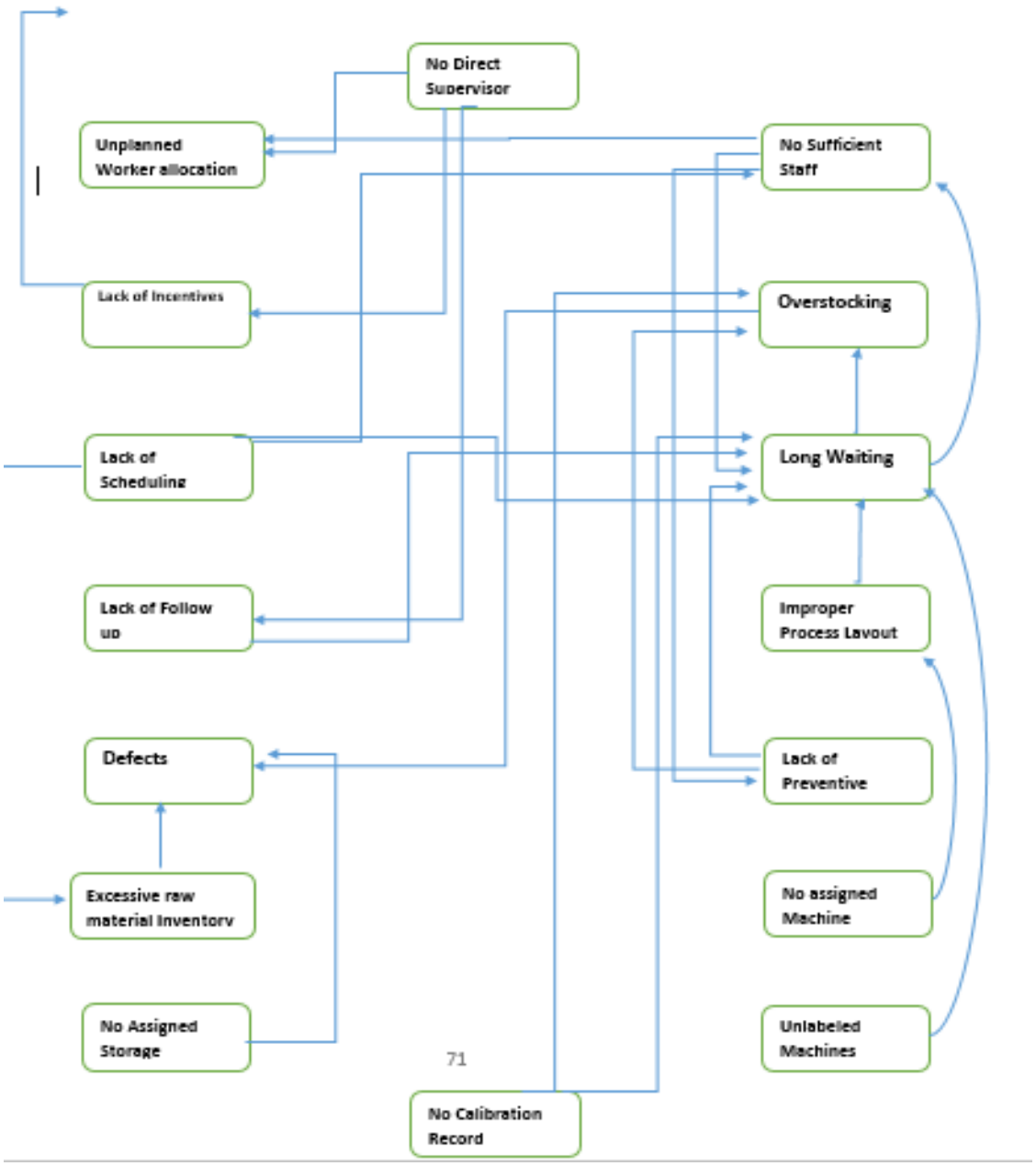


Figure 4-4 Interrelationship Diagram

The improvement team prepared the interrelationship diagram to identify causes of the problems presented in the fishbone diagram. The results are presented in table (4-3) below:

Table 4-3 Interrelationship Diagraph Analysis

Cause/Effect	**Arrows In**	**Arrows Out**	**Result**
Unplanned reallocation of workers	3	0	Effect
No direct supervisor	0	3	Cause
No sufficient staff	0	3	Cause
Overstocking	5	1	Effect
Long waiting	7	1	Effect
Improper Process Layout	1	2	Cause
Lack of preventive maintenance	1	2	Cause
No assigned machine location	0	1	Cause
Unlabeled machines	0	1	Cause
No calibration record	0	2	Cause
No assigned storage	0	1	Cause
Excessive inventory	1	1	Effect
Defects	3	0	Effect
Lack of follow up	1	2	Cause
Lack of scheduling	0	3	Cause
Lack of incentives	1	0	Effect

After identifying the causes, the improvement team will target these causes to be solved which will help in reducing/eliminating their effects. The improvement team proposed the following solutions for each cause as shown in table 4-4.

Table (4-4) Proposed Solutions for the Root Causes Identified in Interrelationship Diagraph Analysis:

Cause	Proposed Solution/Tools
No direct supervisor	Assign supervisor
No sufficient staff	Hire maintenance technician
Improper Process Layout	Plan new layout / 5S
Lack of preventive maintenance	TPM
No assigned machine location	Plan new layout / 5S
Unlabeled machines	TPM
No calibration record	TPM
No assigned storage	Assign storage / 5S
Lack of follow up	Assign supervisor
Lack of scheduling	Prepare production schedule form

4.3.6 Implementation of the 5S Tool

5S is a Lean and process improvement system to clean the workplace, reduce waste and improve work productivity. The 5S concept helps maintain an organized workplace and uses visual cues to achieve more consistent production processes (Al-Aomar, 2011).

The 5S model is one of the mandatory waste disposal methods used in a Lean Management organization. Implementation of the 5S system in the company helps in eliminating waste (MUDA), increasing productivity, reducing costs and increasing employee satisfaction, freeing up and cleaning space, improving workplace conditions, and most importantly increasing security, safety and visual factory generation that allows for quick identification of the state of the workplace(Bicheno & Holweg 2009).

The 5S concept is implemented in five phases ; the sort phase aims to sort out unnecessary items, the set in order phase aims to arrange a place for everything, the shine phase aims to clean the workplace, the standardize phase aims to document business procedures and the sustain phase objectives to continuously maintaining established procedures (Osada,1991).

An initial introductory session was scheduled with the employees responsible for the stores (raw materials, empty bottle and labels) in order to explain, define and clarify the importance and necessity of applying the 5S model in the Warehouse and the steps that will be followed. Accordingly, the tasks were distributed to the employees and the work mechanism was clarified.

In order to have a better view of work environment, the improvement team draw the factory layout as presented in figure (4-5) and Figure (4-6) and Figure (4-7):

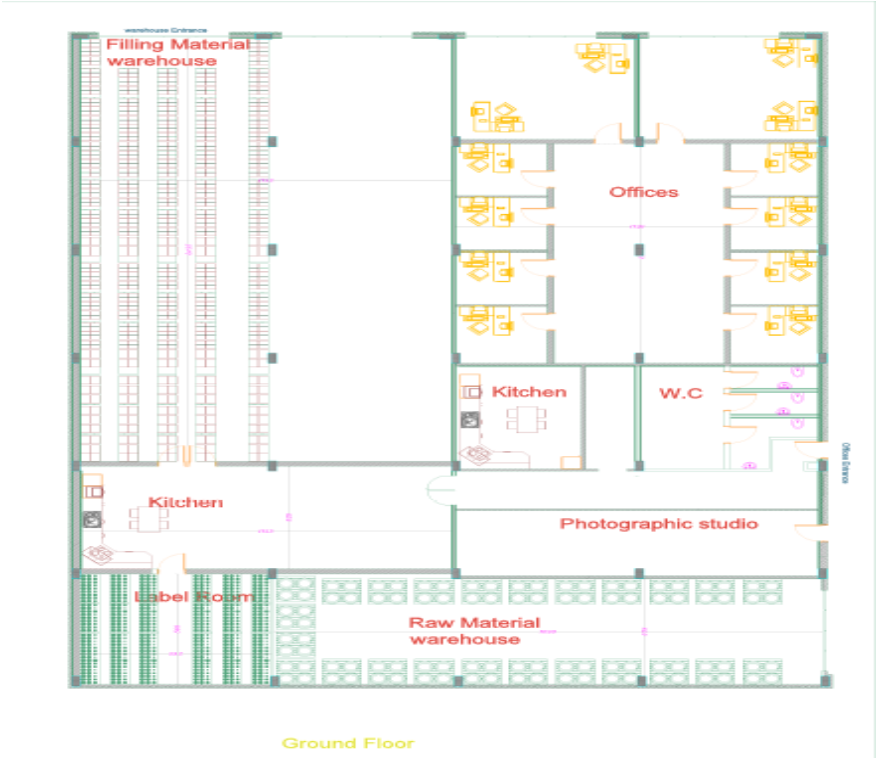


Figure 4-5 Planning of Storage Away the Factory

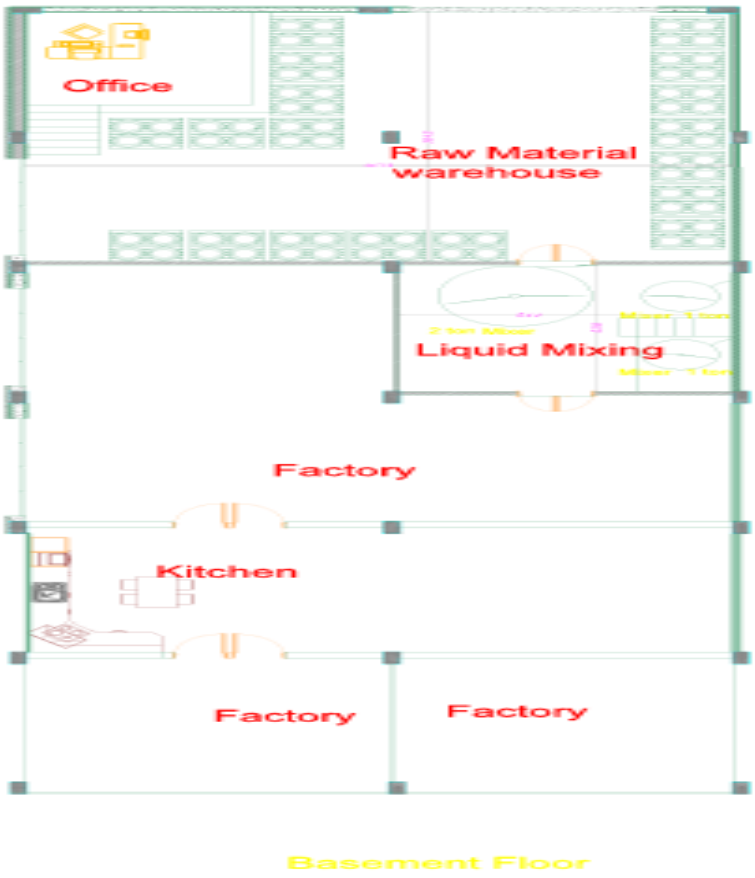


Figure 4-6 Layout of Storage near from the factory.

