Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/AF6.20250171
Published: April 8, 2025

Production Model Based on Lean Manufacturing to Increase Productivity in The Cutting Area in A Textile SME

Giancarlo Alberto Barrantes-Sánchez
Facultad de Ingeniería, Universidad de Lima
Peru
20190216@aloe.ulima.edu.pe

José Luis López-Vargas
Facultad de Ingeniería, Universidad de Lima
Peru
20181063@aloe.ulima.edu.pe

Nicolás Salazar-Medina
Research Professor
Facultad de Ingeniería, Universidad de Lima
Peru
nsalazar@ulima.edu.pe

Abstract

In recent years, the Peruvian garment industry suffered drops in its production levels and its participation in the national market due to the low level of productive efficiency of its companies. In the cutting process of a garment company, productive problems were found such as defective overproduction, disorganization of the area and unproductive times that did not add value. The objective of the research is to propose an improvement model using Lean Manufacturing tools, specifically 5s, Kanban, SMED and Poka-Yoke, to increase the productivity level, currently at 78.12%. The results showed an increase in productivity of 10.78%, a reduction in defective production by 5.43% and a decrease in setup time of 12.03 minutes. These results were validated through a simulation of the tools in Arena 14.0, demonstrating the validity of the proposed model.

Keywords
Productivity, 5S, Kanban, SMED, Poka-Yoke

1. Introduction
In Peru, the textile industry is of significant importance due to its strong economic impact on the country. This industry is the third activity with the highest contribution to the manufacturing GDP with a 6.49% share in 2019 (SNI 2021); and represents 3.7% of total national exports and 6.6% of exported items in the last ten years (PRODUCE 2020). However, the sector has fallen 1.5% each year in the last decade in contrast to the positive annual variation of the national GDP of 3.6% and the manufacturing GDP of 1.7% due to lower productive activity caused by low technology, labor costs, infrastructure, and informality, which resulted in lower participation in the national economy (SNI 2022).

The pandemic affected all manufacturing industries in 2020. According to the SNI (2021), the apparel subsector fell by 35.9% and the textile subsector fell by 25.7% with respect to 2019, generating a sector drop of 32.1%. In recent years, it has registered a decreased production level, which distances it from the levels registered in past seasons. Considering the production level of 100 in 2012, its performance in recent years has been below the normal standard, as medium-sized companies now possess a productivity index of 77.6% (SNI 2021).

When producing garments, defective products and shrinkage often appear in the process, generating negative effects on companies in terms of unfulfilled orders, expenses, transportation and labor (Khan et al. 2021). The problem is evidenced in an improvement project conducted in Lima where the lack of planning for the reduction of shrinkage and defective products caused a bottleneck and affected the following processes, resulting in failures in the delivery of the final product (Anampa 2020). There is a significant difference between the productivity of small, medium and large companies in the sector due to a combination of factors such as the availability of resources, access to financing, economies of scale and management capacity (PRODUCE, 2020). Consequently, several studies have explored the implementation of Lean Manufacturing tools as alternative solutions to production problems. The main benefits of Lean tools are lead time reduction, stock and cost reduction, and less need for rework flows, which allows us to better understand processes and identify waste (Ribeiro et al. 2019). However, the implementation of lean manufacturing concepts alone is not enough, as a comprehensive approach that adopts a holistic perspective is required to face market competition (Sadiq et al.2021).

The main objective of this research is to increase the productivity of a textile company, which is below the industry standard. To achieve this purpose, a continuous improvement model is proposed that integrates four Lean Manufacturing tools: 5s, Kanban, Poka-Yoke and Single Minute Exchange of Die (SMED), which will be implemented specifically in the cutting area of the organization. It should be noted that one of the major limitations was the accessibility to the company's data information due to the confidentiality that the organization has with respect to them, so the data of the cutting area is limited.

1.1 Objectives

The research seeks to demonstrate that the model based on 5S, Kanban, SMED and Poka-Yoke will increase the level of productivity in the cutting area of textile and apparel companies. First, 5S will be used to organize the work environment and eliminate unproductive elements and processes. Secondly, Kanban will be used to visually regulate the workflow and materials used. Thirdly, Single Minute Exchange of Die (SMED) will be used to reduce non-value-added time and thus increase work flexibility. Finally, Poka-Yoke will be used to reduce the occurrence of human errors during the process.

2. Literature Review

2.1 5s in the textile sector

The 5s methodology is a useful tool to eliminate activities that do not add value and improve efficiency, and implementation of the 5S methodology can have many benefits for textile companies, including reducing unnecessary relocations, improving workplace organization, reducing penalties for late deliveries, and increasing revenue. (Andrade et al. 2019). Its principles of sorting, order, cleanliness, standardization, and self-discipline help companies eliminate waste, increase productivity and achieve a healthier work environment (Ribeiro et al. 2019). It is simple to implement by companies of all sizes, in one case study it increased productivity by 20% and reduced defective products by 30% (Senthil et al. 2022). Demirtas et al. (2022) agree that Kaizen and 5S methodologies can be valuable tools for SMEs seeking to improve their production processes but to do so, employees must be trained in 5S principles and must be committed to implementing them.

