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Improving Delivery Compliance through the Application of 5S, Kanban, and Standard Work in an Orthopedic Products Manufacturing Company

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Abstract

The research focuses on improving the low compliance rate in the delivery of finished products at a textile orthopedic manufacturing company. Initially, the company had a compliance rate of only 79.8%, mainly due to a high rate of defective items (28.57%), inefficient inventory management (23.81%), and disorganization throughout the production process (19.05%). After applying several Lean Manufacturing techniques, the company's compliance rate increases noticeably—from 79.8% to 84.33%—showing clear progress in product quality, process flow, and overall operational performance. The proposed model includes two phases, the first one is sort and organize. Where the 5s method and work standardization are applied. The second one is classify and monitor using Kanban. Thanks to the optimal combined application of these tools, a positive impact of 4.53% was achieved, along with multiple benefits for both the organization and the workers in warehouses of companies within the manufacturing sector.

Keywords
Lean Manufacturing, 5S, Work Standardization, Kanban, Textile Industry, Orthopedic Industry.

1. Introduction
Many opportunities have emerged across different economic sectors as a result of the economic recovery and the gradual return of individuals to their workplaces. According to INEI (2021), in Metropolitan Lima, Peru, alone, during the March–April–May 2021 quarter, the employed population increased by 73% compared to the same period in 2020. Industries linked to health, wellness, and sports face the challenge of meeting a steadily growing demand. This is particularly true for the orthopedic industry, which is significant for its contribution to health services and integrated social care (Javaid and Haleem 2020). Within orthopedics, there is a wide variety of textile-related products such as knee braces, arm slings, ankle supports, and lumbar belts, all of which are produced through manufacturing processes. For this reason, the textile and orthopedic industries are closely interconnected. Moreover, in 2020, the textile and apparel sector accounted for 0.8% of the national Gross Domestic Product (GDP) and 6.3% of the manufacturing GDP (SNI 2021). Similarly, compared to 2019, it was the third-largest contributor to manufacturing GDP (6.4%), surpassed only by petroleum refining and non-metallic products (SNI 2021).

At present, companies are increasingly adopting lean philosophies to address the main challenges caused by the lack of planning and efficient production, with the aim of remaining competitive by reducing costs and surpluses (Ciccarelli et al. 2022). One line of research suggests that the effects of lean practices are positive for the performance of manufacturing SMEs (Valente et al. 2020). A representative case is a study conducted in Latin America, in Colombia's textile industry, where the most critical issue identified was the absence of process standardization due to insufficient documentation. This gap made it difficult to properly analyze and improve both textile and manufacturing production operation (Arteaga et al. 2019).

Against this backdrop, a case study was selected to illustrate the problem of noncompliance in finished products stemming from deficiencies in production processes within the sector. As a proposed solution, an improvement model is introduced through the application of 5S, work standardization, and Kanban techniques—tools belonging to the Lean Manufacturing methodology. These aim to identify elements that do not add value to the customer and to eliminate or mitigate them through the systematic and consistent application of a set of manufacturing practices oriented toward enhancing production processes by reducing all forms of waste (Hernández and Vizan 2013). Additionally, the limited availability of information on both the orthopedic-textile sector and applied Lean Manufacturing models in such companies serves as a key motivation for this research (Koloszar 2018).

This article is structured as follows: Objectives, literature review, methods, data collection, results and discussion and conclusions

1.1 Objectives
The main objective of this research is to improve compliance in the delivery of finished products through the simulated implementation of Lean Manufacturing practices within a manufacturing company that produces orthopedic goods. This improvement will be achieved through the combined application of 5S, work standardization, and Kanban. These are Lean manufacturing tools. The following specific objectives are proposed, along with their corresponding benchmarks, to ensure proper project measurability:

- Increase the order fill rate to values above 82%.
- Reduce the defective product rate to below 9.48%.
- Raise the monthly production capacity to 2,100 arm slings.
- Decrease the material search time in both storage and workstation areas by 10%.

