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PROCESS IMPROVEMENT AND ELIMINATION OF WASTE BY APPLYING LEAN MANUFACTURING TECHNIQUES

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Master's Thesis

Supervisor

Asst. Prof. Dr. Engin SANSARCI

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I hereby declare that this thesis meets all format and submission requirements for research Master's thesis.

I hereby declare that all information/data presented in this graduation project has been obtained in full accordance with academic rules and ethical conduct. I also declare all unoriginal materials and conclusions have been cited in the text and all references mentioned in the Reference List have been cited in the text, and vice versa as required by the abovementioned rules and conduct.

Otmane TAZI

Signature

DEDICATION

This term project subject was developed during an internship in Morocco. During this internship, I constructed a new implementation with Lean manufacturing, and I encountered few challenges other than those that every intern would face. I want to thank everyone on Marisa's crew for hosting me throughout the internship and providing me with the opportunity to improve my understanding of the garment business and complete a professional-level project. Thank you to my advisor, Dr. Engin SANSARCI for answering all of my inquiries. I also want to thank Mr. BOUDAD Mustapha, my company advisor, for his contributions to my work and for giving me the knowledge I needed to complete my project. My gratitude also goes to my family, who taught me to be serious, patient, and courageous. My gratitude also extends to all of the professors who were requested for their open-mindedness and knowledge. Finally, I would like to express my gratitude to everyone who helped make my end-of-study project a success.

ABSTRACT

PROCESS IMPROVEMENT AND ELIMINATION OF WASTE BY APPLYING LEAN MANUFACTURING TECHNIQUES

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Throughout my internship at Marisa, a clothing company, we gained an understanding that manufacturing sectors as a whole are encountering several obstacles that impede their output. Marisa is experiencing issues with line balancing and execution, the presence of various forms of waste, low productivity, inadequate communication between departments, extended production lead time, lengthy waiting periods, and delayed shipments, among other challenges. These problems can be resolved by implementing Lean Manufacturing tools. The project aims to address these issues by utilizing continuous flow or single-piece flow, specifically by implementing a new U-shaped layout.

Additionally, the study provides solutions for the 8 types of waste known as MUDA. Once the tools are established and implemented, the effects may be noticed in several aspects such as the number of successful outcomes, the time it takes to complete a process, the time it takes to complete a task, the daily production rate, and other related factors. This case study focuses on the Coat line, which is one of the assembly lines in the manufacturing department and has the biggest amount of waste.

Keywords: Lean Manufacturing, Lead Time, 8 MUDA Types of Waste, ContinuousFlow, Single Piece Flow.

ÖZET

PROCESS IMPROVEMENT AND ELIMINATION OF WASTE BY APPLYING LEAN MANUFACTURING TECHNIQUES

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Bir giyim şirketi olan Marisa'daki stajım boyunca, imalat sektörlerinin bir bütün olarak üretimlerini engelleyen çeşitli engellerle karşılaştığını anladık. Marisa, diğer zorlukların yanı sıra hat dengeleme ve yürütme, çeşitli israf türlerinin varlığı, düşük verimlilik, departmanlar arasında yetersiz iletişim, uzun üretim teslim süresi, uzun bekleme süreleri ve geciken sevkiyatlarla ilgili sorunlar yaşıyor. Bu sorunlar Yalın Üretim araçlarının uygulanmasıyla çözülebilir. Proje, sürekli akış veya tek parça akışı kullanarak, özellikle de U şeklinde yeni bir yerleşim düzeni uygulayarak bu sorunları ele almayı amaçlamaktadır. Ayrıca çalışma, MUDA olarak bilinen 8 atık türü için çözümler sunmaktadır. Araçlar oluşturulduktan ve uygulandıktan sonra, etkileri başarılı sonuçların sayısı, bir süreci tamamlamak için gereken süre, bir görevi tamamlamak için gereken süre, günlük üretim oranı ve diğer ilgili faktörler gibi çeşitli yönlerden fark edilebilir. Bu vaka çalışması, üretim departmanındaki montaj hatlarından biri olan ve en fazla israfa sahip olan Coat hattına odaklanmaktadır.

Anahtar Kelimeler: Yalın Üretim, Teslim Süresi, 8 MUDA İsraf Türü, Sürekli Akış, Tek Parça Akışı.

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ABBREVIATIONS

JIT	:	Just In Time
VSM	:	Value Stream Mapping
TPS	:	Toyota Production System
SWOT	:	Strength, Weakness, Opportunities, Threats
KPI	:	Key Performance Indicators
SIPOC	:	Supplier, Input, Process, Output, Customer
CRM	:	Customer Relationship Management
CFS	:	Continuous Flow System
SW	:	Standardized Work
MHS	:	Material Handling System

1. INTRODUCTION

Lean manufacturing is a methodology that enables firms to reduce waste and increase production efficiency. The objective is to minimize resource utilization, including labor hours and production time, while establishing highly efficient processes. Waste reduction, like overproduction, aims to decrease several forms of waste, including excess inventory of finished parts, defective goods, garbage, work-in-progress inventory, waiting periods, and unnecessary motions. Also, the main objective of Lean Manufacturing is to minimize manufacturing waste to enhance value for the client. Value is defined as the capacity to supply goods to the client in a timely manner and at a reasonable cost and meeting their expectations. Also, to minimize manufacturing waste in small-scale firms, several lean methods can be implemented, including 5S, preventative maintenance, Kaizen, value flow mapping, and job standardization. The interaction between different tools leads to a reduction in reprocessing, defective goods, long lead times, and scrap. This, in turn, improves operations and lowers production costs. The 5s principles can improve the workplace and increase productivity by organizing, categorizing, cleaning, standardizing, and maintaining workstations, while also reducing workplace-related waste. Moreover, utilizing this Lean tool can effectively reduce production-related waste and quality issues. Thus, productive activities will lead to the creation of homogeneous products.

Finally, preventive maintenance involves the active participation of all employees in continuously enhancing equipment performance. This maintenance approach employs a range of well-established methodologies to enhance reliability, quality, and productivity through direct maintenance processes.

1.1 ADDED VALUE

The principal value of implementing the Lean strategy is the elimination of waste and reduction of product lead time. The additional values can be described as follow:

a. Provide reliable performance indicators
b. Enhanced labor conditions
c. Waste eradication
d. Decreased time required to complete each individual product
e. Implementation of the Lean production methodology

1.2 ADOPTED METHODOLOGY

To achieve our goals, we shall implement the following methodology:

1. This project will focus on the production department of a clothing firm, namely the assembly line. The objective is to conduct a detailed analysis of waste reduction and process improvement.
2. It is necessary to examine the current condition of this department in order to gain an understanding of the assembly lines SIPOC, the company's SWOT analysis, the current implementation of the production line, and the 8 MUDA wastes that exist in our department.
3. Conducting an analysis of the present condition will enable us to identify opportunities for process enhancement and waste reduction. The last component will consist of the future state, which will incorporate the ISHIKAWA and PARETO tools, the establishment of a new implementation with continuous flow, KANBAN implementation, VSM, and MUDA solutions.

2. LITERATURE REVIEW

The Lean methodology is commonly employed to minimize waste in manufacturing industries. However, despite its extensive utilization, implementing Lean concept can be notoriously challenging. To obtain amazing results in terms of cost, quality, and time, it is necessary to utilize lean ideas and methodologies to enhance process performance. These concepts facilitate the differentiation between value and waste, optimizing customer value while minimizing waste. This thesis examines the implementation of lean ideas in the manufacturing and service industries to enhance understanding of how lean may lead to substantial improvements in specific processes and the necessary steps to apply it. Several literature evaluations were undertaken to get knowledge about lean methodology and its application across various business domains. To enhance understanding and facilitate research, a case study is selected from the apparel sector. The problems are initially identified before being resolved through the use of the lean methodology. Implementing lean practices is a strategic endeavor that requires sustained and diligent efforts from organizations to achieve substantial transformations. However, the outcome is also contingent upon the specific nature of the process under examination. This demonstrates that lean encompasses more than a mere assortment of manufacturing tools. The study also examines the seven categories of lean waste and lean principles in the apparel manufacturing industry to demonstrate the efficacy of waste elimination in improving quality, reducing expenses, and ensuring punctual delivery. This chapter will encompass a range of subjects, such as the historical background and objectives of the study, the methodology employed, and prospective research areas. Subsequently, the text delineates the fundamental concepts and underscores the significance of the research. A framework is also created to organize the literature review and emphasize the study topics.

2.1 LEAN MANUFACTURING BACKGROUND

The lean mindset (TPS) was derived from the Toyota Production System. Sakichi Toyoda, Kiichiro Toyoda, and Taiichi Ohno, the founders of Toyota, created the Toyota Production System (TPS).

The mass production lines developed by Henry Ford and the implementation of statistical process control (SPC) by W. Edwards Deming had a profound influence on the Toyota

Production System (TPS). The Japanese were unimpressed by Ford's plan due to its enormous manufacturing, substantial inventory, and prolonged waiting periods. Toyota identified these deficiencies in Ford's manufacturing process and implemented the requisite adjustments to enhance the efficiency and reliability of their own manufacturing process. Just-in-time inventory is also employed in TPS and lean methodologies, wherein minimal quantities of stock are ordered, and minimal stock is kept in anticipation of manufacturing. This approach was markedly different from Ford's assembly line, which routinely procured substantial amounts of resources and stored stockpiles to minimize expenses. After Toyota implemented the Toyota Production System (TPS), other companies modified their manufacturing methods to incorporate lean principles. Following a comprehensive worldwide assessment of the effectiveness of automotive assembly plants, the implementation of lean management was initially introduced in the United States during the early 1980s. The core concept underlying lean is that it is a production methodology aimed at reducing waste, enhancing quality, and reducing prices. Waste is minimized by identifying and eliminating non-value-added activities. The primary objective is to offer the buyer optimal value by delivering a product of impeccable quality that is devoid of any inefficiencies or excesses. Lean manufacturing differs from typical business processes by prioritizing the elimination of waste throughout the whole value stream, rather than targeting specific areas of waste. As a consequence, these methods necessitate reduced human labor, decreased physical area, diminished capital, and shorter timeframes to manufacture goods and services at substantially reduced expenses and with significantly fewer flaws. Businesses may face many challenges while integrating lean principles into their production processes. Lean methodology should initially be introduced in firms that possess production lines characterized by reliability, predictability, stability, and suitability for flowcharting. Furthermore, large corporations may allocate significant financial resources and invest several years in the implementation of lean methodologies. The success of a lean implementation is contingent upon the level of connectivity between systems and the efficiency of the production line.

In order to implement lean manufacturing, it is important to have a thorough understanding of many core principles of lean. Failure or a lack of commitment from all individuals is likely to occur due to a failure to understand and implement these concepts. Here are the guidelines:

Efforts should be focused on eliminating waste, implementing ongoing improvements, prioritizing respect for individuals, ensuring timely and levelled output, and emphasizing the construction of quality.

2.1.1 Lean Manufacturing System History

In a study conducted by Liker J. (2007), the author investigated the common misconception of TPS, perceiving it as a specialized set of tools that are employed in a systematic manner to produce predetermined results. The performance improvements achieved by lean systems are often remarkable, significantly enhancing quality, cost, and delivery. Lean production, as described by Shah, R. et al., is a comprehensive method that incorporates several management approaches, including just-in-time, quality systems, work teams, cellular manufacturing, and supplier management. According to Petersen, J., who undertook a survey of the lean literature for his article, lean is not only a set of tools but rather a philosophical approach.

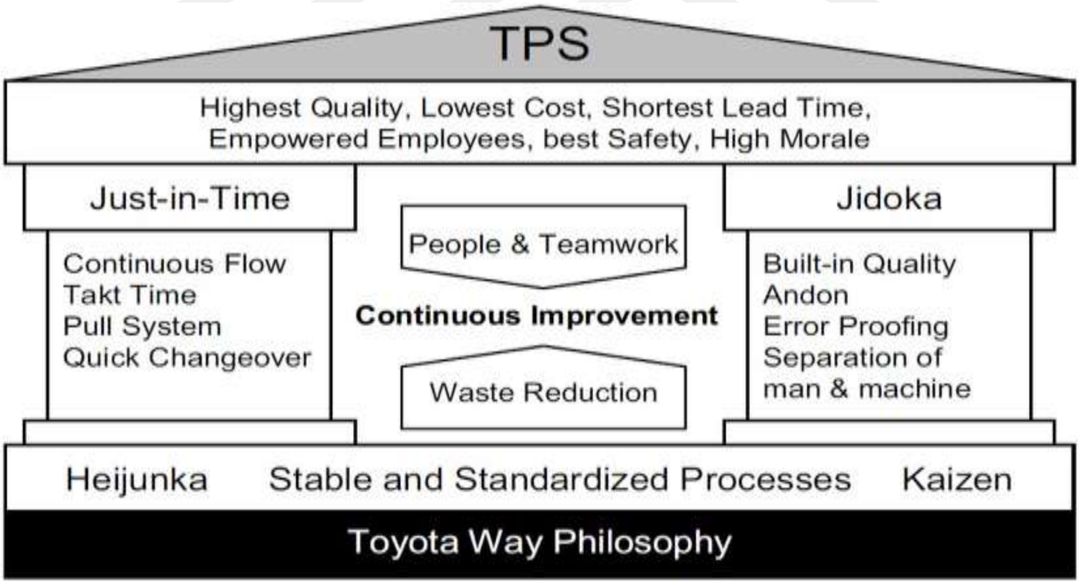


Figure 1.1: Toyota Way Philosophy.

Consequently, the notion of lean production is also regarded as a practice that involves continuous improvement and consideration for others.

2.1.2 Tools of Lean Manufacturing

The most significant lean management techniques discussed by Vorne et al. include 5S, Andon, Bottleneck Analysis, Continuous Flow, Gemba, Heijunka, Hoshin Kanri, Jidoka, Kaizen, Kanban, KPI, Overall Equipment Effectiveness, PDCA, Poka-Yoke, Root Cause Analysis, Single Minute Exchange of Die (SMED), Six Big Losses, SMART Goals, Standardized Work, TaktTime, Total Productive Maintenance The objective of cellular manufacturing (CM) is to optimize product diversity while minimizing inefficiencies. In order to provide a seamless movement of resources and components throughout the process, a cell consists of tools and workstations that are arranged systematically. Continuously Enhancing (5S): 5S is a highly effective technique for continuous improvement and serves as the initial step towards establishing an efficient lean firm. 5S is an initial and modular approach to significantly reducing waste. The concept of 5S consists of five Japanese terms: Seiri (Sort), Seiton (Straighten), Seiso (Sweep and Clean), Seiketsu (Systemize), and Shitsuke (Standardize). Seiri: Involves relocating items that are not in regular usage (e.g., those that will not be utilized in the next month or so) away from those that are. Seiton: This pertains to the proper placement of appropriate goods in specific areas. Any objects that are not part of a specific area should not be present within that area. Seiso involves systematically cleaning and sweeping the workplace. The workspace should exhibit a neat, immaculate, and well-prepared state in anticipation of the subsequent shift. Seiketsu refers to maintaining a meticulous standard of cleanliness and organization in the workplace. Shitsuke: Is it the management's duty to provide training to staff in order to ensure compliance with housekeeping regulations? While proponents of 5 S argue that safety will ultimately be achieved through the effective implementation of 5 S, others also advocate for the inclusion of a sixth S specifically dedicated to safety. Punctual: The just-in-time management philosophy, which seeks to minimize production waste by producing the exact part in the appropriate location at the precise moment, is strongly associated with lean manufacturing. The three primary components of the system are JIT production, JIT distribution, and JIT purchasing.

