Lean model implemented in a textile MYPE for order fulfillment: Case of Peru

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ABSTRACT

The objective of this research is to develop a model with lean tools and sup-plier management to reduce non-fulfillment of orders for a Gamarra textile MYPE dedicated to the production of jean garments. The contribution of this research is to develop a model that combines Lean Manufacturing tools, such as Poka Yoke, VSM and Kaizen, with Supplier Management, considering the commitment of workers as the key to its implementation. This will allow to easily identify those activities that do not generate value and that are not necessary in the current production chain of the company. The company's current non-compliance indicator is 41%, which is expected to be a reduc-tion to 10% of the non-compliance percentage, taking as a reference the in-dicator of the textile sector in Guayaquil.

Keywords: Kaizen, Textile, Poka Yoke, Supplier Management, Lean Purchasing

INTRODUCTION

Globalization has been the main promoter of opportunities for the birth of textile companies in developing countries, this has occurred because the panorama of the industry has labor at an accessible price and lax environmental policies (Ah-mad, Hossen & Ali, 2017). The textile industry has become extremely competi-tive as today's customers demand high-quality products at a reasonable price (Boran & Ekincioğlu, 2017). This situation has forced companies to improve their value chain in order to survive in this hostile environment that requires firms to be constantly more competent. As a strategy, companies look for tech-niques and tools that help them increase their productivity and the quality of the products offered; therefore, they resort mainly to the principles of Lean Manu-facturing, focused on the elimination of waste (Brito, Ramos., Carneiro & Gon-çalves, 2017).

In Peru, the textile sector is one of those with the highest levels of informality with 15.3%; this figure reflects an inefficient value chain and a lack of standardi-zation of business processes (INEI, 2018). This situation has led to a gap between the Peruvian textile industry and other countries.

The motivation that has led to the execution of the project is to develop a pro-posal that improves the performance of the company and reduces late delivery of orders. Without the need to buy expensive software, based only on the knowledge of lean manufacturing, including Poka Yoke, also a work study to identify the main problems in the production of jean garments.

The proposal consists of a first stage of awareness and sensitization, where the operators recognize the importance of the role they play in this change and un-derstand the need to know the concepts related to the subject. Previously, a diag-nosis is carried out with VSM in order to know the current state of the value chain and identify points for improvement. In the second stage, the Poka-Yoke tool is used, additionally to complement it, a time study is carried out to stand-ardize the processes in which failures have been identified, accompanied by a delegation of roles with the objective that each operator is assigned responsibil-ity in each process once the improvement has been implemented. Finally, a ma-trix of supplier management criteria is applied as a solution to the deficient sup-ply of raw material, taking into account the most appropriate criteria according to the needs of the company; finally a process of delegation of roles will be carried out as a long-term measure to continue with the improvement.

STATE OF THE ART

Lean Manufacturing

Lean or agile manufacturing is understood as a continuous and systematic pro-cess of identification and elimination of waste or excess, calling excess all activi-ty that does not generate value in a process, but does result in cost and work (Socconini, 2019). The author comments that the true power of Lean Manufactur-ing lies in constantly discovering, throughout the company, those opportunities for improvement that are hidden. Lean Manufacturing tools and methodologies can be applied in all areas of the value chain, in order to improve product quality, reduce lead time and reduce working capital (Myerson, 2019).

Principles of the model: The Lean Manufacturing or Lean Manufacturing mod-el is more than a model, it is a whole business management philosophy that seeks efficiency in all its processes, reducing the greatest number of obstacles that pre-vent them from achieving their objectives. For this, there are a series of princi-ples that resemble a house, if its foundations and pillars are solid, the overall housing will have more resistance (Cuellar-Valer, Gongora-Vilca., Altamirano-Flores & Aderhold, 2021). Between them we have: Continuous improvement, Standardization, Information technology system, Elimination of waste, Produc-tion "Just in Time", Human Resource Management, Supply chain management, Commitment of senior management, TQM, Relationship with the client.

Kaizen. Different authors have defined Kaizen, among the most recent the fol-lowing have been investigated:

Kaizen is a word from two Japanese ideograms, KAI which means change and ZEN which means good (to improve) (Cuellar-Valer et al., 2021).
The authors state that Kaizen is focused on continuous process improvements, which will result in a higher quality in the products offered (McLoughlin & Miura, 2017).
The authors define Kaizen as a management and Know-How philosophy that produces continuous, participatory, incremental and low-budget improvements in quality, production, cost, delivery, safety, morale and the environment (Hibino, Noguchi & Plenert, 2017).

Poka Yoke. Poka yoke is a tool developed by Shigeo Shingo after the Second World War and was created exclusively to focus on finding source quality and collecting data from the front of him (Shingo, 1987).