These objectives will later be validated through simulation using Arena software and compared with previous studies to ensure that the results obtained are measurable, achievable, and significant for improving the operational performance of small and medium-sized enterprises (SMEs) in the orthopedic textile sector.

2. Literature Review
This study seeks to identify appropriate tools that, when properly applied, can generate optimal outcomes in operational and procedural efficiency. Through effective innovation management strategies and the application of Lean principles, organizations are increasingly capable of achieving sustainable overall management (Pagliosa et al. 2021). Companies are adopting Lean philosophies to streamline their production systems, utilizing the least possible resources while maintaining product quality, thereby protecting their competitiveness in the current market (Cicarelli et al. 2022).

The first tool considered is 5S. This methodology can be regarded as both a philosophy and a way of life, capable of boosting morale, creating a positive impression on customers, and enhancing overall efficiency (Raluca 2015).
The 5S tool is commonly used among small and medium-sized enterprises (SMEs) to foster clean and orderly environments and to minimize waste caused by spills and leaks through early detection. It also establishes a foundation for SMEs to engage in systematic waste management and disposal practices (Caldera et al. 2019).

The main benefit of implementing 5S lies in increasing productivity by minimizing waste, maintaining well-organized working conditions, and promoting continuous improvement (Inga et al. 2022).
A successful case study demonstrated that implementing the 5S methodology led to an 18% reduction in operation times and a 66% reduction in tool search times within the workspace (Shahriar et al. 2022).

The second tool proposed is work standardization. The main findings indicate that this approach is ideal for normalizing work procedures, enabling greater flexibility, higher production rates, and reductions in waste and assembly errors (Barrientos et al. 2020). Its application allows the acquisition of precise knowledge regarding personnel, machines, materials, procedures, measurements, and information, ensuring reliable, safe, fast, and cost-effective production outcomes (Hernández and Vizan 2013). By establishing standardized work procedures and instructions, organizations can enhance worker versatility, optimize time usage, and reduce process variability—thereby enabling better control of operations and fewer quality errors (Bragança and Costa 2015).

As emphasized by Koloszar (2018), work standardization is a key element of production management, as it defines clear and consistent methods for performing tasks. It provides the structure that allows successful practices to be replicated and ensures that performance remains stable over time. Standardizing procedures and measuring service times helps identify bottlenecks and drive continuous improvement. (da Rocha Nascimento et al. 2021)

The final tool applied is Kanban. The Kanban method is an essential system used to control and optimize material flow and production processes. Its implementation helps reduce waiting times, prevent overproduction, and improve communication between different stages of the process (Guzel and Sirin 2018). Kanban enables the visual management of workflow, balancing production according to actual demand and fostering continuous improvement throughout processes (Abbes et al. 2022)

Among its benefits are better task and inventory management, improved process visualization, and maximized efficiency. The use of Kanban cards improves company productivity while simultaneously minimizing waste in production (Abdul and Mohamed 2013). According to Ratnayake et al. (2021), the implementation of Kanban can lead to a 12% increase in production efficiency within a short period, among other operational improvements.

3. Methods

As an application proposal, a model is presented consisting of three Lean Manufacturing tools: 5S, work standardization, and Kanban. The significance of this model lies in the innovation it represents through the implementation of these tools in a company within the orthopedic/textile sector, which faces a limited availability of prior information. Figure 1 illustrates the proposed model.