Kaizen is a management approach originated in Japan that aims to consistently implement incremental enhancements for improvement, encompassing all members of the business, ranging from executives to employees. Kaizen is a Japanese concept that can be understood as the ongoing process of making improvements or changes to achieve growth and excellence. The objectives of Kaizen encompass enhancing working conditions, achieving increased productivity and value while minimizing waste (enhanced efficiency), and establishing consistent processes through standardization.

2.1.3 Lean Manufacturing Implementation

The introduction of lean manufacturing requires continuous practice development and improvement (Marodin and Saurin 2013). As a result, Japan developed a culture of continuous improvement focused on reducing waste and saving costs at the same time (Imai 1997). Kaizen refers to a systematic approach that prioritizes client expectations. According to Glover et al. (2011), it is geared toward processes and encourages the active involvement and initiative of each individual.

The implementation of lean manufacturing is a complex process that encompasses all levels of the organization and all aspects of business operations. To delineate the essential procedures for implementing lean, certain authors have proposed recommendations (Black 2007; Serrano Lasa, Castro, and Laburu 2009; Vienazindiene and Ciarniene 2013), while Marodin and Saurin (2013) contend that further investigation is necessary to establish cohesive strategies for operationalizing lean systems.

2.2 SUBJECT LITERATURE REVIEW

2.2.1. Continuous Process Improvement Using Lean Manufacturing

Lean process improvement is not limited to production circumstances; it is also relevant in various settings such as healthcare, software development, services, and government. Meeting client expectations through the implementation of a highly efficient and error-free process is the ultimate goal when utilizing lean methodologies. The technique aims to minimize waste, optimize resource utilization, and foster continuous progress.

Below are a few strategies for effectively implementing Lean processes:

a. Monitor the overall movement of goods and services

b. Analyze all available resources, technology, and departments involved

c. Minimize inefficiencies throughout the entire process, rather than focusing on specific areas

The implementation of a Lean strategy enables the production of goods and provision of services more efficiently, resulting in reduced time, cost, and space requirements compared to conventional methods. Instead of keeping a large stock of items, you already have the necessary inventory for your urgent requests.

2.2.2 Elimination Of Waste Using Lean Manufacturing Techniques

Efficient waste reduction is a fundamental principle of lean methodology. Waste is a significant factor that negatively impacts profitability in all types of businesses. Time, resources, and labor are instances of lean waste. However, it could also be attributed to insufficient readiness and the improper utilization of specific skill sets. Waste in lean manufacturing refers to any expenditure or exertion that is expended but does not yield a product that the customer will remunerate. During every phase of the production process, the focus is solely on enhancing the process and eliminating any unnecessary elements in order to maximize the actual value created. Lean Manufacturing model today recognizes eight distinct types of waste within an operation. Initially, the Toyota Production System was created with seven categories, but an additional category was eventually incorporated when the lean approach was adopted in the Western context.

2.3 OBJECTIVES

The objective of implementing a lean manufacturing approach in an organization is to eradicate all forms of waste and contribute to the knowledge generation of lean principles. This leads to improved performance in each workshop, allowing the organization to excel in the areas of lean manufacturing development. Through practical experience, the organization can adapt and implement the most suitable lean tools and methods, while fostering a shared lean mindset.

3. LEAN MANUFACTURING TECHNIQUES

3.1 SIPOC

SIPOC is an acronym that represents the key elements of a process: Suppliers, Inputs, Processes, Outputs, and Customers. SIPOC is a practical technique for mapping and improving processes. It involves using a SIPOC diagram to summarize the inputs and outputs of one or more processes. Certain firms utilize the acronym COPIES, which represents the contrasting notion and underscores the significance of the consumer to the business.

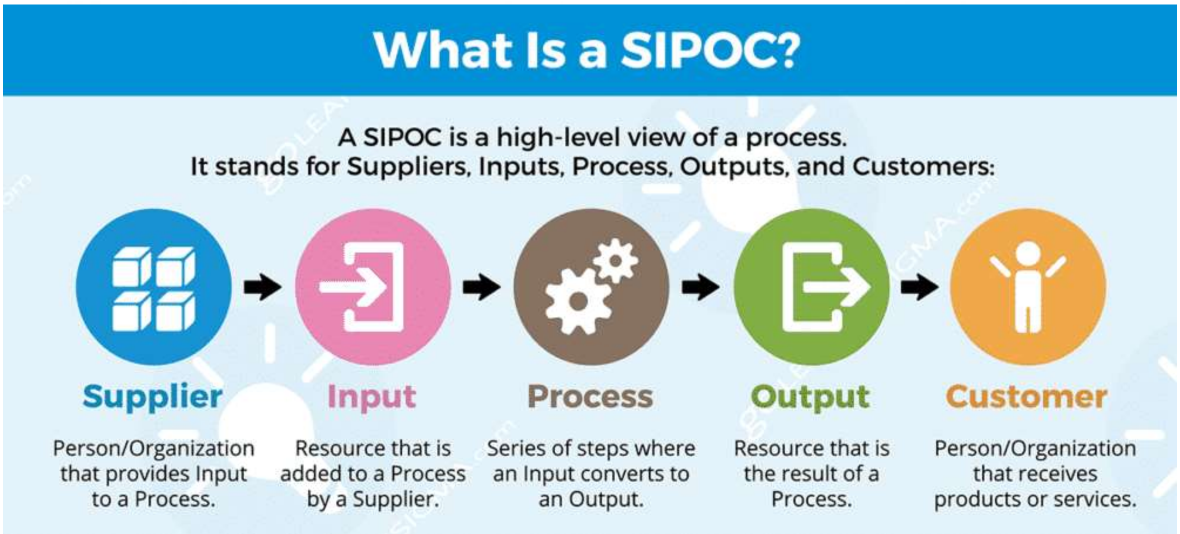


Figure 3.1: SIPOC Description.

SIPOC is a term linked to the quality movement that originated in the 1980s. SIPOC has been incorporated into the practices of Six Sigma, lean manufacturing, and business process management.

To formulate a plan of action, utilize project management software to collect all the necessary elements for your SIPOC. Project Manager is a web-based program that facilitates the organizing and execution of tasks and projects. You have the freedom to work in whichever manner you like using our diverse project perspectives. For example, you may consolidate all the data from your SIPOC into a comprehensive task list, allocate responsibilities, set priorities, and monitor the progress of the work once it commences.

3.2 SWOT ANALYSIS

Figure 3.2: SWOT Analysis Description.

The SWOT analysis is a strategic planning tool that assesses an organization's strengths, weaknesses, opportunities, and threats in comparison to its competitors. While Albert Humphrey is commonly attributed to devising the design in the 1960s, the veracity of this assertion remains a subject of contention. There is no universally recognized creator. It is now acknowledged as valuable for distinguishing and establishing a specialized position within the broader market. The SWOT Matrix is an alternative name for it. SWOT Analysis is a versatile method that can be applied beyond the corporate context to evaluate an individual's position in comparison to their competition. The tool has been designed with both internal and external factors in mind. There are internal connections between "weaknesses" and "strengths." The former pertains to a distinguishing feature possessed by a firm or entity that provides it with a competitive advantage over its rivals. The latter refers to a characteristic of the same entity, which puts it at a disadvantage compared to its competitors. Regarding external factors, "opportunities" refer to elements in the broader environment that an entity can exploit for its benefit. Nevertheless, the entity may encounter challenges due to the presence of "threats" in the broader environment.

Strategic fit, a common objective among all firms, can be described by the degree to which the components with internal relationships align with those with external relationships.

3.3 KPI

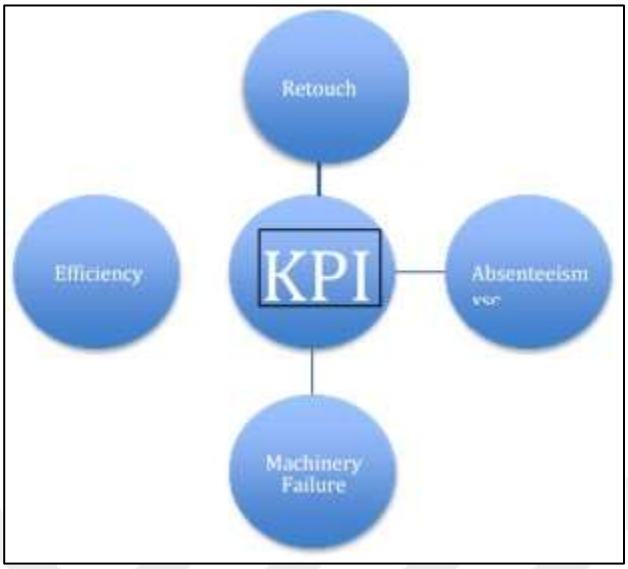


Figure 3.3: KPI Description

Key performance indicators (KPIs) are quantitative indicators that are vital for measuring progress towards a specific aim. KPIs provide a basis for analysis to support decision-making, offer guidance for strategic and operational enhancement, and help focus attention on critical priorities.

Establishing objectives (the desired level of achievement) and tracking advancement towards those objectives are likewise components of overseeing key performance indicators (KPIs). Managing with Key Performance Indicators (KPIs) sometimes involves concentrating on enhancing performance by applying leading indicators, which are signs of prospective future success, to subsequently produce the desired outcomes indicated by trailing measurements.

3.4 8 WASTES OF MUDA

Figure 3.4: 8 Wastes of MUDA Description

The Japanese term "Muda" encompasses the notions of waste, uselessness, and futility. However, it is predominantly employed in a business context to specifically denote garbage or unnecessary activities.

Overproduction: The inclusion of excessive features beyond the team's capacity may result in unnecessary fatigue, leading to more errors as developers become exhausted, ultimately diminishing the quality of the output.

Waiting: Procrastination consumes valuable time and drains one's energy. Examples include waiting for multiple authorizations to acquire or enhance an essential tool and writing software on a sluggish hard disk instead of a faster SSD drive.

Transport: The practice of multitasking, wherein a developer is assigned to work on many projects simultaneously in a single day.

Extra processing: Extraneous procedures, duties, or activities that do not provide any advantage to the consumer and are often caused by inadequate equipment, outdated methods, or a lack of understanding of client needs. For example, a method of examination that replicates information commonly found in a centralized data dictionary by mandating detailed textual specification of data pieces after the use of case documents.

Inventory: Incomplete work refers to tasks that have been half finished, such as an early investigation of a low-priority feature that is likely to be abandoned. Additional instances are initiating the simultaneous advancement of multiple tasks at the onset of a sprint yet failing to complete any of them by the conclusion of the sprint, only to subsequently realize that the user's requirements were misconstrued.

Motion: Motion refers to the purposeless movement of individuals, information, or instruments. For example, dedicating more than 20 minutes to searching for a misplaced analysis or architecture document on the local network and repeatedly visiting the supervisor's office (located in a different place) to obtain authorization prior to proceeding with any other steps. Defects encompass several issues like as bugs, unclear requirements, an inconsistent data model, and a subpar design or architecture.

Under-use of abilities: The underutilization of skills, such as assigning software work to developers who lack sufficient expertise. Additional instances encompass possessing limited autonomy and accountability, excessively controlling, necessitating multiple authorizations for computer or software program upgrades (which also entails waiting), encountering difficulties in resolving problems when individuals are operating independently, and lacking the ability to assess the quality of one's own output.

3.5 VSM

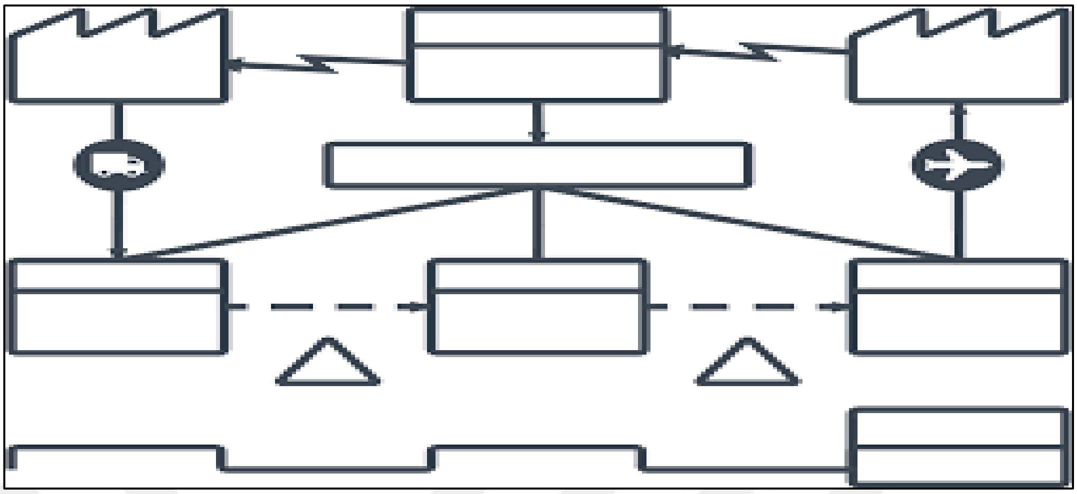


Figure 3.5: VSM Description.

Although numerous applications have lately been created, initially VSM was primarily focused on the analysis and improvement of disconnected flow lines in manufacturing contexts (Tapping and Shuker 2002b; Jones and Womack 2003).(Rother and Shook 1998). This framework is established and described by Hayes andWheelwright 1979 a b in a well-known process of making the product.

The VSM application process is based on five phases that are implemented bya dedicated team assembled for this purpose (Rother et al. 1998). The phases are:

a. Choosing a product family
b. Mapping the current and future states
c. Creating a work plan
d. Carrying out the work plan.

Furthermore, in order to assist individuals in defining the map, certain lean concepts are necessary. Here is a concise overview of these rules:

a. The production process must align with the demand for the product. Takt time refers to the concept that represents this rhythm or tempo.

b. Whenever possible, it is necessary to establish a continuous flow, using distinct batches for product transfer.

c. Pull systems should be used when it is not feasible to have a continuous flow between different work centers.

d. The production of the various components should be regulated by a single procedure, referred to as the pacemaker process. This step will determine the speed of the entire value stream.

e. The pacemaker process scheduling will optimize the balancing of production volume and variety by implementing Heijunka systems.

f. The overall efficacy of the entire treatment should be enhanced. The VSM team might initiate projects aimed at improving work techniques and reducing cycle time, minimizing changeover time, and enhancing maintenance management.

3.6 CONTINUOUS FLOW

The continuous flow process is a system where goods are continuouslyproduced at a single facility utilizing a single methodology without any downtime.

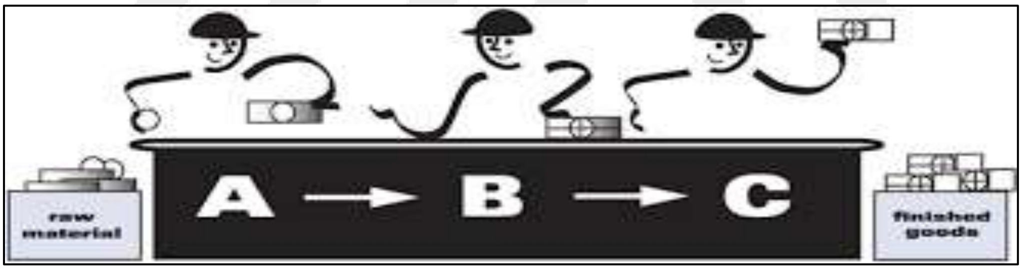


Figure 3.6: Continuous Flow Description.

Pharmaceutical tablets move sequentially through the production process on a continuous flow production line. At the onset of the manufacturing process, manufacturing specialists identify and rectify any defects or problems with the tablets. Under this methodology, the commodities maintain a high level of uniformity and superior quality until they are ready to be packaged. Through early identification of tablet faults, a continuous flow approach reduces the time needed for rectification and allows professionals to fix the product before it completes the production process.