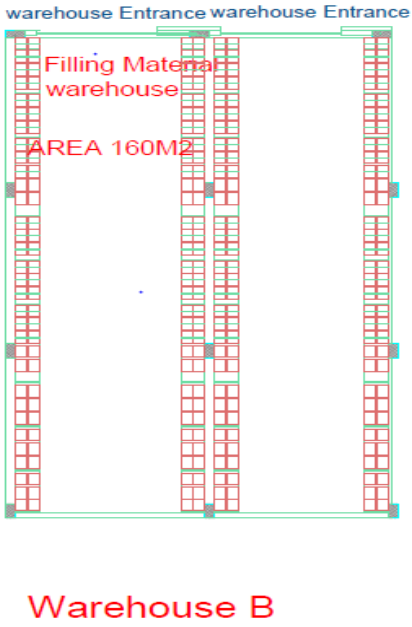


Figure 4-7 Layout of Storage away from the factory.

The company has two stores for raw material, two stores for empty bottles and covers, one room for labels, and three rooms for production, one of them is assigned for liquid production process.

4.3.6.1 Sort Phase:

This phase included sorting out all defects, unnecessary items, tools or machines, and keeping the needed ones to be able to organize the work environment and create spaces for sorting them.

The sorting targeted all of the stores, labels room, and liquid production room. Photos were taken for the current status to be compared with the new status.

The accounting system includes the purchased material and it does not include the material used in production, this leads to false stock in the stores. Accordingly, the team replied on the material list from the accounting system to be able to identify what is available and what are the most used ones.

The first stage of sorting targeted the raw material, empty bottles and covers, and labels. During this stage 2500 empty bottles with covers were sold with total amount of 7300 NIS, 2000 empty bottles with covers were sorted out and scrapped since it is no longer used in production and cannot be sold, no defects were found in the raw material, around 3000 labels were sorted out, 42 empty barrels were sold with total amount of 600 NIS, two filling machines were sold, and two filling machines were sent to maintenance and returned to production.

Due to the created spaces, the company was able to get rid of an external store of 160 square meter area and an annual rent of $12000.

The Liquid Production Line area was cleared from all of the unnecessary items to allow flexible movement of workers and create spaces for production items.

4.3.6.2 Set in Order and Shine Phases:

The shine phase was implemented in parallel with the set-in order phase to achieve the cleanliness of each area after the set in order is finished, so once the sorting stage is completed, the process of cleaning from the accumulated dirt begins, and training the stores workers to take advantage of the new clean place. And training the stores administrator on the cleaning mechanism and documenting the process using the developed records. The sorting and shine phases were divided into three stages.

Sorting Raw Material Areas, A:

There are two stores for raw materials, one near the production area, and the other is on the second floor with external entrance. Reply on the sales report, the most used materials were sorted in the near stores, and the less used material were sorted in the far store. The company agreed on ordering 14 rack for sorting raw materials as presented in figure 4-8.

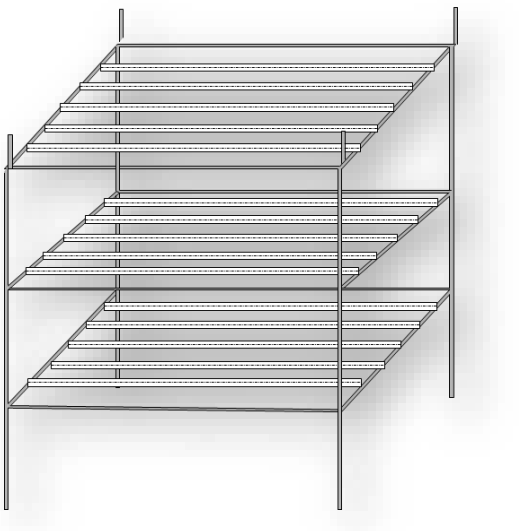


Figure 4-8 Design of New Stand for Raw Materials and Final Products Storage

These racks helped in avoiding accumulation of raw material on top of each other and reducing defects. It also helped in labeling this material and provide better visibility for workers to sort them and also identifying the needed material for production process, this also reduces workers movement, eliminates unnecessary transportation, and reduce delays in preparing raw material for production.

The raw material was sorted according to their category (perfumes, colorings, dry material, empty barrels, and liquid material) to guarantee easy sorting and easy access to these materials. The racks were labeled to help the workers in identifying these materials. This will also lead to faster stock check.

Table (4-5) presents the old status and new status of raw materials storage:

	Before	**After**
Raw Material in store A (away the factory)		

<table>
<tr><td></td><td>  </td><td>  </td></tr>
<tr><td rowspan="3">Raw Material in store

(near the factory)</td><td>  </td><td>  </td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>  </td><td>  </td></tr>
</table>

Sorting Empty Bottles & Covers Storage B:

The cartons of empty bottles and covers were sorted according to the shape and size, the most consumed ones were sorted in the internal store and the least consumed ones were sorted in the external store. Some of the cartons were labeled with symbols to identify the bottles inside, these symbols are presented in a table so that the workers can track the needed ones. Other cartons were labeled in a different mean where one bottle was taken from the carton and was sticked to the carton so that the workers can identify the needed ones easily. This labelling helped in faster sorting of received bottles and faster consumption of needed ones. Spaces were created between the sorted cartons to allow ease of movement.

Table (4-6) presents the old status of bottles storage and the new status:

	Before	**After**
Empty Bottles & Covers Storage (away from factory)		

		
Empty Bottles & Covers Storage **(near from factory**		
		

Empty Bottles & Covers Storage **(away from factory)**		
		
		

Sorting Labels C:

A new room was assigned for sorting the labels to guarantee easy access to the labels. New shelves were added for the sorting in a safe proper manner according to product name and size. The shelves were labeled to provide easy identification of the needed labels by the workers, easy sorting for purchased ones, and easy stock check. A staff member was assigned for this room who will handle labels consumption and ordering.

Table (4-7) presents the old status and new status of labels storage:

	Before	**After**
Label Storage		
		

4.3.6.3 Standardize Phase

The 5S standardize and sustain phases were implemented simultaneously to sustain the gained improvements. These phases will include monitoring and controlling storage and consumption of raw material, empty bottles/covers, and labels.

In order to manage and control inventory the improvement team agreed on assigning a staff member for raw material stores and another one for stores of labels and empty bottles/covers. The company manager and the quality manager will follow up the conformance to standards in sorting by the assigned staff members.

A purchase order form was prepared to monitor and control sorting process of inventory and avoid excess inventory or shortage. The form is show in Table (4-8). The Arabic check list is presented in Appendix A.

Table 4-8 Purchase Order Form

Purchase order form for raw materials /empty bottles / labels	
Date:	
Ordering Part	
Item Name and Description	
Specifications	
Available Quantity	
Needed Quantity	
Supplier Name	
Applicant signature	
Manager Signature	
Receiving Part	
Reception Date	
Received Quantity	
Conformity to Specifications	
Notes:	
Storage Location	
Recipient Signature:	

The purchase order form is divided into two sections, ordering section and receiving section. The ordering section of the form will be filled and signed by the applicant; it includes date of application, item name, item specifications, available quantity, needed quantity, and potential supplier name which will be filled by the applicant and confirmed or amended by the accountant. The factory manager will sign the form to confirm approval of purchase. Then the accountant will check, contact suppliers, and confirm supplier name. The assigned receiver of the purchase process will fill the receiving items that includes date, received quantity, matching specifications, any notes including less or extra quantity, change in item specifications, defects, returns to suppler, …etc. Finally he will sign the form and deliver it to the factory manager. In case of different specifications and/or quantity, the receiver will directly inform the factory manager who will inform the applicant of the order to confirm receiving or rejecting the order partially or fully. The received items will be stored in place as written in the purchase form. Finally the form is returned to the accountant who will insert the data in the accounting system and arrange filing in assigned folders.

This form helps in managing and controlling purchased items. Any missing step is easily detected by the factory manager or the accountant and the assigned staff member will be informed directly to avoid future mistakes. The factory manager will follow that the purchased item is stored in the assigned location.

The store manager will ensure the following to guarantee organized sorting and withdrawal of items from the stores:

1- All items will be drawn from stores based on the production order.
2- Sorting will depend on first in first out for raw materials to follow consumption according to shelf life.

3- Consumed quantities of each item will be sent to the accountant to control the inventory.

4- Barrels are stored on wooden pallets to avoid damage or spoilage.

5- Regular check of shelf life each two week and reported to the accountant.

The improvement team prepared check list presented in table (4-9) for each store to ensure conformance to standards and sustaining the achieved outcomes. The Arabic check list is presented in Appendix B.

Table 4-9 5S check List:

1.	Removal of machinery and equipment from the cargo storage area.	
2.	The materials are completely closed to avoid the entry of insects or dust or their contamination.	
3.	Do not leave or store any unnecessary items.	
4.	Ensure that all materials are identified for easy access.	
5.	Leave a space between the wall and save the materials to avoid the arrival of insects and moisture.	
6.	Are the materials sites well organized and clear?	
7.	Are dry ingredients separated from liquids from perfumes?	
8.	Is the labels preserved and identified in appropriate conditions?	
9.	Are there labels to identify the material?	
10.	Is the process of arranging the materials in the designated place?	
11.	Are the floors clean and free from dust and dirt?	
12.	Are the stored items clean	
13.	Are the shelves clean	

Store Name: . . . . . Date: . . . . . .

