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A Lean-Based Production Model for Defect Reduction in Textile SMEs: A Case Study in Emerging Markets

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Abstract

Textile industries in emerging markets often faced persistent quality problems in garment stamping processes, where defects increased costs and limited competitiveness. Previous research on Lean Manufacturing primarily examined large companies or isolated practices, leaving a gap in evidence for SMEs and for stamping operations in particular. This study addressed the urgent need to reduce defective garments and stabilize production in resource-constrained environments. A production management model was designed by integrating Standardized Work and 5S to strengthen parameter control, workplace organization, and communication across shifts. The model was applied to the garment stamping process of a textile SME and validated through statistical testing and financial appraisal. Results revealed a reduction in defective garments of more than 26% relative to the baseline and an internal rate of return of 9.72%, confirming both operational and economic feasibility. The study enriched academic understanding and offered practical guidance. Future research should explore sustainability and cross-sector applications.

Keywords
Lean Manufacturing, Production Management Model, Defect Reduction, Textile SMEs, Garment Stamping Process.

1. Introduction
The textile industry is significant for many developing and/or first world countries, due to the amount of income it generates in the country. International trade has been a key factor in this, because many countries, in recent decades, have opened their doors to the world. Among the largest textile marketers is China with an average share of 65%, India has 7%, South Korea 5% and Japan 4% (Barrientos et al., 2020).

Likewise, in the textile and apparel sector in Peru it plays a crucial role in the national economy, standing out for its quality and competitiveness in the international market. This sector not only generates employment for thousands of people, but also contributes significantly to the country's exports, boosting economic and social development. (García

& Mendoza, 2022). It is the third activity with the highest contribution to manufacturing GDP (6.4% share in 2019), surpassed only by the oil refining and non-metallic products industries. (Sociedad Nacional de Industrias, 2021).

In 2019, the textile and clothing sector provided 400,000 direct jobs, which meant that it accounted for 26.2% of the manufacturing workforce. (Sociedad Nacional de Industrias, 2021, p.2). The textile and clothing sector faces structural problems (ComexPeru, 2022). The textile sector in Peru faces the constant challenge of maintaining high quality standards to avoid the production of defective products. Approximately 15% of formal companies reported incidents related to defective textile products during the last fiscal year. (Ministerio de la Producción, 2023).

In this context, the competitiveness of Peruvian textile SMEs in the export market relies heavily on effective operational management, integrating production, supply chain, distribution, and human and financial resource management to adapt to dynamic international markets and mitigate inefficiencies such as defective products (Quiroz-Flores et al., 2024). Such operational integration not only addresses structural issues, as reported by Ministerio de la Producción (2023), but also enhances profitability and global positioning, aligning with the need for Lean tools to stabilize operations in resource-constrained emerging markets.

Despite the sector's constant growth, companies face production problems such as reprocessing, quality issues, defective products, among others. The technique to be used is Lean Manufacturing, also known as Lean Production, which is a comprehensive management system that seeks to generate a positive impact on the company using different tools, from diagnosis to implementation and monitoring. The lean manufacturing technique can be used in any industry and offers various benefits, such as increased operational efficiency, innovation in operations and processes, waste reduction, increased productivity, and improved quality. (Bellido et al, 2018).

For this reason, the case study was chosen so that, with the help of the proposed model, the problem could be identified and an innovative solution proposed in line with the literature reviewed, taking into account the information collected at the production plant. Based on this, different Lean Manufacturing tools were used, such as Standardized Work and 5S. The aim is to address the problem of defective products in the stamping area, seeking a 20% improvement in unproductive minutes in the area.

The central problem addressed in this study is the persistently elevated defect rate in the stamping process of Peruvian textile manufacturing, which undermines product conformity, increases rework and unproductive time, and erodes profitability. Persistent deviations from quality limits in stamping operations point to fragile setup practices, inconsistent work methods, and deficient housekeeping routines that allow variation to propagate across shifts and machines.

Despite the growing adoption of Lean techniques in textiles, the literature provides scarce empirical evidence for the combined effect of Standardized Work and 5S on defect reduction in stamping within the Peruvian context, rigorously validated through statistical testing and financial appraisal. Prior research tends to emphasize waste reduction or lead-time improvements in other process areas or industries (e.g., Barrientos et al., 2020; Bellido et al., 2018; Gebeyehu et al., 2022; Jarufe-Majluf et al., 2022), with limited AQL-oriented evidence and few studies that jointly report operational and economic results for stamping.

This article proposes and validates a production management model that integrates Standardized Work with 5S to stabilize setup parameters, formalize shift-change communication, and institutionalize workplace organization. The model is implemented under real plant conditions and evaluated with before–after statistical tests using Minitab, complemented by a financial assessment (@Risk) to confirm economic viability. This integrated and evidence-based approach constitutes the main novelty and offers a transferable blueprint for quality-driven improvement in stamping operations.

2. Literature Review

This section presents the theoretical foundations that support the proposed model. It reviews the main contributions of Lean Manufacturing and its tools, focusing on Standardized Work and 5S, as well as the role of AQL in ensuring product quality in textile processes.

2.1 Lean Manufacturing
Lean Manufacturing is a work organization system that focuses on improving the production system. (Salazar López, B., 2019). It can be used in any industry and offers various benefits, such as increased operational efficiency, innovation in operations and processes, waste reduction, increased productivity, and improved quality. (Barrientos et al., 2020). With the Lean Manufacturing approach, a process improvement strategy can be developed, i.e., reducing the consumption of resources that do not add any value to the product. (Gebeyehu, Abebe, & Gochel, 2022, p. 10).

2.2 AQL
The Acceptable Quality Limit (AQL) is a method that defines the sample size required to determine compliance with quality and customer specifications. When a specific LCA value is designated for a certain nonconformity or group of nonconformities, it indicates that, with the sampling scheme, the vast majority of the lots presented will be accepted, provided that the quality level (percentage of nonconformities or nonconformities per 100 product units) in these lots does not exceed the designated LCA value. The sampling plans provided are arranged in such a way that the probability of acceptance, according to the designated LCA, depends on the sample size for a given LCA value, generally being higher for larger samples than for smaller ones. (INACAL, 2008, p. 20).

