ISBN: 978-628-95207-4-3. ISSN: 2414-6390. Digital Object Identifier: 10.18687/LACCEI2023.1.1.198

Lean Management model to improve production efficiency in an MYPE in the textile sector

Vannia Candelario-Cordova, BSc[1], Sebastian Chumpitaz-Quispe, BSc[1] and Juan Quiroz-Flores, PhD[1]
[1]Facultad de Ingeniería, Programa de Ingeniería Industrial, Universidad Peruana de Ciencias Aplicadas, Lima, Perú
u20163947@upc.edu.pe, u201629172@upc.edu.pe and pciijqui@upc.edu.pe

Abstract*—— In Peru, the textile sector represents 6.3% of GDP within the manufacturing sector, being one of the most important in the country. Peru is considered one of the main exporters of organic pima cotton, however, the main problem in the textile sector is low efficiency, with the national average being 50.3%, remaining below the average of other countries such as Colombia (79.12%) India (90%) and Bangladesh (41% to 62%). The causes that generate low efficiency are: disorder in the work area, absence of standardized processes and erroneous preventive maintenance plan. The present study proposes a lean model based on the 5S components, Standardized Work and the autonomous pillar of the TPM, these tools have the objective of reducing the causes presented that cause low efficiency. The present proposed research manages to reduce rework from 13.39% to 7.39%, reaches a 5S authorship level of over 75% and increases production efficiency from 44.78% to 50.3%; With this, a precedent is set that contributes to the increase in the efficiency of the country's textile SMEs.

Keywords—Lean Manufacturing, 5S, Standardized Work, Efficiency, TPM.

I. INTRODUCTION

Currently, the textile and clothing sector represents one of the largest economic activities in Peru and the world, since, according to the Ministry of Production, the manufacturing sector contributes 14% to the national GDP [1] within which, the sector textile is positioned as the third most representative activity contributing with 6.4% [2]. Likewise, it is estimated that the textile sector generates more than 400,000 direct jobs per year [3]. It should be noted that 96.5% of Peruvian companies belong to the SME sector [4]. On the other hand, in the period from 2019 to 2020, the textile sector experienced a drop in exports of 17.6% due to the situation generated by Covid-19 [5]; however, an increase in exports was recorded during the first quarter of 2021 thanks to the growing demand for cotton garments, with the main markets being: USA (+5.29%), Chile (+53.64%), Colombia (+ 13.64%), Brazil (+2.88%) and Canada (+111.86%) [6].

Exports from the textile sector totaled $351 million, representing an increase of 22.7%, in relation to the year 2020 [6]. This indicates the importance of this market and its improvement for continuous annual growth. Different investigations affirm that the problems of the textile sector occur due to the lack of models for the implementation of the productive processes and due to the different technical failures in the equipment and personnel [7]. It is necessary to indicate that these problems affect companies in various fields; For example, the case of a micro-manufacturing company in the metal-mechanical sector is highlighted, which, due to the low efficiency of its plant, only fulfills 65% of its clients' orders, affecting profits by $150,000 per year [8]. Additionally, the case of a textile Mype is presented that presented reprocessing problems in 32% of the annual orders that resulted in an annual loss of $43,000 per year [9]. The companies in the cases presented opted for the implementation of lean manufacturing with the mission of eliminating or reducing the problems presented.

The tools belonging to Lean Manufacturing are used by different authors in companies in the manufacturing sector in different countries of the region with the main objective of increasing efficiency, reducing rework and optimizing costs [10]. Some studies indicate that for the correct implementation of lean manufacturing it is important to have the techniques of the methodology and take into account the development of the appropriate organizational culture image [11] In the case of SMEs textile companies, it is necessary the commitment of the entire company as well as senior management in order to comply with the training and resources for the correct implementation of the LM. [12] One of the main LM tools used to increase efficiency and meet order deliveries on time are the 5S [13]. According to the reviewed literature, the main function of this tool is to eliminate waste in the process through the order and cleanliness of the workstations [14]. On the other hand, another of the tools used is the standardization of work with the aim of reducing downtime and increasing the efficiency of production lines. The main objective is to prevent operators from carrying out their activities randomly [15]. Work standardization is not a routine that cannot be changed, on the contrary, it is a way of performing operations efficiently in the present [15]. The lack of detailed sequences of work procedures is a common problem in small manufacturing companies [16].