3.7 KANBAN

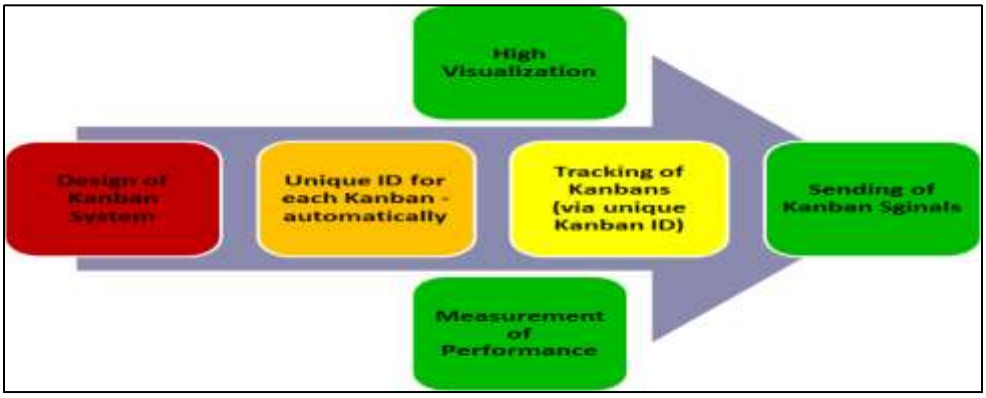


Figure 3.7: KANBAN Description.

Kanban is a popular Lean workflow management method used to define, supervise, and enhance the delivery of information job products. It allows you to visually represent your work, enhance efficiency, and consistently improve. Kanban boards visually depict work, allowing for efficient management of complex projects within a unified environment, while improving task distribution across several teams.

3.8 PARETO Diagram

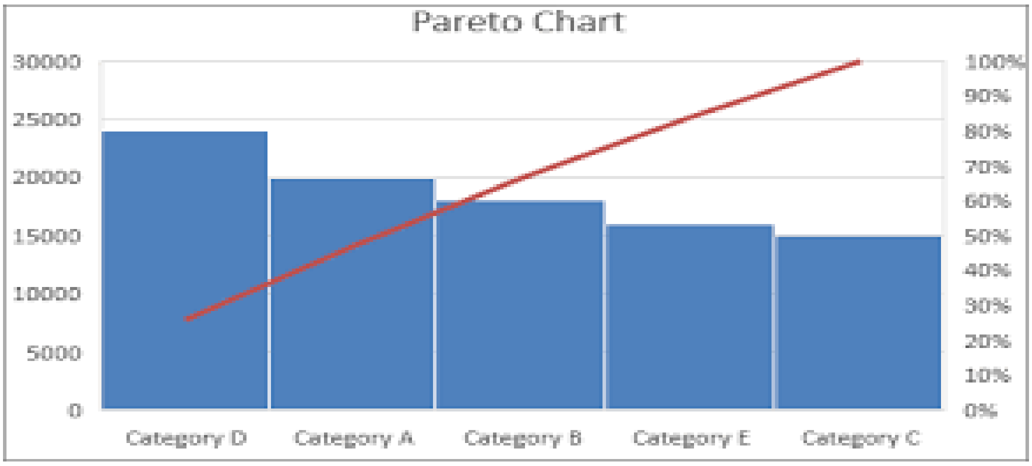


Figure 3.8: PARETO Diagram Description.

The Pareto Chart is a highly effective tool for visually representing the relative significance of different concerns.

The visual representation includes both bars and lines. The bars depict the individual values arranged in descending order, while the curved line illustrates the cumulative total of the sample. The 80/20 rule is applicable when the vital few factors that require the most attention are encompassed within the 80% threshold, which is also included in the 80% threshold.

The 80/20 Rule, also known as the Pareto principle or the law of the vital few and trivial many events, states that 80% of the consequences of an event are caused by only 20% of its origins.

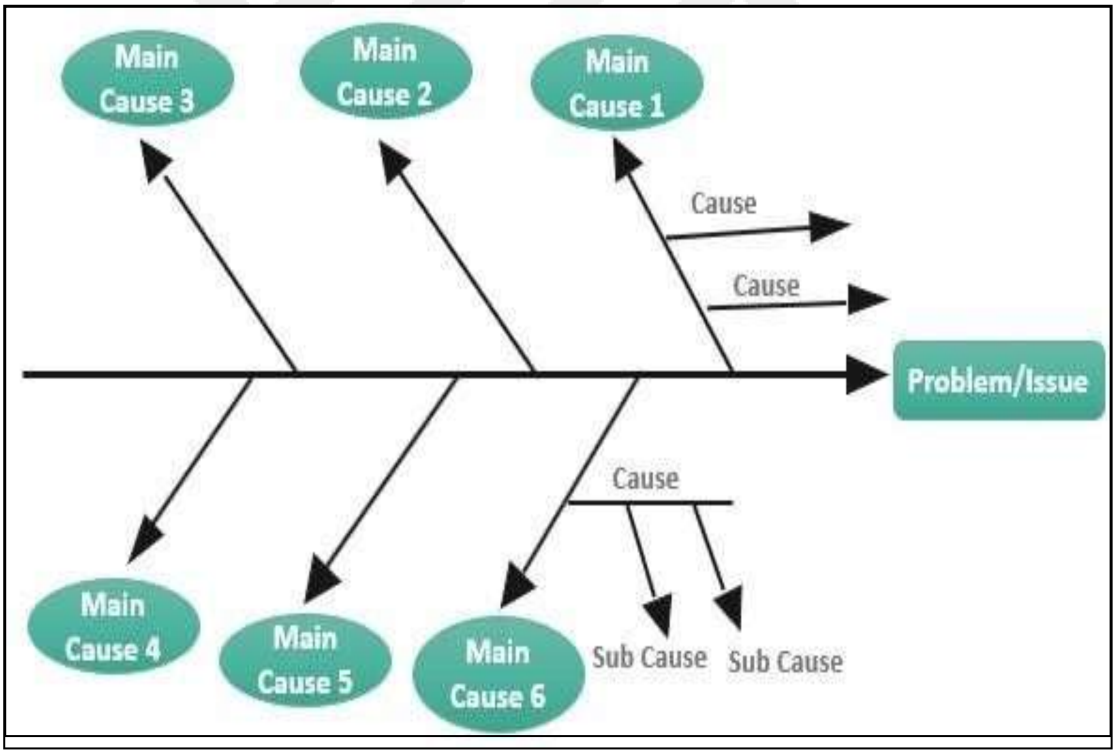
To prioritize their efforts, a team can use the Pareto chart to identify the variables with the most significant impact. Moreover, it enhances the team’s capacity to elucidate the significance of particular locations.

3.9 ISHIKAWA Diagram

The diagram is attributed to Kaoru Ishikawa, its creator. The graphic's structure bears a visual resemblance to the skeletal framework of a fish. The cranium of the skeleton signifies the outcome, whilst the thoracic bones serve as a representation of the causes behind an occurrence. Ishikawa diagrams are commonly referred to as fishbone diagrams because of their distinctive form. These diagrams are alternatively referred to as cause-and-effect diagrams, herringbone diagrams, and Ishikawa diagrams.

The primary concern, often referred to as the "effect," is situated on the extreme right side of the picture. A line referred to as the "spine" is seen on the left side, from which other branches, known as "affinities," extend both above and below. Subsequently, throughout the course of brainstorming sessions, subcategories could be established to incorporate specific

Figure 3.9: ISHIKAWA Diagram Description.



3.10 Equations

The equations mentioned earlier are utilized in many computations throughout the results chapter, particularly in the Key Performance Indicator section...

$$Presence\ time\ =\ Hours\ of\ work\ per\ day\ \times\ 60\ \times\ Work\ value \tag{3.1}$$

The Presence Time is indicated in the "Table 4.8: Overall Company Performance" on page 30. Equations (3.2) and (3.3) originate from the identical table.

$$Production\ time\ =\ (Minutes\ of\ work\ per\ day - Break)\ \times\ Work\ value \tag{3.2}$$

$$Production\ Time = (Production\ Time/\ Presence\ Time)\ x\ 100 \tag{3.3}$$

Equation (3.4) is the method used to compute the absence rate depicted in the "Figure 4.3: Absenteeism Chart" on page 31.

$$Absenteeism\ Rate = (Absent\ employees\ of\ the\ day/\ Total\ workforce)\ x\ 100 \tag{3.4}$$

Equation (3.5) is the method used to compute the rate of machine failure in the "Figure 4.4: Machine Failure Chart", on page 31.

$$Machine\ Failure\ Rate\ =(Number\ of\ failed\ machines\ a\ day/\ Total\ machines\ number)\ X\ 100 \tag{3.5}$$

Equation (3.6) is utilized to compute the Retouch rate, which is also included in the calculations of the Key Performance Indicators.

$$Retouch\ Rate = (Number\ of\ articles\ to\ retouch\ today/\ Daily\ production)\ x\ 100 \tag{3.6}$$

4. FINDINGS

4.1 COMPANY PRESENTATION

Marisa is a Moroccan firm situated in Casablanca, it was established in 1892 and has a capital of 1,530,000 MAD. It is a corporation that operates in the textile and clothing industry. The primary focus of this company is the production of various items, catering to the needs of women, men, and children. Moreover, Marisa is very efficient, employing about 400 individuals. The assistance provided is in the form of a chain and tram system. The CEO is Jalil Rais, who serves as the Director of the apparel and textile industry in Morocco.

4.1.1 Company Overview

The Presence time is 9 hours, starting from 8 am and ending at 6 pm, with a one-hour break from 1 pm to 2 pm.

Their company operates three manufacturing lines, whereas our proposal aims to develop a new continuous flow system on just one of those lines.

From the beginning, Marisa has prioritized client satisfaction by consistently providing superior products within the specified timeframe. Their commitment to maintaining high standards of quality allows us to maintain our clients' ongoing support, thanks to their well-designed infrastructure, skilled management, and efficient organizational collaboration. The cornerstone of Marisa's continuously growing reputation in the garment business is a clear and unwavering philosophy that influences every aspect of the production process: QUALITY!

Marisa formerly collaborated with renowned worldwide companies like as DIOR, CHANEL, and others.

Regrettably, following the Covid-19 pandemic, Marisa saw a significant decline in her customer base. Previously, she had a diverse range of clients, but now she is only dealing with four clients.

Marisa has the capability to make a wide range of items. However, owing to the impact of Covid-19 and the loss of clients, they are presently prioritizing the production of coats and fulfilling the demands of their primary client, ZARA.

4.1.2 Customer Market Identification

Table 4.1: Customer Market Identification.

Market	Pays	Clients
Europe	France	American Vintage
	Spain	ZARA
Local	Morocco	Local Market

During my internship, Marisa mostly worked with ZARA due to the pandemic, however, she had previously worked with a diverse range of clients.

4.1.3 Product Market Identification

Table 4.2: Product Market Identification.

Categories	Product Type	%
Women	Jackets	11%
	Coats	22%
	Dresses	12%
Children	Pants	8%
	Shorts	10%
	Jumpsuits	7%
	Dresses	10%
Men	Coats	10%
	Pants	10%
TOTAL	---	100%

Marisa has achieved a high level of product variety, which is supported by their adaptable operators and impressive manufacturing capacity.

4.1.4 Supply Numbers Identification

Table 4.3: Supply Number.

Category	Sub-category	Vendor	Quality	Price	Limit Time	IP /27
Furniture	Thread	**COATS Maroc**	3	3	3	27
	Polyamide tape	**Commercial Araque**	3	3	3	27
	Attachment Loop	**Eclaire Prym**	3	2	3	18
	Braided thread-Cordon	**La maison du Ruban**	3	3	3	27
	Sewing buttons	**Mondial Boutons**	3	3	3	27
	Billet	**QST**	3	3	2	18
	Size sticker	**Sepa accessoires**	3	3	3	27
	ZIP	**YKK**	3	3	3	27
Raw Material	Tissue, 100% cotton	**Troficolor**	3	3	3	27
	Tissue, Polyamide	**Lemar**	3	2	3	18
	Tissue, Linen	**Textile**	3	2	2	12
	Jean	**PureDenim**	3	3	3	27
	Tissue, Flamingo	**Manteco**	3	3	2	18
	Tissue	**Royo**	3	3	3	27

Marisa has a highly broad range of suppliers, encompassing both accessories and supplies, as well as raw materials.

4.1.5 Identification of Numbers in The Machine Park

Table 4.4: Machinery Numbers Identification.

Category	Type of machinery	Number	Performance rate	Obsolescence rate
Assembly	Stitching	266	67%	33%
	Overlock	77	73%	18%
	Double needle	70	74%	26%
	Broderies	20	82%	23%
	Button laying	20	69%	31%
	Buttonhole	17	78%	22%
	Offset arm	13	77%	23%
	Ironing table	64	100%	
	Elastic stretching	4	78%	22%
	Press	5	85%	15%
	Belting	5	86%	18%
Cut	Tip Top	7	74%	26%
	Quilting cart	3	75%	25%
	Saw	2	82%	18%
	End cutting	1	79%	25%

The firm possesses more specialized machinery that I was unable to display all on the table. In addition to the machines now in use, not all of them are operational. We also have a stock of machines that are no longer functioning, machines that are waiting to be used, and machines that are currently being repaired. The rate of obsolescence is significant.

4.1.6 Human Resources Numbers Identification

Table 4.5: Human Resources Number Identification.

Categories	**Effective**		**Competencies**		
	Number	Rate %	Managerial	Technique	Relational
Directors	2	0.5%	3	3	3
Senior executive	15	5%	3	3	3
Foreman	17	6%	2	3	3
Qualified operator	280	77.7%	--	3	3
Non-qualified operator	45	11%	--	2	--
Total	359	100%	--	--	--

MARISA faces a shortage of workers in the assembly workshops as well as in other divisions. Thus, training the unskilled operator in other operations to improve their skills is a good idea.

4.2 PRODUCTION DEPARTMENT (ASSEMBLY LINES)

The selected case study pertains to a Moroccan apparel enterprise situated in Casablanca, where I completed an internship. The firm in question faced several production issues, prompting my decision to use Lean manufacturing principles. This strategic move aimed to enhance the production process, eliminate inefficiencies, and ultimately achieve improved quality, reduced lead time, and timely delivery.

The production section is equipped with three manufacturing lines situated at various levels within the structure. Each line is dedicated to a specific sort of product, depending on the season. However, one line is only for coats, thus our project will focus on that line.

4.2.1 The Applied Method in the Assembly Lines

This approach involves the simultaneous production of several smaller commodities on parallel assembly lines. The final product is formed by combining all individual components or smaller objects at the conclusion of each manufacturing line. The following are the sequential actions:

a. The assembly of model pieces is carried out by technical agents and qualified professionals.

b. Research on the operational stages conducted by the methodological agents

c. The chain manager prepares the launch of the head of the series and seeks approval.

d. The validation and introduction of new models are carried out in the presence of the quality agent and the method agent.

e. Inventory management.

f. The work chain leader ensures continuous monitoring and control across the chain.

Although the work may appear flawless at first glance, a closer inspection of the assembly lines reveals various faults. This is why every production manager recognizes the significance of traceability and measurability in improving both quality and productivity and, therefore, competitiveness. We recommend implementing a continuous flow system or one-piece flow system to enhance traceability and measurability. In the continuous flow system, each action inside each bundle is performed by a solitary individual at a certain moment referred to as the "T" instant. The continuous flow system may be monitored. Information tools facilitate the easy measurement, promotion, and establishment of a verifiable production system. The continuous flow system has several benefits, including less reliance on intermediary labor for transportation, improved bottleneck management, and simplified task sharing.