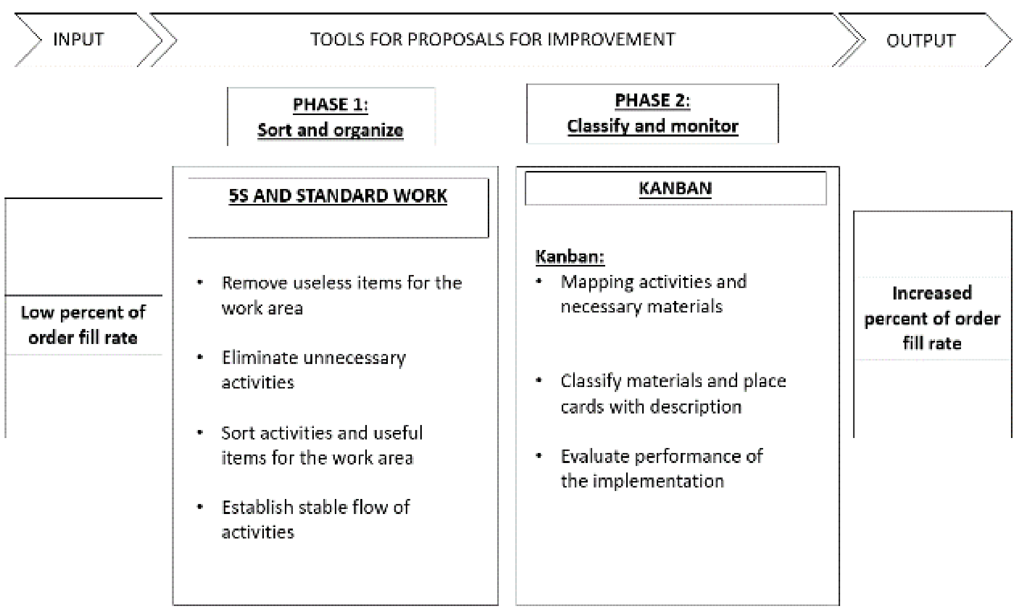

Figure 1. Model components

The structure of the proposed model begins with the definition of the problem: the low compliance rate in the delivery of finished products. The proposed improvement tools are presented below, organized into two main phases:

Phase 1: Sorting and Organizing. The first tool selected was 5S. To understand the current situation, photographic evidence was collected. This was followed by an evaluation using scalar questions to measure how well each of the five S's was being applied. Finally, the results were analyzed to identify improvement opportunities.

Once each stage of the 5S methodology had been evaluated, the total score was calculated, resulting in a compliance rate of 35.8%. This result is shown in Figure 2, which uses a radar chart to visualize and compare the current condition with the desired future state.

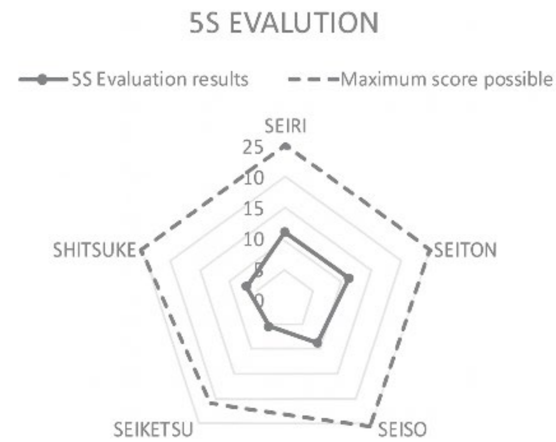

Figure 2. 5S Radar Diagram

These objectives will later be validated through simulation using Arena software, and the outcomes will be compared with previous research to confirm that the results are measurable, achievable, and meaningful in improving the operational performance of small and medium-sized enterprises (SMEs) in the orthopedic textile sector (Figure 2).

- Seiri (Sort): Unnecessary materials used in production were identified and marked with red tags, indicating whether they should be discarded, repaired, or relocated.
- Seiton (Set in Order): Items on worktables were organized, and storage areas were defined for each type of component.
- Seiso (Shine): The facility was thoroughly cleaned, and a detailed cleaning plan was prepared to maintain order.
- Seiketsu (Standardize): A Procedures and 5S Best Practices Manual was created to document standard operating methods.
- Shitsuke (Sustain): A 5S visual board was implemented to display the manual, updated performance indicators, and the cleaning schedule, ensuring continuous improvement and employee involvement.