With the literature review, cases were evidenced in which the non-compliance of the orders affected by 13% the operating costs of a manufacturing company, who implemented the 5S and Study of Methods to increase the level of compliance, obtaining as a result the increase in productivity by 83% and the reduction

Digital Object Identifier: (only for full papers, inserted by LACCEI).
ISSN, ISBN: (to be inserted by LACCEI).
DO NOT REMOVE

of defaults by 19%. [17]. On the other hand, the case of a Peruvian textile company with reprocessing problems and excessive losses in the production process was reviewed. In this case, the 5S, Poka Yoke and Standardized Work were implemented, obtaining as a result a 3% increase in efficiency, raising it from 68% to 71% [18]. The literature found belongs, for the most part, to studies in large companies and not in SMEs. Therefore, the present study seeks to relate the tools with the objective of increasing the efficiency of the production line of polo shirts for children. The study is classified as follows: Section II focuses on the state of the art, where the tools used to solve the problem are explained. Section III presents the contribution of the article. Finally, in section IV, the initial diagnosis of the company under study is shown.

II. LITERATURE REVIEW

A. *Lean Manufacturing in the textile sector*

According to previous studies, various authors highlight that applying LM reduces and/or eliminates overload (muri), instability (mura) and waste (muda) in all procedures of manufacturing companies [19]; For this reason, the LM philosophy focuses on continuous improvement, focused on customers and the quality of their products by eliminating waste [20], encouraging companies to offer better quality products [21], since, with the application of the tool, efficiency can be increased, production costs reduced and processes standardized in the short term [22].

Similarly, other authors proposed the implementation of a model of the LM methodology together with Change Management in a small textile manufacturing company located in Peru, in order to reduce downtime, said model is based on Lean tools and work study tools with a focus on change management, through Change Management. In addition, the theory of restrictions, the Balance of Lines and the Time Measurement Method were used as pillars of change, in order to reduce unnecessary movements and improve the ergonomics of the staff. So that standardized work is finally used to commit staff to the new proposed model. The implemented model achieved a reduction in cycle time from 26.8 minutes to 20.1 minutes, productivity from 13 min/garment to 24 min/garment, and order fulfillment was reduced from 39% to 18% [17].

B. *5S in the production process of the textile sector*

According to previous research, they indicate that 5S is defined as an act of making the difference between necessary and useless things in the real place where each employee works [23]. Likewise, the 5S concept is constantly used in small and medium-sized manufacturing companies, since it is considered a strategic tool to improve product quality [24]. The 5S tool improves the work area of a company and the quality of the products through five steps that in turn need adaptability and the involvement of the company's personnel [18].

Taking this into account, several authors have applied Lean tools (VSM, 5S, Standardized Work) in textile SMEs, where they first carried out a VSM to observe the cycle times per unit and batch to establish the production capacity, to apply the 5S tool , the authors made the "5 whys" which was a support tool to identify which tool can be proposed to eliminate the identified waste. Finally, for the standardized work, a technical sheet was applied in the cutting process and the order sheet was redesigned so that a list of materials can be made and it can be made visual. The result obtained shows that, thanks to the use of the 5'S and standardization of work, a time reduction in the cutting process (bottleneck) of 50 minutes was achieved, which caused the production capacity to increase by 4 units per day, increasing 12% of capacity [25].

Similarly, in a similar study, various LM tools were used, such as Deming Cycle, 5S and Kanban, in a textile SME, with the mission of reducing production times. For the application of the 5S, a training schedule model, red card and a cleaning program model were applied to facilitate the operators in the application of the 5S. For Kanban, the authors modeled a training schedule and an improved record sheet. Finally, for the Deming Cycle, they implemented a flow that will allow a complete analysis of the company, from the collection of information to the simulation of the solution. Thanks to the application of these tools, the production time was reduced from 671 seconds/unit to 380 seconds/unit, increasing the production of 576 garments per month, which caused unfulfilled orders to decrease from 9% to 2% [26]. Similarly, in a similar study, various LM tools were used, such as Deming Cycle, 5S and Kanban, in a textile SME, with the mission of reducing production times. For the application of the 5S, a training schedule model, red card and a cleaning program model were applied to facilitate the operators in the application of the 5S. For Kanban, the authors modeled a training schedule and an improved record sheet. Finally, for the Deming Cycle, they implemented a flow that will allow a complete analysis of the company, from the collection of information to the simulation of the solution. Thanks to the application of these tools, the production time was reduced from 671 seconds/unit to 380 seconds/unit, increasing the production of 576 garments per month, which caused unfulfilled orders to decrease from 9% to 2% [26].

C. *Standardized work applied in production process to improve efficiency in the textile industry*

According to various authors, standard work can be defined as specific instructions that can help make a product more efficiently [18]. This tool specifically defines how tasks should be performed to obtain a competitive advantage over the competencies by establishing the best methods and sequences for each process [27]. Standard work is made up of three key elements: standard cycle time, standard work sequence, and standard work-in-progress [18]. The main objective of this tool is to prevent operators from performing their operations randomly [27]. The standardized work registers the standard process in a flow so that it can be available to everyone, it is important that there is consistency in the standardization in order to maintain improvements with constant evaluations in the future [18].