2.3 Trabajo Estandarizado
Standardized work is the foundation upon which continuous improvement practices in Lean Manufacturing systems are built. It ensures that processes are executed as efficiently and effectively as possible, providing a standard that all employees must follow to maintain quality and improve results. (Bhisey, 2020, p. 21). Standardized work is a fundamental practice for improving efficiency and quality in industrial production. It consists of establishing clear and detailed methods and procedures for each task, ensuring that all employees perform activities consistently and efficiently. (MTPE, 2020, p. 10).

2.3 5S
There are several Lean Manufacturing tools, among which 5S stands out. Each component of this tool is described below: Sort (Remove all unnecessary items from the location), Set in Order (Everything has a place and everything is in its place), Shine (Clean and inspect the work area), Standardize (Standardize the processes used in previous cases), and Sustain (Sustain the processes developed through worker self-discipline) (Jarufe-Majluf et al., 2022, p. 30).

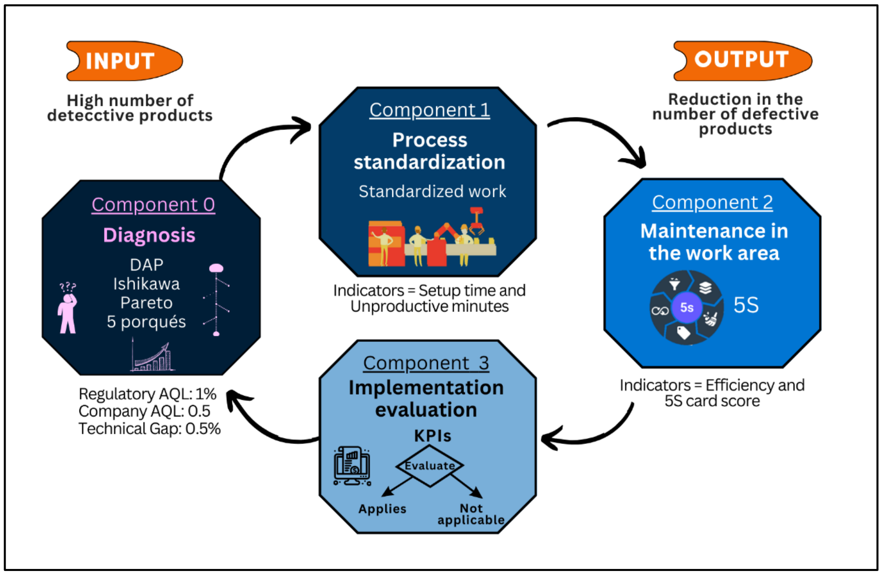
The insights obtained from the literature emphasize the relevance of Standardized Work and 5S. Based on these findings, the following section outlines the proposed model designed to address the quality issues identified in the case study.

3. Methods
Building on the insights from the literature and the identified problem in the case study, this section details the proposed production management model. The structure, components, and indicators of the model are described to provide a clear framework for implementation and evaluation.

3. 1 Basic of the Proposed Model
Previous work and studies were researched in order to develop the defective product reduction model. The objective of the proposed model was to use Lean Manufacturing tools to reduce defective garments, thereby complying with

the required AQL, which must be less than 1%. It is important to note that the model focused only on the printing production process. The process evaluated required the following inputs: neutral base, plastisol, and HD (Figure 1)

Figure 1. Proposed Model



3.2 Description of the model components

Component 0: Diagnosis

An analysis of the situation in the textile company's stamping area was carried out. The objective was to identify the main problems, causes, and reasons. This helped to develop strategies to improve the indicators related to the problem. Information was collected through technical visits to the plant, reports on unproductive minutes and efficiency, interviews with operators and managers in the area, and emails from the administrative operations area. Subsequently, the following diagnostic tools were used: Pareto chart, 5 Whys, Process Activity Diagram (PAD), and Ishikawa. This made it possible to identify the causes and reasons for the main problem.

Component 1: Process Standardization

Standardized work helps establish a solid foundation for the lean system, providing consistent procedures that enable organizations to continuously improve their processes and results. (Dennis, 2021, p. 34). In component 1, the standardized work tool was implemented. The process begins with two simultaneous activities: the first consists of conducting a survey on work methods, and the second of measuring the setup times for automatic octopus machines. Once both activities were completed, the results were analyzed in order to identify areas for improvement. The objective was to select the best way of working and to draw up a document with the necessary indicators to standardize the machinist's process. This document was drawn up and then reviewed by supervisors for approval. Once approved, plant workers were informed via a form identifying the required inputs and the specific configuration of the following data: drying temperature, number of turns, time, and number of plates. The garment was then placed on the automatic octopus and the production process continued. The area operates day and night shifts, which is why the "Shift Change" form was completed at the end of each shift. This helps with the transmission of information. This information was used to evaluate the configuration times. In addition, the information in the "Unproductive Minutes" and "Efficiency per Machine" reports was reviewed. Finally, the data was digitized and the information analyzed.

Component 2: Maintenance in the work área

5S is a system for reducing waste and optimizing productivity and quality by performing simple actions such as keeping a workstation tidy, clean, and safe, and using visual cues to achieve more consistent operational results. (Collantes et al., 2019). The process began with an assessment of workplace cleanliness, the results of which were used to classify workstations. Each area was then cleaned, with special attention paid to machines and screens that could cause errors if not clean. An assessment of order and cleanliness was then carried out to determine current conditions. It was proposed to implement training on the 5S methodology for the operational area, a cleaning kit, and lockers so that workers could leave their belongings without any problems. Once approved, these measures were implemented, and finally, supervision was carried out to ensure compliance with and control of the 5S methodology.

3.2 Model Indicators

The following indicators were used to evaluate the results of the proposed model.