4.2.2 SIPOC for Assembly Lines.

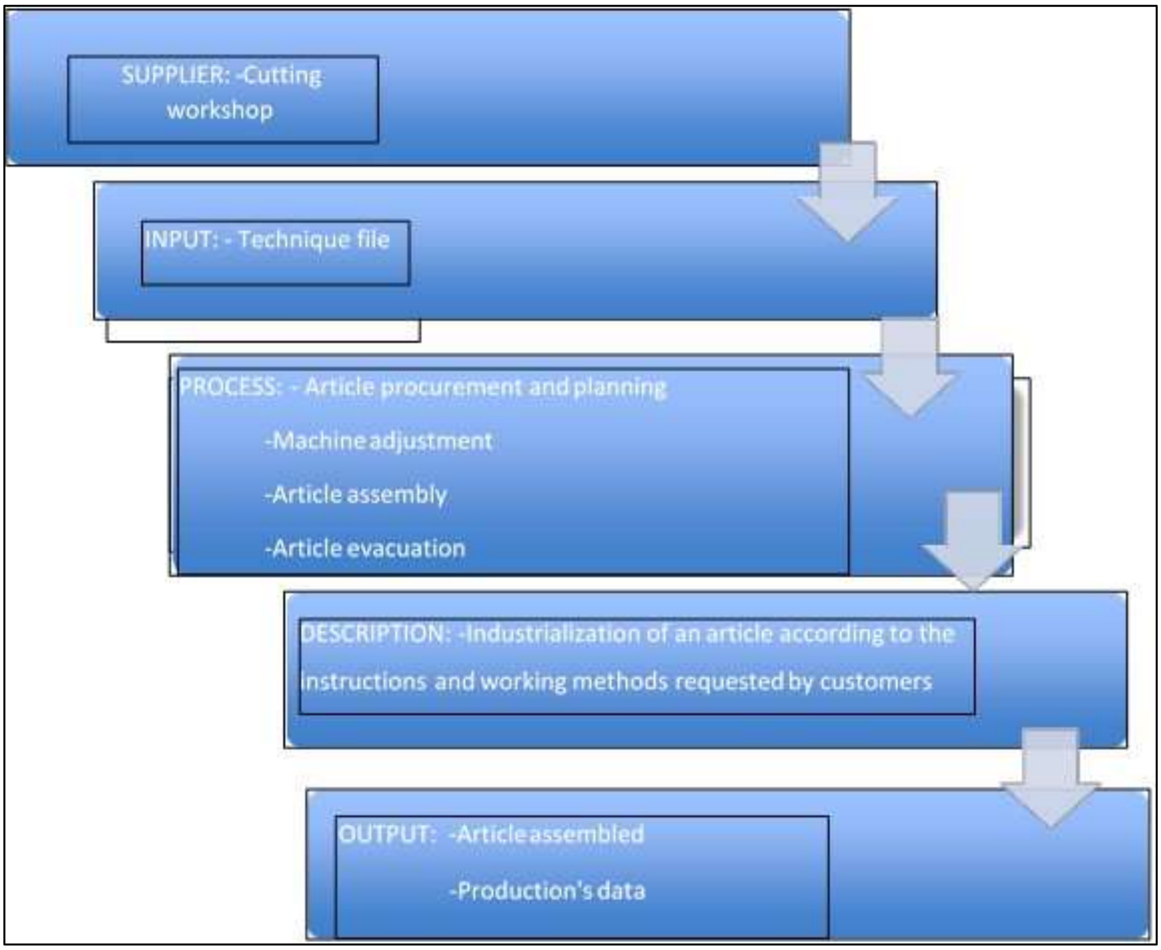


Figure 4.1: SIPOC Assembly Lines.

The SIPOC for assembly lines provides a concise overview of the process, including a brief explanation of the labor involved.

4.2.3 5M: Strength and Areas for Improvements

Table 4.6: 5M for Improvements.

5M Strength	
Management	The work environment allowed for good productivity
Manpower	The presence of a continuous training plan in operator versatility Presence of an alternative training center
Machinery	Good machinery in terms of quality and quantity
Methods	Presence of team cohesion at the workshop level. Presence of sheets at the position level Review of schedules and objectives daily
Material	Diversification of the launched models
5M Areas for improvements	
Management	Working environment not well exploited, too much space
Manpower	Determine the qualification criteria of the manpower Train the manpower on versatility. Standardize working methods and tools
Machinery	Have safety stock to avoid production stoppage
Methods	Insure the respect of the operating mode
Material	Delicate material

The purpose of the 5M presented in the table above is to provide a comprehensive assessment of the strengths and opportunities for development.

4.3 CURRENT STATE

4.3.1 SWOT Analysis

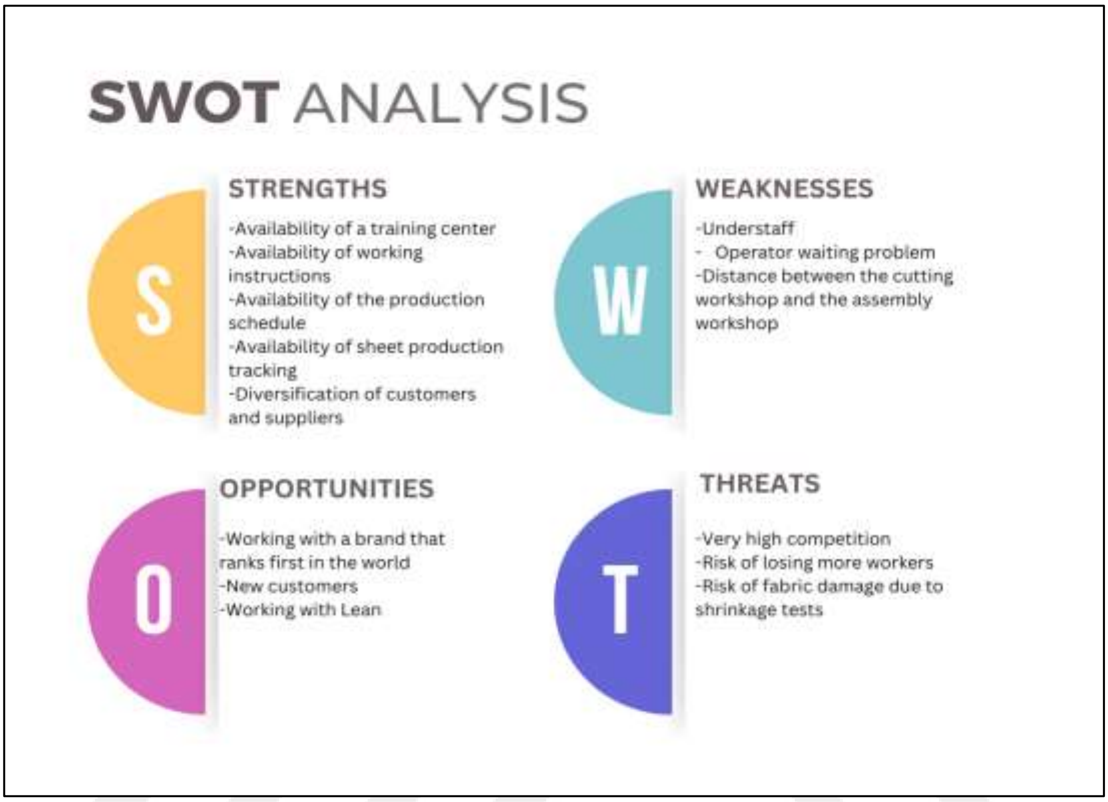


Figure 4.2: SWOT Analysis.

a. Marisa has significant qualities, however, regrettably, the training center is underutilized, the instructions are insufficient, and the production tracking is not consistently carried out.
b. Marisa is facing a significant shortage of managerial personnel, particularly in the role of head staff. While there are additional operators available, there is a dearth of responsible individuals to oversee departments. Furthermore, the physical layout of Marisa, with its 6-level building, is exacerbating the issue by creating a power distance between departments, resulting in delays, and waiting times.
c. Marisa previously collaborated with renowned companies, and each one would endorse her work to another client, resulting in the acquisition of additional consumers and chances. However, this might also pose a potential hazard, since the intense rivalry may adversely impact the workforce, increasing the chance of employee attrition.

4.3.2 SIPOC

The following SIPOC diagram incorporates all processes and divisions within Marisa, serving as the comprehensive representation of the company's overall SIPOC. This tool provides a comprehensive overview of the company's processes, including both inputs and outputs, presented in a single chart.

Table 4.7: SIPOC Departments.

Suppliers	Input	Process	Output	Clients
External provider	Purchase order	Reception of raw materials	Raw material	Stock
Stock	Purchase order	Fabric preparation and accessories	Roller and accessories	Cutting workshop
Cutting workshop	Cutting order	Cutting	Cut fabric	Assembly workshop
Assembly workshop	Order planningand manufacturing	Preparation, assembly and finishing	Final Product	Control
Treatment after conditioning	Final product	Treatment of articles	Final product Treated and conditioned	Packing and shipping
Packing andshipping	Final product	Final product packaging and shipping	Delivery form	Customer

4.3.3 Key Performance Indicator

The Key Performance Indicators (KPIs) provide an overview of the current performance within our manufacturing department. The data shown here was collected over a one-week period and pertains specifically to the production of pants.

Performance/ Efficiency:

Performance enables us to quantify the degree of efficiency of a collective. Workshop 2 operates for a duration of 9 hours every day, employing a total of 73 individuals. There is a 20-minute break in the morning, another 20-minute break in the evening, and a 1 hour and 30-minute break for lunch.

Table 4.8: Overall Company Performance.

Day	Date	Refer -ence	Work value	EFF	Daily Produc --tion	Presence time	Producti on on time	Perfor-mance
Monday	March 22nd	4366	73.40	73	390	39 420	28 626	73%
Tuesday	March 23rd	4366	73.40	73	450	39 420	33 030	84%
Wednes -day	March 24th	4366	73.40	73	450	39 420	33 030	84%
Thursday	March 25th	4366	73.40	73	440	39 420	32 296	82%
Friday	March 26th	4366	73.40	73	460	39 420	33 764	85%

Our workshop's average performance or efficiency is 82%.

The workshop's efficiency is commendable at 82, but there is room for improvement. Marisa has the potential to enhance both efficiency and performance. The implementation of Lean Manufacturing has led to significant improvements in firm performance, which is a key aim and benefit of this approach.

Absenteeism:

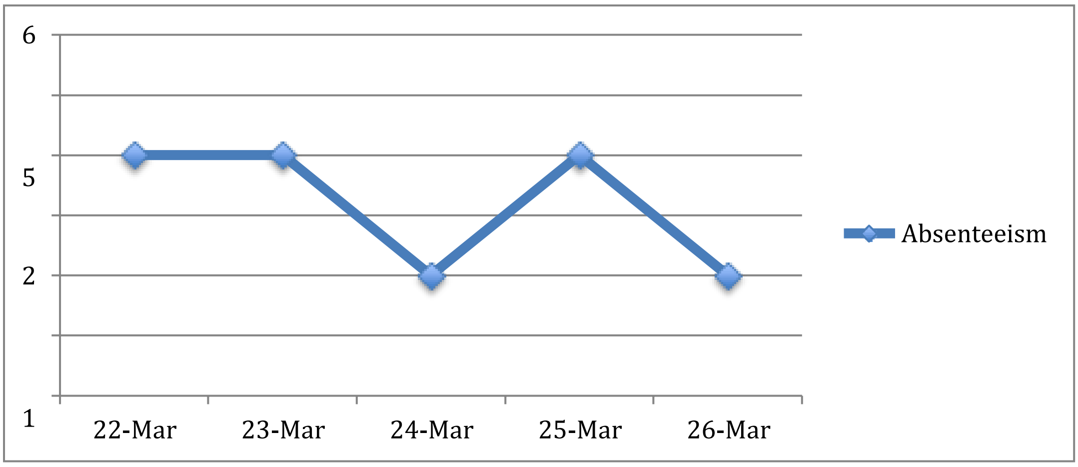


Figure 4.3: Absenteeism Chart.

Absenteeism rate is 4%.

PS: You can find the formulas of the performance and Absenteeism in the literature review.

Machine failure

An analysis and examination have been conducted on a sample of 500 machines.

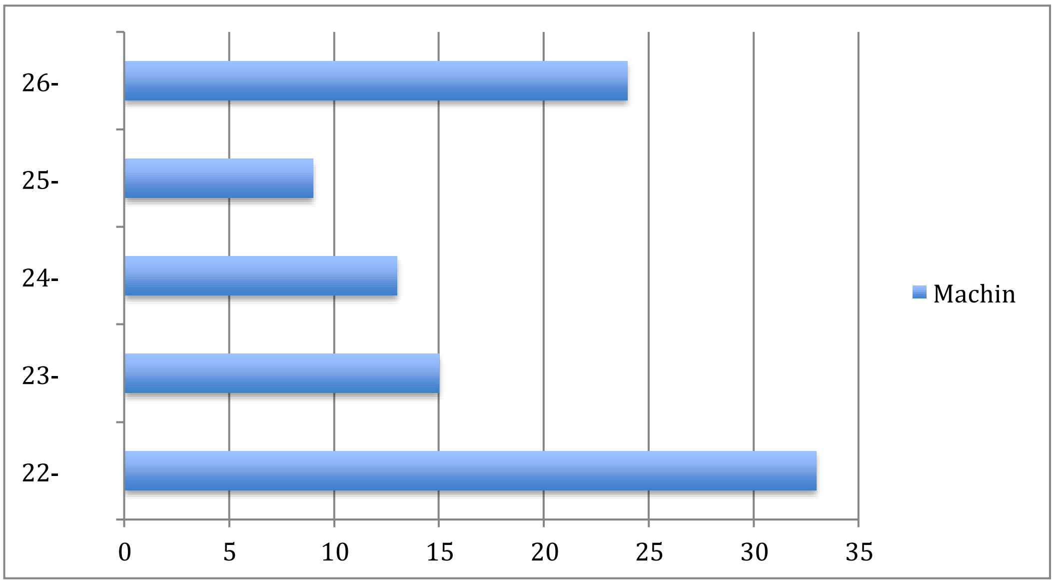


Figure 4.4: Machine Failure Chart.

Monday 22	Tuesday 23	Wednesday 24	Thursday 25	Friday 26
33	15	13	9	24

Machine Failure: 4%

Retouch

Monday 2	Tuesday 2	Wednesday	Thursday	Friday 2
13	9	4	18	14

Retouch: 3%.

Essentially, the Key Performance Indicator (KPI) provided us with a comprehensive assessment of the tasks and the level of achievement during the session. Implementing Lean manufacturing techniques and solutions will improve our performance, surpassing the existing rate of 82%. Additionally, it will minimize absenteeism and enable us to address machinery issues through preventative maintenance. By utilizing the provided methods, we may eliminate the need for “Retouch”.

4.4 Workshop analysis and measurement

4.4.1 Production Monitoring

The production follow-up in a clothing firm enables the monitoring and control of article manufacturing, as well as the management of operators' working time. This table, which I have produced, displays the daily production of all the workshops involved in the production process, from cutting to packing the final product.

Also, the objective of production monitoring is to enhance the efficiency of human resources, material use, inventory management, and physical operations, ultimately leading to a reduction in production expenses.

			Mar-21										
			L	M	M	J	V	S	D	L	M	M	J
OF	Quantity	STEPS	22	23	24	25	26	27	28	29	30	31	1
4562	15000	CUT						360		960	720	720	846
		IRONING						340		940	720	750	816
		PREPARATION						42		240	400	500	520
		ASSEMBLY						300		450	472	500	315
		FINISHING						300		440	482	500	315
		EMBALLAGE											

D	L	M	M	J	V	S			
18	19	20	21	22	23	24			
							15000	0	
	840						15000	0	
	427	450	450	480	488	440	11354	-3646	PRODUCTION
	450	210	450	333	488	520	11363	-3637	
	320	520	540	540	540	540	12027	-2973	
							5820	-9180	

Figure 4.5: Production Monitoring Excel Table.