Another study confirms the ideas mentioned above by other authors, mentioning that it is important to carry out a methodology that is intended to counteract situations such as the variability of the manufacturing process, so that a detailed

sequence of operations can be obtained in a clear and orderly manner. the different procedures that may exist within the company, since they generally present a diversity of products [16].

Similarly, other authors proposed the implementation of Line Balancing and standardized work in the textile sector, in order to avoid long times and low production capacity. For this model, the authors implemented a VSM, to verify the delivery time together with the times that add and do not add value, then Line Balancing was applied so that resources can be optimally assigned and thus the lines can be balanced. of company production. Finally, a procedure manual for the making of a blouse was made, so that the operators can take ownership of their work area and a responsibility can be generated on their part. The implemented methodology achieved an increase in the efficiency of the production line from 55.88% to 76.79%.

D. Autonomous maintenance in the production process of the textile sector

According to previous research, the TPM is a Japanese methodology developed in the 70's due to the need to improve the products and services of companies [28]. Likewise, the TPM aims to establish a loss prevention system in all commercial activities. This system does not include accidents, errors, or failures throughout the production cycle [29]. The autonomous maintenance pillar is fundamental in the TPM and consists of activities that the operators can carry out in order to properly care for their own equipment [30], likewise, it is necessary to acquire a culture of order and cleanliness with the support of the 5S as a fundamental part for the fulfillment of the outlined objectives.

According to another investigation carried out, it indicates that autonomous maintenance increases the participation of production personnel in the various maintenance activities, it also emphasizes the importance of having trained personnel, so that they can become familiar with their equipment and put them into operation, it is important establish routines related to cleaning activities and maintenance tasks. to ensure the reliability of the equipment [31].

III. INNOVATIVE PROPOSAL

A. Proposed model

Thanks to the diagnosis made to a Peruvian company in the textile sector, one of its main problems in said company is low efficiency. The initial analysis carried out in the research showed that one of the main reasons for the low efficiency of the textile sector is the reprocessing that represents 89% of the categories with the highest index for the year 2020-202. Thanks to the diagnosis made, it was possible to know the 2 root causes of the problem: disorder in the work area (with an impact of 53% on the problem) and absence of standardized processes (with an impact of 36% on the problem)

This research project seeks to use the most effective tools of the LM methodology (VSM, 5'S, Standardized Work) and TPM (Autonomous Maintenance) in the production process of the textile sector, the previously mentioned cases show improvements in the production process, which leads to better production efficiency. However, it has been shown that there is much research on 5S standardized work and autonomous maintenance, as tools to improve efficiency, but little research that applies these tools together. In this sense, it is necessary that these Lean tools can be validated and disseminated to improve efficiency in the textile sector. Regarding the innovation of the model, corresponding to [26] who applies the 5S tool, to reduce production times, in said article I apply the 5S tool in an efficient and successful way, but I do not apply the standardized work tool, to that the operators can have defined their activities to carry out after the application. Likewise, in the fourth step of standardizing, it only assigns this function to one person, which could be improved by assigning activities and roles on a panel using tools and visual instructions. Regarding [32] who applies the Lean 5S tools and standardized work in the same way as tha model presented to reduce the defect rate, the innovation is that we apply the study of methods in standardized work compared to these authors. This model consists of applying these tools to identify, analyze, and solve the root causes that generate low efficiency in textile SMEs.

Taking as a starting point the diagnosis already carried out thanks to the VSM. It is important to specify that this model has as its main objective to disseminate and validate the use of Lean Manufacturing model, Figure 1, it is important that the model presents a precedent that serves as scientific evidence that contributes to improving the efficiency of the textile sector. It is important to highlight the new model that will be presented in the research, where the LM "5" S and Standardized Work (Study of methods and standardized work) tools will be continuously implemented, where these tools have the same objective: to increase the efficiency of a textile company

Mentioning the above, in Figure 1, the first component of the model is the application of the 5, in order to correctly order and organize the materials and tools located in the wrong spaces in the production area, for which management tools were included. visual and audits within its 5 phases. The main tools considered for the application of this component are:

- Initial audit
- 5'S training
- List of objects
- Red cards
- Clean Program
- Check List of compliance with cleaning activities
- 5'S audit formats and future improvements

The second component aims to increase the efficiency of the production area by reducing downtime and reprocessing, after having applied component 1, in order to standardize it. Therefore, a new study of methods was carried out to measure the improvement that was previously carried out, successively the standardized work was applied, in order to implement the new method to be carried out, for which the new workers were trained and guided so that they do not exist problems in the development of the proposed model.