Efficiency per machine in %: This is a metric used to evaluate the effectiveness with which project or process resources are used. Objective: Increase machine efficiency by 2.5%.

$$\% \, Efficiency = \frac{\frac{Total\ number\ of\ machine\ revolutions}{Number\ of\ laps\ per\ style} * Time\ per\ lap}{Total\ minutes\ worked}$$

Setup time: This is the period during which the automatic octopus operator configures the system, involving a series of technical and adjustment procedures that are essential to ensure correct operation and time optimization. Objective: Reduce setup time by 25%.

$$Setup\ time\ (in\ minutes)$$

Defective garments in %: This is a tool used to measure and evaluate the number of garments that do not meet established quality standards. Objective: Reduce the number of defective garments by 20%.

$$Defective\ garments(\%) = \frac{Number\ of\ defective\ garments}{Number\ of\ garments\ examined} \times 100\%$$

Downtime: This is the period during which machines are stopped or not producing due to various problems. Objective: Reduce the plant's downtime by 20%.

$$Unproductive\ time\ (in\ minutes)$$

4. Validation

This section explains how the proposed model was tested under real operating conditions. The validation process uses diagnostic tools, statistical analysis, and practical implementation steps to ensure the reliability and applicability of the model.

4.1 Initial Diagnosis

The following tools were used to identify the root causes: Process Activity Diagram (PAD), Ishikawa Diagram, Five Whys, and Pareto. This allowed us to identify the following reasons.

Reason 1 is the ***slanting of the print on the garments***, which accounts for 39% of all defective products. It is based on the following causes: Poor garment hanging (37%) and incorrect polo shirt positioning (2%). The Lean Manufacturing tool, Standardized Work, will be used because the company's operators have different ways of working, both in terms of machine configuration and the garment printing procedure. This results in production that is not uniform in terms of quality and procedure. In addition, during shift changes from day to night, there is no order for transmitting the relevant information in order to maintain continuity in the printing process.

Reason 2 is ***incorrect print tone***, accounting for 12% of all defective products. The following causes were identified: Incorrect toning (8%) and coverage failure (4%). The Lean Manufacturing tool, Poke Yoke, will be used, as there are three operators in the Tinting area who are responsible for preparing the mixture, but two of them do not yet have sufficient experience to do so correctly and without errors. Therefore, Poke Yoke would help to maintain constant supervision to avoid failures. In addition, it would provide feedback to the tinters, if necessary.

Reason 3 is ***stamping failure***, accounting for 9%. The following causes were identified: lack of cleanliness in the frames and meshes (5%) and paint stains (4%). The implementation of the 5S methodology is planned to improve cleanliness in the stamping machine and to maintain constant supervision, preventing stains on garments. According to Vásquez et al (2018), this methodology focuses on establishing and subsequently maintaining cleaner, more organized, and safer work areas. It consists of five steps: sort, organize, clean, standardize, and discipline. In addition, standardized work will be used because many operators do not perform preventive cleaning, which causes defective products (Figure 2).