The second part of this phase corresponds to work standardization. The process begins with informing and training workers on the tool's purpose. Next, operation times are measured, and operator performance is evaluated. The goal is to identify both strengths and weaknesses in the process. The third step involves a proposed improvement plan. This plan consists of written and graphical instructions that illustrate the optimal method for performing tasks. The results are compiled in a work procedures manual. The five main aspects considered are:

- Mapping the location of materials and supplies.
- Proper delimitation of the workspace.
- Pre-operational supervision of machinery.
- Organization of worktables.
- Removal of items unrelated to the process.

These actions led to better productivity. The sewing and riveting machines are also checked regularly, and workers are trained to use them in the most efficient way possible.

Phase 2: Classifying and Monitoring. In the second phase, Kanban cards were selected as the principal tool. The first step involves measuring the time required to locate materials needed for manufacturing operations. Allowing for a comparison of the initial situation and the situation after implementing the Kanban system. Next, materials such as glue, fabric, magnets, foam, and neoprene are sorted, classified and identified with labels. Each Kanban card contains details about the material, its designated storage area, and the current stock level, facilitating traceability and efficient replenishment.

Three key performance indicators (KPIs) were considered for this study. In first place, Order Fill Rate (OFR). This indicator measures the company's ability to fulfill customer orders completely. Competitive firms typically achieve an average OFR of 94.7% (Tompkins 2022). A deviation of up to two percentage points is considered acceptable; values below this threshold indicate a significant opportunity for improvement.

$$OFR = \frac{\text{Total orders shipped}}{\text{Fully completed orders}}$$

In second place, the Production Capacity. This represents the maximum production level the plant can achieve within a given time frame under ideal operating conditions. It is calculated based on the total production time and the time required to produce one unit, yielding the number of units produced per month. According to company data, the benchmark range for this indicator is 2,100 to 2,300 units.

The last indicator is Defective Product Rate. This indicator measures the proportion of products that fail to meet quality standards. For a company to be considered competitive, the defective product rate should not exceed 5% (Tompkins 2022).

4. Data Collection

At this point, a detailed analysis focuses on a small Peruvian enterprise, dedicated to the production and commercialization of orthopedic products derived from textile activities. Its main products include orthopedic knee braces, postoperative belts, and arm slings, with the latter being the company's top-selling item (Table 1).

Table 1. OFR and defective products

Indicator	Benchmark	Current situation
%OFR	94.78%	79.8%
%Defectives products	5%	10.3%

The first indicator is the Order Fill Rate (OFR), which measures the company's performance in fulfilling customer orders completely. According to Tompkins (2022), a competitive company maintains an average OFR of 94.7%, while surpassing the 98% threshold indicates a level of excellence in order fulfillment. Regarding the analyzed manufacturing company, Table 1 shows that during the period July 2021 – June 2022, the OFR reached 79.8%, representing a –14.9% performance gap compared to the benchmark.

The second indicator in Table 1 reflects the company's defective product rate. This KPI has a reference value of 5%, which denotes good management of the production process (Tompkins 2022). While it would be ideal to keep this rate, the company is currently seeing an average defect rate of 10.3%.

