Improvements in the production and packaging of personal care products through the implementation of Lean Manufacturing

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Abstract — *The manufacturing sector for personal care and beauty products is one of the most competitive today, creating the need to innovate and improve processes to remain competitive. This project used the DMAIC methodology and investigated lean manufacturing tools to increase the productivity of a packaging line of Beauty Manufacturing Solutions Corp. The 5S system was implemented in a pilot packaging line, increasing productivity. Productivity managed to increase by 4.5% compared to the beginning of the period. It is recommended to continue creating a Lean culture in the company to implement other Lean tools that generate continuous improvement in the future.*

Key Terms — *Lean, Six Sigma, 5S, DMAIC.*

INTRODUCTION

The market for beauty and personal care products is on the rise and is highly competitive. Due to its rapid growth and demand, the cosmetic and beauty product manufacturing industries continue to develop new technologies and optimize their production processes to increase product quality, process efficiency, and competitive advantages.

Beauty Manufacturing Solutions Corp (BMSC) is a manufacturer of beauty, personal care, and baby care products for leading brands in the United States. Given the changing needs of the market and the increase in competition, it is necessary to establish effective improvement processes to meet the company's objectives and increase its profitability. To stay ahead and competitive, it is essential to establish a process improvement system, advanced waste management, and elimination system.

This project investigated one of the problems that BMSC faces and affects its productivity. It was identified that in the manufacturing and packaging process, waste of waiting time and repetitive movements is generated without adding value. When there is a delay in the manufacturing and packaging process, unnecessary costs are incurred. For this reason, the need arises to implement continuous improvement processes that allow the optimization of production times and the company's available resources.

The objectives of this project were to:

- Reduce production costs.
- Increase productivity.

LITERATURE REVIEW

Given the globalization of the economy, competitiveness has increased in manufacturing industries and profit margins have been reduced. This has caused many industries to implement Lean manufacturing principles and tools to remain competitive in the market. The foundation of Lean Manufacturing was originated by Toyota with the “Toyota Production System” (TPS) which focused on reducing all kinds of waste and improving quality performance in the production process [1]. Lean manufacturing is a philosophy focused on reducing waste in order to reduce costs, improve quality, improve processes, and maintain profit margins. Lean is a philosophy that can be implemented for all types of an organization regardless of scale.

In all processes and areas of a company, there is waste that generates losses. For this reason, continuous improvement should be promoted with a focus on the identification and elimination of waste. Waste is defined as tasks, activities, or processes that do not add value in the production [2]. To reduce or eliminate waste, it must first be identified.

There are seven different types of waste [3]:

- Transportation: moving the product more than is necessary, generating more time without adding value.

- Inventory: when raw materials, work in progress (WIP), and finished goods are not processed effectively.
- Movement: excess movement or any movement that does not add value to the product
- Wait: any time when value cannot be added due to delay due to lack of information, materials, people, and maintenance.
- Over-processing: when more work or operations are done on a product; or that do not add value for the customer.
- Overproduction: manufacturing or making more than is necessary, producing more goods than existing customer orders require.
- Defects: tasks or processes that were not performed or were performed outside of standards and that require rework or inspection.

After identifying the type of waste, the appropriate Lean tool must be chosen to eliminate it. Lean manufacturing has several tools focused on identifying and eliminating waste with different impacts. Among the tools that stand out, the most are 5S, Value Stream Mapping (VSM), Kaizen (Continuous improvement), Kanban (Pull System), Single-Minute-Exchange of Dies (SMED), and Total Productive Maintenance (TPM) [4]. It is substantial to properly classify waste and use the right tools for different types of waste to ensure effective and successful implementation.

Through the literature and studies carried out, the successful application of Lean Manufacturing principles has been proven in various sectors such as pharmaceuticals, electronics, services, and health, among others. For the successful implementation of Lean Manufacturing, the following principles must be followed: identifying value, mapping the value stream, creating flow, establishing pull, and seeking perfection [5]. The application of the Lean methodology can sometimes be combined with the Six Sigma methodology to obtain greater benefits. The Six Sigma methodology is focused on improving customer satisfaction and increasing quality and profitability. These two methodologies together can be more effective than individually, reinforcing each other. DMAIC is a problem-solving tool that belongs to the Six Sigma methodology, which has five phases: define, measure, analyze, improve, and control. The implementation of Lean tools via DMAIC has achieved good results. It has led to a more accurate analysis of the problems, which leads to a better selection of the Lean tools to use [5].

