5th Asia Pacific Conference on Industrial Engineering and Operations Management
Tokyo, Japan, September 10-12, 2024
Publisher: IEOM Society International, USA DOI: 10.46254/AP05.20240102
Published: September 10, 2024

Optimizing Operational Efficiency and Product Quality in Fashion SMEs: A Lean Manufacturing Approach in Jeans Production

Jorge Luis Huaylinos-Vicente
Bachelors in industrial engineering
Facultad de Ingeniería, Universidad de Lima, Peru
20163189@aloe.ulima.edu.pe

Jaime Manuel Martín-Calero
Bachelors in industrial engineering
Facultad de Ingeniería, Universidad de Lima, Peru
20163288@aloe.ulima.edu.pe

Abstract

The small and medium-sized enterprises (SMEs) sector in the fashion industry, particularly in jeans manufacturing, is crucial globally, in Latin America, and specifically in Peru. However, it faces significant challenges such as excessive waste in the cutting phase, unproductive times during manufacturing, and low quality of subcontracted products, affecting operational efficiency and market competitiveness. To address these challenges, a production model based on Lean Manufacturing philosophy and Work Study was proposed, structured into four phases: organization of workstations using the 5S methodology, critical process analysis, production process control using poka-yoke, and consolidation of the production process. This model aimed to improve operational efficiency and product quality by standardizing processes and reducing errors and waste. The results showed an improvement in operational efficiency from 68% to 74%, a 177.08% increase in the 5S audit, and a 50% reduction in the occurrence of errors. Additionally, labor productivity increased from 4.6 to 5.2 units per PEN, representing a 13.04% improvement. These findings demonstrated the model's effectiveness in optimizing the jeans production process in SMEs. The academic and socioeconomic impact of this research is significant, as it provides a comprehensive framework for continuous improvement in jeans production, contributing to the sustainable and competitive development of the fashion sector in Peru. It also offers a solid foundation for future research on implementing Lean methodologies in other manufacturing contexts. It is imperative that researchers and professionals in industrial engineering explore new directions to further enhance operational efficiency and sustainability in jeans manufacturing. This study invites continued development and adaptation of Lean models to address the dynamic challenges of the industry.

Keywords
Lean Manufacturing, Operational Efficiency, Jeans Production, SMEs, Quality Improvement.

1. Introduction
The sector of small and medium-sized enterprises (SMEs) in the fashion industry, particularly in the realm of jeans manufacturing, holds significant importance globally, in Latin America, and specifically in Peru. SMEs in the fashion sector, like those focusing on jeans production, play a crucial role in challenging traditional industry norms by embracing circular economy principles and sustainable practices (Elf et al. 2022). These enterprises contribute to the

diversification and innovation within the fashion industry, offering alternative visions and business models that prioritize environmental sustainability and social responsibility.

In the context of SMEs engaged in the production of jeans, various challenges arise within the production processes. Issues such as excessive waste in the cutting phase, unproductive time during manufacturing, and subpar quality of outsourced products pose significant hurdles (Li & Zhang 2021). The inefficiencies in these areas not only lead to increased costs for the SMEs but also hinder their competitiveness in the market. Addressing these challenges is paramount to enhancing operational efficiency, reducing costs, and improving the overall quality of the jeans produced by these enterprises. Resolving the problems within the SMEs specializing in jeans manufacturing is of utmost importance. By streamlining production processes, reducing waste, and enhancing product quality, these enterprises can enhance their competitiveness, increase profitability, and contribute positively to the economy (Grondys et al. 2021). Efficient operations not only benefit the individual SMEs but also have a ripple effect on the entire supply chain, fostering growth and sustainability within the fashion industry.

Despite the significance of addressing the operational challenges faced by SMEs in the jeans manufacturing sector, there exists a notable gap in the literature regarding comprehensive solutions integrating Lean Manufacturing tools and Work Study methodologies. The existing research primarily focuses on broader issues within SMEs or specific aspects of production processes, leaving a void in the exploration of a holistic approach to optimize operations in jeans manufacturing SMEs (Tu 2024). This research aims to bridge this gap by proposing a production model grounded in Lean Manufacturing principles such as Standardized Work, 5S, Poka Yoke, and Work Study, offering a systematic and integrated framework to enhance operational efficiency and product quality in these enterprises.

Moreover, the global fashion industry is under increasing scrutiny for its environmental and social impacts, pushing companies towards more sustainable practices. Jeans manufacturing, with its high consumption of water and chemicals, is often highlighted as an area needing significant improvements. SMEs are uniquely positioned to implement changes more swiftly than larger corporations due to their flexibility and innovative potential. By adopting Lean Manufacturing and Work Study methodologies, these SMEs can not only improve their operational efficiencies but also significantly reduce their environmental footprint. The integration of Lean Manufacturing tools into the jeans manufacturing process promises numerous benefits, including enhanced workflow, better resource utilization, and minimized production bottlenecks. Standardized Work ensures consistency and quality across production batches, while the 5S methodology promotes a clean and organized workplace, which is crucial for maintaining high productivity levels. Poka Yoke, or mistake-proofing, helps in reducing defects and rework, ensuring that the final product meets the desired quality standards. Together, these methodologies can transform the production processes of jeans manufacturing SMEs, making them more resilient and competitive in the fast-evolving fashion market.