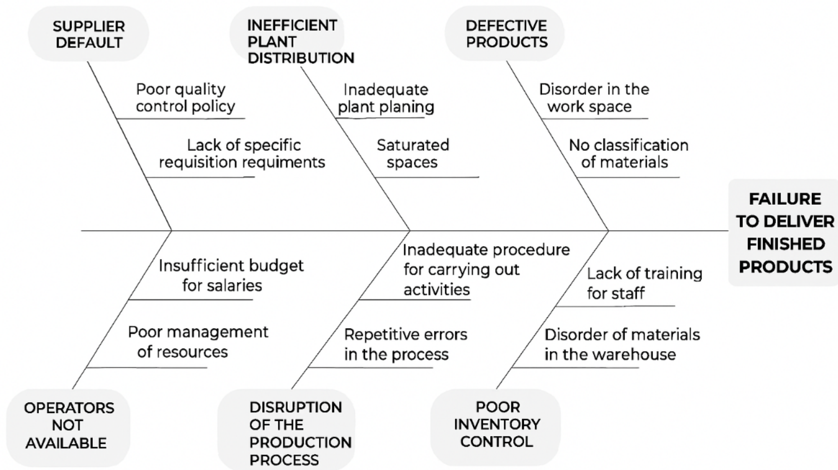

Figure 3. Ishikawa diagram

Figure 3 presents the Ishikawa diagram, which illustrates that the main problem—non-compliance in the delivery of finished products—stems from six root causes: High defective product rate, poor inventory control, inefficient plant layout, production process interruptions, supplier failures, operator unavailability.

In relation to defective products, disorder in the workspace and lack of material classification and inspection are observed (Kolus et al. 2018). The proposed solution is the 5S methodology, known for promoting organization and cleanliness in the workplace. This tool was selected due to its high implementation feasibility, as noted by Hernández and Vizan (2013), who state that the principles of the 5S methodology are easy to understand, and their implementation requires neither specialized knowledge nor significant financial investment. Beneath this apparent simplicity lies a powerful and multifunctional tool.

Regarding poor inventory control, the root cause identified is the disorder of materials in the warehouse. The proposed solution is the implementation of Kanban cards, since, according to Hernández and Vizan (2013). Kanban is a tool that ensures high-quality standards and enables production of the right quantity at the right time.
As for production process disorganization, the analysis revealed two contributing factors: inadequate work procedures and repetitive operational errors. To address this issue, work standardization is proposed as the main improvement measure.

Figure 4 shows the problem analysis tree, which is derived from the analytical process and illustrates the main causes of non-compliance in the delivery of finished products. The results indicate that the main problem is the high defective product rate (28.57%), followed by poor inventory control (23.81%), and process disorganization (19.05%). Together, these three factors are 71.43% of the main operational challenges within the company.

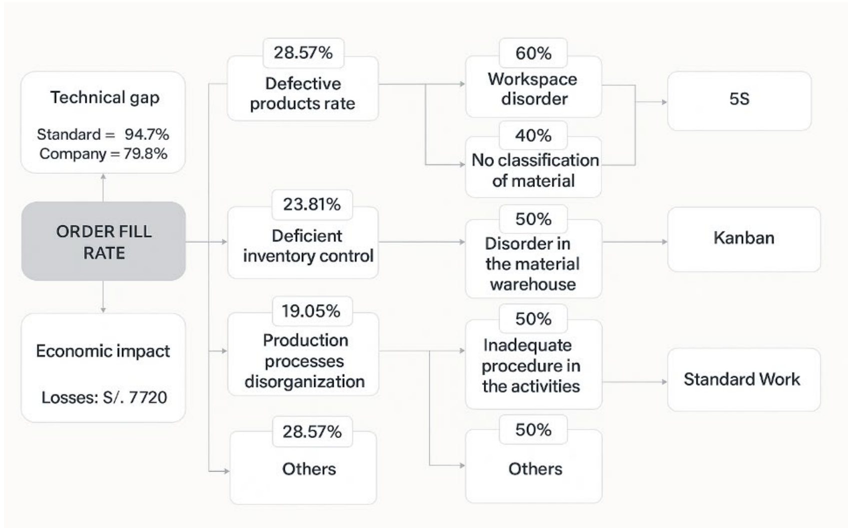

Figure 4. Problem analysis tree

5. Results and Discussion

5.1 Numerical Results

Table 2. Results: Initial Scenario vs Improve Situation

Problem	Current	Target	Improved	Cause	Indicator	Current	Target	Improved
Compliance in the delivery of finished products	79,8%	82%	84,33%	Deficient inventory management	Material search time in warehouse	3,758 min/piece	3,33 min/ piece	3,32 min/ piece
				Lack of order in the workplace	Material search time in the work area	0,64 min/ piece	0,22 min/ piece	0,54 min/ piece
				Inadequate procedures for performing activities	Production capacity	2000 slings/ month	2100 slings/ month	2334 slings/ month
				Inadequate procedures in operations	Percentage of defective products	10,3%	9,48%	8,72%