This Excel document contains a calendar of the days on which work is scheduled, together with the corresponding OF (Order Form) or article reference, quantity, and manufacturing processes. The table will facilitate our decision-making process over whether to export the piece to the client or retain it in the production line. The second segment of the diagram involves a decision-making process. Regrettably, the manufacturing has not been finalized due to a delay in this particular aspect.

Note: The Excel table is big, I couldn’t extract it all, thus I divided the work.

4.4.2 Lead Time

The lead time, also known as the order cycle time, refers to the period between the placement of a supplier order and the subsequent ability to place another order. It represents the time span between order placement and delivery.

In order to enhance Lead Time, I suggest determining it by identifying the primary production phases at Marisa. This involves studying the sub-processes and estimating the expected duration and execution time for each sub-process. Below is a summary of the table that displays the computed lap timings for each stage.

Table 4.9: Lead Time.

Services													
Steps	STOCK		CUTTING		ASSEMBLY		FINISHING		CONDITINNING		Lead Time	Min CostDH	Waste
Phase	Wait	prod	wait	prod	wait	prod	wait	prod	wait	prod		0.7	
4567	50	135	300	4860	540	4320	400	2100	1080	4860	16145	6830	4781
	0.3 %	1.1%	2.4%	39.1 %	4.3 %	34.7 %	3.2 %	16.9 %	8.7%	39.1 %	114.0 %		
	185		5160		4860		2500		5940		10985		

In this approach, the Lead Time is characterized by a brief duration, meaning that the time required for execution exceeds the time spent waiting. Conversely, there are some models where the waiting time exceeds the execution time, mostly owing to considerations such as order priority.

The losses incurred in this model amount to 4871 DH, and certain models can experience losses of up to 10,000 DH or higher. Within a garment industry, the assembly workshop is where the bulk of difficulties are often faced. The production of an order is quite complex. Factors such as series changes, machine changes, operator involvement, and waiting time have a detrimental impact on production and result in decreased productivity.

4.4.3 Delivering Time

One of the performance metrics that allows us to assess a firm is its adherence to delivery deadlines. In order to meet a customer's expectations, it is imperative that we provide the precise amount of a product that meets all necessary requirements and deliver it within the specified timeframe.

The table below provided me with the means to determine the level of adherence or fulfillment of deadlines:

Table 4.10: Non-Satisfactory Delivery Time.

Table of rates of non-satisfactory with deadlines					min Cost	0.7
N°	Ref	Planned delivery date	Real date delivery	Delay (Day)	Cost of Delay (DH)	min delay workshop
1	TIN11C 1	4/20/21	4/23/21	3	85050	1620
2	TIN15A	4/21/21	4/26/21	5	141750	2700
3	4573	4/27/21	4/30/21	3	85050	1620
4	AM734 9	5/4/21	5/5/21	1	28350	540
5	TIN11C 2	5/12/21	5/12/21	0	0	0
6	4846 15	5/12/21	5/15/21	3	85050	1620
7	TIN11C 3	5/17/21	5/17/21	0	0	0
8	ANGL1 5	5/21/21	5/25/21	4	113400	2160
Total delay days				19	538650	10260
Delivery Rate non-satisfactory				38%		
Delivery rate satisfactory				63%		

The amount of time wasted directly translates to financial losses. The total losses incurred over this period amounted to 538,650 DH, which is a substantial figure to lose in just 40 days.

In what follows I will detail the cause of the loss with the 4M:

Table 4.11: Non-Satisfactory Delivery 4m.

N	Machines	Men Power	Material	Method
1			Lack of accessories	
2	High machine failure rate	Absence of operators		
3	Lack of machinery		Lack of thread	
4	Lack of machinery			
5			High retouch rate	OM Non respected
6		Operators' absenteeism	Lack of fabric	
	75.00%	**50.00%**	**100.00%**	**25.00%**

The duration of the delay from April 20 to May 25 is 19 days.

a. The rate of non-compliance with deadlines is 38%.

b. The rate of meeting deadlines is 63%.

c. The delay duration is 10.26 minutes.

The primary reasons for the issue are attributed to the raw material, with the machinery being the secondary contributing factor. During the project initiation phase, many solutions will be provided.

4.4.4 Current production line implementation

Out of the company's 3 production lines, we will only implement the modification and develop a continuous flow on one specific line that is solely dedicated to making coats.
The existing implementation results in excessive movements and causes various forms of waste, leading to significant time loss for the organization. Consequently, timely deliveries are not achieved, quality is not enhanced, and cost penalties are imposed.
There are several changes in the current layout. Adopting a new just-in-time design is the optimal solution for eliminating travel and various forms of waste while enhancing the

manufacturing process. The organization will derive advantages from its adoption, whether it is in terms of cost savings or time efficiency, as well as enhanced quality as per client requirements. This is achieved by reducing the time required to produce an article, hence enhancing productivity and assuring optimal use of all resources, including human and material. The work will be appropriately organized after the new facility has been constructed.

Additionally, this will contribute to the Key Performance Indicators (KPIs) by enhancing the overall performance of the workshop.

The Implementation Line Process:

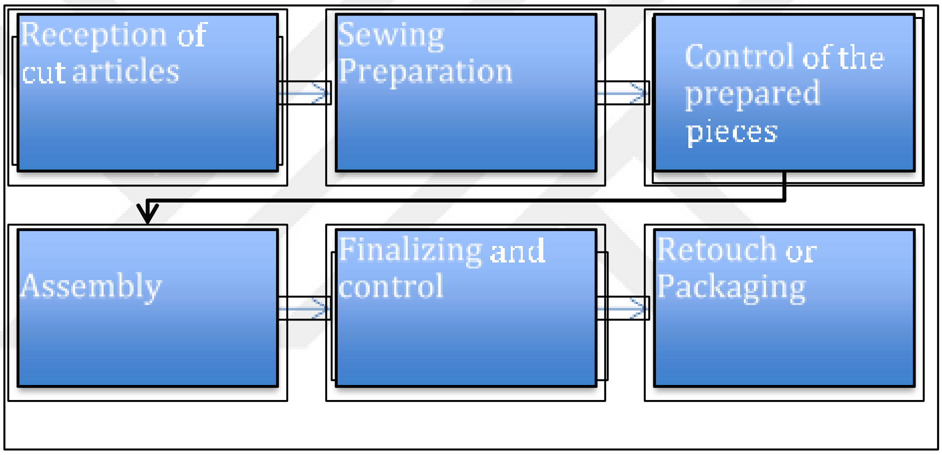


Figure 4.6: Production Line Process.

The graph below illustrates the present implementation, depicting the movements between postings:

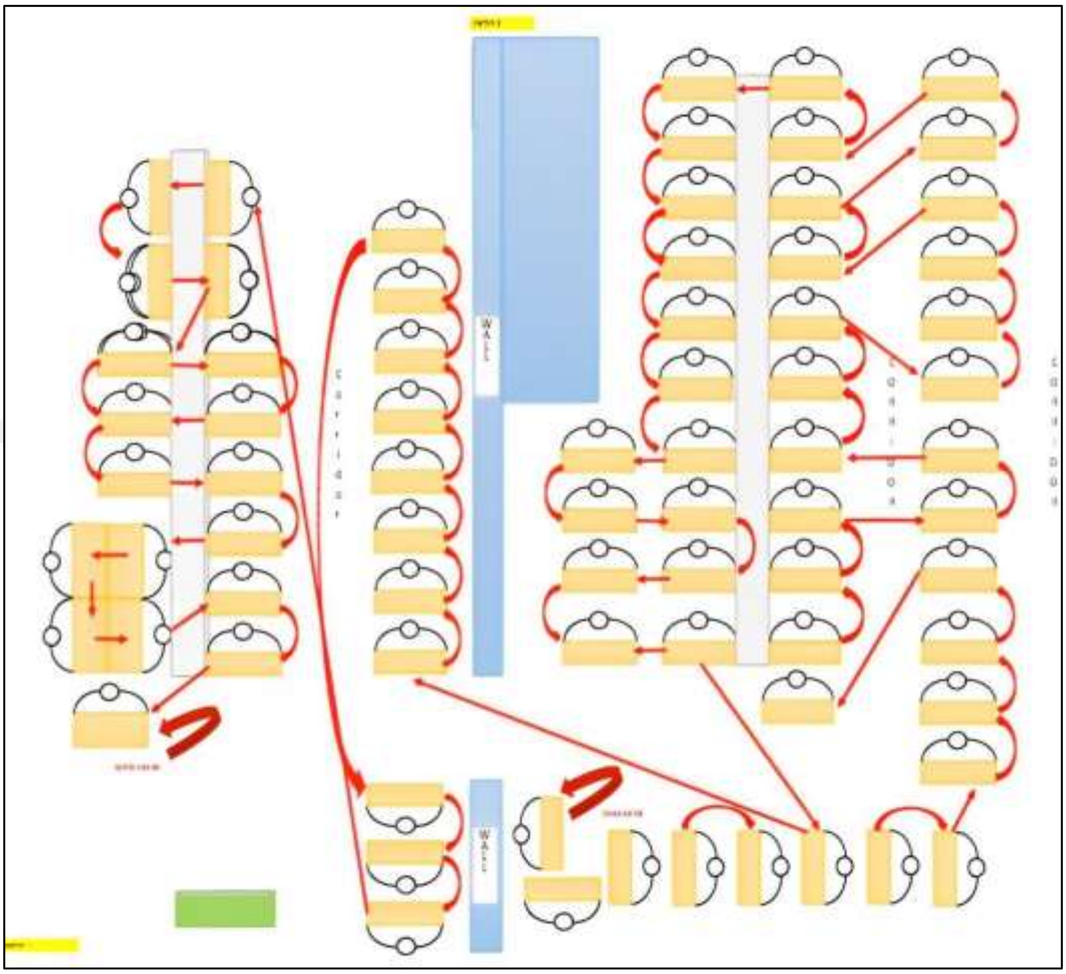


Figure 4.7: Current Implementation.

The graph depicted above illustrates the execution of an assembly line, which we will be focusing on to optimize for continuous flow and one-piece flow manufacturing methods. As depicted in the graph, there are numerous movements (highlighted in red) that result in significant wastage. Some posts are collaborating with others in a random manner, without a system in place to collect articles from each post and transfer them to the next one. The space is not effectively utilized, with a considerable amount of unused space that is not occupied by any machinery or department. The presence of non-functioning machinery further contributes to the lack of organization in the workshop.

The lack of coordination among operators results in increased article processing time, leading to lower productivity and a negative impact on the firm's profitability. This is particularly detrimental as the company incurs a cost of 0.7 Dh per minute. Due to the machinery's energy consumption without productivity, the firm is experiencing losses in both financial and operational aspects. Additionally, the quality of the products may be compromised due to the lack of proper transportation and storage facilities. Marisa often has significant delays that often exceed the allotted time limit, resulting in fines from their clients. None of these actions are advantageous for the organization; they are incurring significant financial losses. Therefore, implementing a continuous flow strategy would be the most optimal approach for them.

The process at hand begins with the production responsible individual receiving the cutting order. Subsequently, this order is forwarded to the cutting responsible party. Once the articles have been completed, the production responsible individual creates a production plan, which is then sent to the lines and implemented in the workshop. The production and manufacturing order is issued by the production responsible individual to ensure its completion. Prior to finalizing the estimated daily and weekly production, the limited date is calculated based on these figures. Regarding the production process, the operators are promptly provided with the cutting parts to commence work. This implementation consists of only 3 stages, with the preparation portion being the initial one to begin with. They are assembling various sections of the articles and overseeing them at various stages of the preparation process. Following the preparation step, a comprehensive quality control is conducted to determine whether the pieces need to be sent for ironing, if necessary for this product. After ironing, if necessary, the components are then transferred to the initial stage of the assembling process. After completing the item design to meet the client's requirements, a comprehensive inspection is conducted on all manufactured articles. If necessary, ironing, or chemical treatment is applied. If not, the products are promptly sent for packaging and shipment. During this procedure, there may be instances of machinery failure, necessitating the rapid intervention of a mechanic staff to rectify the issue.

4.4.5 Muda Inventory: The 8 types of waste

a. Muda Inventory

Figure 4.8: Accessories and Furniture Overstock.

b. Muda's Machinery Overstock

One of the types of waste that Marisa experiences is excess inventory. Marisa possesses a stock of textiles, accessories, and machinery that are either no longer in use or awaiting further action.

Figure 4.9: Machinery Overstock.

c. Muda's Overproduction

Overproduction refers to the act of manufacturing an excessive amount of goods or services when there is little demand from customers. This can result in the accumulation of excess inventory, also known as overstock.

Figure 4.10: Overproduction articles.

d. Muda's Transportation

Movements seen in the workplace may not always indicate productive work being carried out by the operators. These movements can often be considered as non-value-added actions, such as retrieving a lost part. Similarly, meetings held outside the firm or unnecessary excursions can also be regarded as wasteful movements.

Figure 4.11: Transportation Obstacles.

4.5 WAITING MUDA

Every industrial organization has delays at several stages. Waiting is a form of inefficiency that does not have any added value.

Types of expectations at Marisa:

a. Awaiting the availability of machinery

b. Awaiting the repair of machines

c. Awaiting the delivery of unprocessed materials or supplies...

Figure 4.12: Waiting for Operators to Move the Furniture.

4.6 MUDA DEFECTS

This waste is retained for the purpose of making modifications, handling consumer returns, addressing customer unhappiness, and managing any form of waste that may lead to customer displeasure.

Figure 4.13: Articles for Retouch.

4.7 MUDA UNNECESSARY PROCESSING OR EXTRA-PROCESSING

An inactive step, stain, or control is also considered wasteful. Complex computer systems or software that are difficult for operators to navigate, as well as unneeded files, can be considered a form of efficiency or waste.

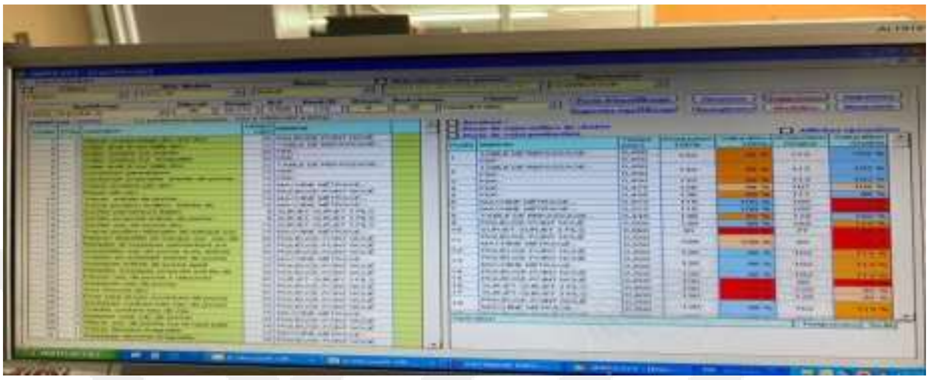


Figure 4.14: Complicated Software for Operators.

4.8 MUDA MOTION

Unproductive time resulting from waiting for a job, supply, or an inactive operator is categorized as waste within the Muda motion family.

Figure 4.15: Inactive Machine Waiting Time.

4.9 MUDA NON-UTILIZED POTENTIAL

Observing the inefficiencies is the initial stage towards their eradication. Most individuals fail to recognize that the underutilization of abilities also contributes to waste, albeit in a less visible manner. Insufficient operator training at MARISA leads to the generation of waste. The company's difficulty stems from a lack of operator training, either on different processes or on different equipment. Providing training to both managers and staff of the organization yields long-term benefits. In addition, the absence of motivation inside the organization might contribute to a failure to utilize abilities effectively among both employees and operators.