✔ / x

Name: ……

Signature: ……

4.3.7 Total Productive Maintenance

4.3.7.1 Overview:

TPM is a process improvement method that includes many things of a good maintenance program to achieve higher levels of equipment effectiveness and helps with the participation of employees from all departments and levels to further modify existing equipment and processes to reduce errors and accidents from the production sector (Williamson, 2000).

The goal of any TPM program is to improve productivity and quality along with increased employee morale and job satisfaction. Earlier preventive maintenance was considered as nonvalue adding process, but now it is essential requirement for longer life cycle of machines in an industry. TPM is an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns, and promotes autonomous operator maintenance through day-to-day activities involving the total workforce (Ranteshwar Singh & other, 2012)

4.3.7.2 Current Status of Maintenance System:

The improvement team conducted several inspections to the production lines including all machines and check the status of these machines regarding operation, breakdowns, maintenance plans and assessed the current status of the maintenance of the machines as follows:

Machines:

- No assigned places for the machines.
- There are no labels on the machines and workers cannot identify the needed machines for production in some cases.

- There is no assigned staff member for maintenance of the machines.
- There are not planned maintenance works for the machine, no preventive maintenance, no maintenance records, and no catalogs for the machines.
- Maintenance is done upon machine breakdown or faulty output in filled quantities.
- Maintenance is done by several workers by based on their experience with the machine.
- There are no calibration records for the machines and the calibration is done by trial and error.
- The only preventing work done by the workers is the lubrication of the machines.
- Due to lack of experience or training on maintenance; a third party is contacted to fix the machines which take a long time and delay production.
- The maintenance of the water system of the machines is done by a third party twice a year with high cost despite the simple works to be done by this contractor.

Tools and Spare Parts:

- No records for tools or parts.
- Tools and parts are stored in random places and not returned to assigned place after use.
- Lack of spare parts and tools for the maintenance works.
- Lack of worker's experience in the needed spare parts for the machines delays maintenance works and production.
- Workers use manual cutting tools to adjust the size of bottle's covers.
- No assigned staff member for maintaining or ordering tools or spare parts.
- Presence of defected tools and spare parts with good ones.

After the assessment of the current status of the maintenance system it was clear that the company has no maintenance system, it just responds to machines failure or breakdown and there are no records for maintenance works, spare parts, or tools.

4.3.7.3 Implementation of Total Productive Maintenance System (TPM)

In order to decrease machines breakdowns and failures; the company should build a total productive maintenance system to improve productivity and quality of the output. The key player in this system is the qualified staff member to handle the required duties including preventive and corrective maintenance works, maintain records of all of the elements of the maintenance system, and prepare the required plans and tools to achieve and effective maintenance system.

After discussing the current status of the maintenance system with the company manager and explaining the importance of the presence of an effective maintenance system in improving the productivity and decreasing cost, it was agreed that the first step is to hire a qualified person and the company hired an industrial engineer who was informed about his role in building and sustaining the achievements in the new maintenance system. The engineer was introduced to the improvement team and given an overview of the improvements that were done and his importance as a part of this team in reaching the desired outcomes and sustaining them.

The improvement team agreed to divide the work to be done into two stages:

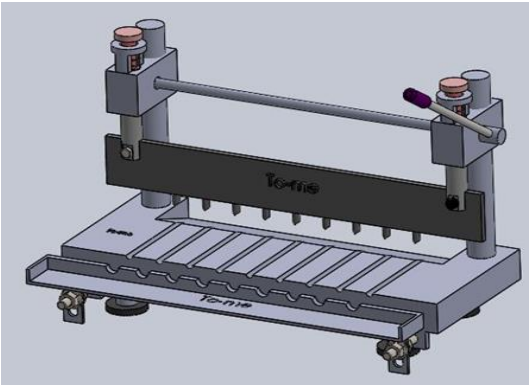
1- Assigning place for each machine, label, spare parts record, and maintenance record either preventive of corrective.
2- Sorting tools and spare parts in assigned places and labelling them.
3- Preparing checklist to control and sustain the achievements.

After a brain storming session with the improvement team to start identifying the suitable place for each machine, it was agreed with the company manager to purchase an air compressor for the purpose of cleaning bottles and covers from dust and humidity as presented in figure(4-9),

Figure (4-9) Air compressor

and to be used for other cleaning purpose which will eliminate manual work for these tasks, the maintenance engineer also was able to design a cutting machine as presented in table (4-10), this machine helped in speeding the cutting of covers and reduced manual work and defects.

Table (4-10) design a cutting machine:



The improvement team labelled all machines as presented in table (4-11), and assigned a place for each machine to prevent machines reallocation without written permission from the maintenance engineer. Production manager informed all workers about the assigned location of the machines.

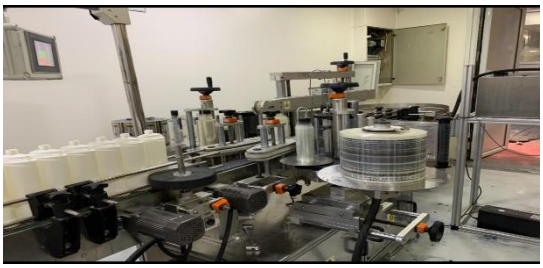
Table (4-11) Definition of machines

In order to increase the output of the mixing stage of the liquid line, the maintenance engineer was able to fix a mixer and returned it to production, this will also increase productivity and reduce delivery period. This step is presented in table (4-12).

Table (4-12) addition the liquid machine 2 ton

He was also able to add new parts to the labeling machine to be able to coat the largest possible number of product labels, which contributed to speeding up the labeling process for the liquid production line. This step is presented in table (4-13).

Table (4-13) add new parts to the labeling



The next step was to sort the spare parts and tools in a safe and organized manner to assure easy access, easy use, and easy return to assigned places. The improvement team disposed of the defected tools and spare parts, and then sorted the good ones in cupboard. The sorting was done according to category, machines, and purpose of use.

The status of the sorting in the old status and the new status is presented in table (4-14) and table (4-15).

Table (4-14) sorting in the old status to the spare parts and tools

Before

After

Table (4-15) sorting in the new status to the spare parts and tools

And in order to follow up the maintenance works and the sustainability of the achieved outcomes, the improvement team prepared the following tables and check lists as described below:

Table (4-16) Receipt list for tools and spare parts

Receipt list of tools and spare parts (MN-01 F1)					
#	**Date**	**Tool/Part Name**	**Quantity/No.**	**Use**	**Signature**

1- Receipt list for tools and spare parts to follow order the availability, ordered quantities, and be able to collect data in the future to identify mostly required ones. This list is presented in table (4-16). The Arabic check list is presented in Appendix C.

2- List of all of the machines in the company to be able to follow up the status of the machines and the maintenance works. This list is presented in table (4-17). The Arabic check list is presented in Appendix D.

Table (4-17) List of all of the machines

List of machines and systems (MN-01 F5)				
#	**System / Machine / Device Name**	**Code**	**Trade name according to workers**	**Model Number**
1	Shampoo Mixer 01	Sh.001	خلاط شامبو	B1653
2	Shampoo Mixer 02	Sh.002	خلاط شامبو	TS342-1
3	Shampoo Mixer 03	Sh.003	خلاط شامبو	S230
4	Semi Solid Mixer 01	SSM.001	خلاط البلسم	TW-124
5	Semi Solid Mixer 02	SSM.002	خلاط البلسم	B1689

6	Cream Mixer 01	CM.001	خلاط الكريمات	98T-10
7	Cream Mixer 02	CM.002	خلاط الكريمات	GU986-0
8	Moving Mixer	MM.001	خلاط المتحرك	-
9	Shampoo Filling Machine 01	SFM.001	ماكينة تعبئة الشامبو	-
10	Shampoo Filling Machine 02	SFM.002	ماكينة تعبئة الشامبو	-
11	Shampoo Filling Machine 03	SFM.003	ماكينة تعبئة الشامبو	UM2754
12	Semi Solid Filling Machine 01	SSFM.001	ماكينة تعبئة البلسم	1864E
13	Cream Filling Machine 01	CFM.001	ماكينة تعبئة كريمات	-
13	Oil Filling Machine 01	OFM.001	ماكينة تعبئة الزيت	-
14	Skin Care Cream Filling Machine	SCFM.001	ماكينة تعبئة كريم العناية بالبشرة	P659N
15	Gel Filling Machine	GFM.001	ماكينة تعبئة الجل	8941
16	Raw Material Filling Machine		ماكينة تعبئة المواد الخام	861-E0
17	Semi Solid Pump 01	SSP.001	مضخة شبه الصلب 01	N7632
18	Semi Solid Pump 02	SSP.002	مضخة شبه الصلب 02	-
19	Shampoo Pump	SP.001	مضخة الشامبو	-
20	Moving Pump	MP.001	مضخة متحركة	-
21	Labeling Machine	LM.001	ماكينة الليبل	09120
22	Citronix Machine 01	Ci5000 .001	ماكينة التاريخ 01	-
23	Citronix Machine 02	Ci5000 .002	ماكينة التاريخ 02	-
Systems				
1	نظام التكييف والتبريد	CS.001		-
2	Fire Alarms System	FAS.001	نظام انذار الحريق	-
3	نظام طفايات الحريق	FE.01, FE.02, FE.03, FE.04	-	-
4	Weight Device System	WD.001	نظام جهاز المياه	-
Lab				
1	Ph Meter 01	Ph.001	-	-
2	Ph Meter 02	Ph.002	-	-
3	Conductivity 01	Cond..001	-	-

4	Conductivity 02	Cond..002	-	-
5	Laboratory Incubator	LI.001	-	-
6	**Hot Palet**	**HP.001**	-	-
7	**Temperature Device**	**Temp. D. .001**	-	-
8	**Standard Weights**	**W.01 , W.02 , W.03 , W.04**	-	-

3. Machines maintenance record to follow up the maintenance works done for each machines either preventive or corrective, and to ensure the implementation of preventive maintenance as planned. These records are presented in table (4-18). The Arabic check list is presented in Appendix E.

Table (4-18) Machines maintenance record

Machine maintenance record (MN-01 F1)		
Year :	Device:	Device Code:

Preventive Maintenance						
Maintenance Type Monthly / Semi-annual / Annual/	Planned maintenance date	Date of maintenance	Maintained by	Supervisor	Quality Officer Audit	Notes

Curative Maintenance						
Problem	maintenance date	Maintained by	Replaced parts	Supervisor	Quality Officer Audit	Notes

1. The annual preventive maintenance plan for all of the machines during the year as presented in table (4-19). The Arabic check list is presented in Appendix F.