Finally, the third component has the objective that each of the operators participate in the maintenance activities for the machinery, for which it is important that they carry out periodic

inspections, in order to identify some problems or faults that the machinery could present, with the aim of so that they do not delay production, which would obviously directly affect efficiency.

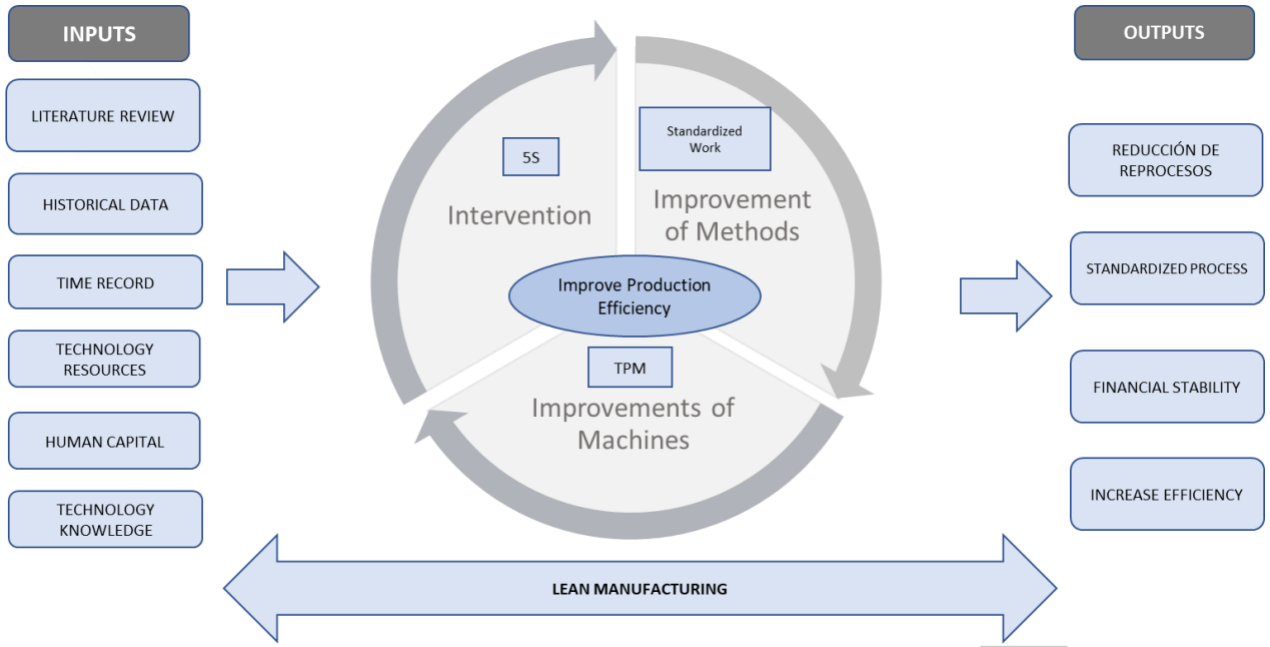

Figure 1. Proposed Model. Adopted from [16], [26], [33]

B. Design of the proposed method

Figure 2 shows in detail the sequence that will be followed to implement the model proposed in the research, starting with the VSM analysis to measure the current situation of the company, the implementation of Lean Manufacturing tools and the application of autonomous maintenance, so that later the indicators and effectiveness of the model design can be evaluated. Next, the phases presented by the solution model will be presented:

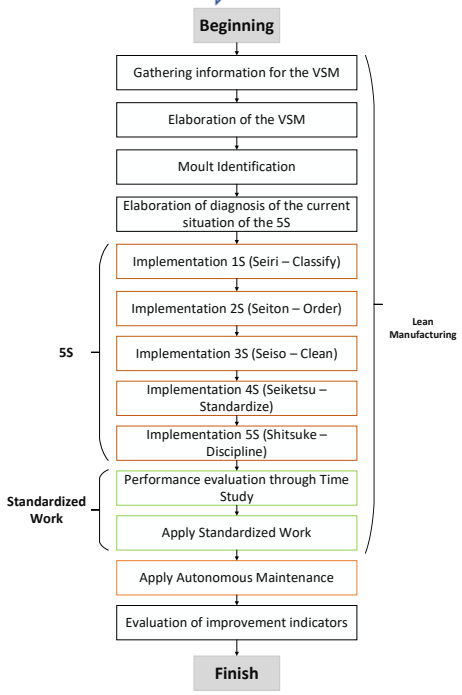

Figure 2. Proposed Method.

