Production Model Based on SMED and Work Standardization to Increase Efficiency in the Cutting Area of a Textile Company

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Abstract

The textile sector in Peru has been growing over the years. This growth has generated an increase in the production of textile products, standing out among international markets for the quality of products and fibers used in the country. Indeed, textile companies mean a lot for the country's economy, so it is important that these companies produce textile products in the most efficient way and can be competitive in the international market. Therefore, this research seeks to improve the efficiency in the cutting area of a Peruvian textile company. As main problems of the low efficiency of the company in the cutting area, problems such as poor preparation of activities and an excess of time in the replenishment of materials were found. In order to solve this problem and reach a level of 90% efficiency in the area, the use of Lean tools such as SMED and Work Standardization was proposed. These allow a better time management and level of preparation for the operations in the area. Also, Arena software is used to simulate the current model and the improvement proposal. The situations are compared, and the margin of improvement is identified after the application of the tools.

Keywords:
Lean Manufacturing, SMED, Work Standardization, Textile company, cutting area

1. Introduction

In Peru, garment manufacturing has been one of the activities with the highest economic growth, representing 1.9 percent of the country's GDP. The quality of textile products manufactured throughout the country reflects the good practices employed by Peruvian companies. Even in challenging scenarios, many companies have been able to adapt to change; for instance, during the COVID-19 pandemic, they shifted production to create essential safety items such as medical uniforms, masks, and other garments. According to the Minister of Foreign Trade and Tourism, the textile and garment sector in Peru is a major source of formal employment, generating over 250,000 jobs (Velarde-Álvarez, 2022). The tradition of manufacturing threads, fabrics, and various garments is also highlighted. With access to the world's finest cotton, such as Pima cotton, many international brands tend to manufacture their garments in Peru.

Given the context of the industry, there are issues related to informality and fragmentation, particularly among small and medium-sized enterprises (SMEs). These companies lack innovation and face financing problems, leading to declines in the GDP during 2021. On the other hand, there are companies with a structured approach and a competitive advantage, and they serve as the main exporters of garments, generating millions of dollars in revenue over recent years.

This research focuses on one of the largest textile companies in the country, specifically addressing issues in the cutting area. Deficiencies in the cutting operation times have been identified, negatively impacting garment delivery times. The root causes of this problem include operator training for the cutting operation, a lack of fabric supply, variations in garment design patterns, inventory management, and limitations or failures in the cutting machine, hindering the capacity to produce a larger quantity of polo shirts. The plant's layout divides each operation into separate cells, leading to increased cutting times. The transition time from the cutting area to the sewing area takes 10-12 days, which significantly exceeds the standard time (1-2 days). To address this issue, indicators such as cutting time per fabric, cost per minute, and excess waste generated during the cutting operation are being considered.

Given the current issues in the company, a solution is sought to meet garment delivery deadlines. The chosen case study involves a textile company that manufactures polo shirts for international brands, and the objective is to reduce operation times in the cutting area. The proposal is to design a new layout using Lean methodology, consolidating operations into a single module to carry out activities more efficiently, thereby reducing the production time by 5 days. Standard values for comparison with the study results have been collected through observation.

Although relevant information is found in the reviewed scientific articles, it is limited in content. Hence, the application of Lean tools to address textile industry challenges becomes a necessity to advance research in companies within this sector, considering their significance to Peru's economy.
This academic article is organized into the following sections: State of the Art, presenting background information to contextualize the problem; Contribution, which highlights the theoretical foundation of the model and describes it along with its respective indicators; Validation, where results before the investigation, pilot implementations, simulations, and post-intervention results are presented; Discussion; Conclusions; and Recommendations for future research.

1.1 Objectives

The present study aims to demonstrate how the application of SMED (Single-Minute Exchange of Die), and Work Standardization tools can increase efficiency in the cutting area of a textile company. The activities that are performed while the machines are running will be identified, as well as those that are not carried out while the machines are running. Subsequently, adjustments will be made regarding preparation activities, and once the times are optimized, standardization will be employed to verify the efficiency of each process within the cutting area.