2.2 Kanban in the textile sector

The Kanban tool is highly effective for performance improvement in the textile industry as it reduces lead times, improves product quality and increases customer satisfaction (Habib et al., 2023). It requires time and effort, but those companies that apply it properly obtain benefits that help identify and correct problems in the production process to improve quality (Mohan et al. 2020). It should be implemented gradually, starting with simple processes and expanding to more complicated ones (Poetters et al. 2020). The implementation of Kanban in a medium-sized company helped reduce task delivery times by 25%, also allowing 10% more tasks to be completed in the same period of time (Weflen et al. 2021). In addition, according to Ribeiro et al. (2019), the main benefits of this tool are lead time reduction, stock and cost reduction, and less need for reprocessing flows, which allows us to better understand the processes and identify waste.

2.3 SMED in the textile sector

The SMED methodology focuses on reducing machine and process changeover times, including the activities required to prepare a machine to produce a new production batch (Collazos et al. 2022). It enables equipment setup operations to be performed in less than 10 minutes by allowing them to quickly move from processing the current product to processing the next product (Yacizi et al. 2020). It is divided into internal activities, which determine equipment stops, and external ones, which can be performed without interrupting the process, and when properly separated, time reduction occurs (Nikolić et al. 2023). After using SMED in a textile company, efficiency was improved with an average of 56.64% in the pretest and an average of 70.54% in the post test (Collazos et al. 2022).

2.4 Poka-Yoke in the textile sector

The Poka-Yoke tool is a valuable and economical tool for error prevention and productivity improvement and has a significant impact on process results (Harish et al. 2023). It helps to prevent human errors during processes, leading to an improvement in the quality of a process or service (Santos et al. 2023). The implementation of error-proof Poka-Yoke devices in a medium-sized company reduced reprocesses by 30%, waste by 20% and preparation times by 15%, in addition to improving the quality of the final product and overall productivity (Aguilar et al. 2023). Bucko et al. (2022) claim that the use of Poka-Yoke in a textile company allowed reducing the percentage of nonconforming parts from 23% to 0% in the case of seals with burrs, and from 10% to 5% in the case of seals without burrs. In addition, the cycle time was reduced from 18 seconds to 8.90 seconds.

3. Methods

This article is a case study, which was conducted in a company belonging to the textile and apparel sector, which allowed an analysis of the operation of companies in this industry. An improvement model based on the Lean Manufacturing tools previously mentioned was proposed with the purpose of increasing production efficiency in fabric cutting, involving aspects such as visual control, reduction of setup times and optimization of cycle times, a reduction of physical limitations and a reduction of quality errors, providing a more agile and efficient process within the area. The proposed method contains an input, which is the low level of productivity of the cutting process, and what is sought is that the output can increase the value of the indicator so that it is above the industry average. The model contains an input, which is the low level of productivity of the cutting process, and what is sought is that the output can increase the value of the indicator so that it is above the industry average. For this purpose, the model has 3 development phases: diagnosis of the problem, simulation and implementation of the simulation, these phases can be seen in Figure 1.

First, a diagnosis of the problem to be addressed was made by analyzing the current situation of the company and the processes involved in the production of garments, with the following steps: An analysis of the main measurement indicators that allow evaluating the company's performance, a Pareto diagram together with a Value Stream Mapping (VSM) to determine the times and quantify the main problems of the process, determining that the cutting was the one that presented the greatest number of setbacks, an Ishikawa diagram to determine the causes that originate the problem and finally a problem tree that evidences the problem to be addressed and its economic impact, in addition to its reasons and root causes. In this way, it was identified that the main reasons for low productivity were poor planning of the fabric layout due to high lot change times and absence of visual tools, inefficient use of the workspace due to different physical limitations, and finally a high amount of waste due to inadequate quality control.

Once the problems and their causes were identified, an investigation was conducted to find tools that could provide engineering solutions and improve efficiency, seeking to improve the productivity indicator. For this, the proposed model considers appropriate the integration of 4 engineering tools through a simulation, which complement each other, which are the following: 5S, Kanban, SMED and Poka-Yoke. Finally, the level of productivity improvement is measured once the simulation has been conducted, and a comparison is made between the current situation and the situation proposed by the model. Considering the above, Figure 1 shows the proposed model and its development.