C. Model Indicators

Next, the four indicators will be shown, which served to measure the performance of the proposed model:

a. Percentage of reprocesses due to disorder in the work area (α)
Thanks to the analysis carried out, the LM model can reduce this indicator to a value. [34]

$$\propto = \frac{\#\ of\ reprocesses\ due\ to\ disorder\ in\ the\ area}{Total\ Production} \times 100 \quad (1)$$

b. Percentage of reprocesses due to the absence of standardized processes (β)
Various studies indicate that the proposed model can reduce this indicator by 66%. [7]

$$\beta = \frac{\#\ of\ reprocesse}{Total\ Production} \times 100 \quad (2)$$

c. 5S audit level percentage (γ)
Various studies indicate that the proposed model can increase this indicator to 73% [42]

$$\gamma = 5S\ questionnaires \quad (3)$$

d. Availability Percentage (δ)
Various studies indicate that the proposed model to increase the availability of machinery to 93% [34]

$$\delta = \frac{Number\ of\ machines\ available}{Number\ of\ machines} \quad (3)$$

IV. VALIDATION

A. Scenario Description

In order to show that the research is reliable and effective in solving the low efficiency in the textile sector, a "simulation" was carried out as a validation method shows in Figure 3 using Arena Simulation Software V16. For these was neccesary 30 replication. The simulator carried out took into consideration all the processes for the production of the scout collar polo shirt: overlocks, straight and covered.

B. Initial diagnosis of the study company

The company under study has a very low rate of efficiency, with an average of 49.5%, as Table I, which is a very low level with the national and international average, which means that the total cost of losses incurred by the company covers a total of approximately $95,160.00. This indicates that the total economic impact of the problems generated in the production area is 7.93%, generating large losses for the company under study.

C. Design and validation result

In order to validate the results expected by the research project, the design of the current system of the production process of the scout collar polo shirt was carried out, the process begins with overlock 1 where an overlock is performed on the shoulders, then it goes through overlock 2 in order to join the shoulders, then it goes through straight 1 where the sleeves are glued, then it goes through overlock 3 where the neck is glued to the body, then it goes through straight 2 where a placket is passed, on line 3 the placket is settled, so that later in overlock 4 the neck is edged, in overlock 5 the sides of the polo are closed, then it passes through covered 1 where it is done the tubular hem in the sleeve, then passes through the covered 2 where the hem of the skirt is made and finally in the station of straight 4 the loop is fixed, after these processes the scout collar polo shirt is obtained.

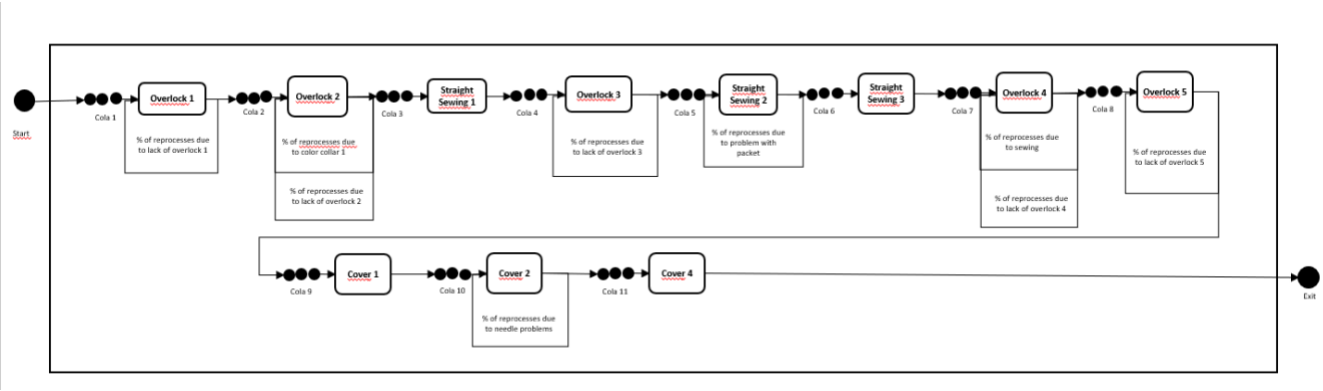

Figure 3. Graphic Simulation of the System

Once the current system was explained, the simulation was carried out with the improvement made. It is important to mention that for the 5'S tool of component 1 "intervention" a pilot was carried out where it was possible to increase the % of the 5'S audit level to 80%. Secondly, thanks to the application of the simulation in component 2 "method improvement", for which the standardized work tool was used, thanks to the application it was possible to reduce the percentage of reprocesses from 13.39% to 10.55%, It was also possible to increase the total production by 24,000.00 more units. Third, through the application of the Autonomous Maintenance Pillar of the TPM, it was possible to increase availability by 8%.

Thanks to the structured application of the research project, carrying out the 3 components where Lean tools are applied, it allowed to increase efficiency by 0.61%.