In the article “Detection of Nut Welding using Poka-Yoke Roller Coaster Jig”, the authors suggest the use of a poka-Yoke device whose purpose is to detect in time the failures in the welds carried out in the process in the production chain; This concept used improves the performance of the company by reducing the average time of the processes and, in turn, reducing the investment in man-hours (Wan Saidin, Idris, Ravi,

Ahmad Zaidi & Kasim, 2015).

Supplier Management

The industrial sector has undergone considerable change in recent decades, which has forced companies to compete in other ways, seeking alternatives that would ensure their competitiveness. To reduce costs and improve speed and flex-ibility, companies are decentralizing some activities, placing responsibilities for implementing secondary functions on third parties such as providers, while com-panies specialize in capabilities that effectively generate value for their business (Krause & Scannell, 2002). In this way, subcontracting is considered a compati-ble strategy since it allows a quick reaction to the constant variations in demand (Hoyt & Huq, 2000).

This method is particularly appropriate due to the contemporaneity of the con-tent, the research question and the impossibility of manipulating behaviors (Scur & Kolososki. (2019). In the case study proposed, it is descriptive: it aims to ana-lyze the interaction between Brazilian customers and suppliers in the sports ap-parel industry in order to verify how this relationship can contribute to the de-velopment of supplier capabilities (Yin, 2009).

PROPOSED MODEL

The design of the model comprises 5 steps based on the pillars of lean manufacturing and supplier management. Focusing on the customer relationship management pillar, as we seek to reduce non-fulfillment of orders.

Step 1: Awareness and awareness. This step includes the pillars of continuous improvement, human resources management and commitment of Senior Management. A Work Plan must be prepared and presented to the Senior Management of the company. This work plan will have the structure of all the activities to be carried out within the project and will be explanatory for each one of them. Likewise, meetings should be held with the members in charge of each process in order to generate awareness and awareness about the current state of the company and the effect it will have on their daily activities.

Step 2: VSM. The VSM is a diagnostic tool that will be used to visualize how the company is initially in order to know what its weak points are, for which an initial time study is carried out, detecting the main weak points that the production chain of the company. In this case, for the company under study they are: reprocessing and supplier management that is not properly approved. This step seeks to comply with the pillars of waste elimination and continuous improvement.

Step 3: Study the work. This stage of the proposed model is based on the following pillars of Lean Manufacturing: standardization of work and continuous improvement. This component focuses on verifying the current work method applied by employees

in each of their activities and in this way proposing improvements. This will be done in 3 stages, the completion of the first stage:

Observation stage. In this first stage, an observation process has been carried out on the initial work dynamics that workers have. In this way, it has been possible to see directly how workers carry out their daily tasks.

Initial work manual. At this stage, the current work dynamics will be reflected in a work manual. This is done with the purpose of standardizing work behavior and proposing improvements.

Final work manual. At this stage, a work manual was made in which certain tasks and behaviors are modified in order to be able to reduce all those activities that do not generate value in the company or that generate losses.

Step 4: Poka Yoke. For the development of the fourth component which is Poka Yoke, the pillars of standardization and waste elimination will be included, for this we have a series of steps that describe the way in which we will approach it:

- Describe possible production error: Verify the steps that are taken in each of the processes.
- Identify the areas where the error occurs: Recognize the moment of the error in the value chain.
- Determine the causes of why the error occurs Perform a 5 why of each identified error.
- Review the fault origin measurement procedure. Map the error in the process related measurement in order to correctly identify the cause of the error.
- Identify possible solution that can be given: Once the error has been identified, a brainstorm is carried out to select the most appropriate solution to the problem found.

Step 5: Supplier Management. Taking into account the pillars of supply chain management and standardization, the implementation of this component will be carried out in this way: a matrix of criteria will be carried out which will show 2 scenarios, the before and after so that the criteria currently used compared to the proposed criteria, in order to be able to choose the supplier that best suits the needs of the company.

In parallel, the delegation of roles will be developed, which consists of issuing a document for each production process, so that all operators and leaders can take into account their functions. It should be noted that this document will be placed in the work area of the collaborators, so that it is visible and they cannot forget or be confused about functions.

CASE STUDY

The development of the application of the proposed model will be carried out in a small textile company in Peru. The case study is a MYPE dedicated to the manufacture of jean garments located in the commercial emporium of Gamarra. The company is dedicated to the production of jean-based garments, in its main products we have: Jeans, Shorts, Poles, Jackets, Vests.

The analysis was carried out from January 2019 to December 2019. The annual average of products that have not been manufactured on time is 22.82%, which affected 28% of the orders that were committed to fulfill, such information can be See the following table:

Table 1. Quantity of orders for wholesale customers

Status	Orders	Percentage
Non-compliant	51	28%
Completed	130	72%
Total	181	100%

The company under study has registered that 28% of its orders have arrived out of time; This percentage is visibly higher than the percentage registered in the Guayaquil textile sector, which is 10% [13]. Clearly it can be seen that the processes are not optimal, which has caused sales to decline in recent years. This has occurred because there were garments that were not delivered on time; the distribution is shown below:

Table 2. Distribution for reasons of products not delivered on time

Reason	Units delivered late
Unallocated spaces	62
Others	123
Non-standard records	163
Late raw material	291
Reprocesses	359
	998

The main economic impact is the loss of 20.8% of the cost of production, due to the reduction of the sale price as part of the strategy to sell products that have not been produced on time.