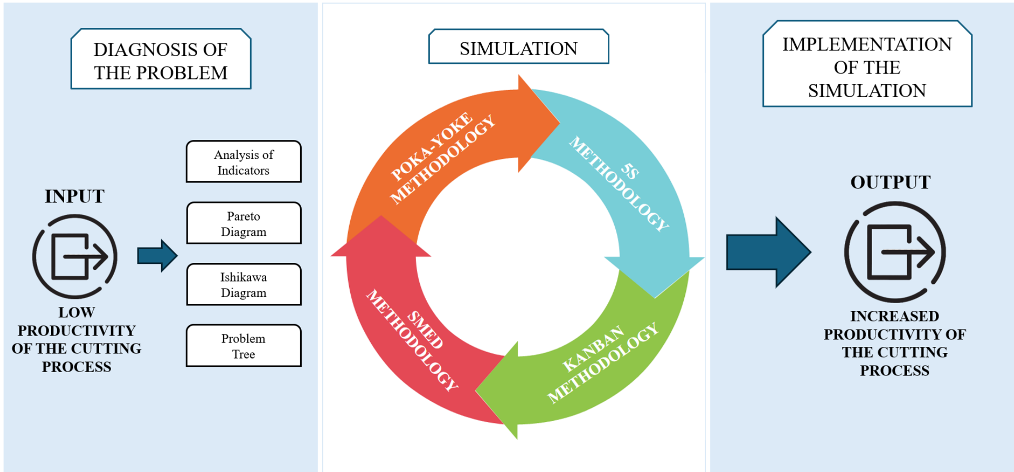

Figure 1. Proposed model

4. Data Collection

In order to collect data for the research, information had to be extracted from diverse sources such as scientific articles, annual industry reports and research books on Lean Manufacturing tools. In addition, several visits were made to the production plant to get a more detailed view of the company and the performance of its activities, the managers of each area were interviewed about the performance of their areas and the indicators they use to measure the performance of their activities. With the information obtained from the workers, a VSM of the production process was made, which included the cycle time of each process and the number of workers per area, then a Pareto was made with the standard cycle times per process, determining that the cutting process was the production bottleneck representing 63.25% of the total. Once this problem was identified, an Ishikawa was performed to explain the reason for the delays in the process, and with this information a problem tree was made to explain the causes, which could translate into problems related to losses in waiting and unnecessary times, as well as an excess in the generation of waste. With the information obtained and the State of the Art, it was validated that it was possible to use Lean Manufacturing tools to provide a solution to the productivity problem. Figure 2 shows the steps followed in the search for results.