Table (4-19) annual preventive maintenance plan

Plan release date:

Quality Assurance Officer:

Operations Officer:

#	Machines	Annual preventive maintenance plan											
		Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.

2. Inspection checklist to ensure that all maintenance works are performed and recorded as planned. This checklist is presented in table (4-20). The Arabic check list is presented in Appendix G.

Table (4-20) Inspection checklist

(Inspection Checklist)
(MN-01 F6)

Machine name: ……

Machine number: ……

Machine type: Mixing ☐ Fill ☐ others ☐

Digital Balance			
Clause	**Yes**	**No**	**Notes**
Electricity check			
Calibrate the scales on a monthly basis			

Mixer Machine			
Clause	**Yes**	**No**	**Notes**
Electricity check			
Motor/ pump check			
Thermostat Check			

Filling Machine			
Clause	**Yes**	**No**	**Notes**
Air Inlet Check			
Sensor sensitivity test			
Packing duct check			
Check the stents			
lashes change			
Electricity check			

Labeling & Citronix Machine			
Clause	**Yes**	**No**	**Notes**
Inspection of the internal raceway of the date machine			
Maintenance and cleaning of skimming of the labeling machine			
Clause	**Yes**	**No**	**Notes**
Change the air filters			
gas check			

3. Daily checklist to follow up maintenance works and progress on daily basis as presented in table (4-21). The Arabic check list is presented in Appendix H .Table (4-21) Daily checklist

Daily check for (MN 01 F6)						
Machine/system name: Machine/system code:						
Required maintenance	Saturday	Sunday	Mandy	Thursday	Wednesday	Friday
	/ /	/ /	/ /	/ /	/ /	/ /
Maintenance Supervisor's signature:						
Notes						

4. Machine maintenance record to clarify the malfunction of each machine as presented in table (4.-22). The Arabic check list is presented in Appendix L.

Table (4-22) Machine maintenance record

Machine maintenance record (MN-01 F8)						
#	Date	Description of the defect	Repairers	The reforms that have been made	Used Piece	Signature
1						
2						
3						
4						
5						
6						

8. And finally, the improvement team prepared the calibration table for the machines as presented in table (4-23), this table will help the workers to record calibration data for each product according to product weight and the used machine, this will help in documenting the manual calibration process and reduce the required time for this process which will reduce the lead time and improve productivity. The Arabic check list is presented in Appendix M.

Table (4-23) Machine calibration

Product Name	Bottle size (ml)	Filling Machine Name	Machine Calibration

4.3.7.4 **Summary for TPM section:**

TPM is important for improving productivity and quality of the output of the production process, the improvement team identified the current status of the maintenance system, it was clear that the company has no maintenance system and no assigned workers in addition to unorganized work environment for machines, spare parts, and tools. With the help of the new maintenance engineer, the improvement team was able to organize the production elements, labelling all machines and assign a place for them, and finally prepare the required forms for planning the maintenance works, follow up, and ensure conformance to the new standards to be able to sustain the achieved outcomes.

4.4 Improving Productivity of liquid production line

The first step in improving the productivity of liquid production line was the implementation of 5S technique. The improvement team managed to organize the work environment, provide easy access to production material, and clean the work environment, which provided easier movement of workers and faster access to production material. The second step was the TPM system which reduced the malfunction of the machines and ultimately reducing breakdown time during production process.

The final step was in preparing a new flow chart for liquid production process based on the new status of the work environment and the quick wins from the eight wastes table.

The improvement team prepared the new flow chart presented in figure (4-10):

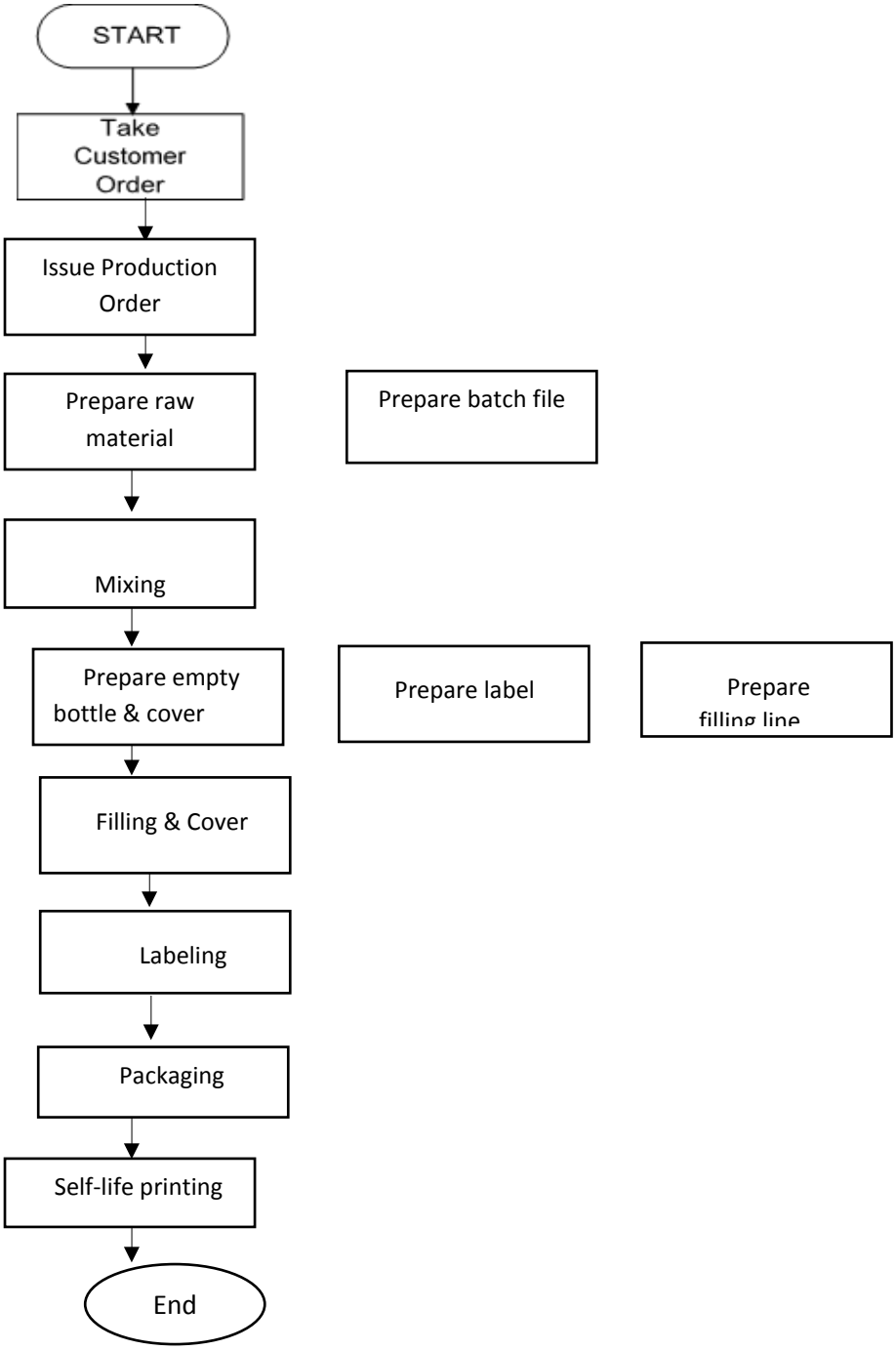


Figure 4-10 Flow Chart of New Status of **Liquid product** Production Process

The new flow chart included performing the preparing raw material step and preparing batch file step in parallel and also the preparation of empty bottles, labels, and filling line will be performed in parallel. After implementing this flow chart in the production

process, the improvement team collected that process data for 10 separate productions. The collected data is presented in table (4-24):

Process step	AVG CT(minute per square meter)	AVG DT(minute per square meter)	AVGLT(minute per square	%VA = CT/LT %
Prepare raw material	191,4	40	231,4	82,7
Prepare batch file	10	5	15	66,6
Mixing	110	30	140	78,5
Prepare empty bottle & cover	70	190	260	26,9
Prepare label	10	5	15	66,6
Prepare filling line	50	10	60	83,3
Filling & cover	160	35	195	82
Labeling	160	20	180	88,8

After identifying the cycle time and lead times of the new flow chart, the improvement team prepared the VSM for this chart as presented in figure (4-11):