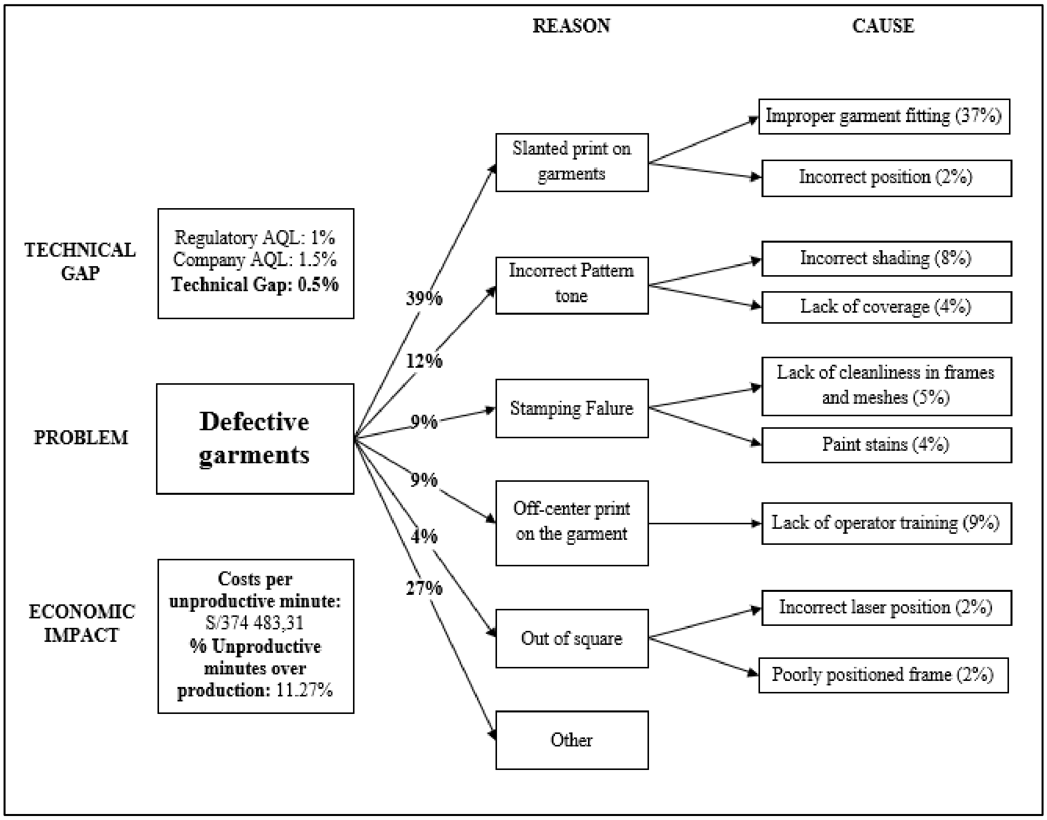


Figure 2. Problem tree

4.2 Implementation of the model in the case study

In the first component, it should be noted that its development was based on a customer request for stamping. The proposed solution is shown below. Figure 3 specifies the process for component 1, “Process standardization.” It begins with two parallel activities: the first is to conduct a survey on working methods, and the second is to measure machine times. Once both activities are complete, the results are analyzed to identify areas for improvement. The objective is to select the best way of working and, based on this, to produce a document with the necessary indicators for the machine operator, standardizing the process. The document must be reviewed by the supervisor, who will approve or reject it, and it may be reprocessed depending on the outcome. Once the document is approved, it will be communicated to the plant workers. They review the document, and based on that, the type of base required for stamping is identified, and the additive is added to the machine. Next, the machine is configured by entering the following data: temperature, number of revolutions, time, number of plates, number of garments produced and to be produced. With all this information, the garment must be placed on the automatic octopus and the production process can continue. At the time of the day-to-night shift change, a form is filled out with the machine data. Once the “Shift Change” form is approved, it is communicated to the area and filled out. With all of the above, a configuration time assessment is carried out. In parallel with the first activity, the information in the reports is reviewed, the data is digitized, and the information is analyzed. Finally, when the implementation is complete, the new reports must be reviewed and the results of the implementation analyzed.

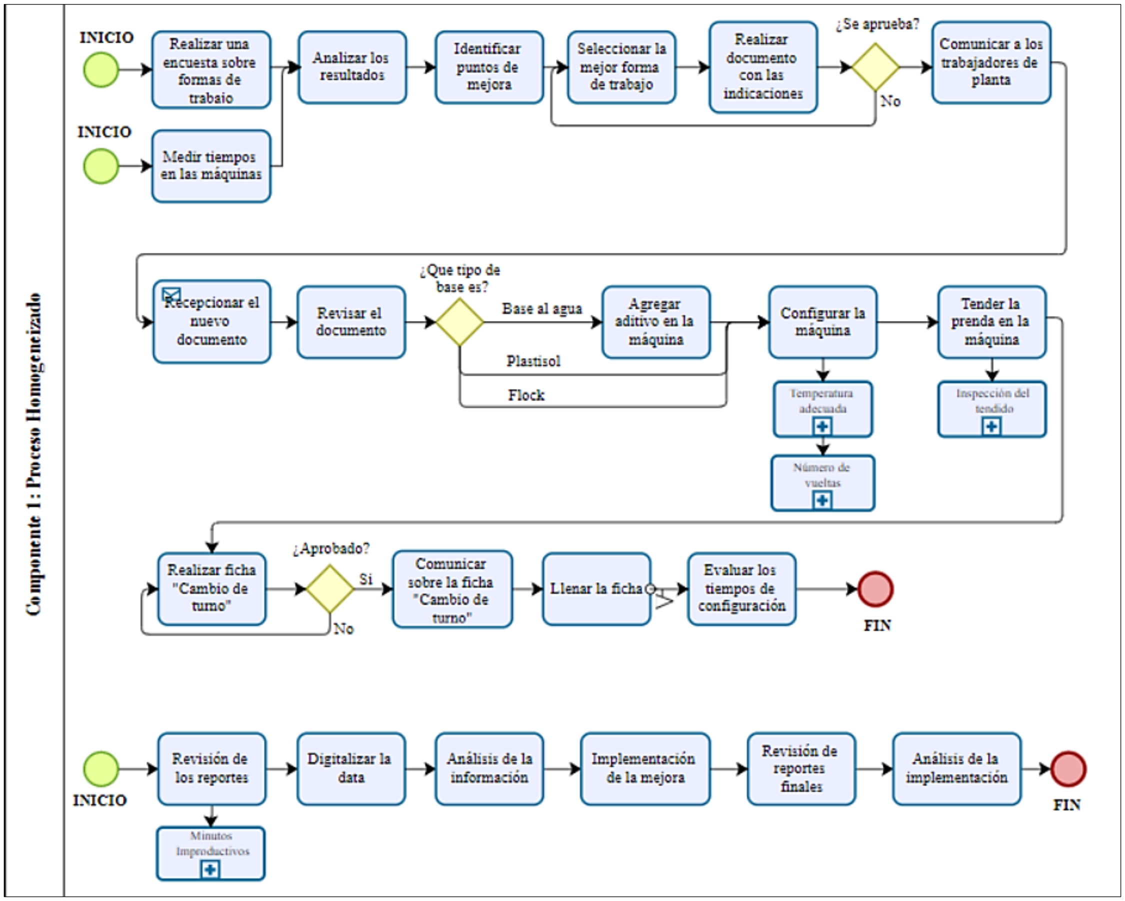


Figure 3. Component 1: Process standardization

Figure 4 details the process for component 2, “Maintenance in the work area.” It begins with an assessment of cleanliness in the workplace. The results are analyzed and, based on this, the workstations are classified. Next, the corresponding workstation for the machine is cleaned, especially the screens, which generate a certain number of errors when they are not clean. Next, an assessment of order and cleanliness is carried out, based on which the current conditions are determined. It was proposed to carry out training on 5S for the operational area. Once this was approved, it was implemented and, finally, in order to have greater control, supervision of the implementation of 5S was carried out.