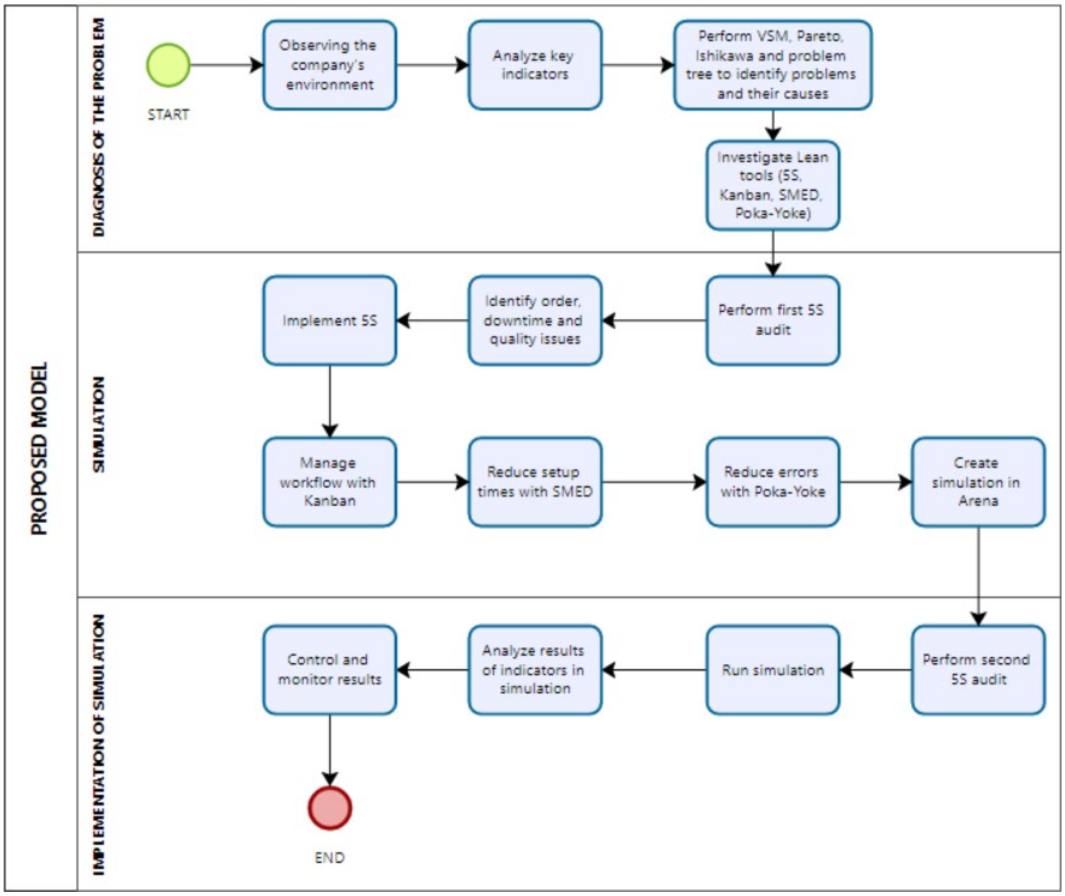

Figure 2. Diagram to achieve results

4.1 Implementation of 5S, Kanban, SMED and Poka-Yoke

In this phase, the Lean Manufacturing tools are put into practice through experimentation and pilot tests within the company. An order of use was proposed, being first the 5s tool to organize the work environment, maintain cleanliness, and allow the implementation of the other tools, then Kanban to visually manage the workflow and manage materials, then SMED to reduce setup times and increase project flexibility, and finally Poka-Yoke to reduce the occurrence of human errors.

For the 5s tool, an internal audit was conducted to determine the current state of the organization and the steps to be taken to improve it. First, all unnecessary items that did not provide value were classified and categorized using 5s cards to indicate the action plan for each of them. Secondly, organizational and product placement measures were proposed to increase awareness of the area's products. Third, a cleaning plan was developed to detect problems caused by dirt and create corrective measures to mitigate them. Fourthly, measures were standardized through continuous maintenance and habit creation. Finally, the previous steps were standardized with the education of the participants of the implementation and a final audit was performed with the changes made and the improvements in the order.

For the Kanban tool, all the sub-processes of the area and the required input and output quantities of each of them were mapped in order to have detailed control of the workstations. Then, Kanban cards were implemented so that the workers have a visual identification of the production system, it should be noted that only one card is used per order. Each card details relevant information such as planned quantity, unused quantity, product and shrinkage, also note that they are differentiated in the colors green as completed, yellow in process and red with immediate attention problems. Finally, Kanban boards will be used in a visible position for the workers, which will display in detail the quantities entering the plant from the processing stage to the authorized stage and the stage of each activity to be conducted.

For the SMED tool, the most important activities during the batch changeover between each order cut were identified and classified according to their category, whether internal or external, specifying the corresponding times for each of them, which were calculated using a stopwatch. With the information obtained, the total batch changeover time was identified through the sum total of internal tasks, allowing the next step of performing an analysis and solution proposals to reduce the times without consuming too many resources for the company, thus reducing the total batch changeover time to a lower value than the current one.

For the Poka-Yoke tool, the main potential failures were identified during the performance of the work by means of an AMEX matrix, analyzing their severity, probability of occurrence and probability of non-detection, determining the riskiest activities of all. Once detected, the reason for the problems was determined and Poka-Yoke cards were prepared, which serve to provide solutions to these problems and detail the improvements that will be obtained if they are implemented. In this way, failures are mitigated in order to have better control of them and avoid their occurrence in future operations.

The following are the results obtained from the current scenario of the cut-off area. To measure the level of productivity, a sample of the monthly production was made, taking the average of the quantities managed during a period of 22 working days. To measure the defective products, the route sheets provided by the workers were used, in which the parts of the fabric that could not pass the cutting process were counted.

- Effectiveness level (%): $\frac{Actual\ production}{Expected\ production} * 100\% = \frac{267462}{316800} * 100\% = 84.43\%$
- Efficiency level (%): $\frac{Actual\ production - Defective\ production}{Actual\ production} * 100\% = \frac{267462-19967}{267462} * 100\% = 92.53\%$
- Productivity level (%): $Effectiveness\ level\ (\%) * Efficiency\ level\ (\%) = 84.43\% * 92.53\% = 78.12\%$
- Average order processing time: $\sum \quad Order\ attention\ lead\ time = 219\ minutes\ and\ 33\ seconds$
- Defective products level (%): $\frac{Defective\ production}{Actual\ production} * 100\% = \frac{19967}{267462} * 100\% = 7.47\%$

5. Results and Discussion

Following the result of the level of organization of the area obtained in the initial 5S audit, which was 44%, a one-month pilot test was conducted to organize the area and create an environment conducive to increased efficiency using this methodology. To improve this result, the cards were placed in those products that do not add value to the area by grouping equal products, these were filled by the person in charge of the area with the corresponding information and were placed in areas of easy visualization for the operators, then it was necessary to register a control of actions in which these could be applied within the work area, registering all those unnecessary elements that need the application of the tool, A cleaning plan was made during the second and third week of implementation with the support of the operators under the supervision of the manager and the cutting assistant, the main errors in cleaning and the causes that originate them were recorded, creating corrective measures to solve these problems. A 5S mural was installed with a record and continuous monitoring of the workers and their rates of compliance with the progress to meet the objectives set, and finally, through discipline, all participants were educated to commit themselves to achieve the objectives previously set through self-discipline and personal responsibility, obtaining a final result after a final audit of 95%.