2. Literature Review

2.1. Lean manufacturing

Lean manufacturing, or the lean philosophy, is an originative concept from Japan that prioritizes waste reduction and activities with little value, such as those consuming resources in companies without adding value to customer needs.
According to the study by M. Mohan et al. 2020, lean manufacturing is a philosophy that Toyota developed in the 1950s to compete with American automotive giants. Lean manufacturing is an effective and recommended approach in most production processes and service industries to minimize waste and address activities with little value. The main objective behind this methodology is to reform existing manufacturing methods and processes to reduce waste, cut costs, enhance process quality, increase profits, and maximize customer value (A. Palanje and P. Dhatrak, 2021). According to Y. Andrade et al., 2020, the implementation of Lean philosophy is crucial for all types of companies as it focuses on reducing or eliminating factors that do not add value to processes, aiming to achieve an efficient production chain. The improvement outcome provided by this approach can be adapted to both manufacturing and service companies, tailored to their specific needs. Lean practices can be implemented across a broad range of service industries, such as healthcare, education, logistics, and administration, to reduce waste, improve productivity, and enhance customer satisfaction.

2.2. Waste Reduction

Waste reduction is one of the core principles advocated in lean manufacturing. It involves identifying and minimizing or eliminating activities that do not add value to the product or service, with the aim of becoming more efficient, achieving higher product or service quality, and optimizing production processes.

According to Montabon et al. 2019, it is crucial to identify and eliminate the eight types of waste recognized in lean manufacturing, such as overproduction, unnecessary transportation, and excess processing. By reducing waste, greater efficiency, cost reduction, improved product quality, and shorter product delivery times can be achieved.

2.3. Textile Industry

A textile company is engaged in the manufacturing and marketing of textile products, such as garments and fabrics. These companies may specialize in different segments of the industry, such as fabric and textile production or the creation of textile accessories and garments. Garment production companies often handle everything from garment manufacturing to distribution.

The areas within this industry are typically multidisciplinary, involving designers, technicians, engineers, workers, quality control, logistics, technology, and sales.
According to Pazdzior et al. 2018, the textile industry represents one of the longest and most complex industrial chains in the manufacturing sector. It begins with the collection of natural resources, such as cotton, wool, or the production of synthetic fibers from derivatives. These raw materials are then processed to transform them into yarn, and the yarn goes through a quality process to turn it into fabric. The process concludes with the commercialization and distribution of the fabric transformed into the final product

2.4. SMED

In relation to the SMED tool, it focuses on reducing machine setup times by converting internal activities to external ones and standardizing the process. The planning cycle begins by observing all activities related to assembly and record-keeping. For activity conversion, the goal is to minimize machine downtime, emphasizing preventive measures. Subsequently, activities that do not allow for time reduction are identified, prompting the implementation of support activities to restructure the task. Finally, the last phase involves recording all successes and incidents.
As a result of this study, machine downtime is improved by 23%, as well as internal setup times for machines such as cutting or embroidery machines (Vargas-Tapia et al. 2022).

3. Methods

Diagnosis of the Current Situation

Firstly, an analysis and diagnosis of the current situation are conducted. The efficiency indicator from the company's last year is compared to the standard in the textile sector.
Additionally, the economic impact of the cutting area per minute of operation is observed. Based on these precedents, the causes that lead to the low efficiency in the cutting area are examined. Once the causes are identified, a problem tree is used to visualize the main issue, its root causes, and the underlying reasons. After assessing the problem tree, the appropriate tools to address the problem can be deduced.