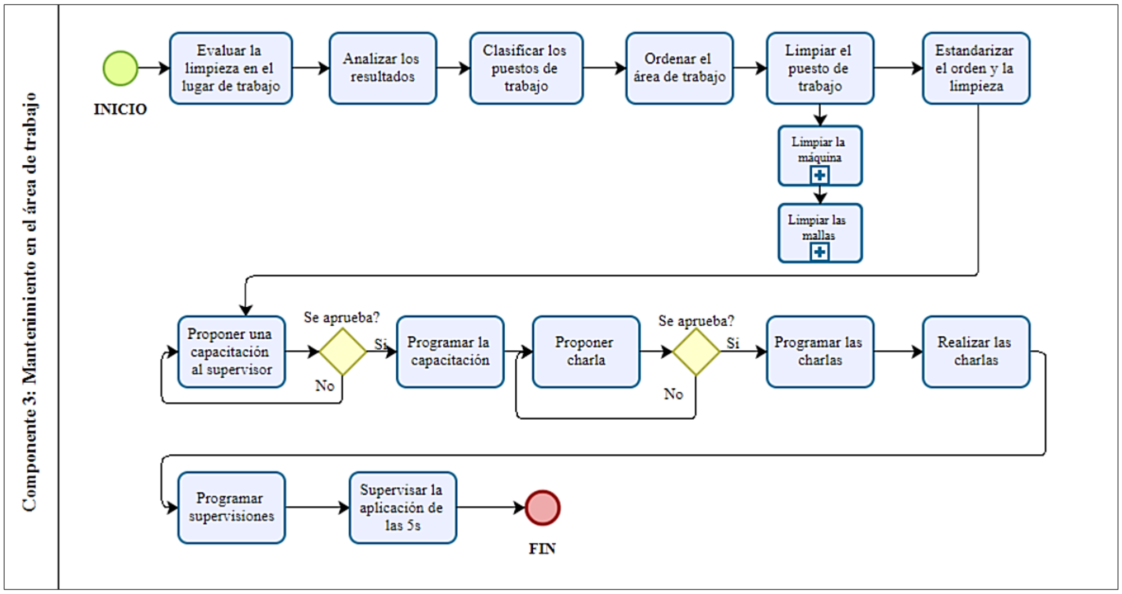


Figure 4. Component 3: Maintenance in the work area

This study focuses on the printing process within the production plant. The plant operates with 24 automatic machines, but the analysis was limited to a sample of 6 of them, specifically selected because they are used for the same type of printing, applied to a short-sleeved polo shirt with a round neck. To validate the proposed model, which was implemented in the plant, several performance indicators were used. These include efficiency per machine as a percentage, which measures the performance of each machine; setup time, which evaluates the time required to prepare the machinery between production batches; the percentage of garments with defects, which quantifies production quality; and downtime, which identifies and measures periods when production stops. In addition to validating the model, the amount of machinery required for the process was determined, calculated according to the company's internal formula.

$$Number\ of\ machines = Number\ of\ garments \times \frac{Time}{Numer\ of\ garments} \times \frac{1}{Time} \times \frac{1}{Production\ days}$$

$$Number\ of\ machines = 11\ 580\ garments\ \times 2.81 \frac{minutes}{garment} \times \frac{1\ hour}{60\ minutes} \times \frac{1}{18.1\ hour} \times \frac{1}{5\ days}$$

$$Number\ of\ machines = 5.99\ \frac{machines}{days}$$

The following steps were taken for the validation model in Figure 5.

Figure 5. Validation diagram

With the data obtained based on the reports and data collection from the two components of the model, Minitab software was used to validate the data. Graphs were obtained, analyzed, and the stabilization and implementation phase was identified.

4.3 Validation development

Different graphs were used to develop the validation, one of which was "Time Series," which helped identify the number of events in the stabilization and implementation phase. There are also simple probability graphs, in which two samples were compared with a "t-student" distribution. The results of the case indicators are detailed below. Regarding the "Configuration time" indicator, it was identified that the stabilization phase consists of seven events and the implementation phase consists of six events. Likewise, the data obtained was approved, as all values are within the permitted range (Figure 6- Figure 7).

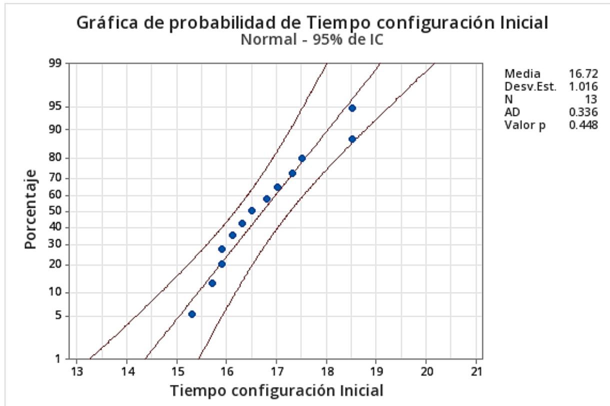


Figure 6. Simple probability graph of "Initial setup time"

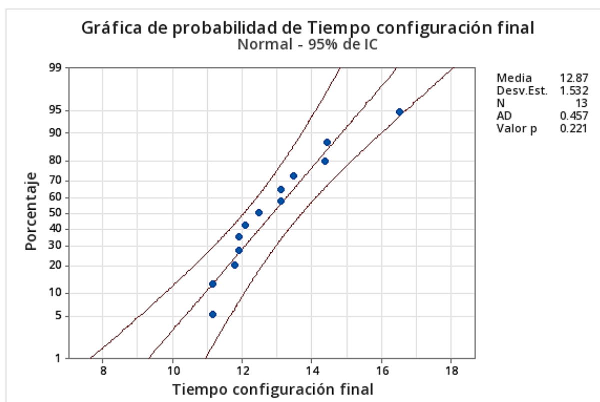


Figure 7. Simple probability graph of "Final setup time"

For the indicator "No. of defective garments," it was identified that the stabilization phase is 4 events and the implementation phase is 9 events (Figure 8). Furthermore, Figures 9 and 10 show that the data for these indicators are within the permitted range, which is favorable and indicates that the values are adequate.