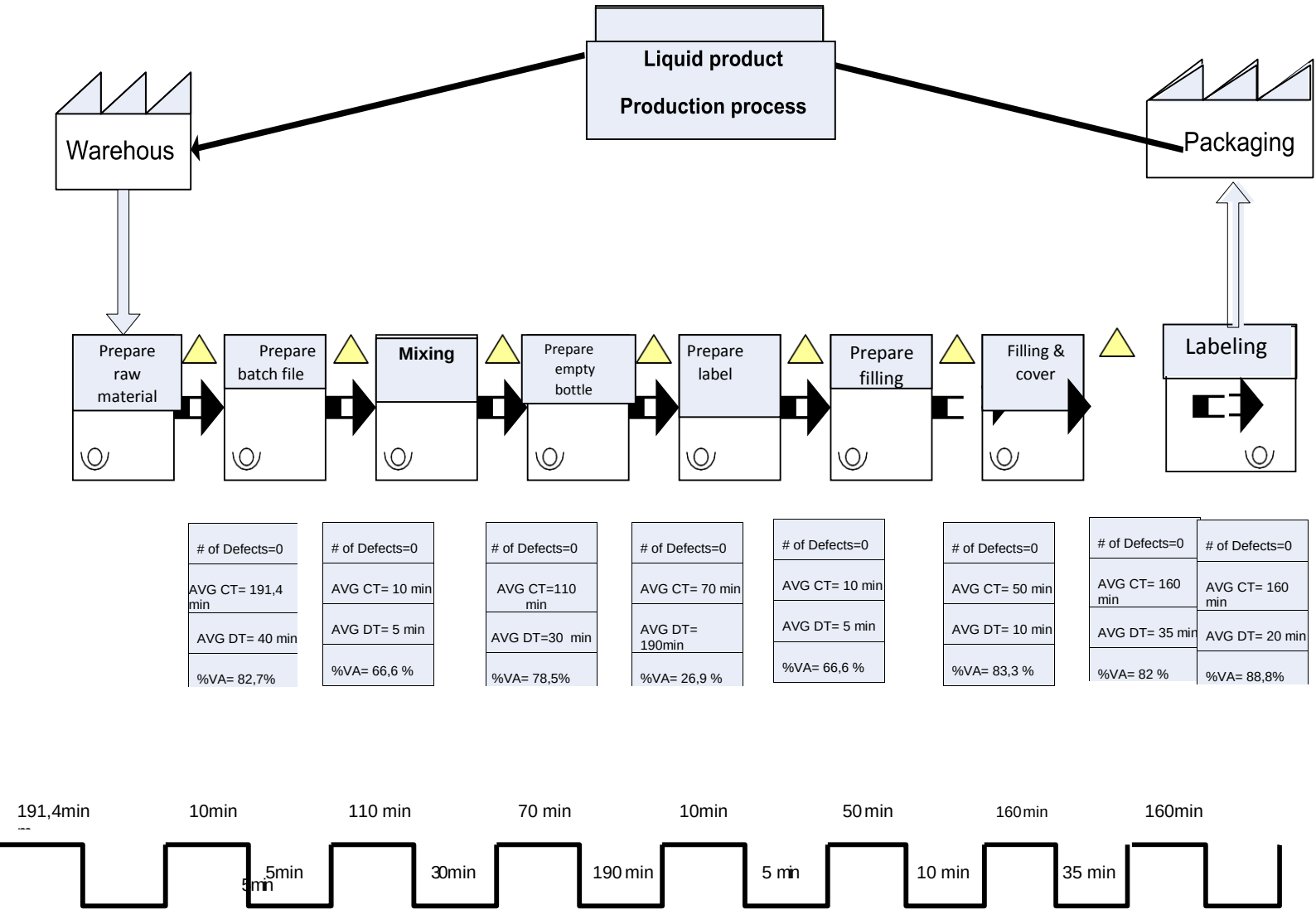


Figure (4-11) Value Stream Mapp of New Status of Liquid product Production process

Process efficiency = %VA of Liquid product Production process

= ∑CT's/∑LT

=761. 4 / 1096

= 69.5%

Based on the data collected, the improvements to the production process through the new flow chart and VSM are as follows:

- Process efficiency has increased from 43% to 69,5% which reflects the improved productivity.
- Lead time was reduced from 2707 minutes to 1096 minutes.
- Reduced order delivery duration to customers from around seven days to two to three days.
- There is still a significant delay in the step of preparing the mixture for filling due to waiting for the product to become clear and free of foam which is considered as a common cause.

And to ensure the follow up of production progress and on time delivery, the improvement team prepared production form presented in table (4-25) to identify quantity of each production material and delivery period, production progress form presented in table (4-26) to follow up production progress, and workers distribution form presented in table (4-27) to avoid unplanned release of workers and delay in the production process. The Arabic check list is presented in Appendix N, O, and T. Table (4-25) workers distribution record

Table (4-26) production progress

Product Name	Machine Code	Working staff	Start and end of work	Notes

Product Name	Mixing time	Filling time	packaging time

Product Name	Quantity (kg)	Quantity				Delivery time
		Containers	Covers	Labels	Boxes	

4.5 Chapter Summary

In this chapter the process of liquid production was improved. Data were collected through interviews and direct observations, problems were identified, flow chart of this process was prepared, VSM was prepared and process efficiency were calculated to be 43% which reflects a low productivity. The improvement team identified the eight waste in each process step and the potential quick wins, the cause effect diagram was prepaid and the cause of the problem of low productivity were identified using interrelationship diagram.

The improvement process started with implementation of 5S and the work environment were organized, the improvement team also prepared productive maintenance that reduced the breakdown time of the machines. Accordingly, the improvement team prepared the new flow chart of the process, collected the data gain, and prepared the VSM and calculated the process efficiency which because 69.5% which reflects the improved productivity due to elimination of waste and nonvalue added activities.

Finally, the improvement team prepared work forms and checklists which helped in standardizing the new procedures and sustaining the achieved outcomes.

Chapter Five: Conclusions and Recommendations

5.1 Introduction

The establishment of various technologies and systems, and the multiplicity and diversity of the tools used, contributed to influencing the behavior of employees, their participation and their way of understanding the conduct of things and the errors that might occur without their knowledge of them, which contributed to making remarkable progress in the company's production and profits.

The LM application at To-me Cosmetics Company has proven to be an essential methodology for increasing and improving Liquid line productivity and optimizing space utilization and creating a maintenance system for equipment and devices.

The use of some LM tools contributed to obtaining the required results, as the following tools were used: VSM, 5S, TPM to find improvement opportunities for quality factors. This helped VSM to measure the current performance and improve the lead time of the target process. The cause-and-effect diagram helps identify potential causes and the interrelationships diagram helps identify the root causes of the problems in progress. The 5S concept helped to streamline the working environment, optimize the use of space, and improve the planning of the fluid line production process. Finally, the flowchart, TPM, and identification of the eight wastes helped standardize and sustain the improvement.

5.2 Conclusions

The results of applying the LM methodology in the Cosmetics Company To-me to improve the productivity of the liquid line and optimize the use of warehouse space are as follows:

1. Improving the productivity of the fluid production line process:

- ❖ The Liquid line production efficiency increased from 43% to 69.5%.
- ❖ The order delivery time has been reduced from 7 day to 2-3 days.
- ❖ Reducing the time required for the liquid production line from 428.4 minutes to 138.2 minutes.
- ❖ Improve fluid production line productivity by reducing cycle times and delays.
- ❖ Lead time was reduced from 2707 minutes to 1096 minutes.

2. Use of warehouse space:
   - ❖ Optimization of raw material storage by using storage racks which reduces storage space from 100 square meter to 55 square meters. Raw materials are stored in carriers and can be drained using a forklift without any obstacles, which facilitates and speeds up the preparation of raw materials for the mixing and production process, the introduction of visual management, prevents material accumulation, improves work flow, and facilitates the process of checking inventory.
   - ❖ Reducing the storage space of empty bottle & cover in the warehouse near the factory from 250 square meters to 120 square meters and in the external warehouse from square 160 meters to 80 square meters.
   - ❖ Provides 45 a square meter of free space used to facilitate the preparation of materials and ease of receiving them.
   - ❖ The empty space in the shampoo room was used by adding a new mixer with a volume of 2 tons, which contributed to increasing productivity.
   - ❖ Reduce the number of accidents by 45%.

3. Implementation of the TPM system and its importance:
    - ❖ Increasing employees' awareness of the importance of monitoring and following up on equipment and machines through the use of maintenance models that help prevent any sudden malfunction or shortage of parts.
    - ❖ Reducing and preventing failure of machines that are not subject to maintenance and reducing pollution from dust accumulated in the maintenance kit as a result of not being set in a specific place.
    - ❖ Continuing to monitor machine spare parts to prevent delays in maintenance when needed.
    - ❖ Preventing any sudden malfunction and thus delaying the production process.
    - ❖ Setting a fixed caliber for each machine, which reduced the time of the production process.
    - ❖ Redefining the machines by placing a sticker, which makes it easier for the employee to reach the required machine.
4. Financial savings as a result of improvement and space savings:
    - ❖ Staff participation and management commitment are important factors in the successful implementation of LM.
    - ❖ 150,000 NIS was obtained from product sales due to the reduce delivery time of orders.
    - ❖ The quantities were transferred and the empty cans and lids warehouse was delivered (away the factory) as a result of the space that was provided from the other warehouse (near the factory), which saved the company 12,000 dollars in rent annually.
    - ❖ Empty bottles which the company never used before were sold for 7300 NIS.

- ❖ The total freed space is 80 square meters, or 50% of the area of the nearby warehouse for packing materials, the value of which according to the current rent is $8000 per year as savings for the company.
- ❖ Saving a sum of 5,000 NIS per month due to the employment of an internal maintenance officer, in addition to saving a lot of time by addressing the defect in some mixers and filling machines by re-maintenance and replacing damaged parts after they were in an irregular state during their work.

5.3 Recommendations

To increase productivity, improve work environment, reduce costs and increase profitability, the company is recommended to:

- Activate the system of incentives and financial rewards because of the significant impact on the employee's performance.
- Hire a warehouse employee at a young age, in order to suit the nature of the work.
- Purchasing equipment for the extraction of raw materials in large quantities, in order to facilitate the process of withdrawing materials.
- Implementation of 5S technology by improvement team frequently to maintain a disciplined work environment.
- The warehouse administrator must make sure that the packing materials are completely closed in order to prevent the boxes from getting dirty.
- Activating the cooling system for the mixers to control the delay in the delivery of orders.

5.4 Future Recommendations

I recommend that To-me Cosmetics company realizes the following suggestions for future work:

1. The possibility of applying LM to all company operations.
2. Follow the ABC system to determine their product costs.
3. Market study on an ongoing basis to deal with market competition.
4. Follow the minimum system when purchasing raw materials, empty cans and lids, and not based on expectations.

List of References

Aadarsh Adeppa, (2015). International Journal on Emerging Technologies, 6(2): 294-297.

Ablanedo-Rosas, J.H., Alidaee, B., Moreno, J.C. And Urbina, J. (q) 'Quality Improvement Supported By The 5S, An Empirical Case Study Of Mexican Organizations', International Journal Of Production Research, Vol. 48, No. 23, Pp.7063–7087.

Adesta, E. Y. T., Prabowo, H. A., & Agusman, D. (2018, January). Evaluating 8 pillars of Total Productive Maintenance (TPM) implementation and their contribution to manufacturing performance. *IOP Conference Series: Materials Science and Engineering*, 012024.

aiprakash Bhamu,agdish Bhadu, Kuldip Singh Sangwan,(2020). Lean Manufacturing Implementation in Ceramic Industry: A Case Study, pp.21-30.

Al-Aomar, R. A. (2011). Applying 5S LEAN Technology: An infrastructure for continuous process improvement. World Academy of Science, Engineering and Technology, 59, 2014-2019.

Al-jawazneh, B. E. (2011).The internal lean manufacturing practices at the apparel manufacturing companies in Jordan. European Journal of Economics, Finance and Administrative Sciences, 43, 109-123.

Anthony.(2018).Lean and green combine to impact environmental and operational performance, 56(4):1-17.

Antosz K., Pacana A., Stadnicka D., Zielecki W. (2015), Lean Manufacturing Doskonalenie Produkcji, Oficyna Wydawnicza Politechniki Rzeszowskiej, Rzeszów.