V. DISCUSION AND RESULTS

A. New Potential Scenarios

Thanks to the simulation carried out, it was possible to substantiate and validate the effectiveness of the proposed proposal that can help reduce operating times, properly organize and order the production plant and increase efficiency. With these results, research was satisfactory and reliable. But in order to demonstrate greater reliability for future research, it is important that they can be shown to be implementable in new scenarios. According to these results, some scenarios that are similar to the model made will be considered, for which they will be applied in the scenarios of jackets and shirts.

- *Jacekts*

The division of jackets presents a large percentage of delays in orders and a high percentage of economic losses, which is also due to the low efficiency that occurs in Peruvian textile SMEs. Currently the current efficiency of jacket production is 47.5%, being surpassed only by the production of polo shirts.

In the same way as the production of poles, it goes through the same stations: overlock, straight and covered, but in a different order. It is important to mention that the percentage of reprocesses due to the absence of standardized work reaches 43% due to the fact that it presents a higher percentage of reprocesses due to open seams and skipped stitches. However, unlike polo shirts, jackets have a longer cycle time, since they require more seams and details.

- *T-Shirt*

This division also presents problems of low efficiency, presenting 49.8%, being surpassed by the two production lines presented above. Just as the scout collar polo line has the same seasons: overlock, coated and straight, it is important to highlight that the seasons of coated 2 and straight 4 change, because the line of shirts requires decorative stitching and elastic finishes. . Likewise, the percentage of reprocesses due to absence of standardized work reaches 41% due to the fact that it presents a higher percentage of reprocesses due to skipped stitches and the absence of remeshing processes. However, unlike polo shirts, shirts have a longer cycle time, but less than jackets.

B. Potencial Scenarios Results

After carrying out the analysis of the new scenarios proposed in the textile sector: jackets and shirts, the evaluations and improvements that could be obtained in said scenarios will be presented below (see Table I and Table II).

TABLE I. JACKETS RESULTS

Indicator	Actual Value	Results
% of reprocesses due to disorder in the work area	11.39%	7.86%
% of reprocesesses due to absence of standardized work	4.58%	3.34%
Total Production	125,000 units	132,000 units
Efficiency level	49.50%	52.28%

C. Analysis of Results

Thanks to the analysis and the application carried out in section IV, the validation and effectiveness of the solution model that is being proposed with the application of the simulation can be carried out, since it was possible to appreciate the fulfillment of the indicators proposed in the production process. , achieving that the times in the Remallado 2 process (bottleneck) are reduced. In order to evaluate and determine the impact of the presented model, it is important that they are also validated in economic and environmental terms, since it is important that the monetary benefits that can be obtained through the project

TABLE II. T-SHIRT RESULTS

Indicator	Actual Value	Results
% of reprocesses due to disorder in the work area	10.18%	6.92%
% of reprocesesses due to absence of standardized work	4.93%	3.55%
Total Production	195,000 units	205,000 units
Efficiency level	50.20%	52.77%

and the repercussions that can be generated are presented and demonstrated. in the environment through the implementation

D. Economic Analysis

As a first result, it is observed that the net cash flow values do not present negative values, therefore, it is observed that in the three scenarios there are no economic losses at the beginning of each year.

In addition, as a result of the financial indicators in the pessimistic scenario, it is found that the NPV is $55,270.00 and the IRR is 27.19%. What this means is that, at the end of the 5 years of investment, the total NPV is recovered in profits and that for each sol invested, profits of S/0.2719 are obtained.

Second, as a result of the financial indicators in the moderate scenario, it is found that the NPV is $108,331.00 and

the IRR is 43.64%. What this means is that, at the end of the 5 years of investment, the total NPV is recovered in profits and that for each sol invested, profits of S/0 are obtained. 4364.

Third, as a result of the financial indicators in the optimistic scenario, it is found that the NPV is $189,890.00 and the IRR is 68.88%. What this means is that, at the end of the 5 years of investment, the total NPV is recovered in profits and that for each sol invested, profits of S/0 are obtained. 6888.

Finally, in the 3 scenarios, the financial indicators are valid according to their criteria, which means that the project investment made does not present risks of losses; that is, there is economic viability.