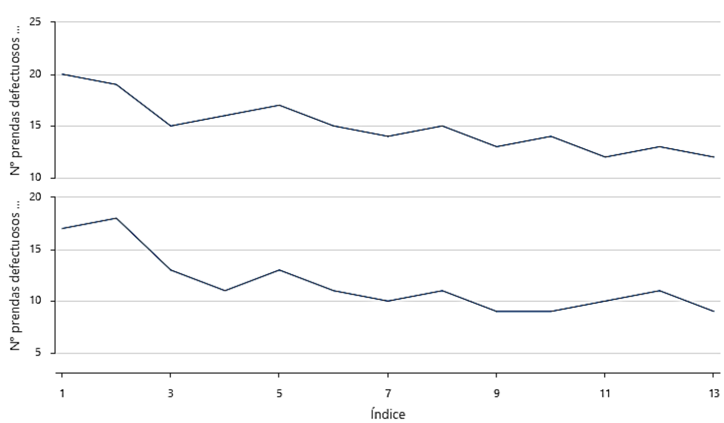


Figure 8. Initial and final number of defective garments

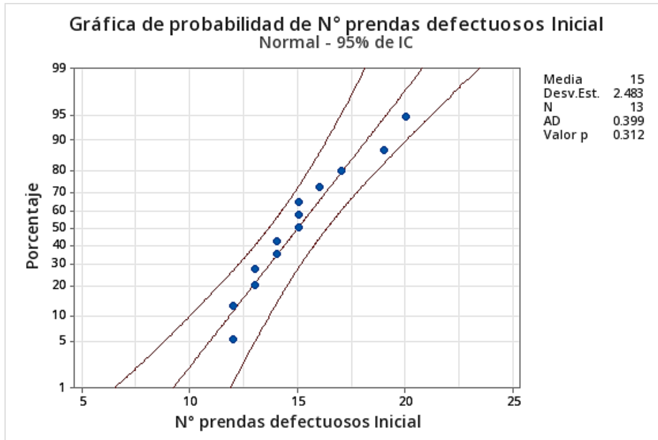


Figure 9. Simple probability graph of "Initial number of defective items"

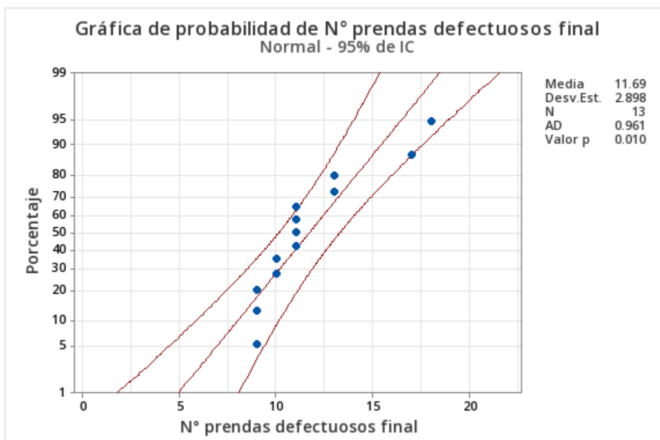


Figure 10. Simple probability graph of "Final number of defective items"

For the "Unproductive Minutes" indicator, it was identified that the stabilization phase consists of 7 events and the implementation phase consists of 3 events (Figure 11). Likewise, Figures 12 and 13 show the validation of the data, as they are within the range.

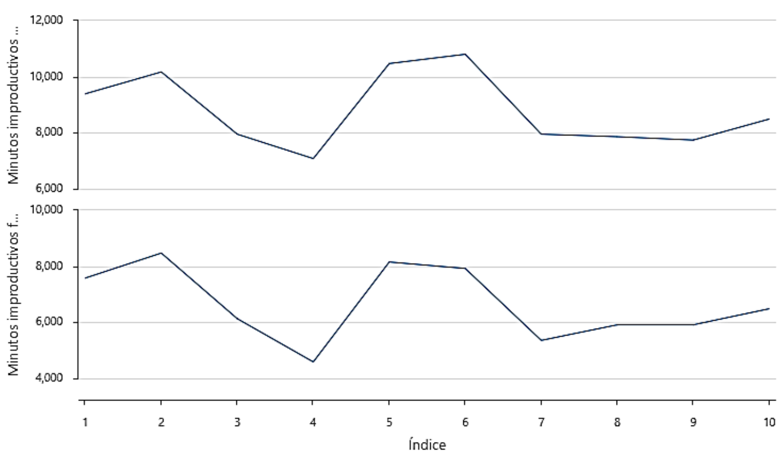


Figure 11. Initial and final unproductive minutes

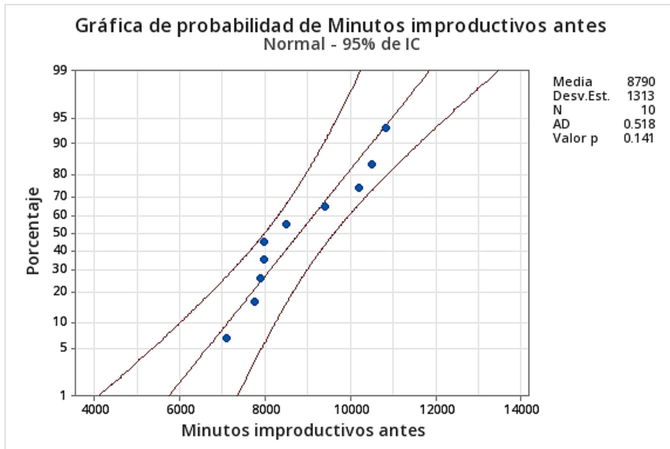


Figure 12. Simple probability graph of "Initial unproductive minutes"

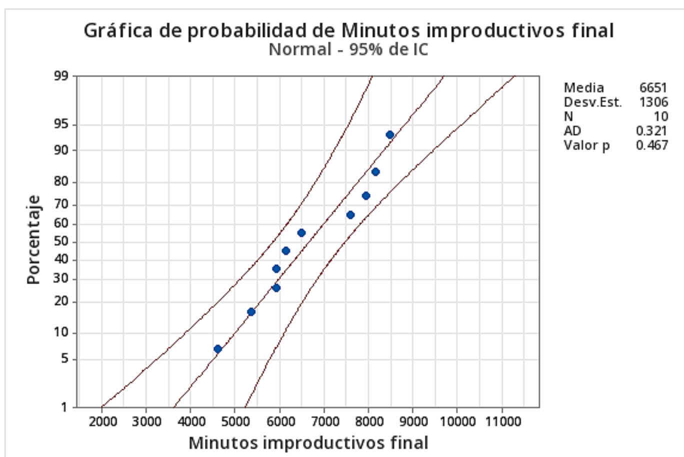


Figure 13. Simple probability graph of "Final unproductive minutes"

For the “Efficiency” indicator, it was identified that the stabilization phase consists of three events and the implementation phase corresponds to three events (Figure 14). With regard to Figures 15 and 16, it can be seen that the values are within the probability range, which is favorable.

