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Service Model Under the PHVA Approach Based on Lean Manufacturing, MPS, MRP to Improve the Service Level of an SME in the Textile Sector: A Research in Perú

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Abstract

Textile SMEs currently have a high demand for orders; however, there is a trend of increasing customer dissatisfaction, which is mainly related to shortages, low product quality and failure to meet deadlines. Therefore, a model was developed using the Lean Manufacturing methodology and analysis tools, including 5S. The case study is about a garment manufacturer and merchant SME in Peru, which developed a model to improve the low level of service they provide to their customers. The investigation shows the improvement of the level of service from 70% to 93%, likewise in the economic aspect a saving of 25,363.53 soles is shown, which represents 77%. This model proposal was implemented through the pilot test and simulation through the Arena V16 software, it also shows that the application of the Lean methodology together with analysis tools provide an improvement in processes such as warehouse management and quality. This study can serve as a guide to lay the foundation for business improvement for SMEs facing similar quality and logistics issues that is needed to improve service level growth.

Keywords
Service level, textile SME, productivity, MRP, Lean Manufacturing

1. Introduction
In Peru, the manufacturing sector and in particular that of the textile and clothing industry is very important as it is a of the industrial activities that contribute the most to development from the country. The Gross Domestic Product (GDP) of this sector represented 14% of the total in the years from 2017 to 2021 occupying the second place with the highest contribution (Banco Central de Reserva del Perú 2022). The textile and clothing industry represents 30.6%, thus becoming the activity with the greatest participation (Sociedad Nacional de Industrias 2019) and according to the Foreign Trade Society of Peru the micro and small companies represent 95% of the sector (Sociedad de Comercio Exterior del Perú 2020).

The problem you are facing is linked to various causes which includes the lack of raw material, lack of product finished, low quality of raw material, among others, being. These are the factors that lead to a low level of service in companies (Guzman et al. 2019). A search for success stories was carried out where lean manufacturing and 5S tools were used to improve the level of service for SMEs. Based on the implementation of these tools, delivery times decreased from 16 to 9 weeks, increased margins of profit from 25% to 27% and sales margins increased from 11% to 32%. (Ahmed et al. 2019), studies are needed futures to refine the postulated model with the aim of bring the values of the indicators closer to the values of the levels required by the industry standard and thus allowing the competitiveness of textile SMEs (Cuellar et al 2019).
The profitability of the company is affected by the problems mentioned, these being causes of a low service level. For this reason, it seeks to incorporate the tools such as the Master Production Plan (MPS), Production Planning Material Requirements (MRP) and 5S, which is in charge of categorize and prioritize materials with the highest turnover, similarly for the stockout problem. For another hand, one of the biggest problems of the company is the low quality of the product that has as causes the low quality of raw material and lack of quality control and has as a framework to the PDCA Cycle (Plan, Do, Check and Do) to improve this problem. This method also known "Deming Cycle" is a very important tool of quality assurance and continuous improvement, which its function is to measure the level of quality offered (Carrillo et al. 2021).

After conducting a review of the literature, it was given to know that the cause of a low profitability of the SME is the low level of service. That is why it is important to improve this aspect because it greatly affects the development of the country, as this is one of the most representative. The afore mentioned indicates that the sector textile needs to be developed through processes that generate value for the industry to advance, applying tools that help drive a better level of service. And continue research to find new tools that can be applied to this problem.

1.1 Objectives
The study aims to demonstrate that applying the production method based on Lean Manufacturing increases the service level of textile companies, firstly, through better availability coverage and the reduction of garments delivered imperfectly; secondly, MRP and the 5's will be applied in the fabric finishing process and finally improve the quality of service provided to the end customer.

2. Literature Review
2.1 Service level in the textile industry
The level of service is improving if the optimization the company continues to increase quality, supply and efficiency, through the identification and elimination of waste; understanding as waste each of those occupations that do not contribute cost to the product and for which the buyer is unwilling to pay (Leon et al. 2017).Likewise, the implementation of tools for lean manufacturing results in the reduction of waste, deficiencies and improved processes, which at the same time, they provide high-quality products at a reasonable price minimum, and this leads to the satisfaction of the buyer or degree of service offered by the company which will correlated with raising the standard of living of society (Singh and Rathi 2019).Therefore, the degree of service is linked to the lean manufacturing instruments if these are used correctly the degree of service of the company goes improving because it would improve the quality of products, the coverage of availability of garments (Chong et al. 2020). For these reasons, this analysis offers the application of lean tools such as 5S and standardization based on the Deming's Continuous Optimization approach.