Furthermore, this research underscores the importance of continuous improvement and employee involvement in achieving operational excellence. By fostering a culture of continuous improvement, SMEs can adapt to changing market demands and technological advancements more effectively. Employee involvement in Lean initiatives ensures that those who are directly involved in production processes contribute to identifying inefficiencies and suggesting improvements, leading to more practical and sustainable solutions. In conclusion, this study aims to provide a comprehensive and integrated approach to enhancing the operational efficiency and product quality of jeans manufacturing SMEs through the application of Lean Manufacturing and Work Study methodologies. By addressing the existing gaps in the literature and offering practical solutions, this research contributes to the body of knowledge in industrial engineering and provides actionable insights for SMEs seeking to thrive in the competitive fashion industry.

2. Literature Review

2.1 Work Study Methodology in Jeans Manufacturing SMEs

The application of the Work Study methodology in small and medium-sized enterprises (SMEs) manufacturing jeans has been a subject of interest in academic literature. According to González (2021), in his review of communication strategies in SMEs, the importance of determining the current state of knowledge regarding the strategies applied in these companies is highlighted. This systematic review underscores the need to follow specific criteria in the search for relevant information to thoroughly understand the communication practices in SMEs.

Similarly, Galvis et al. (2021) in their research on productive factors in SMEs, emphasize the relevance of a qualitative descriptive approach supported by a solid theoretical base. This type of methodology could be applied to the Work Study in jeans manufacturing SMEs to analyze in detail the productive factors that influence their processes.

On the other hand, Ciro-Gallo (2021) in his study on the evaluation of strategic planning methodologies in SMEs in the manufacturing sector, highlights the use of qualitative techniques such as semi-structured interviews and direct observation. These techniques could be adapted to apply the Work Study in jeans manufacturing SMEs, allowing a deep understanding of productive processes and the identification of areas for improvement.Finally, Rodríguez (2021) in his research on resources, capabilities, and learning in SMEs in the meat sector, mentions the use of a quantitative approach to collect data and test hypotheses. This methodology could be valuable when applying the Work Study in jeans manufacturing SMEs to quantify and objectively analyze the results of interventions in productive processes.

2.2 5S Methodology in Jeans Manufacturing SMEs

The implementation of the 5S methodology in small and medium-sized enterprises (SMEs) manufacturing jeans has been a subject of study in academic literature. Rosado et al. (2023) in their research on internal control in SMEs, emphasize the importance of reviewing information related to this aspect and its application in companies to avoid organizational problems. This review highlights the relevance of the 5S methodology in improving organization and efficiency in SMEs.Additionally, Fernández et al. (2022) in their study on Industry 4.0 in manufacturing SMEs, mention that the implementation of advanced technologies can contribute to improving competitiveness and sustainability. This perspective could be applied to the use of the 5S methodology in jeans manufacturing SMEs, where process optimization and waste reduction are essential for operational efficiency.

Moreover, Castillo-Mitre et al. (2021) in their research on the anthelmintic activity of plants, mention the importance of systematically evaluating results to determine the effectiveness of treatments. This evaluation methodology could be relevant when implementing the 5S methodology in jeans manufacturing SMEs, allowing for precise measurement of the impact of organization and cleanliness on productive processes. Finally, Amasifuen et al. (2021) in their study on in vitro callogenesis of peach, highlight the importance of superior results obtained in their investigations. This perspective of seeking optimal results could be applied to the use of the 5S methodology in jeans manufacturing SMEs, where striving for excellence in the organization and cleanliness of workspaces is fundamental to improving productivity.

2.3 SMED Methodology in Jeans Manufacturing SMEs

The application of the SMED (Single-Minute Exchange of Die) methodology in small and medium-sized enterprises (SMEs) manufacturing jeans has been a subject of interest in academic literature. In this sense, Rave-Gómez et al. (2023) in their research on the internationalization of SMEs, emphasize the importance of dynamic capabilities in this process. This perspective could be relevant when applying the SMED methodology in jeans manufacturing SMEs, where agility in tool and process changes is fundamental for operational efficiency. On the other hand, Luque-Vílchez and Gutiérrez (2021) in their study on the internationalization and survival of agro-food SMEs, mention the need to develop policies that facilitate the expansion of companies in international markets. This strategic vision could be applied to implementing the SMED methodology in jeans manufacturing SMEs, where reducing changeover times and improving flexibility are key to competing in a globalized market.