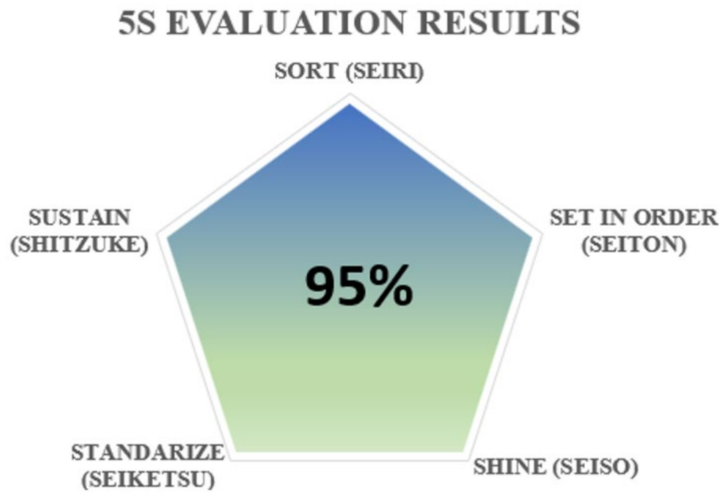

Figure 3. 5S final audit results

Once the 5S pilot test was completed, we proceeded with the simulation. First, an As Is model was made in the Arena software in which the number of orders served in the cut during a working day was simulated by taking the times obtained in the company for each operation performed. Twelve orders are processed daily, entering every 38.12 minutes and arriving at the latest at 4:00 pm to meet the daily production. The distributions of each activity were performed using the exponential and uniform distributions in the Input Analyzer software. To validate the simulation the entities to be modeled will be the production orders attended during the day since the process revolves around their fulfillment. The different operators of the process were modeled in their respective activities and were considered as resources, they are 9 workers and 16 activities in the process, thus obtaining the current values.

Six main indicators were obtained in the simulation: average order attention time, average cutting table cleaning time, average cutter greasing time, average daily work time, number of defective parts and number of parts produced.

Table 1. Current scenario indicators

Simulation indicators	Values obtained
Average order processing time	219.33 minutes
Average cutting table cleaning time	9.49 minutes
Average cutting machine greasing time	5.49 minutes
Average daily working time	627 minutes
Number of defective parts	1185 parts
Number of parts produced	11950 parts

To conduct the improvement, the proposed tools were simulated, elaborating changes in the process and creating a To Be model. Thanks to the Kanban and Poka-Yoke analysis, the use of the Kanban board and the Poka-Yoke cards allowed improving the visual control of the operation and reducing errors, ensuring a lower amount of defective production. Changes were generated in the "Quality Control" sub-process, where 30% of the parts entered the control and 70% of these passed, now only 20% entered since there was a greater confidence of correct production and 90% of the total analyzed passed the control.

In addition, the SMED analysis reduced the setup times of the "Cutter greasing" and "Cutting table cleaning" activities, which occupied a total of 14.98 minutes of the total cycle time. With the changes proposed by the tool, the simulation of these times was reduced to occupy 2.95 minutes in total, thus reducing the unproductive times and the total time of the cutting operation, which previously had a value of 219.33 minutes, to an improved value of 184.46 minutes. For the calculation of the final number of replicas, 186 replicas were simulated to have a maximum error of 480 pieces in the simulation.

Table 2. Improved scenario indicators

Simulation indicators	Values obtained
Average order processing time	184.46 minutes
Average cutting table cleaning time	2.49 minutes
Average cutting machine greasing time	0.46 minutes
Average daily working time	577 minutes
Number of defective parts	263 parts
Number of parts produced	12872 parts

Figure 4 below shows the simulation diagram that was used in Arena to obtain the desired results. It simulates the process from the time the mold is printed, the fabric is stretched, the fabric is cut, it goes through quality control and the finishes are made to leave the cutting area.