2.2 Lean Textile Manufacturing
Lean manufacturing theory is the quality of the product at a low price and the satisfaction of the buyer, for such a technique is estimated to minimize waste by minimum. Lean manufacturing focuses on reducing the waste to maximize product cost (Kumar et al.2022). The lean methodology fundamentally aspires to minimize the waste in the process to finally offer as consequently a process involving primarily the cost optimization to the buyer, there are several lean tools, each referring to a specific objective, how to detect occupations without added cost, workflow optimization, disruption reduction of production, the reduction of Lead Time and a lot plus each manufacturing industry is going to have a vast plurality of challenges (Muthukumaran et al. 2019). The Lean Philosophy manufacturing is linked to cost generation and efficiency in terms of the environment, which involves rethink the goals and tactics of companies to meet the period of life of the products and services offered (Marulanda and Gonzalez 2017). Lean manufacturing or the word "lean" refers to the systematic reduction of waste in a system of production, with or without increased productivity.

2.3 Productivity

Productivity is an indicator of performance of work equipment, machines and operators. For the process of production not only includes the materials to be used, but also the quality, labor, capital, machinery, etc. According to him, Solow model productivity consists of three factors: labor, capital and technology. These will serve to measure the productivity of SMEs based on the results obtained (Ibujes and Benavides 2018). This will be achieved by increasing efficiency and at the same time reaching to be competitive in the sector through economies of scale and specializing, for this it must be flexible to changing customer requirements, competent in the deliveries of the products and in their quality (Singh et al. 2018). Productivity in the textile sector in Peru is still a topic to improve since different problems are observed such as quality, late deliveries and high prices. worth noting that the production process starts from the reception of raw material until the dispatch of the finished product and a once all the activities carried out have been identified, they must eliminate those that do not generate value, so as not to cause an overproduction, excess inventory, movements unnecessary and waste of transportation. Applied studies in textile industries in India improved their productivity, operational performance, inventory minimization, reduction of defects due to the adoption of best practices read as 5S and Jidoka are despite the difficulties that small businesses may have (Argumedo et al 2021).

3. Methods

The proposed model is based on planning, supply management, inventories and quality. The objective is to know when and how much to produce, so that it does not generate shortages, then it is to implement quality controls and manufacture products in perfect condition. All of the above boils down to improving the level of service for the SME in question. In order to make an improvement, Lean Manufacturing tools such as 5S and Jidoka will be applied, the PDCA cycle will also be implemented, as well as the MRP and MPS for material and production planning. Once the inputs (inputs) and outputs (outputs) have been defined based on historical data, evaluation of the current situation and a level of service below the industry standard for inputs.

For exits, there are new tools, indicators that evaluate the situation of the SME and an improved level of service. To start the implementation of the described tools, the PDCA cycle will begin, where the vulnerable points will be identified to act immediately in the organization. The next step will be the application of MPS and MRP to plan the production to be carried out and the materials necessary for said activity. Then the 5S tool will be implemented, where its application will be in charge of the organization and control of inventories.

Finally, Jidoka will be used with the purpose of offering help with the implementation and quality control of the garments made.

Based on the scientific articles of similar case studies, a proposed model was developed for the company's problem: the low performance in fulfilling orders correctly and on time, caused mainly by low efficiency in the order preparation process. Figure 1 shows the model proposed to the company.