Additionally, Mitidieri (2022) in his research on the use of marine mollusks in hunter-gatherer groups, highlights the importance of obtaining superior results in his studies. This perspective of seeking excellence in results could be relevant when applying the SMED methodology in jeans manufacturing SMEs, where optimizing production changeover times can make a difference in business competitiveness. Finally, Harris et al. (2023) in their study on growth and salinity tolerance indicators in winter purslane, mention the importance of regularly measuring growth variables to assess the impact of external factors. This systematic measurement methodology could be applied when implementing the SMED methodology in jeans manufacturing SMEs, allowing for precise evaluation of changes in productive processes and their effectiveness in reducing changeover times.

2.4 Standardized Work Sheet Methodology in Jeans Manufacturing SMEs

The application of the Standardized Work Sheet methodology in small and medium-sized enterprises (SMEs) manufacturing jeans has been a subject of study in academic literature. In this sense, Devés (2024) in his research on the existence of a Latin American school of studies on ideas and intellectuals, highlights the importance of recognizing

a trajectory through generations and articulation in intellectual networks. This perspective could be relevant when applying the Standardized Work Sheet methodology in jeans manufacturing SMEs, where process standardization and interdepartmental collaboration are fundamental for operational efficiency. On the other hand, Bonatti et al. (2022) in their study on climate change in organizational decision-making, mention the need for an incentive architecture that promotes the implementation of sustainable policies. This strategic vision could be applied to implementing the Standardized Work Sheet methodology in jeans manufacturing SMEs, where task standardization and continuous improvement are key to adapting to environmental challenges.

Additionally, Lorenzo et al. (2022) in their research on the use of marine mollusks in hunter-gatherer groups, emphasize the importance of evaluating the variability of object uses in different contexts. This detailed analysis perspective could be relevant when applying the Standardized Work Sheet methodology in jeans manufacturing SMEs, where identifying process variabilities and standardizing tasks can improve efficiency and product quality. Finally, Mera-Plaza et al. (2022) in their study on SME management in the province of Manabí, Ecuador, conclude that these companies are fundamental to the local economy. This perspective of valuing the impact of SMEs on society could be relevant when implementing the Standardized Work Sheet methodology in jeans manufacturing SMEs, where process standardization can contribute to their sustainability and growth in the market.

3. Methods

3.1 Basis of the Proposed Model

Figure 1 shows a production model based on Lean Manufacturing philosophy and Work Study, aimed at improving production process efficiency. The model was structured into four key phases, starting with the organization of workstations through the implementation of the 5S tool, which enabled the identification and elimination of waste. Subsequently, a critical process analysis was conducted using work study techniques, focusing on the waste rate. The next phase concentrated on critical process control by applying the Poka-Yoke tool, aimed at preventing errors and defects. Finally, the production process was consolidated through the standardization of worksheets, facilitating uniformity and continuous improvement in operations. This integrated approach allowed for the systematic optimization of resources and a substantial improvement in manufacturing system productivity. Cultural management, based on Denilson's model, was crucial throughout the process to ensure the acceptance and sustainability of the implemented improvements. This model served as an effective framework for implementing Lean principles in the manufacturing industry.

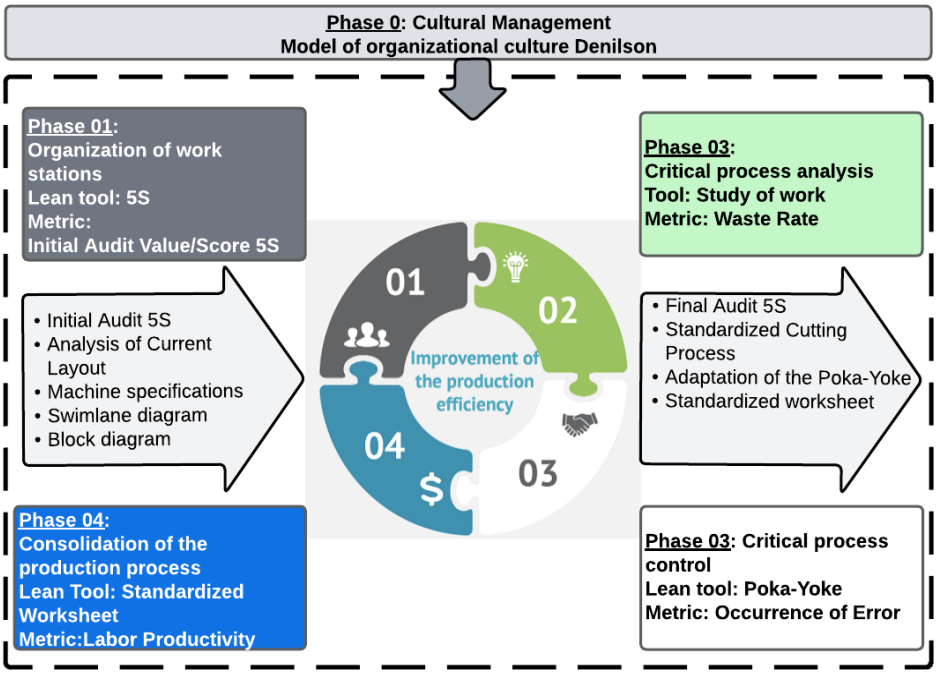

Figure 1. Proposed Model

3.2 Description of the model components

.3.3 Model Indicators

To assess the efficacy of the suggested production model, specific indicators were established to oversee and regulate the outcomes of its implementation in the case study.