Table 2 shows the current situation, the target values, and the results obtained for the indicators defined to measure the level of success achieved through the implementation of the proposed engineering tools. The table demonstrates that material search times in the warehouse and the percentage of defective products were successfully reduced, while production capacity increased as a result of the application of Kanban, 5S, and work standardization, respectively. The three objectives were successfully achieved. Regarding material search time within the work area, a reduction in the time devoted to this activity was obtained. However, the target value was not fully reached.

5.2 Graphical Results

First, regarding the indicator of material search time within the work area, previous studies have reported a reduction of 66% through the implementation of the 5S methodology (Shahriar et al. 2022). As shown in Figure 5, a reduction of 15.63% was achieved. Although a slight improvement was observed, the target established based on previous research was not fully attained.

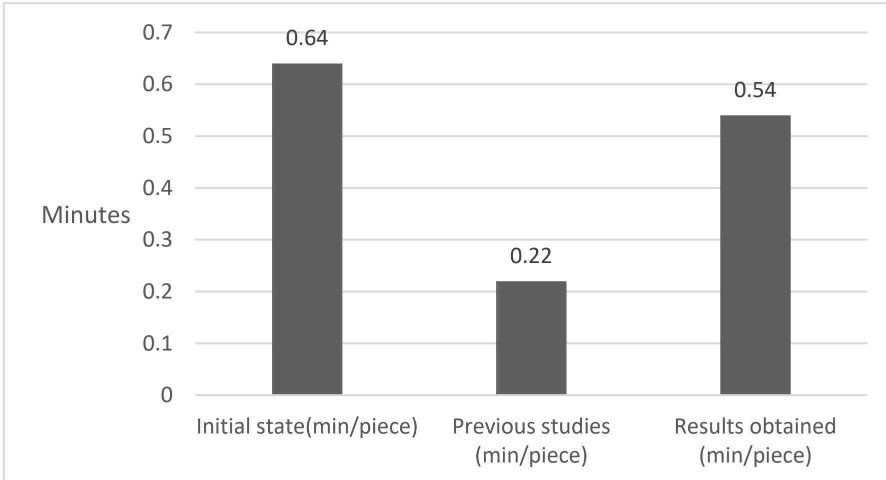

Figure 5. Material search time in the work area

Second, the Kanban tool, according to Ratnayake et al. (2020), leads to a 12% reduction in the time spent searching for items in the warehouse, among other benefits achieved within a short period. In comparison, as shown in Figure 6, the study recorded a 12.4% reduction, thereby confirming the findings reported in previous research on the effectiveness of the Kanban system.