VI. CONCLUSIONS

Lean Manufacturing and Work Study tools in the Arena software, efficiency can be increased from 46.98% to 50.59%, complying with overcoming the technical gap of the company. The main achievement of this work is the increase of 0.61% in efficiency for a Textile SME. It is important to highlight that for the application of the 5S there was resistance from the employees, since it completely changed their schedule of daily work activities, also is necessary to mention that these is faced with training and reinforcing culture. The company's employees do not apply the 5S due to misinformation and lack of interest on the part of the company. The design model is based on a Deming Cycle applying Lean and Work Study tools, so that continuous improvement can be obtained in textile companies, since this design can be constantly improved. It has been foreseen that the project is economically viable thanks to a loan that will be made for 5 years with a TEA of 13.35%, the amount of $ 82,000.00, it is important to highlight that there will be no economic losses, which are reflected in the cash flow. economic cash as a result of the financial indicators in the pessimistic scenario it is found that the NPV is $55,270.00 and the IRR is 27.19%. What this means is that, at the end of the 5 years of investment, the total NPV is recovered in profits and that for each sol invested, profits of S/0.2719 are obtained. Regarding the regulatory framework, it is important to mention that the company must ensure the safety of the employees when applying the 5S, especially when carrying out the Cleaning stage, for which the company must guarantee this stage.

REFERENCES

[1] PRODUCE (2016). Industria Textil y Confecciones, Estudio de Investigación Sectorial.

[2] IEES (2021). Industria Textil y confecciones – marzo 2021. Instituto de Estudios Económicos y Sociales, Lima.

[3] Instituto Nacional de Estadística e Informática (20 de junio de 2018). Encuesta Nacional de Hogares sobre Condiciones de Vida y Pobreza 2017.

[4] Kishimoto, K., Medina, G., Sotelo, F., & Raymundo, C. (2020). Application of lean manufacturing techniques to increase on-time deliveries: Case study of a metalworking company with a make-toorder environment in Peru. Advances in Intelligent Systems and Computing, 18(1), 952-958. Doi: https://doi.org/10.1007/978-3-030- 25629-6_148

[5] Instituto de Estudios Económicos y Sociales (IEES). (2019). Reporte estadistico de la Industria Manufacturera en el año 2019.

[6] La Camara (28 De Septiembre De 2021). La Camara.

[7] Realyvásquez-Vargas, A., Arredondo-Soto, K., Carrillo-Gutiérrez, T., & Ravelo, G. (2018). Applying the Plan-Do-Check-Act (PDCA) Cycle to Reduce the Defects in the Manufacturing Industry. A Case Study. Applied Sciences, 8(11), 2181. doi:10.3390/app8112181.

[8] Kishimoto, K., Medina, G., Sotelo, F., & Raymundo, C. (2020). Application of lean manufacturing techniques to increase on-time deliveries: Case study of a metalworking company with a make-toorder environment in Peru. Advances in Intelligent Systems and Computing, 18(1), 952-958. Doi: https://doi.org/10.1007/978-3-030- 25629-6_148

[9] Mejia Carrera, S., & Rau Alvarez, J. (2019). Analysis of improvement for the implementation of lean manufacturing tools in the clothing line of a textile company in Lima. Proceedings of the LACCEI International Multi-Conference for Engineering, Education and Technology. doi: https://doi.org/10.18687/LACCEI2019.1.1.236

[10] Marudhamuthu, R.K., Krishnaswamy y Pillai, D. M. (2011). The development and implementation of lean manufacturing techniques in Indian garment industry. Jordan Journal of Mechanical and Industrial Engineering, 63(1),527 -532

[11] Santos, A. y Sposito, L. (2020). A New Holistic Approach for the Integration of Lean Manufacturing Tools and Digital Technologies. International Journal of Mathematical, Engineering and Management Sciences, 5(5), 851-868. doi: 10.33889/IJMEMS.2020.5.5.066

[12] Singh, J., Singh, H. & Singh, G. (2018). Productivity improvement using lean manufacturing in manufacturing industry of Northern India - A case study. International Journal of Productivity and Performance Management, 67(8), 1394-1415. doi: 10.1108/IJPPM-02-2017-0037

[13] Kumar, D. V., Mohan, G. M., & Mohanasundaram, K. M. (2019). "Lean tool implementation in the garment industry. Fibres and Textiles in Eastern Europe", 27(2), pp.19–23. https://doi.org/10.5604/01.3001.0012.9982

[14] Durakovic, B., Demir, R., Abat, K., & Emek, C. (2018). Lean manufacturing: Trends and implementation issues. Periodicals of Engineering and Natural Sciences (PEN), 6(1), 130-143.

[15] Mor, R. S., Singh, S., Bhardwaj, A., & Sachdeva, A. (2018). Productivity gains through standardization-of-work in a manufacturing company. https://doi.org/10.1108/JMTM-07-2017-0151

[16] Barrientos Ramos, N., Tapia Cayetano, L., Maradiegue Tuesta, F., & Raymundo, C. (2020). Lean Manufacturing Model of Waste Reduction Using Standardized Work to Reduce the Defect Rate in Textile MSEs. 1–8.