METHODOLOGY

The project used the Lean Manufacturing methods to identify activities and waste in production and packaging that do not generate value. The DMAIC methodology was used to explore the opportunities for improvement. A pilot packaging line was selected, which was evaluated, analyzed, and then an improvement was implemented using these methodologies. The phases of DMAIC are defined as follows:

- Define – key aspects of the organization are identified, define clients, their requirements, and the processes that can affect clients
- Measure – the performance of the studied process is measured
- Analyze – the analysis of the collected data is carried out to determine what are the causes of the deficiencies and the opportunities for improvement
- Improve – possible solutions to the detected problem will be generated, and the most convenient ones will be implemented
- Control – a control plan is established to ensure that improvement is continued

Definition of the problem and current situation

The research was developed in the production area focused on the packaging line. The company determines the efficiency of production lines based on measuring overall equipment effectiveness (OEE). This indicator considers three factors: availability, performance, and quality, each with a different impact. For 2021, the accumulated annual OEE in the production line was 79.1%, while for 2020, it was 79.3%. The objective for this indicator is that the production lines are above 85%, which confirms the need to implement improvements that can increase productivity. The packaging process presents an opportunity for improvement due to its waste, decreased productivity, and generation of unnecessary costs. The productivity of the packaging line was calculated based on the values of units produced during the operating time in relation to the theoretical number of units that should have been produced in that time.

The primary process that is carried out within the packaging line corresponds to the packaging of the different personal care products that are produced in the manufacturing area; in order to understand how the flow of material is throughout the process, it is necessary to determine which are the main inputs and outputs of materials, suppliers and internal customers and how they interact in the process. The SIPOC Diagram (Suppliers, Inputs, Process, Outputs, and Customers) is a helpful tool to visualize these interactions. Figure 1 shows the SIPOC diagram for the packaging process.

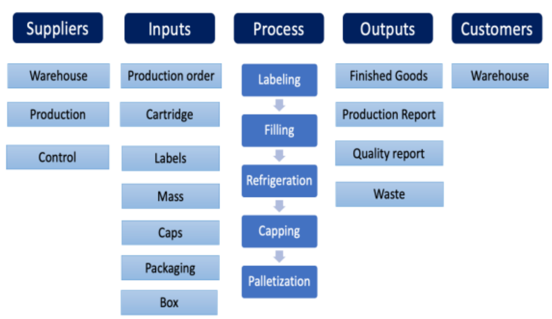

Figure 1
SIPOC diagram of the company packaging process

Analysis

The packaging line selected for this project was the L4 line, which produces and packages deodorant. In the diagnosis phase of the packaging line, the opportunities were identified and characterized, which are summarized in Table 1. These identified opportunities were classified by the waste generated and then analyzed to propose the appropriate Lean tools. Characterized opportunities were analyzed using the 5 Why's technique. The main problems of the packaging line that were characterized are due to the loss of time, and this was caused by the lack of cleanliness in the line, lack of standardized work procedures, and poorly planned maintenance stops.

Table 1
Characterization of opportunities and classification of waste

Description	Waste
The cartridges present dust on their upper part when leaving the labeling machine	Defect
There are repeated stoppages between the labeler and the tumbling	Waiting
The wrapping equipment stops and gives the fault: servo motor overheating	Waiting
A bottleneck is generated at the switch output by the point of convergence of 2 parallel lines into 1	Waiting
The insert distributor delivers the Dead Lock fault and Positioner compressed air fault	Waiting
There are products that come out of the capper without inserts, which corresponds to a quality problem.	Defect
The label is outside the tolerable values of position in the vertical direction	Defect
Wait between steps by requiring pausing the filler for change in the capper	Waiting
Lack of organization and order in the cleaning elements, tools, and raw materials of the packaging line	Waiting
The operator performs too many actions during normal operation, leaving critical activities unattended	Movement
There are times when no line operator performs a task	Waiting

To identify the causes that affect productivity, the Fishbone Diagram presented in Figure 2 was made using the data collected, observations, and opinions of the production supervisors, mechanics, and operators. The Fishbone Diagram is a tool that allows knowing the different causes that lead to the origin of the main problem and helps to determine the areas of opportunity.