Solution Planning

During this stage, the improvement plan is developed to enhance the low efficiency in the cutting area. The application of the SMED tool to improve cutting area efficiency involves four distinct stages. Firstly, the analysis of activities in the closing process, which entails tool change where the cutting process is halted, and tools are dismantled. Secondly, the separation of internal and external activities, wherein activities performed in the cutting area are classified, separating internal from external tasks. Thirdly, converting internal activities into external ones. In this part of the model, the aim is to transform internal activities into external ones to reduce downtime throughout the workstation. Operators will assist in external activities that require preparation time, to expedite and reduce operation times when activities are stopped. Finally, the optimization of operation process times. Once the previous stages are established, times for tasks that have potentially reduced their operation time are fixed, compared to the current situation value, and the achievement of the previously set objective is concluded.

Implementation and Control

Finally, with the work standardization tool, the improvement model presents an optimal record established in the previous phase, enabling the measurement of achieved results. After conducting a thorough analysis of variability in the workers' work times, the need for standardizing the work method was identified. To accomplish this, it was necessary to diagram the personnel's work system in manual processes, using documentation and defining work protocols for each activity in the process. As a result, with the implementation of preparation activities and reduction of downtime, it will be possible to efficiently identify any incidents that may be adversely affecting the operations during their execution. For a visual understanding of the proposed model, refer to Figure 1 where the approach and steps guiding the implementation of lean tools are illustrated.

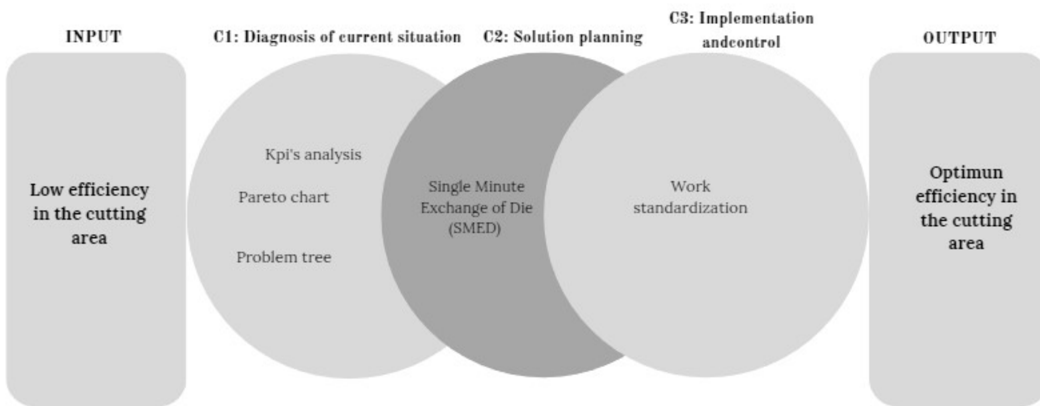

Figure 1. Proposed Model

4. Data Collection

To obtain the company's data and conduct an analysis, it was necessary to visit the study area, in this case, the cutting area, and proceed to measure the operation times. This approach provided values that will be used to simulate the model. Once the collected data is available, the application of tools such as SMED and work standardization proves feasible for incorporation into the improvement proposal. In Figure 2, a comprehensive graphical depiction of the study process is presented, delineating its pivotal stages.