Figure 4.16: Non-utilized Potential.

The 8 wastes of MUDA are an effective strategy for eliminating all forms of waste present in a workplace. In order to eliminate waste, it is imperative that we do a comprehensive analysis of all current waste types, followed by the development of individual solutions for each of them.

4.4.6 VSM- Current State

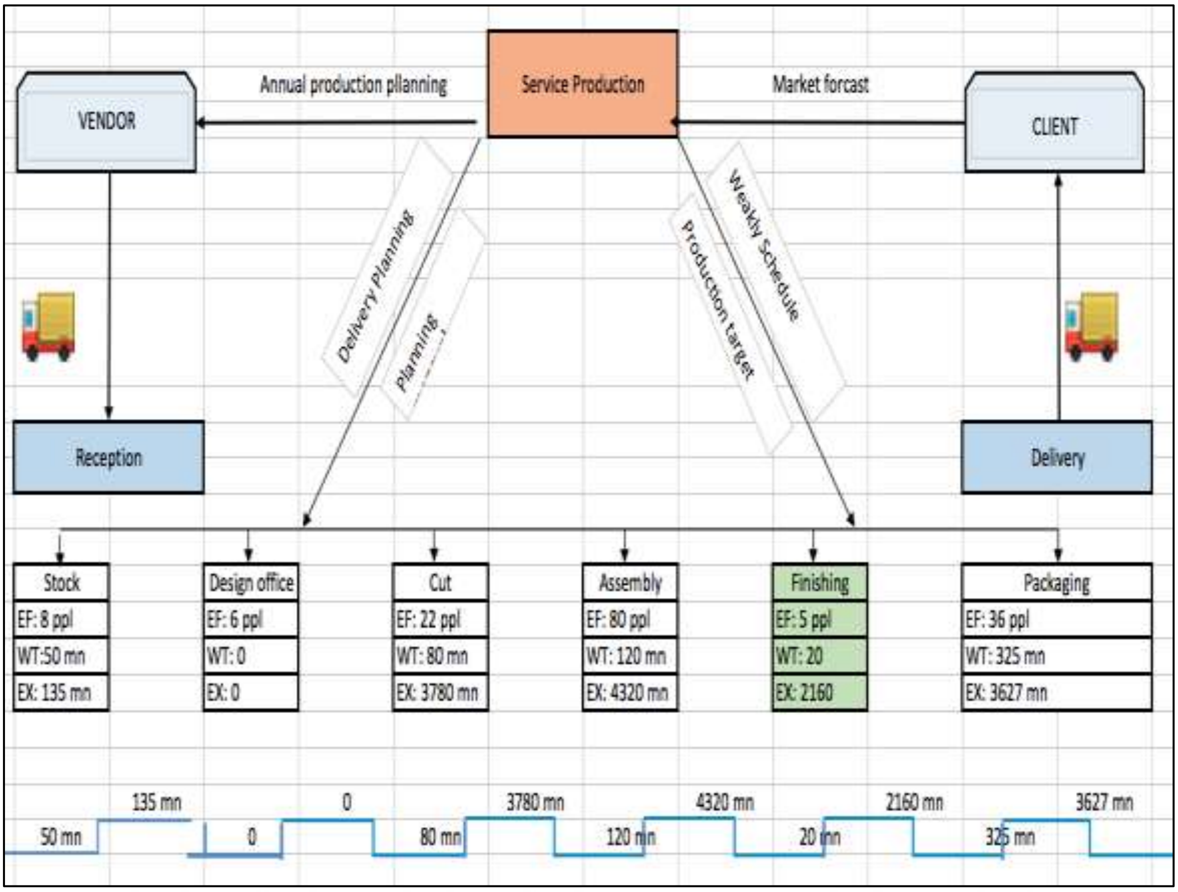


Figure 4.17: VSM Current State.

VSM Calculation

Total transit time: 14,587 Minutes	243,1 Hour
Waiting time: 565 Minutes	9,41 Hour
Execution time: 14,022 Minutes	233,7 Hour
%Waiting: 4%	
% Execution: 96%	

The actions in this Value Stream Map (VSM) are determined throughout the process of industrializing a product, within a specific timeframe of 3 weeks. One of the goals of this initiative is to eradicate the waiting time, which is classified as one of the 8 MUDAs. The current waiting time is 9.41 hours, which corresponds to a percentage of 4%.

In this section, we have observed the present condition of our Process, as well as the many forms of trash that have been put into it. The methods are a set of tools within lean manufacturing that are used to analyze and address current problems.

In the next section, we will present a way to enhance our process by implementing Lean manufacturing principles, specifically focusing on generating a continuous flow. We will do comprehensive research on the 8 wastes by utilizing several Lean Manufacturing technologies, prior to presenting our proposed remedies.

4.5 FUTURE STATE

4.5.1 Establishment of the New Lean Manufacturing Implementation with he Continuous Flow-Future State

To initiate a new implementation, we will employ a manufacturing technique called the Continuous Flow System (CFS), which focuses on processing one unit of the product at a time at each stage of the assembly line. Utilizing this CFS can lead to operational excellence in terms of production, utilization of available space, and staff capacity. Chronic Fatigue Syndrome (CFS) can be considered the fundamental basis for lean manufacturing, and its effective implementation has the potential for substantial operational cost reductions. CFS is achieved in the specified workplace through a series of interconnected kaizen actions. The kaizen initiatives encompass the implementation of the U-shaped line, SW, and MHS. The purpose of all these activities is to eradicate the observed inefficiencies in the workplace

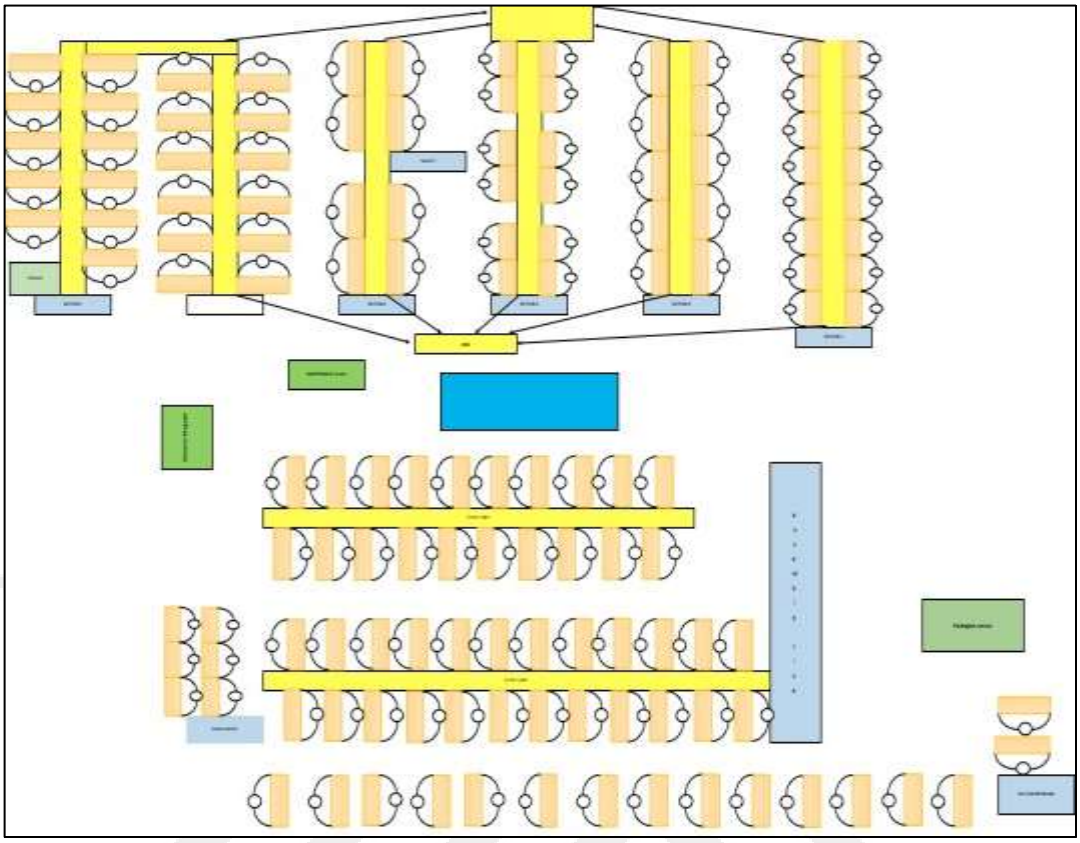


Figure 4.18: Simulation of the Established Implementation with Continuous Flow.

In the current situation, as outlined in Chapter 3, the existing implementation is characterized by excessive movements, lack of organization, resulting in waste creation, diminished quality, delayed deliveries, and increased expenses. To enhance the process, I propose implementing a continuous flow approach.

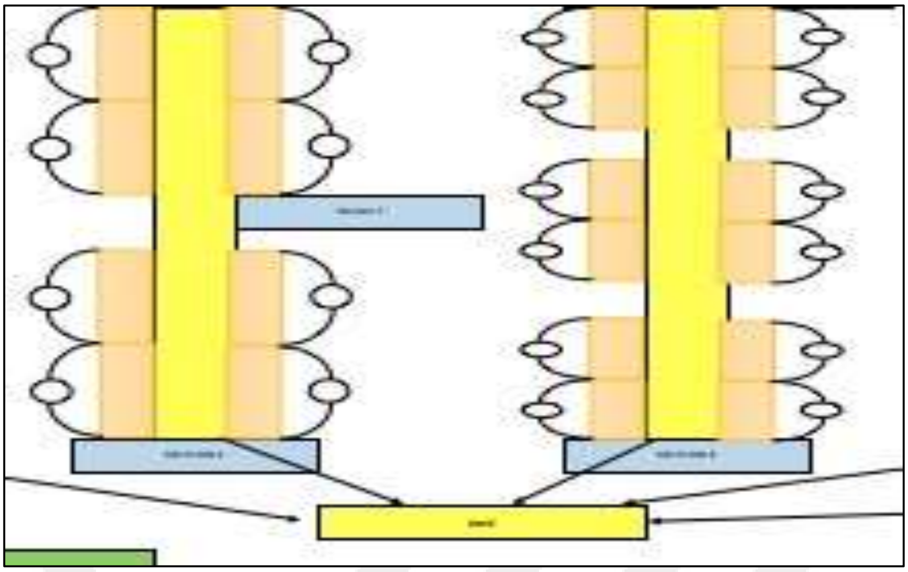


Figure 4.19: Simulation of 3 Sections from the New Implementation.

a. Each section contains a number of stations according to the modelworked.
b. Each section works independently of the other sections

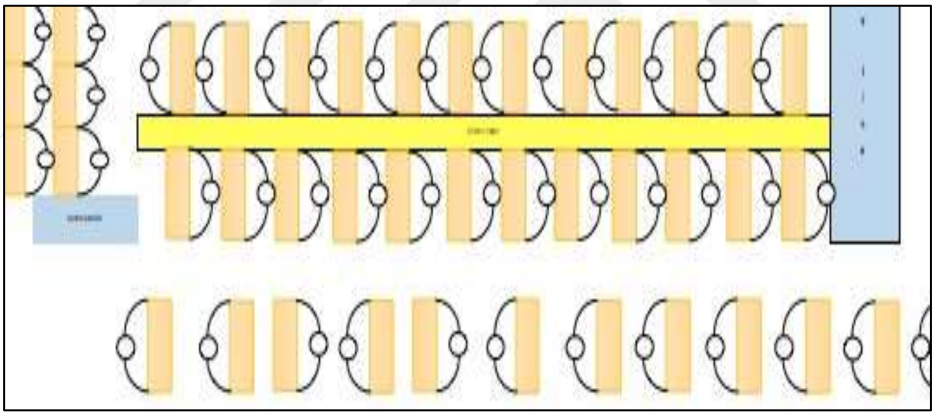


Figure 4.20: Simulation of Assembly and Packaging Sections.

New Implementation Process:

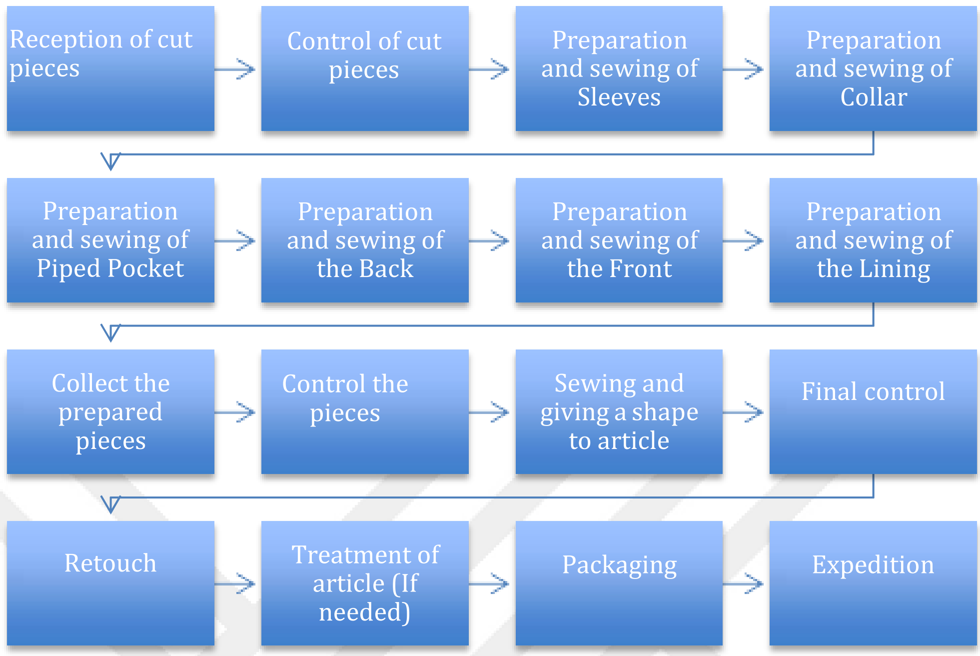


Figure 4.21: New Implementation Line Process.

The new process may appear more intricate than the previous one, but it is superior and more efficient in terms of time. The perceived lengthiness of the new process is due to the division of the preparation step into sections, all of which operate simultaneously. In contrast, the previous process involved separate and time-consuming preparation steps that were conducted in a linear fashion, lacking proper organization. Utilizing the single flow method, each individual item is prepared independently before being placed in a linear assembly line configuration.

a. Each part will gather its components in the designated blue container, which serves as a bin. An operator will then transport the components to the final container.

b. Later, the gathered components from each segment will be taken to the assembly line to complete the process.

c. Our assembly line operates as a continuous flow, resulting in improved processes, enhanced Key Performance Indicators (KPIs), higher quality, decreased time, and no additional expenditures incurred.

The final stage of our process is packing, which is done in a continuous flow manner.

Pictures of Project realized in reality**:**

Figure 4.22: Continuous Flow Implementation in Reality.

The image lacks clarity. As previously stated, there is a privacy policy in place that prohibits photography during the workshop, particularly of staff faces. This image depicts the Assembly and Packaging lines, which operate with a continuous flow. The operators work in a U-shaped line, following a one-piece flow system. This means that the article moves continuously through different sections until it reaches the end bin, where it is then sent to the final stage of production, which is the assembly lines. Within the assembly line, there are multiple control posts, with the most crucial one being the final control. This post is responsible for determining whether the article meets the client's requirements or if it requires further adjustments later on. Finally, the packing section serves as the last phase.

Figure 4.23: Continuous Flow Implementation (sections) in Reality.

This image depicts the many components involved in the creation of a coat, including the collar, sleeve, welt/piped pocket, back, front, lining, assembly, and packaging. The operational mode of each of those sections is indicated in the next section.