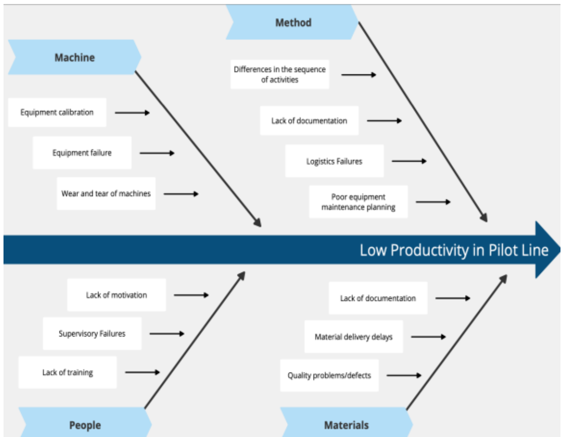

Figure 2
Fishbone Diagram for packaging line

Lean tools to eliminate waste and increase productivity

The Lean Manufacturing tools identified to address the identified opportunities, increase productivity, and improve operational efficiency selected are 5S, standard work, SMED, and TPM. The established order for implementing these tools must be 5S, standardized work, SMED, and TPM.

Implementation in a pilot packaging line

5S was implemented in a pilot line, and the other lean manufacturing tools are proposed for future implementation. 5S is focused on the systematic application of the principles of order and cleanliness, whose objective is to reduce waste and increase productivity by eliminating movement waste and improving the flow of people and materials [6]. This lean tool consists of five pillars: Sort (Seiri), Set in Order (Seiton), Shine (Seiso), Standardize (Seiketsu), and Sustain (Shitsuke) which are applied in phases in that order [6]. Before implementing 5S in the pilot line L4, it was necessary to train and involve all the participants in the improvement process. Therefore, a workshop was held to explain the improvement project, introduce the changes that were going to be made, and deliver instructional guides for the 5S system implementation plan. Table 2 presents a summary of the activities and formats implemented.

Table 2
5S phases and methods implemented in the L4 line

5S Phases	Methods
1S-Sort	Each of the objects (components and tools) of the line was identified and classified. Red tags were used to document unnecessary items, and an evaluation was made as to whether they would be removed or retained.
2S – Set in order	The area of use of each object, frequency, and a nearby location were established A checklist was created for the verification of the objects that belong to the area
3S – Shine	Sources of dirt on the line were identified, and cleaning was instituted before starting the packaging process. A cleaning format was designed especially for the line. The objects and machines to be cleaned were assigned with their respective operator and frequency.
4S – Standardize	Instructions and procedures were made for each activity to ensure that the operators carried out the activities in the same way. Visual management was applied to standardize the appearance of the line
5S – Sustain	A control system was established for the fulfillment of daily activities and a periodic evaluation was realize Operators who were able to meet standards efficiently were recognized

Results

An audit was carried out to have control of the implementation of the 5S system and ensure its compliance efficiently. The productivity results obtained before and after the implementation of the pilot plan in the line were compared. Productivity managed to increase by 4.5% compared to the beginning of the period. This increase in productivity also means a reduction in costs and waste.

Conclusion

The project met its objectives by implementing the 5S system, increasing productivity, and reducing costs generated by waiting waste. With the improvement implemented, it is expected that productivity will increase by up to 20% in the long term. It is recommended that a lean culture continue to be created in order to implement the identified lean tools in the future to improve waste disposal, increase productivity and achieve significant improvements in the operating efficiency of the selected line.

REFERENCES

[1] L. Wilson, "Lean Manufacturing and the Toyota Production System," in *How to implement Lean Manufacturing*, New York, NY, NY: McGraw-Hill Education, 2015, pp. 133–159.

[2] Sucipto, E. Susilowati, and U. Effendi, "Reducing waste on wheat flour packaging: An Analysis of Lean Six Sigma," *IOP Conference Series: Earth and Environmental Science*, vol. 475, no. 1, p. 012002, 2020.

[3] F. Lamb, "Industrial and Factory Business Systems," in Industrial Automation: Hands On, New York: McGraw-Hill, 2013, pp. 272–274.

[4] I. Leksic, N. Stefanic, and I. Veza, "The impact of using different lean manufacturing tools on waste reduction," *Advances in Production Engineering & Management*, vol. 15, no. 1, pp. 81–92, 2020.

[5] H. Rifqi, A. Zamma, S. Ben Souda, and M. Hansali, "Lean manufacturing implementation through DMAIC approach: A case study in the automotive

[6] "Lean Thinking and Methods - 5S," *EPA*. [Online]. Available: https://www.epa.gov/sustainability/lean-thinking-and-methods-5s. [Accessed: 10-Apr-2022].