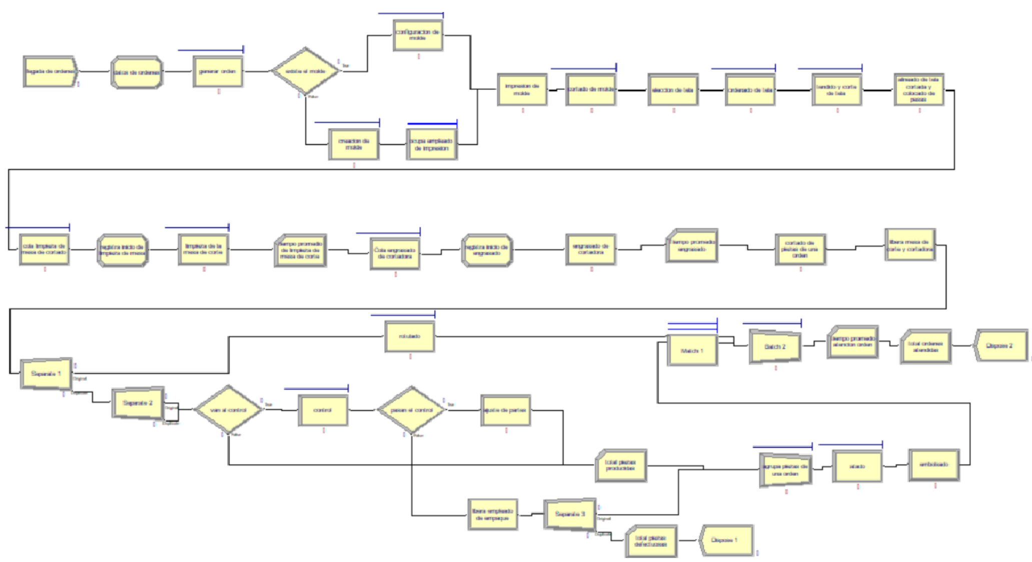

Figure 4. Graphical representation of the improved model

5.1 Numerical Results

The indicators after the simulation are presented below, it should be considered that the productivity level of the average production conducted within 22 working days is considered.

- Effectiveness level (%): $\frac{283162}{31800} * 100\% = 89.38\%$
- Efficiency level (%): $\frac{283162-5786}{283162} * 100\% = 97.96\%$
- Productivity level (%): $89.38\% * 97.96\% = 87.56\%$
- Average order processing time: $184\ minutes\ and\ 46\ seconds$
- Defective products level (%): $\frac{5786}{283162} * 100\% = 2.04\%$

5.1 Graphical Results

The following visual results were obtained during the implementation of the pilot test and simulation:

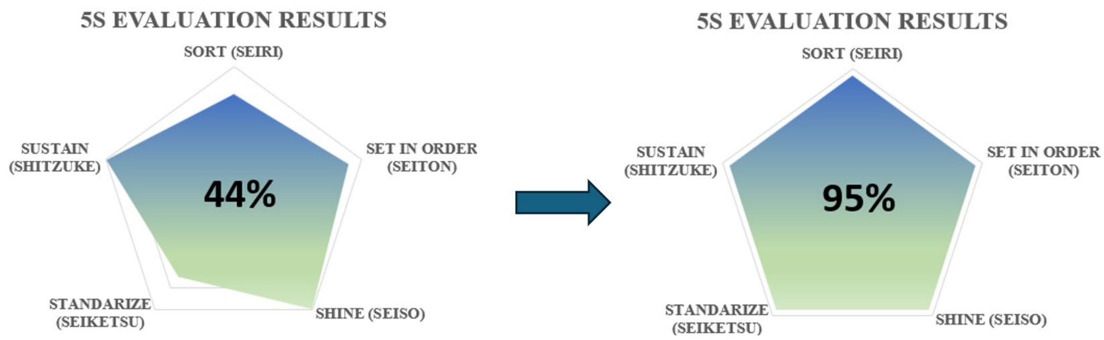

Figure 5. 5S Audit Comparison before and after

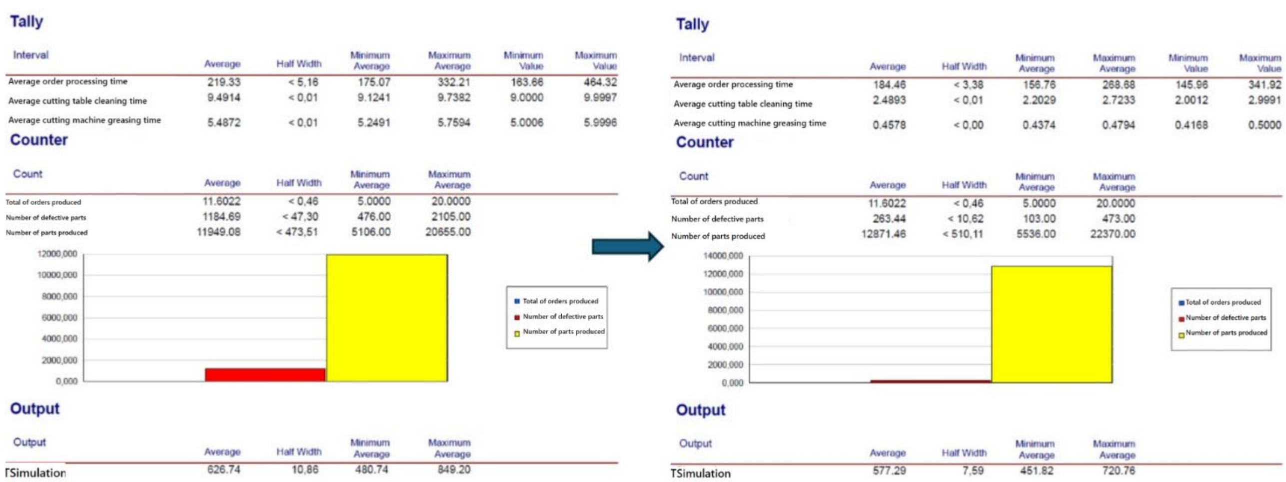

Figure 6. Simulation indicators As Is and To Be

5.1 Validation

The proposed model was validated through a pilot test that lasted 1 month for the 5S tool and a simulation in Arena software for the other methodologies, with the latest information obtained after the simulation results, the calculation of the indicators was performed again. The table shows the variation between the initial and final results.

Table 3. Comparison of indicators results between scenarios

Indicators	Initial Situation	Final Situation
Productivity Level (%)	78.12%	87.56%
Order Processing Time (min)	219.33	184.46
Defective Products (%)	7.47%	2.04%

With the results obtained for the indicators in the final situation after the simulation, it can be concluded that the main objective of the research was met, since all the indicators showed an improvement with respect to the initial situation, validating the improvement. However, if the model is implemented in the company, it may be open to further improvement.

6. Conclusion

The implementation of the Lean Manufacturing tools was of vital importance for the improvement of the productivity of the fabric cutting process since, when applied correctly and with appropriate standardization and commitment on the part of the workers, they facilitate the reduction of waste and unproductive time. At the end of the implementation of the improvements, productivity of 87.56% was achieved, representing an increase of 9.44% compared to the initial value of 9.44%, demonstrating the reduction of the technical gap of the indicator and validating the contribution of the methodology conducted to obtain better manufacturing efficiency.

The 5s tool improved the level of organization and distribution of materials and resources in the work area by establishing classification and cleaning measures, Kanban and Poka-Yoke improved production flow control thanks to visual and faulty production control, and SMED reduced waiting times between processes to achieve a reduction in total cycle time, thus generating a more efficient cut.In conclusion, the results obtained validate the improvements achieved in the organization thanks to Lean Manufacturing tools and their impact on efficiency, effectiveness and productivity, demonstrating that they are a valuable alternative for streamlining processes, optimizing manufacturing work and obtaining better results.

References

Anampa, C., Propuesta de mejora para reducir mermas en el proceso de producción de prendas de vestir en la empresa CMT Del Sur S.A.C., Universidad Inca Garcilaso de la Vega, Lima, Perú, 2020. Available: http://repositorio.uigv.edu.pe/bitstream/handle/20.500.11818/5209/TRSUFICIENCIA_ANAMPA%20TASAYCO%20CRHISTIAN%20.pdf?sequence=1&isAllowed=y

Andrade, Y., Cárdenas, L., Viacava, G., Raymundo, C. and Domínguez, F., Lean manufacturing model for the reduction of production times and reduction of the returns of defective items in textile industry, Advances in Intelligent Systems and Computing, vol. 954, pp. 387-398, 2019.

Bucko, M., Schindlerova, V., and Krupova, H., Application of Lean Manufacturing Methods in the Production of Ultrasonic Sensor, Tehnicki Vjesnik, 2022. doi: 10.17559/TV-20220421141917

Collazos, E., Reátegui, V., Balbuena, J., Chong, R., and Chiroque, D., SMED methodology and the 5S philosophy to improve the process in the sewing lines of a garment company, Revista Universidad y Sociedad, vol. 14, no. S6, pp. 415–426, 2022. doi: 10.24874/IJQR17.01-16

Demirtas, E. A., Gultekin, O. S., and Uskup, C., A case study for surgical mask production during the COVID-19 pandemic: continuous improvement with Kaizen and 5S applications, International Journal of Lean Six Sigma, vol 14, pp. 679–703, 2022. doi: 10.1108/IJLSS-02-2022-0025

Habib, M., Rizvan, R., and Ahmed, S., Implementing lean manufacturing for improvement of operational performance in a labeling and packaging plant: A case study in Bangladesh, Results in Engineering, vol. 17, 2023. doi: 10.1016/j.rineng.2022.100818

Harish, D., Gowtham, T., Arunachalam, Narassima, M., Lamy, D., and Thenarasu, M., Productivity improvement by application of simulation and lean approaches in a multimodel assembly line, Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture, 2023. doi: 10.1177/09544054231182264

Khan, M., Khatri, A. and Marri, H., Identification of Defects in Various Processes of Spinning: A Case Study of Kotri, Sindh, Pakistan, Proceedings of the First Central American and Caribbean International Conference on Industrial Engineering and Operations Management, pp. 385-395, 2021.