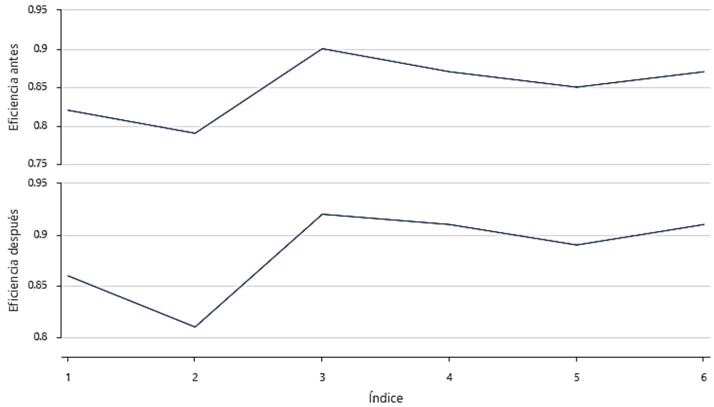


Figure 14. Simple probability graph of “Final unproductive minutes”

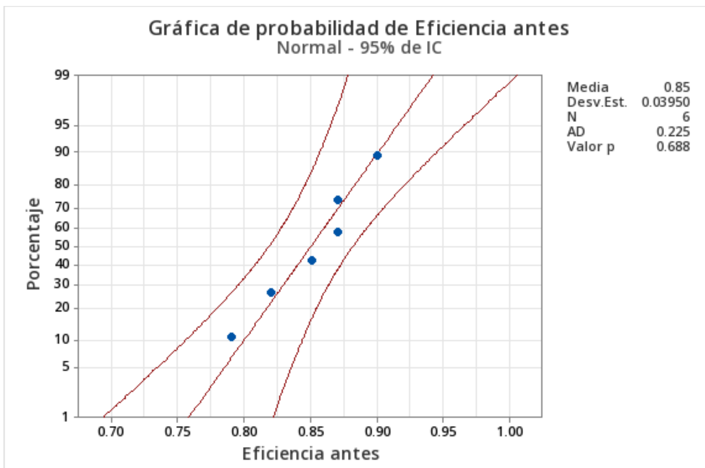


Figure 15. Simple probability graph of “Initial efficiency”

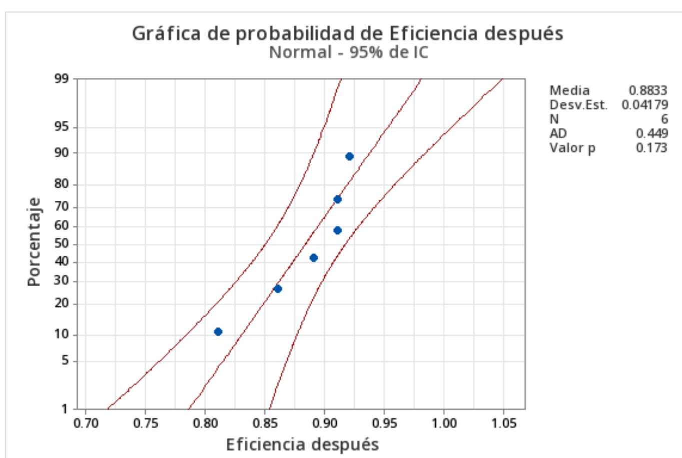


Figure 16. Simple probability graph of “Final efficiency”

5. Results

The results section presents the comparative analysis before and after implementation of the model. Key performance indicators are statistically evaluated to measure improvements in setup time, defect reduction, unproductive minutes, and efficiency.

To evaluate the results, two scenarios were compared using the initial and final indicators. The implementation results were evaluated in MINITAB using the two-sample t-student distribution. The confidence level is 95%.

In the first comparison, the "Setup time" indicator was used, which shows a change in the mean from 12.87 to 16.72, i.e., an improvement from the initial scenario to the final one. The analysis was also performed for the second indicator, "Number of defective garments." The mean for the initial scenario was 15 and for the final scenario it was 11.69, indicating that there was a significant change with the implementation. For the third indicator, "Unproductive minutes," a comparison of both scenarios was performed. The mean for the before scenario is 8,790 unproductive minutes and the final scenario is 6,651. This means that there was a significant change, as the implementation led to a reduction. The fourth indicator is "Efficiency," which shows favorable results. The average before was 0.85, and the average after implementation was 0.8833. An improvement in efficiency can be identified after implementation.

To evaluate the results, two scenarios (before and after implementation) were compared, taking into account the main performance indicators of the process. The statistical analysis was performed using MINITAB software, applying Student's t-test for two independent samples with a 95% confidence level. This made it possible to determine whether the differences observed in the means were statistically significant and, therefore, attributable to the implementation of the proposed improvements.
In the case of the first indicator, Setup Time, there was an increase in the average from 12.87 to 16.72 time units, with a variation of 3.85 minutes. This change reflects greater efficiency in the preparation of operations, since an increase in this value implies better management of the time allocated to setup. The result suggests that, after implementation, workers are able to stabilize the process more quickly, reducing losses associated with waiting and unnecessary adjustments.

The second indicator, Number of defective garments, showed a reduction in the average from 15 to 11.69. This decrease is significant, as it directly impacts the quality of the final product and customer satisfaction. In addition, a lower defect rate means less rework and waste, which translates into optimized resources and costs. Statistical analysis confirmed that the observed variation is significant, validating that the implementation had a positive effect on process quality.

With regard to the third indicator, unproductive minutes, there was a considerable reduction, from 8,790 to 6,651 minutes. This decrease reflects better use of operating time, which is directly related to overall productivity. The difference shows that activities that previously generated stoppages, delays, or downtime were effectively mitigated. From a statistical point of view, the result is significant, confirming that the implementation contributed to a more efficient use of the time available in the production process.