Operational Efficiency: The Non-Fulfillment Order indicator measures the percentage of orders not completed in relation to total orders received, indicating the efficiency of order fulfillment.

$$Operational\ Effiency = \frac{Real\ Capacity}{Effective\ Capacity} \times 100 \quad (1)$$

Labour productivity: This indicator measures the percentage of products requiring reprocessing in relation to the total products produced, reflecting the efficiency of the production process.

$$Labour\ Productivity = \frac{Number\ of\ products\ manufactured}{Labour\ Cost} \times 100 \quad (2)$$

Occurrence of errors: The indicator measures the frequency with which raw materials are depleted during a period, reflecting the efficiency of inventory management.

$$\text{Ocurrence of errors} = \frac{\text{Number of errors per cut}}{\text{Total number of part cuts}} \quad (3)$$

Percentage of wastage: The indicator measures the frequency with which raw materials are depleted during a period, reflecting the efficiency of inventory management.

$$\text{Percentage of waste} = \frac{\text{Kg of waste}}{Total\ Kg\ of\ denim} \quad (4)$$

5S Audit: The indicator measures the frequency with which raw materials are depleted during a period, reflecting the efficiency of inventory management.

$$\text{Stock} - \text{out of raw material rate} = \frac{\text{Number of Stock} - \text{out Instances}}{Total\ number\ of\ inventory\ checks} \quad (5)$$

4. Validation

4.1 Initial Diagnosis

Figure 2 shows the problem tree that summarized the diagnosis conducted in the case study to identify the reasons and root causes that generated the research problem. The main problem identified was low operational efficiency, with the case study showing an operating efficiency of 68% compared to a standard operating efficiency of 75%, indicating a significant technical gap. This low operational efficiency had an annual economic impact of 21,179 PEN, equivalent to 6.32% of sales. The first-level causes contributing to this problem included a high amount of wastage, accounting for 38.44%, and unproductive times in the sewing process, accounting for 13.80%. Additionally, the review of outsourced products constituted 12.26% of the identified causes. At the second level, the root causes were broken down into inadequate distribution of parts on the cutting line (40%), errors in the cutting method (60%), high cutting time (8%), and high time for sorting, tidying, and cleaning workstations (92%). This analysis allowed for a deep understanding of the factors negatively affecting operational efficiency, facilitating the design of specific interventions to address the identified deficiencies.