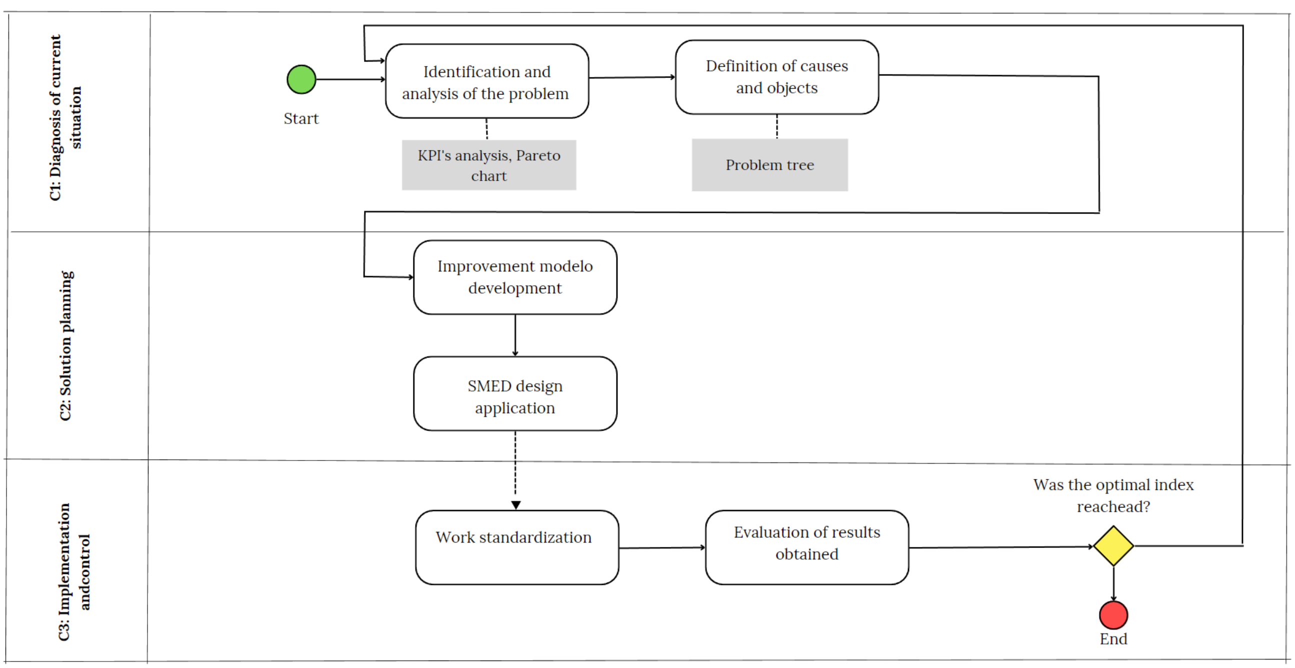

Figure 2. Proposed Flowchart

4.1. Implementation of SMED and Work Standardization

Implementation of SMED:
To achieve a significant improvement in the cutting area's efficiency, we have opted for the application of the SMED (Single-Minute Exchange of Die) methodology. The implementation of SMED focuses on reducing tool change and machine setup times, thereby minimizing downtime and enhancing overall process productivity. Our multidisciplinary team conducted a comprehensive analysis of existing changeover and setup times, identifying opportunities to optimize these critical activities. Through the conversion of internal to external activities, standardization of procedures, and collaborative efforts with our operators, we aim to streamline production changes and ensure smoother transitions between different cutting jobs. The implementation of SMED represents a crucial strategy in achieving our goal of reducing changeover times and increasing overall cutting area efficiency.
Work Standardization in the Cutting Area:

As part of our approach to improve efficiency in the cutting area, we have established a rigorous process of work standardization. We recognize the significance of having uniform and well-defined procedures for each activity in the cutting process, eliminating unnecessary variations and enhancing production consistency. Our team has closely collaborated with the operators to identify best practices in each task and meticulously document key steps for machine setup, cutting, and other related activities. Additionally, we have implemented clear work protocols and a visual reference guide to ensure that all employees adhere to the same standards for each operation. Standardization not only enhances the quality and precision of cutting but also reduces training times for new operators, ensuring a more efficient and consistent production process in the cutting area. In Figure 3, a comprehensive breakdown of the stages involved in the implementation of the 'work standardization' tool is provided.