The efficiency indicator showed an increase in the average from 0.85 to 0.8833. Although the increase may seem small in absolute terms, it is significant from a productivity standpoint, as it represents an improvement in the relationship between the resources used and the results obtained. In an industrial environment, even marginal improvements in efficiency can have a considerable impact on competitiveness and long-term sustainability.

Overall, the results show that the improvements implemented generated positive and statistically significant changes in the indicators analyzed. These findings demonstrate not only an impact on reducing downtime and defects, but also an optimization in the efficiency and quality of the production process.

In addition to the implementation and analysis of the results, a financial evaluation was carried out to demonstrate that the proposal is viable in terms of financial results. First, the annual labor costs for the two components and the implementation expenses were calculated. With this data, the total cost of the proposal was determined. Subsequently, the income statement was prepared, where revenues represent 23% of the economic impact, obtained from the results, which is based on unproductive minutes.

Table 1. Income statement

Income statement	
Revenue	
Economic impact	S/ 147,031.70
Expenses	
Implementation of the model	S/ 52,280.69
Net Profit	**S/ 94,751.01**

Next, cash flow was calculated in relation to income and available profit. Finally, the Net Present Value (NPV) and Internal Rate of Return (IRR) of the project were calculated, yielding results of 14,680.44 soles and 9.72%, respectively, indicating that the project is profitable (Table 1).

In this case, an evaluation of the NPV and IRR was performed. The IRR calculation is essential for determining whether an investment project is viable and provides a clear measure of profitability, helping managers make informed decisions about whether to proceed with an investment (Sanz, 2022), considering four different scenarios. These scenarios varied according to fluctuations in the projected income obtained during implementation. The objective was to identify the range of conditions under which the project remains viable and profitable, providing a deeper understanding of the risks and opportunities associated with implementation (Table 2).

Table 1. Scenarios

% of economic impact	**Revenue**	**VNA**	**TIR**
5%	S/ 31 963,41	-66 604,51	-
15%	S/ 95 890,24	-21 535,66	-3%
23%	S/ 147 031,70	14 519,42	9,72%
40%	S/ 255 707,31	91 136,46	27,70%

In the first scenario evaluated, where revenues represent only 5% of the economic impact, the project did not meet minimum profitability expectations. In the second scenario, it can be seen that the IRR is greater than one, suggesting that the project could be approved from a profitability perspective. However, the NPV is negative, indicating that the project would not generate additional economic value for the company and, therefore, would not justify its implementation despite its apparent financial viability.

In the scenario obtained after implementing the improvements, with an economic impact of 23% compared to the ideal, both the NPV and IRR were positive. This indicates that the project generated revenues that exceed the company's cost of capital, demonstrating that the work is profitable and meets financial return expectations.

6. Discussion of findings

The observed reductions in defective garments, setup time, and unproductive minutes indicate that the joint deployment of Standardized Work and 5S effectively stabilizes stamping operations. The 26.4% reduction in defects and the 27% decrease in setup time suggest that method discipline and workplace organization protect parameter integrity and reduce quality drift during changeovers, while the 23% drop in unproductive minutes reflects improved time utilization at the machine level. Together with the reported IRR of 9.72%, these outcomes support the operational and economic feasibility of the model under real production conditions.

These findings align with prior Lean-based evidence on waste and defect reduction in textile and related industries while extending the state of the art in several ways. First, the results are consistent with the role of Standardized Work in stabilizing execution and reducing variation (cf. Barrientos et al., 2020; Dennis, 2021), yet this study explicitly couples method discipline with a structured 5S routine in stamping. Second, whereas previous works emphasize waste minimization and lead-time improvements in adjacent processes (Bellido et al., 2018; Gebeyehu et al., 2022; Collantes et al., 2019; Jarufe-Majluf et al., 2022), this research demonstrates an AQL-oriented quality effect in the stamping stage, where visual controls, cleanliness of screens, and standardized parameter sheets are critical.

In terms of applicability and sustainability, the artifacts produced—parameter sheets, shift-change forms, and 5S audit routines—are lightweight, auditable, and easy to scale to parallel lines or plants. By lowering rework and stabilizing setups, the model reduces material losses and energy-intensive reprocessing, thereby supporting operational sustainability. The approach is readily transferable to printing, packaging, or light assembly environments where short runs, frequent changeovers, and workforce rotation make method fidelity and housekeeping decisive performance levers.

6. Conclusion

This research demonstrates that the stamping process in the Peruvian textile sector presents structural weaknesses that compromise quality and efficiency. By introducing a model based on Standardized Work and 5S, the study provides empirical evidence of the capacity of Lean tools to reduce variability and strengthen process stability. The intervention led to a reduction in defective garments equivalent to more than one quarter of the initial level, while the internal rate of return exceeded the minimum expected threshold, confirming that technical improvements can be sustained economically. These results reveal a path from fragmented corrective actions to systematic preventive routines, where discipline and workplace order translate into measurable competitive benefits.

The importance of this study lies in its ability to integrate operational and financial perspectives in a sector where improvement initiatives are often implemented without rigorous validation. Demonstrating that process stabilization not only improves quality outcomes but also ensures financial feasibility reinforces the value of holistic approaches to industrial management. The research highlights that effective improvement requires both methodological fidelity and managerial commitment, offering lessons that extend beyond the specific case examined.

The contributions of the study to the field of industrial engineering are threefold. First, it shows that Lean tools acquire greater power when applied jointly and systematically rather than in isolation. Second, it enriches the literature by reporting quantitative evidence that links defect reduction with economic feasibility in a context of high variability. Third, it provides practitioners with tangible artifacts—such as parameter sheets and audit routines—that strengthen implementation fidelity.

Finally, the study opens avenues for future research. Further work may explore how continuous monitoring through statistical process control enhances sustainability of results, or how training depth influences adherence to standardized work. Expanding applications to industries such as packaging or light assembly would test transferability and refine the scope of the proposed model.

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