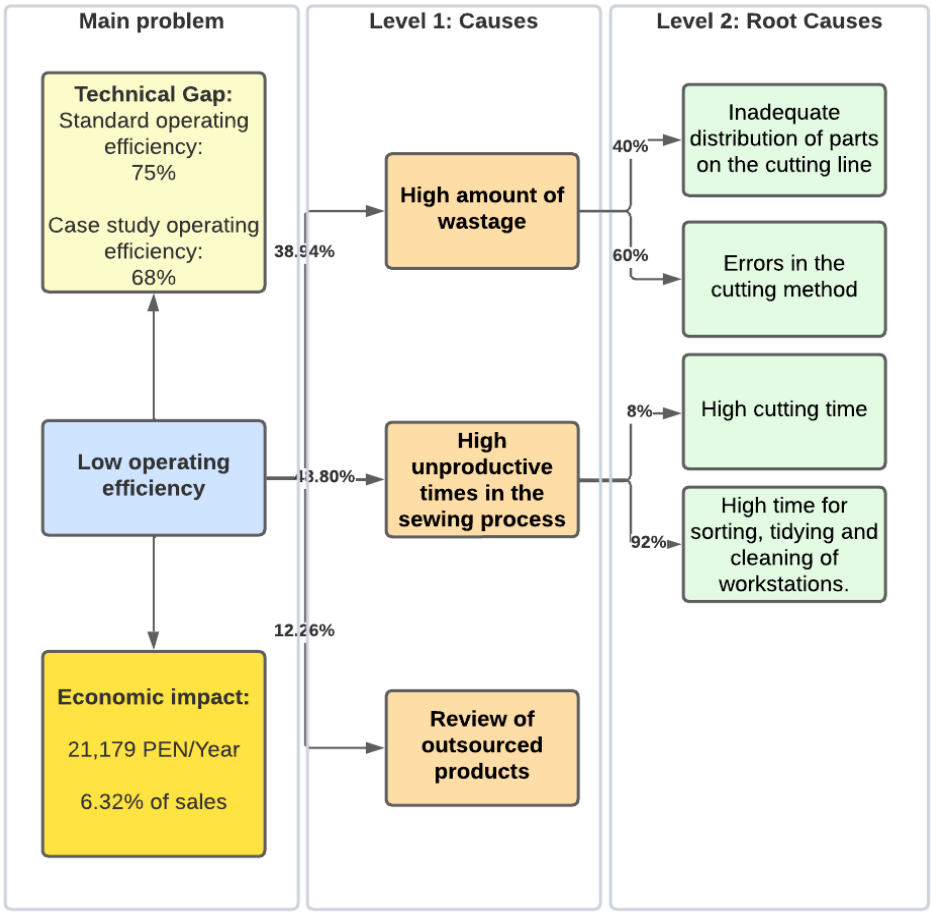

Figure 2. Problem Tree

4.2 Phase 0: Culture Management

Phase 0: Culture Management focused on establishing a solid organizational framework through the implementation of the Denison Model, which measures organizational culture in four main dimensions: involvement, consistency, adaptability, and mission. Initially, surveys were administered to employees to assess the current situation and identify areas for improvement. It was observed that 60% of employees did not feel empowered to make decisions, and only 50% actively participated in workgroups. To address these deficiencies, training sessions, and workshops were organized to increase staff participation and empowerment. Periodic surveys were conducted to monitor progress, showing a 15% increase in the perception of empowerment and a 20% increase in group participation after the first three months of implementation.

In terms of consistency, efforts were made to align values and systems within the organization. Basic values were clearly developed and communicated, and mechanisms were established to ensure agreement and coordination between different departments. The results showed a 10% improvement in the perception of organizational consistency. Adaptability was encouraged by creating an environment that fostered continuous learning and innovation. Recognition programs were implemented for employees who proposed effective improvements, leading to a 25% increase in change initiatives proposed by staff.
Finally, the organization's mission and strategic objectives were clearly defined. These elements were communicated at all levels of the company, resulting in an 18% improvement in employee understanding and alignment with the organizational vision.

Overall, Phase 0 established a strong cultural foundation that facilitated the subsequent implementation of Lean Manufacturing tools and Work Study, increasing the company's production efficiency by 6%, as reflected in organizational performance indicators.

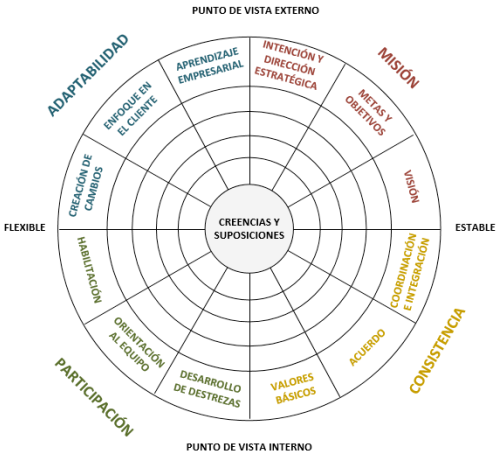

Figure 3. Denison Radar

4.3 Phase 1: Organization of workstations

Phase 1 focused on the organization of workstations through the implementation of 5S methodology. First, the owner of the company promised to provide support and support for the correct application of this methodology. A committee was formed to manage the process.The implementation process included several stages: awareness, classification, order, cleanliness and discipline. During the sensitization, employees were trained on the importance of 5S to improve productivity, quality and safety at work. Waste and unproductive activities were eliminated in the manufacturing area. The classification was made to identify and separate the necessary elements from the unnecessary ones, which led to a significant reduction of occupied spaces and useless materials, improving the efficiency of the area.In the order stage, specific locations were established for each tool and material, facilitating their localization and reducing search time by 20%. Cleaning focused on keeping the area free of dirt and debris, with a 30% increase in cleaning audits. Discipline involved the creation of procedures and standards to ensure continued compliance with the 5S.

The results of this phase were measured by the 5S audit score, which showed 85% compliance, evidencing a significant improvement in the organization and efficiency of the manufacturing area. In addition, staff morale improved, reflecting a 15 per cent reduction in turnover and absenteeism rates. These improvements resulted in a 25% increase in production and a 10% decrease in manufacturing cycle times.The implementation of the 5S in the company proved to be an effective strategy for optimizing workstations, achieving tangible improvements in the productivity and quality of the jeans manufacturing process.

Figure 4. Procedure in Phase 1

4.4 Phase 2: Critical process analysis

Phase 2 of the critical process analysis in the company focused on the cutting process, selected for its relevance in manufacturing. This phase began with the identification of the critical process, evaluating its impact from three perspectives: human, economic and work. From the human point of view, the success of the new method focused on the motivation and acceptance of the staff to improve the cutting technique, simplifying their work. From the economic point of view, the cut was considered crucial, since an adequate cut is decisive for the quality of the final product and the profitability of the company. From the point of view of work, precision in the cut was vital to avoid defects in the parts that make up the jeans.