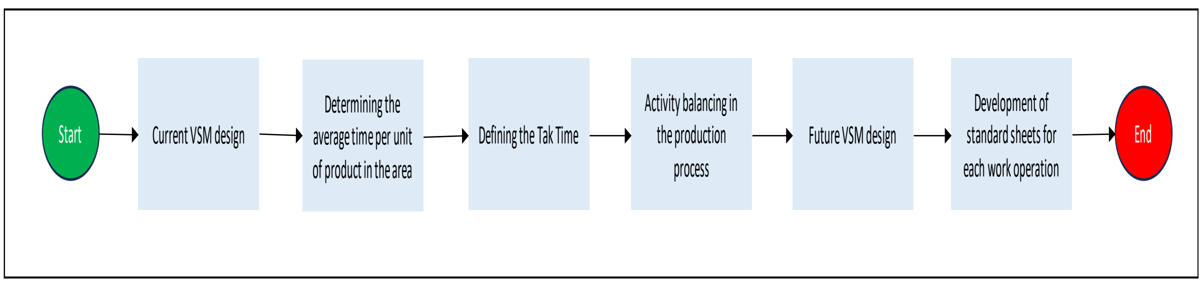

Figure 3. Standardized Work

5. Results and Discussion
Firstly, we are using a model to simulate an order for a company seeking the production of 565 round-neck polo shirts. In the current situation, the order is processed in 238.11 minutes. By applying the SMED tool and eliminating the roll matching activity, the operation time is reduced to 202.72 minutes. This result demonstrates a positive impact on operational efficiency within the cutting area.

The model successfully represents the optimization of preparation times, ensuring that the necessary tools for fulfilling an order are organized to have immediate operational availability for each shift within the plant. Moreover, by identifying issues that cause delays in activities, work standardization

is employed to ensure efficient operations throughout the cutting area, reducing idle time in work cells and transportation times for each garment.
Activities like spreading and bagging are adjusted to achieve the desired efficiency for the company. In the case of spreading, the task time is reduced by 2.77 minutes per garment, and for the bagging activity, pre-activity preparation allows achieving a time of 10.04 minutes.
Finally, the results are compared with the research indicators, and it is observed that an improvement is achieved in the order's Lead Time, reducing the number of reprocessed garments, and achieving a lower value of out-of-spec items. Table 1 displays the simulation results.

Problem	Actual	Object	Improved	Cause	Indicator	Actual	Object	Improved
Low efficiency in production processes in the cutting area	70%	95%	90.02%	Long transport times between activities	Process Lead Time	**70%**	**95%**	**90%**
				Poor coordination between storage and court	Rework index	**28.65%**	**15%**	**22%**
				Lack of standardization in plugins bull	% of out-of-measure items	**12%**	**10%**	**11%**

Table 1. Semaphore Indicators

6. conclusión
The problem of low efficiency in the cutting area of a textile company has allowed us to thoroughly examine the root causes that generate this issue. The identification of solution tools, such as the implementation of SMED (Single-Minute Exchange of Die) and the use of Work Standardization, has successfully achieved the research objective.
Data collection to simulate the cutting area problem is carried out for the purpose of validating the model and the implementation of the tools. Thus, the model demonstrates feasibility and resolves the existing issues within the cutting area.
Working with different clients and varying order volumes, the company enhances garment production by considering standardized setup times, downtime, and operations. This approach enables the identification of periods of low performance.

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Joseph Richard Huerta-Palacios graduated from Universidad de Lima, where he studied Industrial Engineering from 2017 to 2023. He currently works at Textile Source Company in Lima as a commercial assistant. He has the knowledge about Excel, Power Bi, SAP and English language.

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Martín Collao-Díaz at ESAN University and Industrial Engineer from Universidad de Lima specialized in supply chain management and operations. A leader with more than 25 years of local and international experience in national and multinational companies in industrial, hydrocarbon, and mass consumption sectors.
Broad experience in supply chain management (purchasing, inventory, suppliers and supply sources management, logistics: transport, distribution and warehouse management), operations (planning and control of production and maintenance), and integrated system management (ISO 9001, ISO 14001, and OHSAS 18001).

Business alignment based on sales and operations planning (S&OP). Besides, continuous search for improvements in profitability based on process optimization and saving projects using tools such as Six Sigma methodology, among others, focused on being a High-performance Organization (HPO). Development of a high- performance team. Member of IEEE and CIP (College of Engineers of Peru).