The project was implemented. Regrettably, I was unable to capture a photograph of the entire installation owing to privacy concerns. It is prohibited to snap photos near individuals. The team, consisting of myself as the firm adviser and two workers, dedicated a period of four weeks to achieve the ideal establishment. We encountered opposition from the operators who were resistant to change. It took us a considerable amount of effort to convince them that this new approach to work is superior. During my study of the project, I endeavored to enhance comprehension by demonstrating the potential benefits. One of the senior members, responsible for simulating time and costs, successfully conveyed to the operators that article production time would be reduced, and delays minimized.

Following the achievement of our institution, we require the long-term viability and endurance. Regrettably, my internship period had already concluded at that time, hence I will provide my comments in the recommendation section.

4.5.2 Operating Mode

The firm is now utilizing a generic operating mode that encompasses all operations in a random manner. The recommended operational approach is to work on a per-section basis, like our continuous flow implementation. Providing an operating mode based on sections would be highly beneficial for both operators and senior staff. This approach would streamline work processes and save time.

Table 4.12: Coat Operating Mode.

Section	Op no	Operation
SLEEVE	1	Assemble elbow +slot E
	2	Open seam at the bottom of the sleeve
	3	Assemble sleeve
	4	Open sewing assembly sleeve
	5	Draw + execute buttonhole slit bottom sleeve
	6	Glaze sleeve/head sleeve
	7	Control sleeve
Collar	8	Lay straight grain below and above collar
	9	Assemble under and over collar
	10	Topstitch below and above the collar
	11	Draw neck runner
	12	Slide collar
	13	Strip + turn collar
	14	Conform collar
	15	Control collar
Welt/piped pocket	16	Trace lip piping
	17	Slide lip piping
	18	Strip + flip lip piping
	19	Conform piping lip
	20	Conform piping lip
Back	21	Sew center back
	22	Open center back seam + lay straight grain
	23	Sew back split + turn over
	24	Sit low + back slit
	25	Control back

Table 4.12: Coat Operating Mode. “Table Continued”.

Front	26	Place straight on the neckline +shoulder +trim
	27	Assemble short side
	28	Open small side + conform bottom front
	29	Draw piping position
	30	Execute passport
	31	Strip + turn over the piping
	32	Attach piping pocket
	33	Assemble pocket bag
	34	Close pocket bag
	35	Rest pocket
	36	Close pocket
	37	Control in front
Lining	38	Prepare sleeve liner
	40	Sew center back + fasten hollow folds
	41	Trace +plate brand claw
	42	Assemble short side with back
	43	Prepare composition + glaze on the side
	44	Assemble trim/princess cutout on the front
	45	Close shoulder / side
	46	Set up sleeve/ Armhole
	47	Trace collar
	48	Assemble elbow +slot E
	52	Draw + execute buttonhole slit bottom sleeve
	53	Ironing lining
	54	Control lining
Assembly	55	Lay straight grain below and above collar
	56	Assemble under and over collar
	57	Topstitch below and above the collar
	58	Draw neck runner
	59	slide collar
	60	Strip + turn collar
	61	conform collar
	62	Lay straight on the piping lip
	63	Trace lip piping

Table 4.12: Coat Operating Mode. "Table Continued".

	64	Slide lip piping
	65	Strip + flip lip piping
	66	Conform piping lip
	67	Control lip piping
	68	Sew center back
	69	Open center back seam + lay straight grain
	70	Sew back split + turn over
	71	Sit low + back slit
	72	Control back
	73	Place straight on the neckline +shoulder +trim
	74	Assemble short side
	75	Open small side + conform bottom front
	76	Install piping position visline
	77	Draw piping position
	78	Execute passport
	79	Strip + turn over the piping
	80	Attach piping pocket
	81	Assemble pocket bag
	82	close pocket bag
	83	Rest pocket
	84	close pocket
	85	Control in front
	86	Prepare sleeve liner
	87	Sew center back + fasten hollow folds
	88	Trace +plate brand claw
	89	Assemble short side with back
	90	Prepare composition + glaze on the side
	91	Assemble trim/princess cutout on the front
	92	Close shoulder / side
	93	Set up sleeve/ Armhole
	94	Trace collar
	95	Assemble lower collar/ Lining
	96	iron lining
	97	Control lining

Table 4.12: Coat Operating Mode. "Table Continued".

	98	Assembly
	99	Close shoulder/side
	100	Open shoulder/side seam
	101	draw sleeve
	102	Raise handle
	103	Mount epaulette
	104	Set back fullness handle
	105	Lower body hem
	106	Control body
	107	Combine lining / body
	108	Assemble stand/body
	109	Mount revert + trim+ bottom
	110	Strip + turn trim + collar
	111	Install stairs and slide trim
	112	Open seam packing trim +collar
	113	close collar
	114	Sew slit lining +fabric
	115	Topstitch toggle slit
	116	Close bottom lining/ fabric
	117	Stitch sleeve slit + fasten back seam
	118	Slide bottom sleeve+ fastening
	119	Remove composting + return the piece
	120	Rest revert+ trim
	121	Topstitch collar +trim
	122	Trace position of buttons/sleeve slit
	123	Run sleeve slit buttons
	124	Trace buttonhole position
	125	Run buttons in front
	126	Draw button position in front
	127	Draw button position in front
	128	Close bookmark sleeve/ lining
	129	Finishing
	130	Check item

4.5.3 Establishment of the KANBAN System

Kanban is a very effective Lean approach that focuses on achieving output in a sequential manner while ensuring a harmonious balance between production and demand.

Kanban is founded upon four fundamental principles:

a. Minimize manufacturing expenses

b. Prevent excessive production

c. Decrease lead times

d. Achieve optimal product quality

The project team opted to use Kanban methods at the section level to effectively control production and minimize inefficiencies.

An established example of KANBAN:

Regrettably, I was unable to get a photograph as it was prohibited. However, this is only a limited representation of the KANBAN system that I have implemented.

Table 4.13: KANBAN System Simulation.

Received Orders	Preparation	Manufacturing	Packaging & Stocking	Shipment
Order 1				
Order 2				
Order 3				
Order 4				
Order 5				

Too Urgent	
Urgent	
Shipped as soon as possible	
On time	

Rules of a KANBAN board:

Table 4.14: KANBAN Rules.

Rules	Definition	Application
Movement Rule	Say when and why the card was moved from one column to another. Tell the average time or deadline to complete the task.	The card moves from one column to another when the substance moves between stages.
Animation Rule	Discuss when and how to track, measure and report news and changes. Visual tools cannot replace meetings. On the contrary, it optimizes the flow of the meeting to reduce the meeting time and reduce the essence of "improving" communication.	We measure and report information in daily meetings with supervisors and managers to see each OF's progress and its current stage. We also have an MES (Manufacturing Execution System).
Load Rule	Each state of the board can contain a predefined maximum number of concurrent tasks (defined according to the team's capacity). This is called WIP (work in progress)	We deliver the most urgent only in May and June. Who does not have Our chart does not list goods that need to be delivered urgently or after June.

The approach for enhancing the process is to develop a continuous flow and maintain its sustainability by implementing the KANBAN system.

4.6 ELIMINATION OF THE WASTE-FUTURE STATE

Prior to discussing the proposed remedies for the 8 MUDA Wastes, it is important to analyze the current waste present in the workshop and identify their origins by utilizing various Lean manufacturing methods. The Pareto diagram identifies the primary 1 or 2 sources that account for 80% of the waste. The Ishikawa diagram, also known as the cause-and-effect diagram, allows us to identify the reasons based on the 5M factors. We can then categorize these causes using the 8 MUDA categories. Only after this classification can we provide the most effective remedies.

4.6.1 Pareto Diagram

To construct a Pareto diagram, it is necessary to initially categorize the issues in a tabular format, followed by determining the number of observations, the total count, and the corresponding percentage:

Table 4.15: Pareto Decision Table.

Cause	Number of events	Cumulative	%
Machine breakdown	120	120	56%
Unnecessary physical movement	51	171	23%
Lack of staff	20	191	9%
Poor storage (disorganization)	13	204	6%
Non-compliant products	4	208	1.8%
Poorly communicated information	3	211	1.4%
Data entry errors	2	213	1%

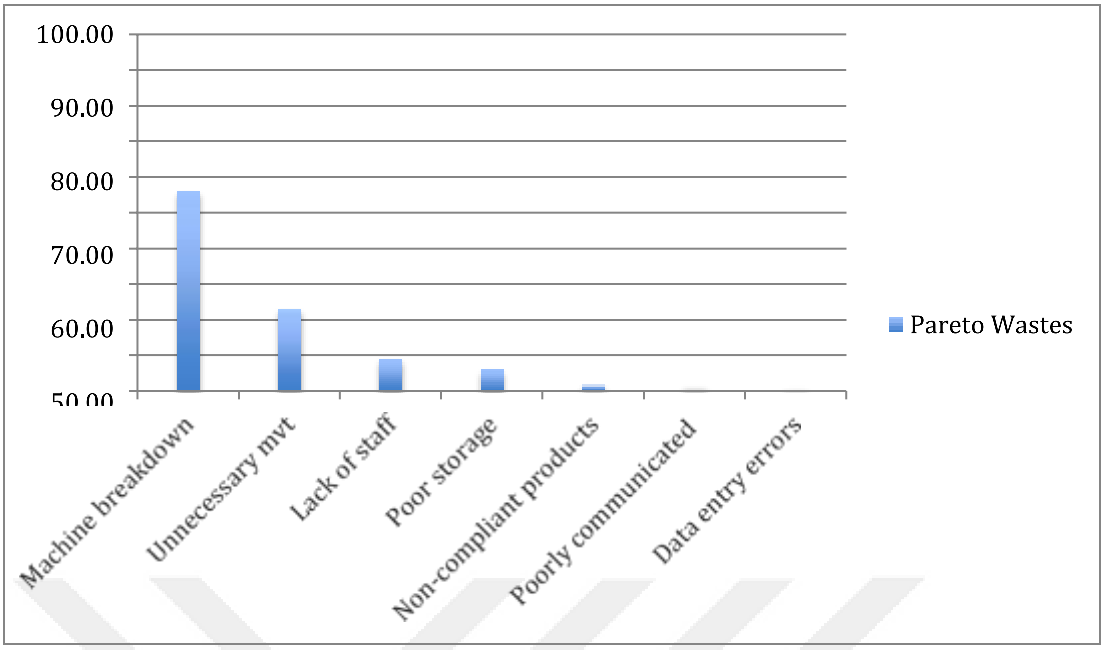


Figure 4.24: Pareto Chart.

After determining the proportion, I proceed to apply the Pareto diagram to analyze waste:

The problems that represent 80% of waste are:

a. Machine breakdowns

b. Unnecessary physical travel

The PARETO table is a decision table that identifies the events responsible for generating trash. It allows us to determine the reasons that contribute the highest proportion, with one event accounting for 80% of the waste generated in the workshop. Based on our PARETO Decision table, the occurrence of Machine breakdown accounts for 56% of the total. To reach an approximate total of 80%, we need to include another event. The next event is Unnecessary physical movement, which has a proportion of 23. The combined total of both occurrences will yield a result of 79%. The primary factors contributing to the majority of waste generated in the workshop are as follows:

a. Machine malfunction.

b. Superfluous bodily motion.

Next, the events will be classified according to the 5M framework in the ISHIKAWA Diagram, allowing us to identify the wastes based on the 8 MUDA.

4.6.2 Ishikawa Diagram

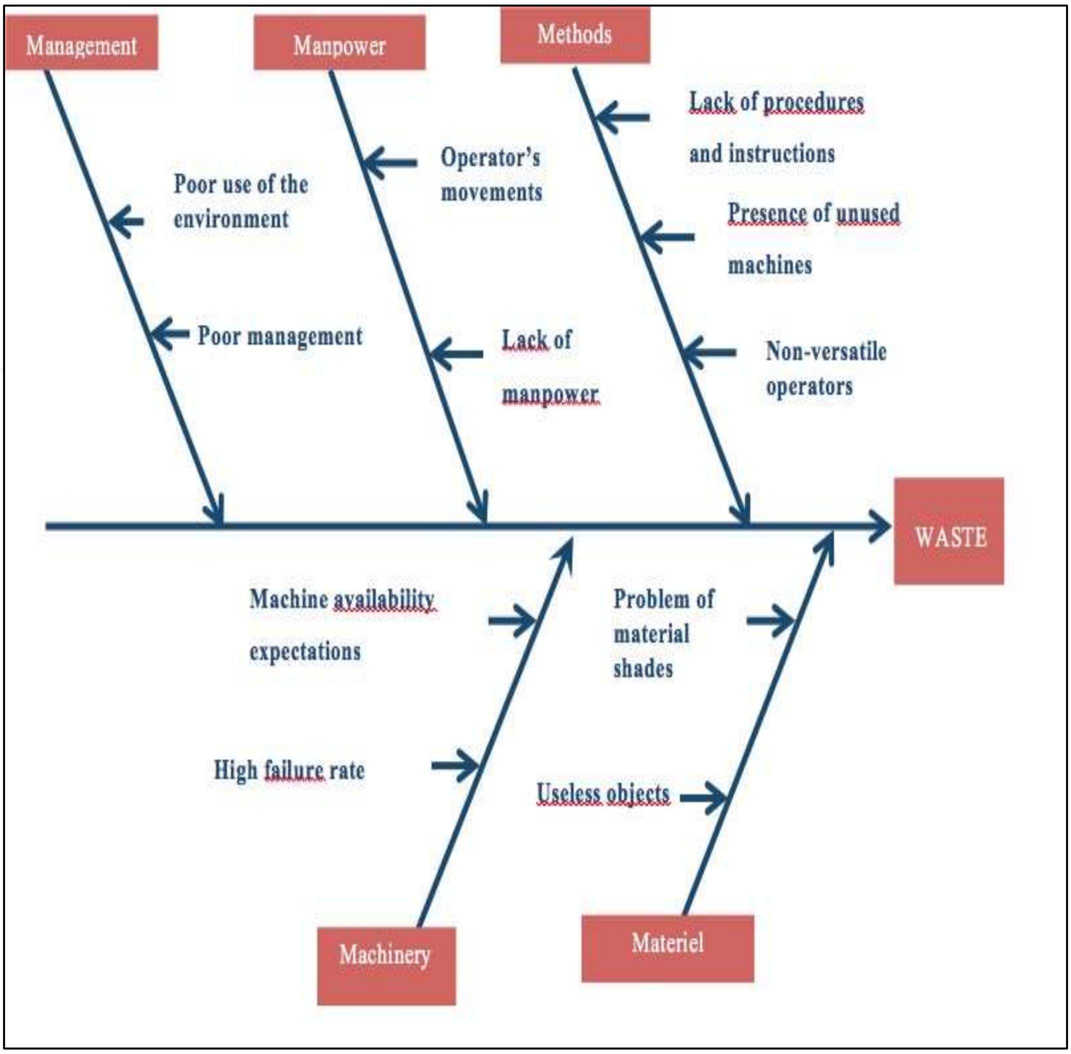


Figure 4.25: Ishikawa Diagram.

The factors contributing to waste are depicted in the fishbone diagram based on the 5M framework. Having obtained the Ishikawa diagram, we can now categorize the waste based on the 8 Muda:

Table 4.16: Muda Waste Based on Ishikawa.

Waste	Cause	Type of Waste
Poor use of the environment	Many trips due to poorarrangement of the workshop	Transportation
Operators' movements		Motion
High failure rate	Overloaded machines in deadstock or under repair	Inventory
Useless objects		
Presence of unused machines		
Poor handling management	Balancing is carried out to increase productivity and the capacity of the production station to maximize production	Over-production
Lack of procedures and instructions		Inventory Extra-processing
Machine availability expectations	Unavailability of resources with under-loaded positions and high machinery failure rate	Waiting
Lack of manpower		
Non-versatile operators	Lack of updating of the versatility table to enhance skills	Non-utilized potential
Problem or material shades	Sub-quality of the raw material delivered by the customer Lack of self-control and lack of training	Defects

4.6.3 8 MUDAs-Future state

Table 4.17: MUDA Waste Based on ISHIKAWA Diagram.