[17] Durand-Sotelo, L., Monzon-Moreno, M., Chavez-Soriano, P., Raymundo-Ibañez, C., & Dominguez, F. (2020). "Lean production management model under the change management approach to reduce order fulfillment times for peruvian textile SMEs. Paper presented at the IOP Conference Series: Materials Science and Engineering", , 796(1) doi:10.1088/1757-899X/796/1/012023

[18] Cespedes-Pino, R., Hurtado-Laguna, J., Macassi-Jaurequi, I., Raymundo-Ibañez, C., & Dominguez, F. (2020). "LEAN production management model based on organizational culture to improve cutting process efficiency in a textile and clothing SME in peru". Paper presented at the IOP Conference Series: Materials Science and Engineering, , 796(1) doi:10.1088/1757-899X/796/1/012004

[19] Gijo, E., Jiju & Vijaya (2018). Application of Lean Six Sigma in IT support services – a case study. The TQM Journal, 31 (3), 417- 435.

[20] Buehlmann, U. & Fricke, C. (2016). Benefits of Lean transformation efforts in small- and medium-sized enterprises. Production & Manufacturing Research, 4(1), 114- 132.

[21] Simeonova, A. & Nedyalkov, A. (2019). A Priori Research on Lean Tools in Business. Proceedings of University of Ruse, 58(1), 134-145.

[22] Amin, A., Mahmood, W. & Kamat, S. (2019). Lean Practices for Waste Prioritising in Machining Based Product. International Journal of Mechanical and Production, 9(1), 305-308.

[23] Ghosh, M. (2012). Lean manufacturing performance in Indian manufacturing plants. Journal of Manufacturing Technology Management, 24(1), 113-122

[24] Setiawan, N., Salleh, M. R., Ariff, H. A., & Rahman, M. A. A. (2021). "A proposal of performance measurement and management model for 5S sustainability in manufacturing SMEs": A Review. 15(2), 1–15. https://doi.org/10.1299/jamdsm.2021jamdsm0017

[25] Carlos, L. H. J., & Polo, J. E. R. (2021). Improvement in the sportswear manufacturing process using lean manufacturing tools and mathematical optimization. Paper presented at the Proceedings of the LACCEI International Multi-Conference for Engineering, Education and Technology, , 2021-July doi:10.18687/LACCEI2021.1.1.251

[26] C. Aranda-Yaulimango, M. Ramos-Aleman, J. Quiroz-Flores, and J. Alvarez-Merino, "Proposal for improvement in the management of the productive process to increase profitability in a SME of confections applying lean tools," SHIRCON 2019 - 2019 IEEE Sci. Humanit. Int. Res. Conf., no. November 2016, 2019, doi: 10.1109/SHIRCON48091.2019.9024884

[27] A. Carrillo-Corzo, E. Tarazona-Gonzales, J. Quiroz-Flores, and G. Viacava-Campos, "Lean Process Optimization Model for Improving Processing Times and Increasing Service Levels Using a Deming Approach in a Fishing Net Textile Company," pp. 443–451, 2021, doi: 10.1007/978-3-030-75680-2_50.

[28] Pérez Sierra, V., & Quintero Beltrá, L. C. (2017). Metodología dinámica para la implementación de 5's en el área de producción de las organizaciones.

[29] Gijo, E., Jiju & Vijaya (2018). Application of Lean Six Sigma in IT support services – a case study. The TQM Journal, 31 (3), 417- 435.

[30] Roosefert Mohan, T., Preetha Roselyn, J., Annie Uthra, R., Devaraj, D., & Umachandran, K. (2021). Intelligent machine learning based total productive maintenance approach for achieving zero downtime in industrial machinery. Computers and Industrial Engineering, 157. https://doi.org/10.1016/j.cie.2021.107267

[31] Manihalla, P. P., Gopal, R. C., Rao, S. T. R., & Jayaprakash, R. (2020). A survey approach to study the influence of management factor in implementing TPM in selected SMEs. AIP Conference Proceedings, 2236. https://doi.org/10.1063/5.0007046

[32] Pombal, T., Ferreira, L. P., Sá, J. C., Pereira, M. T., & Silva, F. J. G. (2019). Implementation of lean methodologies in the management of consumable materials in the maintenance workshops of an industrial company. Procedia Manufacturing, 38, 975-982.

[33] S. Zamora-Gonzales, J. Galvez-Bazalar, and J. Quiroz-Flores, "A Production Management-Based Lean Manufacturing Model for Removing Waste and Increasing Productivity in the Sewing Area of a Small Textile Company," pp. 435–442, 2021, doi: 10.1007/978-3-030-75680-2_49.

[34] Khoryanton, A., & Harmanto, S. (2021). Assessment Standards for 5S Implementation on SMEs of Ship Component. Journal of Southwest Jiaotong University, 56(2).