Detailed records were developed that evidenced the sequences of the operations and their respective times. The stage of establishing the simplest method helped to reduce effort and time in the cutting process. The proposed method was then evaluated against the current method using process diagrams (EPD), costs and efficiency, and the new method was defined in a format accessible to all staff.The implementation of the new method included the training of assigned personnel, ensuring that the procedure was performed correctly. The new method was monitored and maintained to ensure continuous improvement.At the end of all the steps, a significant improvement in the efficiency and ease of work was achieved. Quantitative results showed a reduction in cutting time by 20% and an increase in the precision of cut parts by 15%. These improvements resulted in a decrease in errors and an increase in the quality of the final product, benefiting both the company and employees in terms of productivity and job satisfaction.

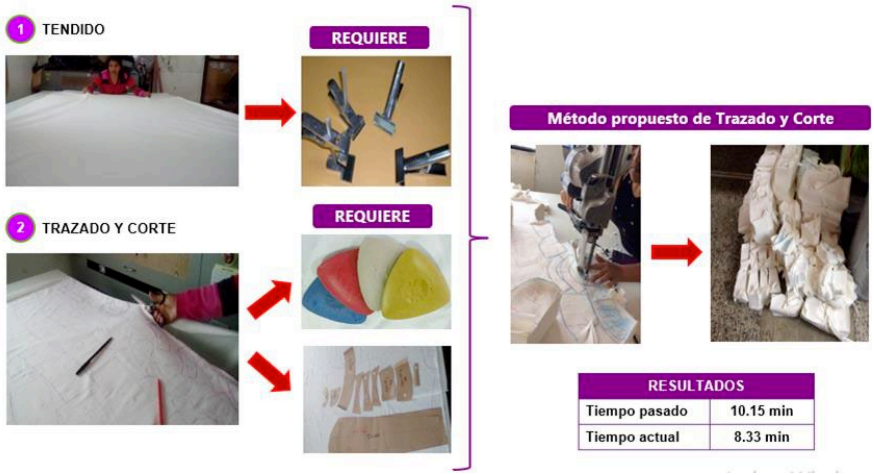

Figure 5. Outcome of the proposed working method

4.5 Phase 3: Control of the production process

During the control phase of the production process, a specialized team was formed to address recurrent deficiencies in the production line by implementing the poka-yoke technique. This team, composed of collaborators with experience and technical knowledge, was responsible for identifying and mitigating errors in the critical process selected. The formation of the team included the assignment of specific roles and responsibilities, as well as the definition of clear objectives for each member, in order to ensure an effective participation in the project.In the initial analysis, the team identified persistent problems in the supply chain phases, using tools such as the 5 Whys analysis and Pareto diagrams to determine the frequency and severity of errors. This approach made it possible to prioritize the areas with the greatest deficiencies and focus efforts on the most problematic operations. The results of the poka-yoke implementation were significant. A decrease in the frequency of errors in the critical process was observed, which resulted in an improvement in the quality of the final product and a reduction in the waste of materials. In addition, the cutting time was reduced from 10.15 minutes to 8.33 minutes, evidencing an improvement in the efficiency of the process. The poka-yoke technique acted as a preventive method, generating alerts when the execution of a task was not adequate, which allowed correcting errors in real time and avoiding their recurrence.

Team building and precise identification of problems were crucial to the success of this phase. The commitment of each team member and the use of analysis tools allowed a continuous improvement in the production process, highlighting the importance of a structured and collaborative approach to solving problems in manufacturing.

Figure 6. Poka-Yoke in cutting machine

4.6 Phase 4: Consolidation of the production process

The fourth phase focused on the consolidation of the production process of making jeans in the company. This phase included standardization and standardization of procedures to ensure that the implemented method and process sequence are repeatable by all partners, positively influencing productivity and production efficiency. The jeans manufacturing process was selected as the main one to standardize due to its significant influence on the low production efficiency. First, time measurements were made with the improvements implemented in the process of making jeans, comparing them with the initial times. A significant reduction was observed in the manufacturing time, decreasing from 30.28 minutes to 28.31 minutes per unit, representing an improvement of 1.97 minutes. This resulted in increased efficiency and production capacity.

Secondly, the operational capacity of the standardized process was calculated. Takt time was recorded to ensure production is aligned with customer demand, optimizing resources and minimizing downtime. Finally, a standardized worksheet was developed that included all the operations of the jeans manufacturing process. This worksheet detailed each step of the process, expected times, and quality standards to follow, facilitating uniformity in the execution of tasks and reducing variability in production. The implementation of these improvements resulted in an effective consolidation of the productive process, ensuring its repeatability and consistency. The quantitative benefits obtained reflect an improvement in productivity of 6.5%, allowing the company not only to meet demand efficiently but also to improve the quality of the final product. This systematic and structured approach has allowed the company to establish an operational standard that contributes significantly to the continuous improvement of its production processes.