Muda Type	Solution
Inventory	Marisa must buy what she must produce in terms of raw materials and accessories. It can also liquidate it by selling the dead stock to other companies. For the stock of machines, I suggested fixing a few since Marisa finds machines waiting issues, and selling the other machines she doesn't need.
Overproduction	To get rid of overproduction, you have to produce what the customer needs, neither more nor less. That is to say that it is necessary to calculate the exact needs to satisfy the needs of the customers, and not to lose at the level of the means of the company.
Transportation	The operators can only move to look for an object that is related to their workstation, the locations of the objects must be stable so as not to be forced to look for an object and waste more time. Meetings can take place in the company and not take a long duration.
Waiting Muda	Waiting is wasted money, it may be due to poor planning, while managers need to plan well. It is also necessary to balance the workstations well to avoid waiting for workstations, and we must also set up preventive maintenance to avoid waiting.
Extra- processing	To get rid of extra processing, it is enough to set up softwarethat is easy to use and to respect the exact operating mode and no more, not to have an over-quality or a lot of quality control which is not useful.
Motion	In order not to have a waiting time at the level of a few positions, managers must transmit clear and exact information with the implementation of a few instructions and worksheets. Preventive maintenance is also necessary in this case so as not to have a waiting time in the event of a breakdown.
Non-utilized potential	All you have to do is set up an alternative training center to train operators and make them versatile. To collaborate with training canters to train managers as well. Motivate employees by giving them bonuses, we can also have rigid and authoritarian management in the company. And the last and beststep we can take to get rid of the underutilization of skills is the involvement level.

The proposed solutions aim to eradicate the waste, as per the 8 MUDA wastes identified in the Marisa workshop.

4.6.4 VSM-Future State

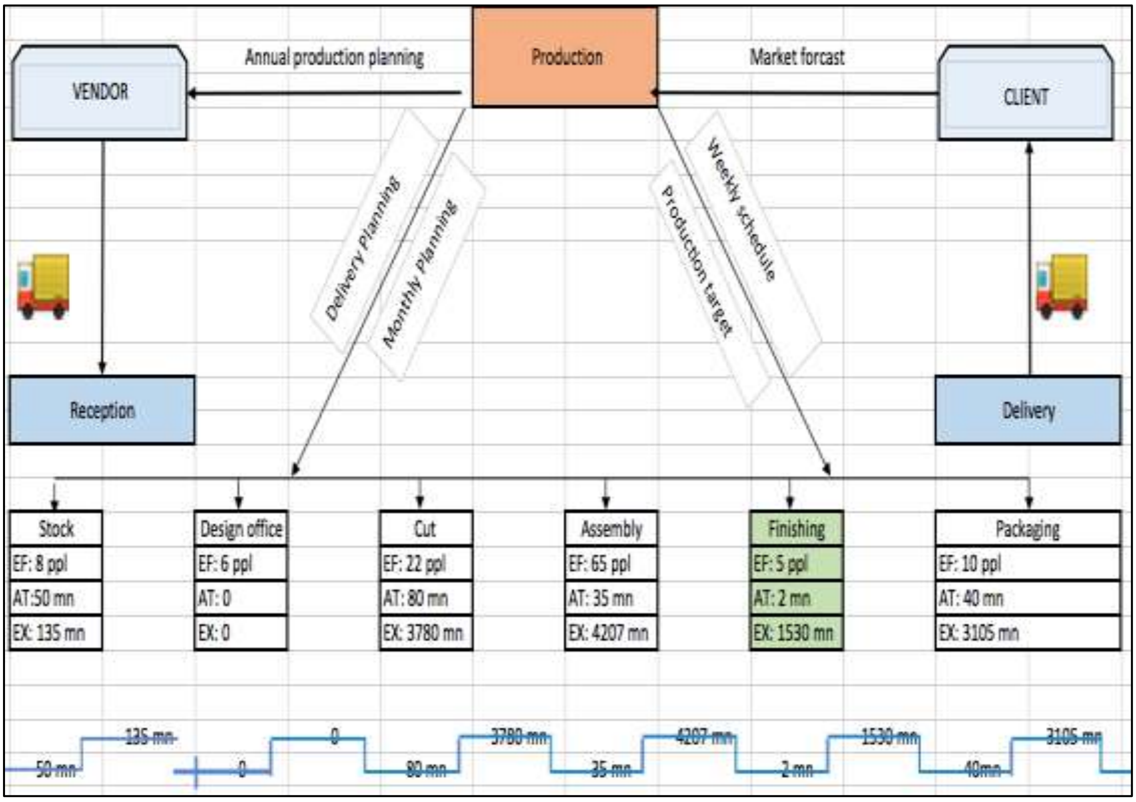


Figure 4.26: VSM Future State.

Table 4.18: VSM Calculation.

Total transit time: 12,965 min	216 Hour
Waiting time: 207 min	3,45 Hour
Execution time: 12,757 min	212,6 Hour
%Waiting: 1,5%	
% Execution: 98.5%	

It is evident that the process has been enhanced in the new VSM, since we are currently operating in the manufacturing department. The waiting and execution time for assembly, finishing, and packing is decreased.

4.7 EARNINGS

4.7.1 New Production Monitoring

			May-21																							
			L	M	M	J	V	S	D	L	M	M	J	V	S	D	D	L	M	M	J	V	S			
OF	Quantity	STEPS	22	23	24	25	26	27	28	29	30	31	1	2	3	4	18	19	20	21	22	23	24			
TIN11C	3462	CUT			577	500	600	240		500	600	445												3462	0	
		IRONING			577	500	600	235		300	300	450												3462	0	
		PREPARATION					412	320		540	630	500	530	530										3462	0	EXPORT
		ASSEMBLY					312	310		530	600	540	585	585										3462	0	
		FINISHING					312	310		530	600	540	585	585										3462	0	
		EMBALLAGE												300	400									3462	0	

Figure 4.27: New Production Monitoring.

In the first Production Monitoring in version 4.3.1, there were issues in some departments that resulted in production delays. The delays were caused by waiting, which led to the production not being completed within the designated timeframe. The customer in question was ZARA, a corporation notorious for imposing fines in the event of delays. Consequently, MARISA had to pay a substantial penalty, resulting in significant financial consequences.

Following the introduction of the new Lean methodology, the production process operated smoothly without any instances of failure or delays in various departments. The continuous flow of production was successful, and based on the information provided in the table, the decision was made to prioritize exports above production, which was the previous focus. Lean Manufacturing approach successfully resolved the issue of timely production by manufacturing 3,462 pieces in this article.

4.7.2 New Lead Time

Table 4.19: New Lead Time.

Services													
Steps	STOCK		CUTTING		ASSEMBLY		FINISHING		CONDITION-NING		Lead Time	Min Cost DH	Waste
Phase	Wait	prod	wait	prod	wait	prod	Wait	Prod	Wait	prod		0.7	
TIN11C	50	135	80	3780	120	4320	20	2160	325	3627	12437	575	402.5
	0%	1%	1%	30%	1%	35%	0%	17%	3%	29%	95.4%		
	185				3860				4440			2180	

The prior Lead Time mentioned in the findings has been identified as having a waste of 4781 minutes in the article referenced as "4567". This is the determined Lead Time following the implementation establishment and the identification of the 8 MUDA waste. The value was decreased to 402.5. Thus, this particular aspect of the output was enhanced by the establishment.

4.7.3 Delivery Time- 4M Solutions

During the initial phase of the delivery period, we conducted calculations for several items and encountered significant delays. Having previously outlined the causes of the delay based on the 4M framework, we will now proceed to provide remedies for each of these 4M factors.

Table 4.20: 4m Solutions for Delivery Time.

MACHINERY	
MAINTENANCE	0 DH
PLANNING MAINTENANCE	0 DH
MACHINERY MONITORING	0 DH
BOUTONHOLE PURCHASE	15 000 DH
SERGER PURCHASE	35 000 DH
TRAINING	5 000 DH
INVESTMENT	**55.000**

MATERIAL	
PURCHASE OF FABRIC ROLLING MACHINE	8 000 DH
PURCHASE 100 BINS	2 000 DH
CONTROL OF ACCESSORIES	0 DH
INVESTMENT	**10.000 DH**

MANPOWER	
RECRUITMENT	9 000 DH
TRAINING	0 DH
INVESTMENT	**9 000 DH**

METHOD	
INTRODUCTION OF FILES	**0 DH**
INVESTMENT	**0 DH**

The issue of unsatisfactory deadlines may be resolved by the proposed solutions. In fact, the deadlines have already been decreased, as evidenced by the Lead time and the Production Monitoring. The effectiveness of the new implementation with continuous flow has been diminished. Specifically, the effectiveness of the assembly has been lowered by 15 operators, which is a significant decrease that benefits the organization.

Marisa had financial gains as the primary aspects that contributed to her success, namely cost reduction, time efficiency, and quality, have improved. Enhancing the quality of both the service and product will attract new clients and retain existing ones, resulting in reduced expenses and time, ultimately leading to more income for the organization. Moreover, the presence of additional money would drive the firm to prioritize its employees by providing enhanced training opportunities, offering promotions, and ensuring proper maintenance and investment in equipment. All these elements are advantageous for the industry.

5. DISCUSSION

Lean manufacturing philosophy is considered the system to implement in any industry, for efficient organization and optimal management. By adopting manufacturing principles companies can minimize waste reduce costs enhance quality, prevent delays and boost employee productivity.

This project consists of two components: process improvement and the integration of manufacturing practices such as U-shape layouts or continuous flows. With a focus on one piece flow production items move continuously through the manufacturing process without interruption until completion. Alongside these changes operational procedures are revamped with updated methods and steps tailored for each section. As part of the U-shape approach all sections must be prepped before being passed along to the assembly line for production. This Lean implementation has resulted in time savings, cost reductions and improved product quality, for MARISA.

Talking about manufacturing inevitably involves discussing waste, which is the focus of the second part of my project; waste reduction. Removing waste from an industry is a task. The Japanese introduced the MUDA system as part of Lean manufacturing to address this issue. The MUDA system encompasses types of waste commonly found in workshops.

Navigating through the project was quite a journey, for an intern aiming to drive change. It took effort to present the project to my company advisor and gain their approval. Subsequently, there was some resistance from employees regarding the proposed changes. We managed to address their concerns and highlight the benefits of this new implementation over the previous one. Overall, I encountered obstacles except for restrictions on accessing company information and taking photographs due to privacy concerns raised by Marisa.

6. CONCLUSION

Manufacturing entails producing components and final products in large quantities for commercial sale. Human and mechanical labor, chemical and biological processes, and a variety of equipment are all part of its toolbox for turning raw materials into finished goods. As is well known in the production sector, the three pillars upon which Marisa's manufacturing process rests are quality, cost, and delay. In order to improve the process and gain on the three elements mentioned, which are the foundation of any manufacturing business, I came up with the concept there. Also, I had to use Lean manufacturing toolset, which included continuous flow for process improvement and MUDA for waste elimination, to do this.

To sum up, here is the outcome I achieved:
a. It saves time. It takes time to turn on and off machinery that require exact pressures or temperatures so they can work properly.
Lower energy use. Companies may save a lot of energy and time by not turning gadgets off and on as often.
b. Simplified technique. With continuous manufacturing, processing time is reduced, and things are produced more efficiently and in less time.
c. The quality and consistency of the product are not an issue. With continuous production, you can be certain that the product specifications will remain constant after the system is set up to produce it in a certain way. This is attractive to companies who have difficulties with products arising from batch production.
d. The cost of labor is reduced. Once a system is operational, there isn't much more to perform than general machinery supervision. Because of this, companies may be able to lower their expensive staff costs and put more money into innovative technologies or higher output.
e. There can be no waiting time, which means costs, energy, and delivery time are all reduced.
f. With waste reduced and a continuous flow set up, processing times will be much shorter and more efficient, leading to a dramatic uptick in workshop output.

7. RECOMMENDATION

a. Once the continuous flow and seven MUDAs for garbage have been established. I suggest using the 5S and KAIZEN, two more Lean manufacturing technologies, to build the company's long-term viability.
b. To keep tabs on productivity, I suggest making forms for each post. It is my recommendation that the operator record data regarding production, machine failure, absence, and daily production on those forms.
c. Also, I think it would be a good idea to employ software for things like scheduling, cutting, production tracking, packaging tracking, planning, and preventative maintenance. Customer relationship management software would be a nice bonus.
d. For the production accountable to make informed operator selections, it is crucial to have access to a versatility chart that details each operator's skill set and the amount of machine knowledge they possess.
e. In addition to the adaptability, I suggest that the business institute a machinery training program for its operators, as they are required to undergo monthly training.
f. Furthermore, it is essential that they are well-versed in scientific concepts like Lean manufacturing or receive training specifically for new initiatives like the one we are launching.

As a result, there will be less pushback against change inside the organization.

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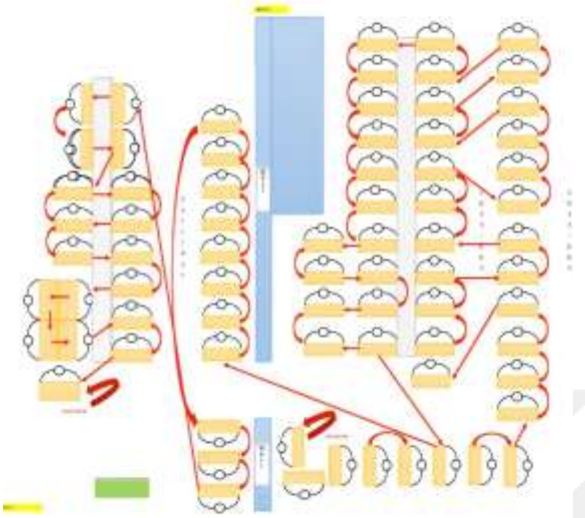
APPENDIX A

A.1 CURRENT IMPLEMENTATION

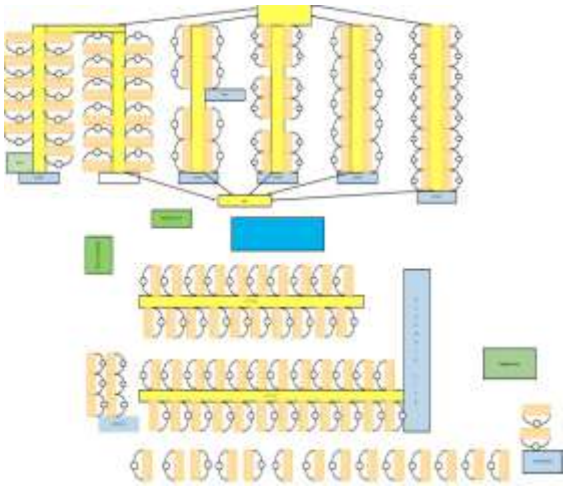


This is the current implementation of the assembly line, which we converted to a continuous flow. The red arrows represent movements between posts that are not structured and do not flow continuously; the posts and operators exchange items at random; the yellow tables represent machines with operators on them; and the blue sections represent walls.

(a)

Figure 17: Current Implementation.

A.2 SIMULATION OF THE ESTABLISHED IMPLEMENTATION WITH CONTINUOUS FLOW



The new implementation has lines, the lines in the first row are sections, the first section is the sleeves sections, the arrows in the back took us to the end, which is a bin with all of the prepared articles, then it's given to the assembly line, which flows continuously, and the last line is for packaging.

(b)

Figure 28: Simulation of the Established Implementation with Continuous Flow.