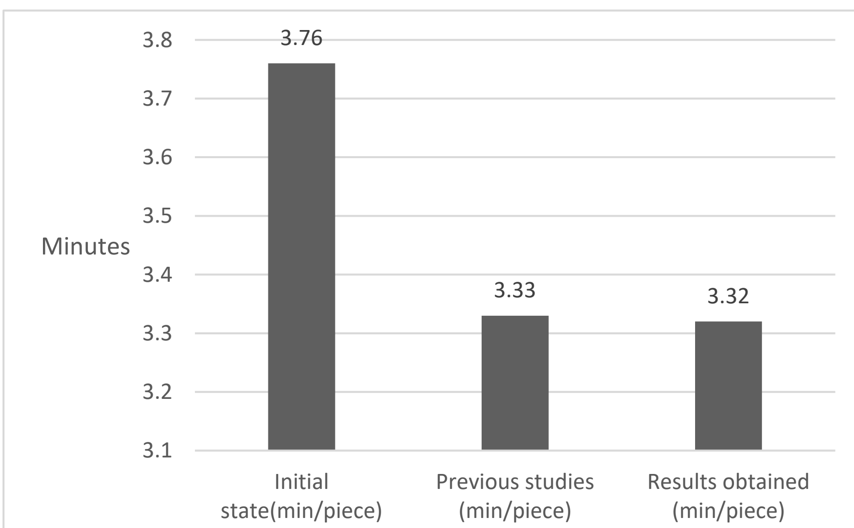

Figure 6. Material search time in warehouse

Thanks to the combined application of Lean tools, a 14.34% reduction in the manufacturing time of an arm sling was achieved. This improvement in efficiency led to a 16.7% increase in production capacity as shown in Figure 7.

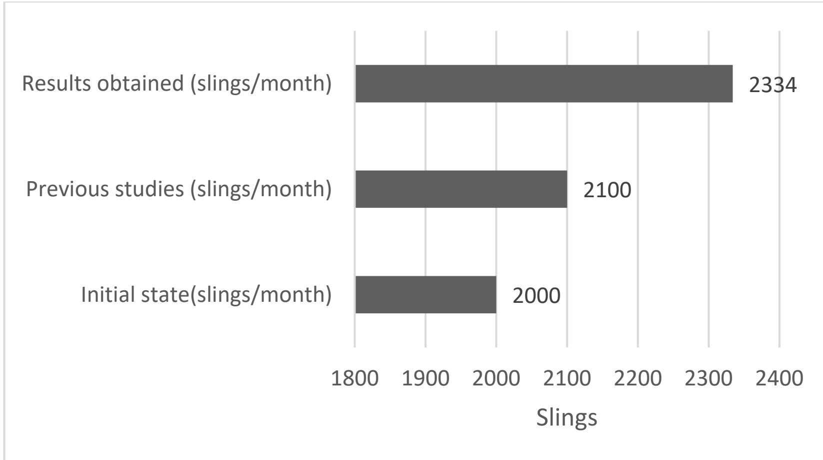

Figure 7. Production capacity

Along the same lines, previous studies have indicated that the implementation of work standardization and 5S leads to an 8% reduction in the defective product rate compared to the initial situation. In contrast, the present study achieved a reduction of 15.34% in defective products as shown in Figure 8.

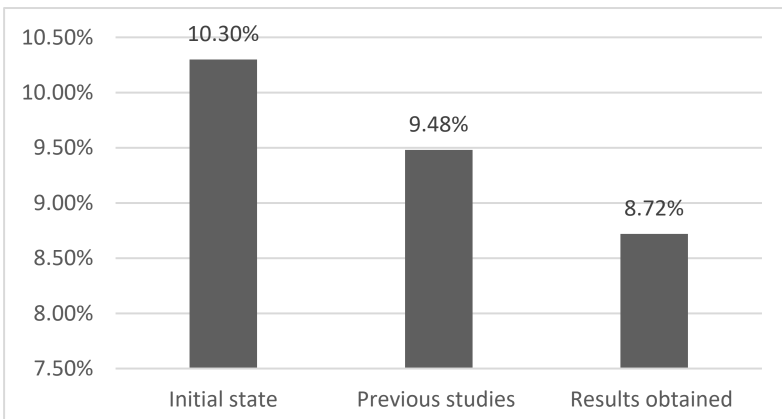

Figure 8. Defective products

5.3 Proposed Improvements

Applying the tools of 5S, Kanban, and work standardization brought noticeable improvements in the company's production process. Organizing the work areas helped reduce the time spent looking for materials, while using Kanban made the movement of materials smoother and improved inventory control. Standardizing the way tasks are done also made the process more stable, leading to a 16.7% increase in production capacity and a 1.6-point drop in defective products.

Even though the company had limited resources, it was able to keep its results thanks to the commitment of its staff and the use of visual management tools. By continuing regular 5S evaluations, updating Kanban cards, and following standard work procedures, these improvements can be maintained over time and help strengthen the company's Lean culture.