Application of value stream mapping for reduction of cycle time in a machining process. Procedia Materials Science, 6, 1187-1196.

Arumugam, V., Antony, J. and Douglas, A. (2012), "Observation: a Lean tool for improving the effectiveness of Lean Six Sigma", The TQM Journal, 24(3), pp. 275- 287.

Ashish Thakur. (2016). A Review on Lean Manufacturing Implementation Techniques: A Conceptual Model of Lean Manufacturing Dimensions. REST Journal on Emerging trends in Modelling and Manufacturing, 2(3) 2016, 62-72.

Bakri, A. H., Rahim, A. R. A., Yusof, N. M., & Ahmad, R. (2012). Boosting Lean Production via TPM. Procedia - Social and Behavioral Sciences, 65, 485–491.

Bakri, A. H., Rahim, A. R. A., Yusof, N. M., & Ahmad, R. (2012). Boosting Lean Production via TPM. Procedia - Social and Behavioral Sciences, 65, 485–491.

Balle, (2005); Chaisorn and Lila, (2011); Nordin et al., (2010). Thought to apply lean manufacturing system, pp1/26/22.

Bayyoud and Sayyad, 2016. CHALLENGES AND OBSTACLES THAT SMALL AND MEDIUM ENTERPRISES FACE IN TERMS OF FINANCING IN PALESTINE, 4(2):49-60.

Bergmiller, Gary G., "Lean manufacturers transcendence to green manufacturing: Correlating the diffusion of lean and green manufacturing systems" (2006). Graduate Theses and Dissertations.

Bessant, John, and Francis. David. (1999). Developing strategic continuous improvement capability. International Journal of Operations and Production Management, 19(11), 1106-1119.

Bhamu, J., & Singh Sangwan, K. (2014). Lean manufacturing: literature review and research Issues. International Journal of Operations & Production Management, 34(7), 876-940.

Bicheno, J. & Holweg, M. 2009. The Lean Toolbox: The Essential Guide to Lean Transformation. 4th Edition. Buckingham: PICSIE Books.

Billington, J. (1999). The ABC's Of ABC: Activity-Based Costing and Management. Harvard Management Update.

Borget Alfred Anoye, Adama Ouattara. (2015). Continual Improvement in Small Soaps Company. INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH, 11, 2277-8616.

Bose, T. K. (2012). Application of fishbone analysis for evaluating supply chain and business process-a case study on the St James Hospital. International Journal of Managing Value and Supply Chains (IJMVSC), 3(2), 17-24.

Brady Worldwide Inc. (2008) 5S/Visual Workplace Handbook: Building the Foundation for Continuous Improvement [Online]

Brady, H. E. and Collier, D. (2004). "Rethinking Social Inquiry: Diverse Tools, Shared Standard". Rowman & Littlefield, USA.

Brijbhushan, Onkar Singh Bhatia, Vikas Ucharia ,2018. Journal of IMPLEMENTATION OF LEAN MANUFACTURING TOOLS FOR IMPROVING PRODUCTIVITY, 2395-7549.

Bryman,A.(2008).Why Researchers Integrate/Combine/Mesh/Blend/Mix/Merge/Fuse Quantitative And Qualitative Research. Advances in Mixed Methods Research, 87-100.

Card, A. J. (2016). The problem with ‘5 whys’. BMJ Quality & Safety, 26(8), 671–677.

Carmen Nadia Ciocoiu (2010). Knowledge Management Research & Practice. Application of Fishbone Diagram to Determine the Risk of an Event with Multiple Causes, 2(1):1-20.

Carter, S. and Henderson, L. (2005). Handbook of health research methods: Investigation, measurement and analysis, chapter 9: Approaches to qualitative data collection in social science. McGraw- Hill education, England, pp. 215.

Casebeer, A. L., & Verhoef, M. J. (1997). Combining Qualitative and Quantitative Research Methods: Considering the Possibilities for Enhancing the Study of Chronic Diseases. Chronic Diseases in Canada, 18(3), 130-135.

Chakraborty, R.K., & Paul, S. K. (2011).Study and implementation of lean manufacturing in a garment manufacturing company: Bangladesh perspective. Journal of Optimization in Industrial Engineering, 4(7), 11-22.

Chan, S. W., Tasmin, R., Nor Aziati, A. H., Rasi, R. Z., Ismail, F. B., & Yaw, L. P. (2017, August). Factors Influencing the Effectiveness of Inventory Management in Manufacturing SMEs. IOP Conference Series: Materials Science and Engineering, 012024.

Chapman, C. D. (2005). Clean House With Lean 5S. Quality Progress, 38(6), 27- Cheng, T. C., & Podolsky, S. (1996). Just-In-Time Manufacturing: An Introduction. Springer Science & Business Media.

Cohen, L., Manion, L. and Morrison, K. (2007), Research Methods in Education, Sixth edition, Routledge, USA.

Collis, J., & Hussey, R. (2003). Business Research (Ed.).Conan Doyle, (1891). (Observe), "Towards the development of an intelligent inventory management system", *Integrated Manufacturing Systems*, Vol. 10 No. 6, pp. 354-366

Cosmetics manufacturing's Central Weighing Area, Processing and Packaging Area for Creams, Liquids and Lotions. International Conference on Industrial Engineering and Operations Management Kuala Lumpur, 2016, 8-10.

Dale, B. G., Van Der Wiele, T., & Van Iwaarden, J. (2007). Managing Quality. John Wiley & Sons.

Dawood, L. M., & Sahib, M. A. (2017, April). Developing total productive maintenance model (TPM) for small medium size enterprises (SME) (researchgate.net, Ed.; pp. 249– 255).

Dawood, L. M., & Sahib, M. A. (2017, April). Developing total productive maintenance model (TPM) for small medium size enterprises (SME) (researchgate.net, Ed.; pp. 249– 255).

Dennis, P. And Shook, J. (2007) Lean Production Simplified: A Plain Language Guide to the World's Most Powerful Production System, Malloy Lithographing, Inc., United States of America.

Deshpande, S. P., Damle, V. V., Patel, M. L., and Kholamkar, A. B. (2015). Implementation of '5S'Technique in a manufacturing organization: A Case Study. IJRET: International Journal of Research in Engineering and Technology, 4(01), 136-148.

Doggett, A. M. (2006). Root cause analysis: A framework for tool selection. Quality control and applied statistics, 51(3), 279-280.

Douglas, J., Antony, J., and Douglas, A. (2015). Waste identification and elimination in HEIs: the role of Lean thinking. International Journal of Quality & Reliability Management, 32(9), 970-981.

Douglas, J., Antony, J., and Douglas, A. (2015). Waste identification and elimination in

HEIs: the role of Lean thinking. International Journal of Quality & Reliability Management, 32(9), 970-981.

Emiliani, M. L. (1998). Lean Behaviors. Management Decision, 36(9), 615-631.

Emiliani, M. L. (2006). Origins of Lean management in America: the role of Connecticut businesses. Journal of management History, 12(2), 167-184.

Fawaz A. Abdulmaleka, Jayant Rajgopalb (2007). "Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study", Int. J. Production Economics V. 107: 223–236.

Feld, W. M. (2000). Lean Manufacturing: Tools, Techniques, and How to Use Them. CRC Press.

Fisher M. (1999), Process improvement by poka-yoke, Work Study, Volume 48 Issue 7 pp. 264 -266.

Fisher M. (1999).Process improvement by poka-yoke,vol.vol. 48(), 0043-8022.

Fled, M.W., Lean Manufacturing: Tools, Techniques, and how to use them (Boca Raton, London: The St. Lucie Press, 2000).

Gerasimos I. Siasos, Georgios I. Skodras, Evangelos Gkanas, Kostas Hrissagis and Sophocles S. Makridis (2017). The Benefits of Lean through an Analysis and Improvement of an Existing Production Line. Mater. Sci. Eng. Adv. Res 2(1): 15-24.

Goriwondo, et al., (2011). Use of the Value Stream Mapping Tool for Waste: Reduction in Manufacturing – Case Study for Bread Manufacturing In Zimbabwe. International Conference on Industrial Engineering and Operations Management Kuala Lumpur, 2011, 22 – 24.

Gupta, B., Nemati, H. R., & Harvey, J. D. (1999). Organizational Factors Affecting Successful Implementation of Decision Support Systems: the Case of Fuel Management System at Delta Air Lines. Journal of Information Technology Case and Application Research, 1(3), 4–25.

Hamrol A. (2015),Strategie i praktyki sprawnego działania. Lean, Six Sigma i inne. Wydawnictwo PWN, Warszawa.

Ibrahim Rawabdeh. (2005). a model for the assessment of waste in job shop environments, 25(8):800-822.

Ilie, G., & Ciocoiu, C. N. (2010). Application of Fishbone Diagram to Determine the Risk of an Event with Multiple Causes. Management Research and Practice, 2(1), 1-20.

Janesick, V. J. (2010). Oral History for the Qualitative Researcher: Choreographing the Story (Illustrated Ed.) [E-book]. The Guilford Press.

JM Mwacharo, (2013). Molecular phylogenetics and Benefits of Lean Manufacturing 58 (2), 374-382

Kawulich, B. B. (May, 2005). Participant Observation as a Data Collection Method. Forum: Qualitative Social Research. 6(2).

Kelle, U. (Jul, 2006). Combining qualitative and quantitative methods in research practice: purposes and advantages. The Qualitative Research in Psychology Journal, 3(4), 293-311.

Kippenberger, T. (1997). Apply Lean Thinking To A Value Stream To Create A Lean Enterprise. The Antidote, 2(5), 11-14.

Kobbacy, K.A.H. & Liang, Y. (1999). "Towards the development of an intelligent inventory management system", Integrated Manufacturing Systems, Vol. 10

No. 6, pp. 354-366.

Koumanakos, D. P. (2008). The effect of inventory management on firm performance. International journal of productivity and performance management, 57(5), 355-369.

Kumar, K. And Kumar, S. (2012) 'Steps For Implementation of 5S', International Journal of Management, IT and Engineering, Vol. 2, No. 6, Pp.402–416.

Lian, Y. H., and Van Landeghem, H. (2002, October). An application of simulation and value stream mapping in Lean manufacturing. In Proceedings 14th European Simulation Symposium (pp. 1-8). C) SCS Europe BVBA.