VALIDATION

Due to the covid situation experienced this year, a validation has been carried out through the arena program and a direct implementation in the company under study.

The validation method that will be used will be a simulation in the Arena program,

which is focused on reducing the main problems, which are: reprocessing at the embroidery and cutting workstations. Additionally, it is necessary to reduce the number of orders for raw material of rolls of jean fabric that arrive late, through the evaluation of suppliers. The main indicators to validate are the following:

Table 3. Validation traffic light indicators

Indicator	Traffic lights			Current value	Projected Value
	Red	Yellow	Green		
Profit margin	X < 17%	X < 23%	X >= 23%	12.90%	26.40%
Process level	X > 9%	X > 4%	X <= 4%	15.50%	0%
Late arrival of jean fabric	X > 30%	X > 10%	X <= 10%	50%	5%

For the simulation, the input analyzer was used to perform the Chi square and Kolmogorov tests; in order to identify the most appropriate distribution for each process.

It should be noted that the simulation has been carried out for a period of one year and that the raw material acquisition process has not been considered, under the recommendation of an expert judgment, as it is a variable that cannot be controlled by the company.

4 simulations have been carried out where the average of the scenarios gave the following numbers of reprocessed products:

Table 4. Average frequency of finished products of the scenarios

	S1	S2	S3	S4	Medium
Embroidery	76	55	87	70	72
Sewing	83	6	12	16	29
Layout	48	24	39	39	38

With them the following results were obtained:

Table 5. Reduction of order and product problems

	START				FINAL			
	Products		Orders		Products		Orders	
Embroidery dimension	278	5%	13	7%	72	5%	13	5%
Overhang seam	10	0.2%	1	1%	0	0%	0	0%
Thread color	71	2%	4	2%	29	1%	2	1%
PM late	291	5%	12	7%	0	0%	0	0%
Assigned spaces	62	1%	4	2%	15	1%	1	1%
Non-standardized records	163	3%	11	6%	10	1%	1	1%
Others	123	2%	6	3%	45	2%	4	2%
TOTAL		18%		28%		10%		10%

The following can be observed:

- It has been possible to reduce the products with a bad embroidery dimension from 278 to 72 products. Which has managed to reduce non-fulfillment of orders by u 2%
- The outstanding stitching has been achieved to eliminate from 10 products to 0 products; which has reduced the affected orders from 1% to 0%. On the other hand, the confusion of the thread color is expected to reduce from 71 units to 29, reducing the level of orders delivered late by one percentage point.
- The layout has been reduced to 38 units, although this affects the delivery of products, but it is important to mention that this point was improved in the simulation

To reduce the following problems in table 12, part of the proposal was implemented in the company:

- The late delivery of raw material has been eliminated to 0% due to the proposed evaluation criteria and the monitoring format of the premium PM. From the months of July to October 2019, it has been recorded that the delivery of jean fabric has not presented delays and that the characteristics have complied with what was requested from the supplier. That is why the number of products that have arrived late has been reduced to 0%.
- It has been shown that the allocation of the finished products count and their correct recording in a standardized format, has helped reduce the problem of unallocated spaces and non-standardized records by 6 percentage points.
- For other reasons, it has been reduced to 2%, which has been given by the first component "Awareness and sensitization" due to employees seeing that the company is concerned about learning new things and seeing their participation in a process of improvement, they tend to stay longer, because their sense of belonging will increase.

CONCLUSIONS

It was identified that the main reasons for the problem were: reprocessing (35.97%), delays in the delivery of raw materials (29.16%), ignorance of the fin-ished product inventory (22.55%) and others (12.32%).

The economic impact represented by the identified problem is approximately S /. 19,181, which represents 15.46% of production costs.

Non-fulfillment of orders has been reduced from 28% to 10%, fulfilling the objective established for the present investigation.

Due to the covid situation, the validation of the proposal was evidenced by means of a simulation carried out in the arena program, where the main reason was considered: reprocessing. Additionally, part of the solution proposal was implemented.

The collaboration of each of the company's operators is important to imple-ment the work manual proposed in this study. So leaders have been chosen with-in each workstation to guide others.

In the supplier management stage, each of the people who supplied raw mate-rials to the company under study was evaluated and it was evident that they were not the right ones. Two new suppliers have been proposed for the most important raw material: rolls of jean fabric and threads for sewing.

The initial VSM has been served so that the production process of the compa-ny under study can be known. 73 data have been worked with, with a confidence of 96%.

The objective of this model is to be easily applied in small and medium-sized companies in the textile sector.

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