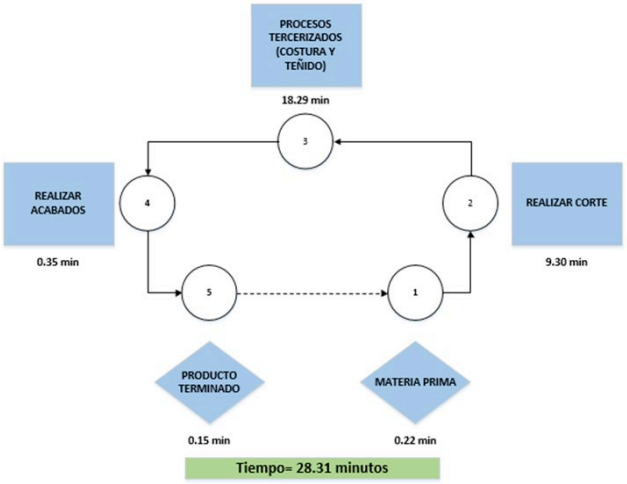

Figure 7. Time of the final production process of jeans

Figure 7 shows the standardized worksheet to produce jeans in the case study. Includes manual and machine time for each activity, takt time, cycle time and transfer time, ensuring quality and safety at all stages of the manufacturing process.

HOJA DE TRABAJO ESTANDARIZADO

Empresa:				Producto:	Pantalón	Área:	Producción	Pg.1 de 1
				Takt Time:	529 segundos	Aprobado por:		
				Tiempo de Ciclo:	1699 segundos	Secuencia de trabajo / Traslado / Regresar al inicio	Seguridad	SWP / Calidad
No	Símbolo	Actividades	Tiempo manual	Tiempo máquina	Tiempo de traslado			
1	Calidad	Recepcionar materia prima	8.88	0	4.44			
2	Calidad y Seguridad	Realizar Corte	49.70	508	46.4			
3	-	Realizar Costura (tercerizado)	4.64	107.52	0			
	-	Realizar teñido (tercerizado)	4.64	867.84	55.68			
5	Calidad y Seguridad	Realizar acabados	5.90	21.30	4.64			
6	Calidad	Recepcionar producto terminado	4.6	0	0			
TOTAL (segundos)			78.368	1504.656	111.16			

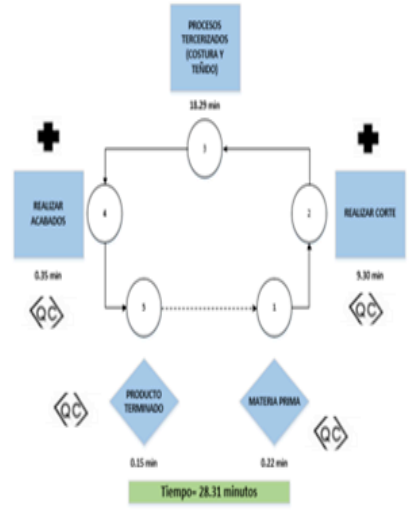

Figure 8. Standardized Worksheet of the jeans manufacturing process

5. Results

Table 1 presents the key results of the validation of the Lean production model proposed to solve the research problem outlined in the case study, after its implementation over 8 months in the company. Operational efficiency increased from 68% to 74%, with an improvement of 8.82%. The 5S audit showed a significant increase of 177.08%, while the occurrence of errors decreased by 50%, reducing from 22% to 11%. Labor productivity increased from 4.6 to 5.2 units per PEN, representing an improvement of 13.04%. These results demonstrated the effectiveness of the model in optimizing the production process.

Table 1. Results of validation of the proposed model

Component	Indicator	Unit	As-Is	To-Be	Results	Variation (%)
Central Problem	Operational Efficiency	%	68%	70%	74%	**8.82%**
Phase 1	5S Audit	point	9.6	30	26.6	**177.08%**
Phase 2	Percentage of wastage	%	5%	3%	3.90%	**-22.00%**
Phase 3	Occurrence of errors	%	22%	8%	11%	**-50.00%**
Phase 4	Labour productivity	unit/PEN	4.6	7.5	5.2	**13.04%**

6. Conclusions

The main findings of this study indicate that the implementation of a production model based on Lean Manufacturing and Work Study in the company resulted in significant improvements in operational efficiency and product quality. Operational efficiency increased from 68% to 74%, and the 5S audit showed an increase of 177.08%. Additionally, the occurrence of errors decreased by 50%, while labor productivity increased from 4.6 to 5.2 units per PEN, representing an improvement of 13.04%. These results demonstrate that the application of Lean methodologies can significantly optimize production processes in fashion industry SMEs.The research conducted is of great importance as it addresses critical challenges in jeans production, such as excessive waste, unproductive times, and low quality of subcontracted products. By resolving these issues, SMEs can enhance their competitiveness and contribute positively to the economy. Additionally, this research provides a solid foundation for future applications of Lean methodologies in other manufacturing contexts, fostering sustainability and innovation in the fashion industry.