The company is a microenterprise, so it works with a very small budget for improvement projects—around 1% of its annual sales. Because the funds are tight and there is still some hesitation toward change, it is not easy for the company to apply new lean practices or take on larger improvements. Even so, the results showed that solid progress can come from small, steady actions. Future efforts should focus on affordable ideas and gradual changes that fit the company's real working conditions.

5.4 Validation

To check the effectiveness of the proposed improvement, a simulation was used as a quantitative method to measure the impact of the 5S, Kanban, and work standardization tools. The simulation was developed with Arena Simulation Software (version 16.10.00) and modeled the production of an arm sling—from the arrival of raw materials to the packaging of the finished product.

A total of 120 activity times were collected and analyzed to determine the optimal sample size. In the model, the entities correspond to arm slings (adult and child sizes), while the attributes describe the times associated with each operation—such as material retrieval, fabric and foam preparation, sewing, and packaging—which were represented by the actions "wait for order" and "process order." Based on this information, the simulation flow shown in Figure 9 was developed. It sequentially illustrates each stage of the process and made it possible to analyze both the performance of the current system and the impact of the proposed improvements on production efficiency.

Figure 9. Simulation model

The simulation results in the initial scenario and in the improved situation are reflected in Table 3. It reflects a decrease of 14.34% compared to the initial cycle time.

Table 3. Indicators

Indicator	Benchmark
Initial situation	11.3525
Improvement time	9.7243

6. Conclusion

Once the engineering tools were applied to the production process, it was found that the combined use of work standardization, 5S, and Kanban had a positive impact on the completion rate of finished products, yielding an improvement of 4.53%. This outcome is attributed to their sequential implementation, which organizes, categorizes, and eliminates all activities or elements that do not add value.

Among the three tools applied, work standardization had the strongest impact, as it directly corrected inappropriate procedures within the activities. This was reflected in a 1.58% reduction in defective products.

The overall analysis confirms that the implementation of the proposed tools leads to improvements in production times. Nevertheless, the practical deployment of these tools is constrained by the resources available to the company. Therefore, a financial analysis should be conducted to assess the feasibility of full-scale implementation.

Finally, the results suggest that future research should focus on applying these tools at the organizational level rather than limiting their scope to individual processes. Such an approach would allow results to be scaled across the entire enterprise, generating a broader impact on productivity indicators throughout all production processes.

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Biographies

Ayron Anamaria is a bachelor's in industrial engineering from the University of Lima, with experience in logistics, operations, and strategic planning. He has developed his professional career in multinational companies, participating in process optimization, customer experience improvement, and operational management enhancement.
His professional interests focus on operations management, process optimization, and continuous improvement.
The motivation for publishing this research is born from his interest in developing practical tools that allows small businesses to improve their processes and grow their competitiveness. This work wants to demonstrate that efficiency and innovation can be achieved through accessible and sustainable strategies, even in resource-limited environments.

Fabrizzio Bianco is a bachelor's in industrial engineering from the University of Lima, Peru. He currently serves as a Senior Operations and Logistics Analyst, where he applies his expertise in process management, operational planning, and continuous improvement. His professional interests center on developing practical solutions that optimize resources and improve efficiency throughout the supply chain. Over the course of his career, he has taken part in projects focused on inventory management, logistics data analysis, and process standardization—initiatives that have contributed to consistent operational growth. This research marks his first academic study, driven by a desire to create a positive impact within his organization and to generate value through analytical thinking, adaptability, and a strong commitment to improvement. Fabrizzio is deeply passionate about operational innovation, sustainable industrial practices, and digital transformation. He is constantly searching for new opportunities to learn, collaborate, and implement ideas that promote long-term organizational success.

Carlos Urbina is an Industrial Engineer from the University of Lima and master's in administration from Pacifico University with professional experience in national and transnational companies occupying managerial positions in commercial, administrative and project areas. Business consultant specialized in marketing and strategic planning Extensive experience in sales, product development, strategic planning, key account management and development of marketing plans for services and mass consumption.