Ministerio de Producción, Estudio de Investigación Sectorial Sector Textil y Confecciones 2020, 2020. Available: https://ogeiee.produce.gob.pe/index.php/en/shortcode/oee-documentos-publicaciones/publicaciones-anuales/item/1065-estudio-de-investigacion-sectorial-sector-textil-y-confecciones-2020

Mohan, M., Dhiyaneswari, J. M., Ridzwanul, J., Mythreyan, S., and Sutharsan, S. M., A framework for lean manufacturing implementation in Indian textile industry, Materials Today: Proceedings, vol. 33, pp. 2986-2995, 2020. doi: 10.1016/j.matpr.2020.02.979

Nikolić, J., Dašić, M., and Đapan, M., SMED as an indispensable part of Lean Manufacturing in the small and medium enterprises, International Journal for Quality Research, vol. 17, no. 1, pp. 255–270, 2023. doi: 10.24874/IJQR17.01-16

Poetters, P., Schmitt, R., and Leyendecker, B., Application of lean methods - a business game study in German companies, Management and Production Engineering Review, vol. 11, no. 2, pp. 3–10, 2020. doi: 10.24425/mper.2020.133724

Ribeiro, I., Godina, R., Pimentel, C., Silva, F. and Matías, J., Implementing TPM supported by 5S to improve the availability of an automotive production line, Procedia Manufacturing, vol. 38, pp. 1574-1581, 2019.

Sadiq, S., Amjad, M., Rafique, M., Hussain, S., Yasmeen, U. and Khan, M., An integrated framework for lean manufacturing in relation with blue ocean manufacturing - A case, Journal of Cleaner Production, vol. 279, 2021.

Santos, E., Lima, T., and Gaspar, P., Optimization of the Production Management of an Upholstery Manufacturing Process Using Lean Tools: A Case Study, Applied Sciences, vol. 13, no. 17, pp. 1-29, 2023. doi: 10.3390/app13179974

Senthil, K., Akila, K., Arun, K., Prabhu, S. and Selvakumar, C., Implementation of 5S practices in a small-scale manufacturing industries, Materials Today: Proceedings, vol. 62, pp. 1913-1916, 2022.

Sociedad Nacional de Industrias, Industria Textil y Confecciones Marzo 2021, Lima, Perú, 2021. Available: https://sni.org.pe/wp-content/uploads/2021/03/Presentacion-Textil-y-confecciones-IEES.pdf

Sociedad Nacional de Industrias, Perspectivas y análisis del sector textil y confecciones, Lima, Perú, 2022. Available: https://sni.org.pe/wp-content/uploads/2022/01/31-Final_Perspectivas-y-analisis-sector-textil-y-confecciones.pdf

Weflen, E., MacKenzie, C., and Rivero, I., An influence diagram approach to automating lead time estimation in Agile Kanban project management, Expert Systems with Applications, vol. 187, pp. 1–12, 2022. doi: 10.1016/j.eswa.2021.115866

Yacizi, K., Gökler, S., and Boran, S., An integrated SMED-fuzzy FMEA model for reducing, Journal of Intelligent Manufacturing, vol. 32, no. 6, pp. 1547–1561, 2021. doi: 10.1007/s10845-020-01675-x

Biographies

Giancarlo Alberto Barrantes-Sánchez is a Bachelor of Industrial Engineering from the University of Lima with experience in production, supply and logistics area with three years of experience in the textile, fishing and automotive industries, and is currently working as a sourcing assistant on a retail company.

José Luis López-Vargas is a Bachelor of Industrial Engineering from the University of Lima and a project management professional with six years of experience in his own real estate company. He specializes in overseeing real estate developments, ensuring efficiency, and optimizing project execution.

Nicolás Salazar-Medina is a professor and researcher at the Faculty of Engineering and Architecture of the University of Lima, Peru. He holds a PhD degree in Industrial Engineering from West Virginia University, United States, and two master's degrees: one in Management Systems from the University of Puerto Rico and the other in Industrial Hygiene from West Virginia University. He is an industrial engineer from the University of Lima and has accumulated extensive professional experience in industries of diverse sectors, including textile, fiber cement and paper, working in the areas of management, process optimization and industrial safety. He has also worked as a consultant in industrial engineering and has been a professor at the University of Lima, where he has contributed to the training of new professionals. His research work is reflected in the publication of academic articles in specialized journals, addressing issues related to operational efficiency, industrial risk management and innovation in production processes.