Liker, J.K. (2004) The Toyota Way: Fourteen Management Principles from the World's Greatest Manufacturer, Mcgraw-Hill, New York.

Lisa shea. (2020). Learning Enrichment Activity Continuous, Vol.4, Pp.764–769.

M.Bresko. (2009). Production preparation process (3P): Lean concepts for project planning.

Ma. Erika R. Laguardia., (2016). Assessment on 5S System of Rules in a

Maccarthy, B. L., and Liu, J. (1993). Addressing the gap in scheduling research: a review of optimization and heuristic methods in production scheduling. The International Journal of Production Research, 31(1), 59-79.

Mahmood, K., Shevtshenko, E. (2015). PRODUCTIVITY IMPROVEMENT BY IMPLEMENTING LEAN PRODUCTION APPROACH, Volume: 2015; pp 45-51.

Mahoney, J., & Goertz, G. (2006). A Tale of Two Cultures: Contrasting Quantitative and Qualitative Research. Political Analysis, 14(3), 227-249. Maskell, B. H., & Baggaley, B. L. (2006). Lean Accounting: What's It All About? Target, 22(1),

35-43.

Mark Doggett (2005) Root Cause Analysis: A Framework for Tool Selection, Quality Management Journal, 12:4, 34-45.

Meier, D. (2001). Learning to think lean: The reality of lean manufacturing. Automotive Manufacturing & Production, 113(3), 74-75.

Melton, T., (2005). The benefits of lean manufacturing: what lean thinking has to offer the process industries.Chemical Engineering Research and Design 83 (A6), 662–673.

Middleton, P., Taylor, P. S., Flaxel, A., and Cookson, A. (2007). Lean principles and techniques for improving the quality and productivity of software development projects: a case study. International Journal of Productivity and Quality Management, 2(4), 387-403.

Miller, G., Pawloski, J., & Standrigde, C. R. (2010). A case study of lean, sustainable manufacturing. Journal of industrial engineering and management, 3(1), 11-32.

Minju, (2009).Improving the layout of recycling centers by use of Lean production principles. Waste management, 31(6), 1121-1132.

Moser, Isaksson and Seifert. (2017). Inventory dynamics in process industries: An empirical investigation.

Motwani, J.10 (2006). A business process change framework for examining lean manufacturing: a case study. Industrial managements and data system 103 (5): 339- 346.

Moura (2015).The Lean Theorem Prover (System Description), pp. 378—388.

Mwacharo, Fiona, (2013).Challenges of Lean Management: Investigating the challenges

and developing a recommendation for implementing Lean management techniques.

Nahmias. (1997). Production and Operations Analysis, Vol. 4, No. 2, Pp.236–237.

Nicholas J.M. (1998), Competitive Manufacturing Management: Continues Improvement, Lean Production, Customer Focused Quality, McGraw-Hill, New York, NY.

Nicholas J.M. (1998), IMPLEMENTING CONTINUOUS PROCESS IMPROVEMENT METHODS IN A MID-SIZE PLASTIC COMPANY, 1(2), 8-8022.

Nielsen, A. (2008). Journal of Implementation of Lean Service with Value Stream Mapping at Directorate Airworthiness and Aircraft Operation, Vol.7 No.4.

Ohno, T. (1988) Toyota Production System: Beyond Large Scale Production. Productivity Press, New York.

Osada , T. (1991) The 5S: Five Keys To A Total Quality Environment, Asian Productivity Organization, Tokyo.

Padhye, N., Deshmukh, S. G., & Garg, S. (2010). Lean manufacturing system for medium size manufacturing enterprises: an Indian case. International Journal of Management Science and Engineering Management, 5(5), 362-375.

Paneru, (2011), Implementation of Lean Manufacturing Tools in Garment Manufacturing Process Focusing Sewing Section of Men's Shirt.

Patel, V. C., and Thakkar, H. (2014). A case study: 5S implementation in ceramics manufacturing company. Bonfring International Journal of Industrial Engineering and Management Science, 4(3), 132-139.

Pathak, V., Jena, B., & Kalra, S. (2013). Qualitative research. Perspectives in clinical research, 4(3), 192.

Peter Machamer, (1970). *American Philosophical Quarterly* 7 (1):1-22 (1970).

Phakiti, A. and Paltridge, B. (2010). Continuum companion to Research Methods in Applied Linguistics, chapter 4: Analyzing Quantitative Data. Continuum International Publishing Group, London, pp. 39.

Philipp Moser&Oloy Isaksson&Ralf W. Seifert, (2019).Manufacturing Management in Process Industries: The Impact of Market Conditions and Capital Expenditure on Firm Performance, PP(99):1-13.

Prof. S. B. Khedkar, Prof. R. D. Thakre, Prof. Y. V. Mahantare, Mr. Ravi Gondne, "Studyof Implementing 5S Techniques In Plastic Moulding", International Journal Of Modern Engineering Research, 2012, Vol.2 (5), 3653-3656.

R. S. Katikar, (2020).Case Study on Lean Manufacturing System Implementation in Batch Type Manufacturing Industry, 0921-5077.

Ranteshwar Singh, Ashish M Gohil, Dhaval B Shah*, Sanjay Desai (2012). Total Productive Maintenance (TPM) Implementation in a Machine Shop, 592 – 599.

Rosnah M.Y. and Othman A. Lean Manufacturing Implementation in a Plastic Molding Industry, AIJSTPME. (2012) 5(4): 43-52.

Rosnah M.Y. and Othman A. Lean Manufacturing Implementation in a Plastic Molding Industry, AIJSTPME. (2012) 5(4): 43-52.

Rother, M., and J. Shook, Learning to See: value stream mapping to add value and eliminate muda (1.2 edition; Brookline, MA: The Lean Enterprise Institute, Inc., 1999)

Sahar and others (2019), XVI INTERNATIONAL FORUM-CONTEST OF STUDENTS AND YOUNG RESEARCHERS "TOPICAL ISSUES OF RATIONAL USE OF NATURAL RESOURCES".

Saunders, M., Lewis, P., & Thornhill, A. (2000). Collecting Primary Data through Observation. Research Methods for Business Students, 218-236.

Shubham Ghushe et al. (2017) .A Case Study: Implementation of Lean Manufacturing Tools on a Coir Product Manufacturing Industry. International Journal of Science Engineering and Technology ,(4098-2348 5(2.

Silva, S. K. P. N. (2012). Applicability of value stream mapping (VSM) in the apparel industry in Sri Lanka. International journal of Lean thinking, 3(1), 36- 41.

Singh, 2018. Process improvement through Lean Kaizen using value stream map: a case study in India.

Singh, B., and Sharma, S. K. (2009). Value stream mapping as a versatile tool for Lean implementation: an Indian case study of a manufacturing firm. Measuring business excellence, 13(3), 58-68.

Singh, B., Garg, S. K., Sharma, S. K., & Grewal, C. (2010).Lean implementation and its benefits to production industry. International Journal of Lean Six Sigma, 1, 157– 168.

Singh, R., & Kumar, H. (2017). Role of TPM paradigms in achieving manufacturing excellence in industry. International Journal of Innovative Research in Science, Engineering and Technology, 6(8), 16624–16633.

Singh, R., & Kumar, H. (2017). Role of TPM paradigms in achieving manufacturing excellence in industry. International Journal of Innovative Research in Science, Engineering and Technology, 6(8), 16624–16633.

Sivaram, N. M., Devadasan, S. R., & Murugesh, R. (2013). Conceptualization For Implementing Total Productive Maintenance Through The ISO 9001:2008 Standard- Based Quality Management System. The South African Journal of Industrial Engineering, 24(2), 33.

Sivaram, N. M., Devadasan, S. R., & Murugesh, R. (2013). Conceptualization for Implementing Total Productive Maintenance through the ISO 9001:2008 Standard- Based Quality Management System. The South African Journal of Industrial Engineering, 24(2), 33.Jirasukprasert, P., Arturo Garza-Reyes, J., Kumar, V., and K. Lim, M. (2014)

Yilmaz, K. (2013). Comparison of quantitative and qualitative research traditions: Epistemological, theoretical, and methodological differences. European Journal of Education, 48(2), 311-325.

Yutthaphon Khayankit & Jirapan Liangrokapart, (2018).LEAN APPLICATION IN A JOP SHOP, vol.8.

Appendices

Appendix A: Arabic Purchase Order Form

استمارة طلب شراء مواد أولية / عبوات فارغة / ملصقات	
التاريخ:	
قسم الطلب	
اسم الصنف	
المواصفات	
الكمية المتوفرة	
الكمية المطلوبة	
الشركة المزودة	
توقيع مقدم الطلب	
توقيع المدير	
قسم االستلام	
تاريخ الاستلام	
الكمية المستلمة	
مطابقة المواصفات	
ملاحظات	
مكان التخزين	
توقيع المستلم	

Appendix B :Arabic 5S check List:

اسم المخزن ..... التاريخ: .....

x / ✓

1.	إخراج الآلات والمعدات من منطقة تخزين البضائع	
2.	المواد مغلقة تماما لتجنب دخول الحشرات أو الغبار أو تلوثها.	
3.	.لا تترك أو تخزن أي أشياء غير ضروري	
4.	.تأكد من تحديد جميع المواد للوصول إليها بسهولة	
5.	.اترك مسافة بين الحائط وحفظ المواد لتجنب وصول الحشرات والرطوبة	
6.	هل مواقع المواد منظمة بشكل جيد وواضحة؟	
7.	هل يتم فصل المكونات الجافة عن السوائل عن العطور؟	
8.	هل الملصقات محفوظة ومحددة في ظروف مناسبة؟	
9.	هل توجد ملصقات لتحديد المادة؟	
10.	هي عملية ترتيب المواد في المكان المخصص؟	
11.	هل الارضيات نظيفة وخالية من الاتربة والاوساخ؟	
12.	هل الأشياء المخزنة نظيفة	
13.	هل الرفوف نظيفة	

اسم المسوول :.....

التوقيع:.....