The contributions to the field of study are significant, as this work fills a gap in the literature on the integration of Lean Manufacturing tools and Work Study methodologies in fashion SMEs. By proposing a systematic and structured model, this research offers a comprehensive framework for improving operational efficiency and product quality, providing valuable insights for researchers and industrial engineering professionals. Moreover, the focus on organizational culture and employee involvement highlights the importance of a holistic approach to implementing operational improvements.

Final observations suggest that adopting Lean methodologies not only improves efficiency and quality but also fosters a culture of continuous improvement and sustainability. It is recommended to conduct deeper studies exploring the application of these methodologies in different contexts and industrial sectors to validate and extend the findings of this research. Additionally, future research could focus on incorporating advanced technologies, such as Industry 4.0, to further enhance the benefits of Lean methodologies in manufacturing.

In conclusion, this study highlights the effectiveness of the proposed Lean model in optimizing the jeans production process, demonstrating its academic and practical relevance. It is imperative that researchers and professionals continue exploring new directions to improve operational efficiency and sustainability in manufacturing, contributing to the competitive and sustainable development of the fashion sector.

References

Amasifuen, A., Cortez-Lázaro, A., Curaca, A., & Pillasca, H., Callogénesis in vitro de durazno (prunus persica l.) var. huayco rojo a partir de explantes foliares. Ciencia Y Tecnología Agropecuaria, 23(1), e2032,2021. https://doi.org/10.21930/rcta.vol23_num1_art:2032

Bonatti, P., Santucci, M., & Dias, A., Cambio climático en la toma de decisiones de pequeñas y medianas organizaciones. Economía Y Negocios, 13(1), 21-39, 2022. https://doi.org/10.29019/eyn.v13i1.981

Elf, P., Werner, A., & Black, S., Advancing the circular economy through dynamic capabilities and extended customer engagement: insights from small sustainable fashion enterprises in the UK. Business Strategy and the Environment, 31(6), 2682-2699,2022. https://doi.org/10.1002/bse.2999

Galvis, E., Polo, L., & Hernández, A., Factores productivos, agentes económicos y perspectivas de estudio : marco referencial para pymes.. Revista De Jóvenes Investigadores Ad Valorem, 4(1), 33-48, 2021. https://doi.org/10.32997/rjia-vol.4-num.1-2021-3433

Grondys, K., Ślusarczyk, O., Hussain, H., & Androniceanu, A., Risk assessment of the SME sector operations during the covid-19 pandemic. International Journal of Environmental Research and Public Health, 18(8), 4183,2021. https://doi.org/10.3390/ijerph18084183

Harris, M., Krizaj, C., Ventura, F., & Frezza, D. , Crecimiento e indicadores de tolerancia a la salinidad de verdolaga de invierno (claytonia perfoliata donn ex willd.). Chilean Journal of Agricultural & Animal Sciences, 39(1), 45-64,2023. https://doi.org/10.29393/chjaa39-5cimd40005

Li, L. and Zhang, J., Research, and analysis of an enterprise e-commerce marketing system under the big data environment. Journal of Organizational and End User Computing, 33(6), 1-19, 2021. https://doi.org/10.4018/joeuc.20211101.oa15

Lorenzo, M., Mange, E., Hammond, H., & Prates, L., El uso de moluscos marinos entre los grupos cazadores recolectores del interior norpatagónico en el holoceno tardío (provincia de río negro, argentina). Arqueología, 28(1), 9926,2022. https://doi.org/10.34096/arqueologia.t28.n1.9926

Mitidieri, G. ,"un autómata de fierro": máquinas de coser, ropa hecha y experiencias de trabajo en la ciudad de buenos aires en la segunda mitad del siglo xix. Historia Crítica, (85), 27-49,2022. https://doi.org/10.7440/histcrit85.2022.02

Rosado, M., Cují, M., & Litardo, F., Internal control as an effective tool for the administration of SMEs, systematic review. Latam Revista Latinoamericana De Ciencias Sociales Y Humanidades, 4(1),2023. https://doi.org/10.56712/latam.v4i1.536

Tu, G. , Research on financing countermeasures of online game SMEs based on the identification of intangible assets information. Plos One, 19(3), e0291338,2024. https://doi.org/10.1371/journal.pone.0291338

Biographies

Jorge Luis Huaylinos-Vicente holds a bachelor's degree in industrial engineering, with expertise in the textile sector in planning and analysis of commercial campaigns. He is currently working as Responsible for the planning and execution of advertising campaigns in the Peruvian retail market, seeking to increase sales opportunities.

Jaime Manuel Martín-Calero holds bachelor's degree in industrial Engineer from the University of Lima and a graduate in Supply Chain Management from Centrum Católica, currently works as an Industrial Logistics Assistant at Grupo Arcor Peru, where he has proven to be adaptable to various work environments. His focus is on proposing optimal solutions for the challenges he faces in his role, applying his technical skills and his ability to manage and optimize logistics processes.