Appendix C: Receipt list of tools and spare parts

قائمة استلام الادوات والقطع الاحتياطية (MN-01 F1)					
#	التاريخ	أسم الأداة/القطعة	الكمية/العدد	الاستخدام	التوقيع

Appendix D: Machine and Equipment List

قائمة الماكنات والانظمة

(MN-01 F5**)**

#	اسم الماكينة / الجهاز/النظام	كود	الاسم المتداول حسب العمال	رقم الموديل
1	Shampoo Mixer 01	Sh.001	خلاط شامبو	
2	Shampoo Mixer 02	Sh.002	خلاط شامبو	
3	Shampoo Mixer 03	Sh.003	خلاط شامبو	
4	Semi Solid Mixer 01	SSM.001	خلاط البلسم	
5	Semi Solid Mixer 02	SSM.002	خلاط البلسم	
6	Cream Mixer 01	CM.001	خلاط الكريمات	
7	Cream Mixer 02	CM.002	خلاط الكريمات	
8	Moving Mixer	MM.001	خلاط المتحرك	
9	Shampoo Filling Machine 01	SFM.001	ماكينة تعبئة الشامبو	
10	Shampoo Filling Machine 02	SFM.002	ماكينة تعبئة الشامبو	
11	Shampoo Filling Machine 03	SFM.003	ماكينة تعبئة الشامبو	
12	Semi Solid Filling Machine 01	SSFM.001	ماكينة تعبئة البلسم	
13	Cream Filling Machine 01	CFM.001	ماكينة تعبئة كريمات	
13	Oil Filling Machine 01	OFM.001	ماكينة تعبئة الزيت	
14	Skin Care Cream Filling Machine	SCFM.001	ماكينة تعبئة كريم العناية بالبشرة	
15		GFM.001		
	Gel Filling Machine		ماكينة تعبئة الجل	
	Raw Material Filling Machine		ماكينة تعبئة المواد الخام	
16	Semi Solid Pump 01	SSP.001	مضخة شبه الصلب 01	
17	Semi Solid Pump 02	SSP.002	مضخة شبه الصلب 02	

18	Shampoo Pump	SP.001	مضخة الشامبو
19	Moving Pump	MP.001	مضخة متحركة
	Labeling Machine	LM.001	ماكينة الليبل
	Citronix Machine 01	Ci5000 .001	ماكينة التاريخ 01
	Citronix Machine 02	Ci5000 .002	ماكينة التاريخ 02
	الانظمة		
1	نظام التكييف والتبريد	CS.001	
2	Fire Alarms System	FAS.001	نظام انذار الحريق
3	نظام طفايات الحريق	FE.01, FE.02, FE.03, FE.04	-
4	Weight Device System	WD.001	نظام جهاز المياه
	Lab		
1	Ph Meter 01	Ph.001	-
2	Ph Meter 02	Ph.002	-
3	Conductivity 01	Cond..001	-
4	Conductivity 02	Cond..002	-
5	Ph Meter & Conductivity	pH&COND..001	-
6	Laboratory Incubator	LI.001	-
7	**Hot Palet**	**HP.001**	-
8	**Temperature Device**	**Temp. D. .001**	-
9	**الوزنات المعيارية**	**W.01 , W.02 , W.03 , W.04**	-

Appendices E: Machine Maintenance Record

الصيانة الوقائية						
نوع الصيانة شهري / نصف سنوي / سنوي	**تاريخ الصيانة المخطط**	**تاريخ تنفيذ الصيانة**	**تمت الصيانة من قبل**	**اشراف**	**مراجعة مسؤول الجودة**	**ملاحظات**

الصيانة العلاجية						
المشكلة	**تاريخ الصيانة**	**تمت الصيانة من قبل**	**القطع المستبدلة**	**اشرف**	**مراجعة مسؤول الجودة**	**ملاحظات**

سجل صيانة الماكينة **(MN-01 F1)**		
السنة :	الجهاز	رمز الجهاز :

Appendices F: Annual preventive maintenance plan

تاريخ اصدار الخطة :

مسؤول توكيد الجودة :

مسؤول العمليات :

الرقم	الماكنة	تكرارية الصيانة الوقائية											
		يناير	فبراير	مارس	ابريل	مايو	يونيو	يوليو	اغسطس	سبتمبر	اكتوبر	نوفمبر	ديسمبر
1													
2													
3													
4													
5													

Appendices G: Inspection Checklist

قائمة الفحص (Inspection Checklist)
(MN-01 F6)

اسم الماكينة :.....

رقم الماكينة :.....

نوع الماكينة : خلط ☐ تعبئة ☐ اخرى ☐

موازين (Digital Balance)			
البند	**نعم**	**لا**	**ملاحظات**
فحص الكهرباء			
معايرة الموازين بشكل شهري			

ماكينات الخلط			
البند	**نعم**	**لا**	**ملاحظات**
فحص الكهرباء			
فحص ماطورات / مضخة			
فحص ثيرموستات			

ماكينات التعبئة			
البند	**نعم**	**لا**	**ملاحظات**
فحص مداخل الهواء			
فحص حساسية سنسور			
فحص مجرى التعبئة			
فحص الدعسات			
تغير جلد			
فحص الكهرباء			

ماكينات الليبل والتغليف

البند	نعم	لا	ملاحظات
فحص المجرى الداخلي لماكينة التاريخ			
صيانة وتنظيف القشط لماكينة الليبل			

نظام التكييف والتبريد

البند	نعم	لا	ملاحظات
تغيير فلاتر الهواء			
فحص الغاز			

Appendices H: daily check form

نموذج التفقد اليومي (MN 01 F6)						
اسم الماكينة /النظام : رمز الماكينة /النظام :						
الصيانة المطلوبة	السبت	الاحد	الاثنين	الثلاثاء	الاربعاء	الخميس
	/ /	/ /	/ /	/ /	/ /	/ /
توقيع مشرف الصيانة						
ملاحظات						

Appendices L: Machine maintenance Record

سجل صيانة الماكينات **(MN-01 F7)**						
الرقم	التاريخ	وصف الخلل	الاصلاحات التي تم عملها	القائمين بالاصلاحات	القطعة المستخدمة	التوقيع
1		اسم المنتج حجم العلبة (مل)		اسم ماكينة التعبئة	معايرة الماكينة	
2						
3						
4						
5						

Appendices M: Machine Calibration

اسم المنتج	الوقت المستغرق لعملية الخلط	الوقت المستغرق لعملية التعبئة	الوقت المستغرق لعملية التغليف

Appendices N: Identify quantity of each production material

Appendices O: Production progress, and workers distribution

اسم المنتج	رقم الماكينة	الموظفون القائمون بالعمل	بدء وانتهاء العمل	ملاحظات
شامبو ارجان	01	رضوان , اشرف , محمد	1:30-8:30	-

Appendices T: Daily production plan

اسم المنتج	الكمية (كغم)	الكمية				وقت التسليم
		علب	اغطية	ليبل	كراتين	

الملخص

في الأسواق التنافسية اليوم، مع زيادة المنافسة في سوق العمل، وزيادة الطلب على الصناعات، وزيادة الوعي بجودة العملاء والحاجة إلى كفاءة أفضل، وخفض التكلفة، وتحسين الجودة ، وتقليل التباين وزيادة الإنتاجية، تضطر الشركات إلى أن تصبح أكثر حرصًا على جانب من جوانب التحسين المستمر واعتماده كمعايير أساسية للثقافة التنظيمية. ومن ثم، تميل الشركات إلى استخدام نظام الإدارة الخالي من الهدر لزيادة إنتاجيتها وتحسين عملياتها التجارية بجودة وكفاءة وفعالية من خلال التطبيق الفعال للأدوات الخالية من الهدر.

تبحث هذه الدراسة في تأثير تطبيق منهجية Lean manufacturing على الشركات الصناعية في قطاع مستحضرات التجميل. علاوة على ذلك ، تشرح كيف أن تطبيق هذه المنهجية يمكن أن يساعد مصنعي منتجات التجميل على تحقيق أقصى استفادة من مواردهم وتنظيم مكان العمل ليصبح أكثر إنتاجية.

تنبع أهمية هذه الدراسة من الحاجة إلى تحسين الإنتاجية لخط انتاج السوائل ، الاستفادة من مساحة المستودعات وانشاء نظام صيانة في شركة To-me Cosmetics في رام الله من خلال التخلص من النفايات وتقليل التباين من أجل البقاء في العالم سريع التطور.

تم تنفيذ منهجية Lean Manufacturing باستخدام مجموعة من الأدوات مثل VSM و S5 وTPM . تم قياس الأداء الحالي في مرحلة القياس باستخدام مخطط التدفق VSM ، ثمانية نفايات . تم تحديد الأسباب الجذرية للمشاكل باستخدام مخطط السبب والنتيجة وفقرة العلاقات المتبادلة. تم تحسين تخطيط وإنتاجية عملية إنتاج خط السوائل باستخدام المراحل الثلاثة الاولى من مفهوم S5 ، ومخطط التدفق ، وتخطيط تدفق القيمة. تم الحفاظ على النتائج المحققة باستخدام المرحلتين الأخيرتين من مفهوم S5 ، مخطط التدفق ، نماذج العمل ، وقوائم المراجعة.

في نهاية جهود التحسين ، تم تحسين إنتاجية خط انتاج السوائل والتخطيط مما أدى إلى تقليل المهلة الزمنية لإنتاج أبواب خزائن المطبخ من 2707 دقيقة إلى 1096 دقيقة مع التحسينات في استخدام مساحة المستودعات أدى إلى تنظيم بيئة العمل ، تقليل عدد الحوادث بنسبة 45 ٪ . علاوة على ذلك ، تم تحسين إدارة المخزون من خلال التحكم في شراء المواد الخام وتخزينها . كما ساهم استخدام TPM من انشاء نظام صيانة وتقليل الوقت الضائع وضبط قطع الصيانة وعمليات الصيانة على الماكينات.

تساهم هذه الدراسة في التعريف بتطبيق الادارة الرشيقة في المشاريع الصغيرة والمتوسطة الحجم في الصناعة الفلسطينية وتؤكد أهمية هذه المنهجية في تحسين الجودة من خلال القضاء على الهدر وتقليل التباين الذي يلعب دورًا كبيرًا في بقاء الاقتصاد الفلسطيني الذي يواجهه الكثير من التحديات.

الكلمات الرئيسية: التصنيع الخالي من الهدر ، خريطة تدفق القيمة ، النفايات الثماني ، S5 ، إجمالي الصيانة الإنتاجية ، مخطط السبب والنتيجة.الكلمات الرئيسية: التصنيع الخالي من الهدر ، خريطة تدفق القيمة ، النفايات الثماني ، 5S، إجمالي الصيانة الإنتاجية ، مخطط السبب والنتيجة.