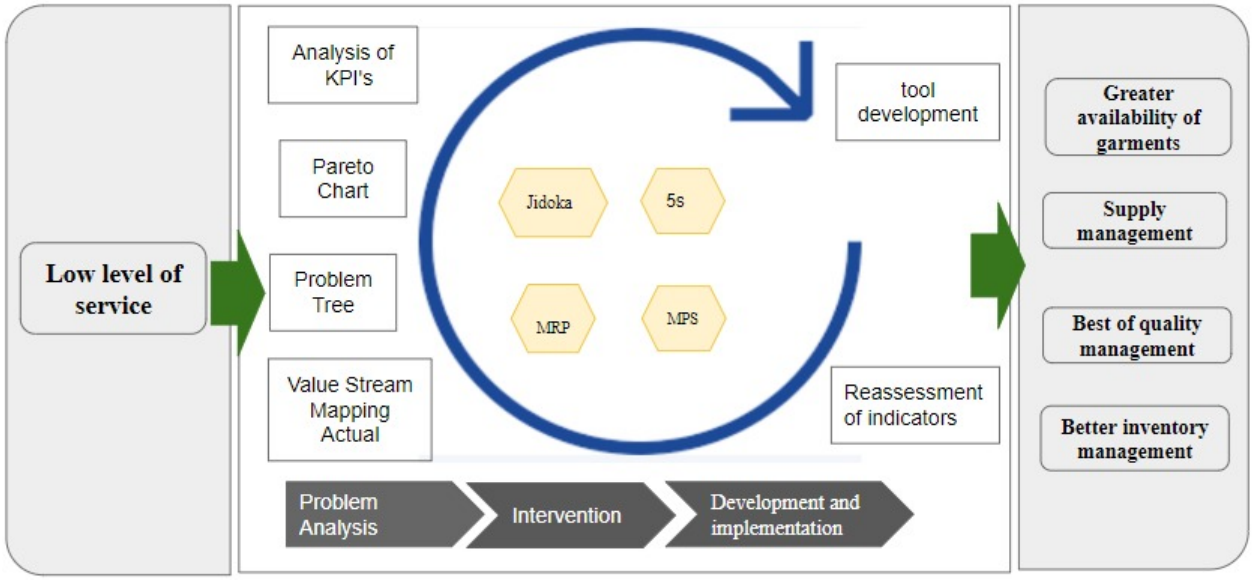

Figure 1: Proposed model

4. Data Collection

Data collection involves collecting and measuring information from various sources for a complete evaluation, using various tools such as: surveys and interviews. In order to obtain information about the operations and technologies involved in the production of clothing. Likewise, the Pareto diagram identifies the most critical problems in the area and uses a problem tree to identify the root causes. After collecting information, it was determined that the tools related to improving the service level are: MRP, 5s and Jidoka y MPS. The process to be followed for the implementation of the proposed model is described in Figure 3.

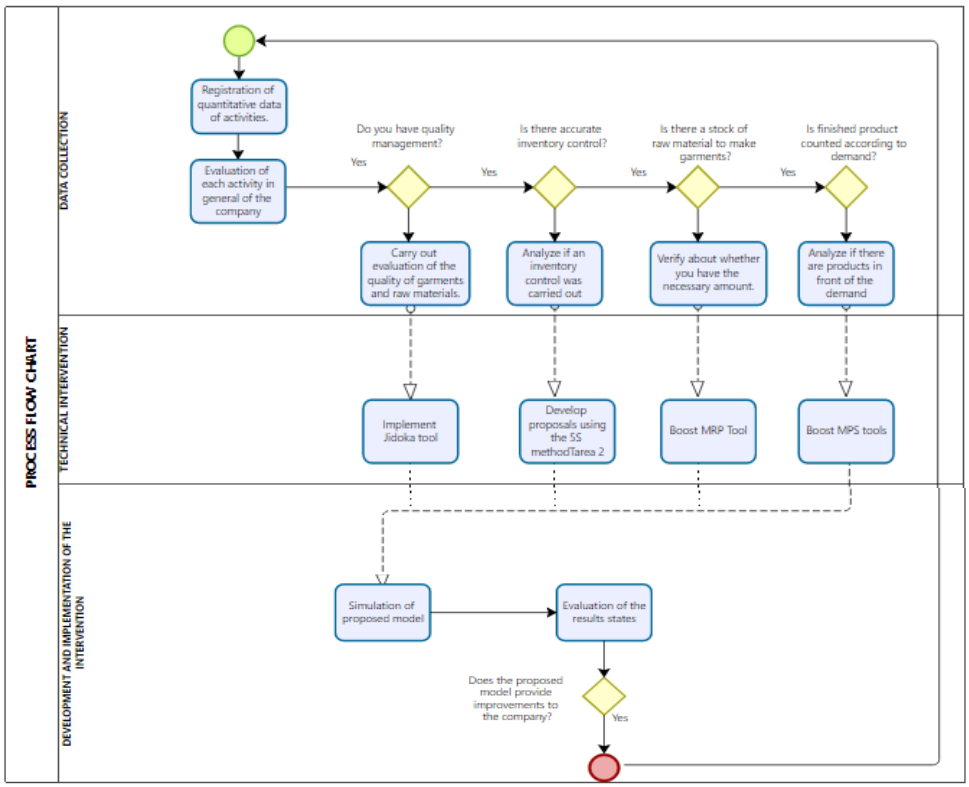

Figure 2: Proposed process

4.1 5S implementation

5S addresses the root cause of efficient raw material and finished product storage. It will be applicable in the analyzed case as it is expected to reduce waste and increase the productivity, efficiency and productivity of the workplace. Next, each "S" will be specified:

First S: Seiri – Classify

It includes the identification and classification of the key materials to carry out the process. The rest will be considered garbage and will therefore be removed or segregated. From now on there will be a standard inventory of each job. This way, the employee has the tools he really needs and nothing else can get in the way of his job.

Second S: Seiton – Organize

Necessary materials are organized, making these tools easy to find, use, and share, and eliminates downtime associated with finding materials and unnecessary operations. The location of each material, part or tool must be marked, for this we use labels, forms, drawings, signs, etc.

Third S: Seiso – Clean up

It is extremely important to locate and remove impurities or dirt from the workplace, as well as keep it properly clean. The proper level of cleanliness and organization directly affects employee motivation and significantly reduces the number of accidents and injuries.

Fourth and fifth S: Seiketsu –Standardize and Shitsuke - Discipline

The standardization process is specifically designed to easily distinguish between "common" and "uncommon" situations, which means that employees must be able to distinguish when the first three principles are applied correctly and when they are not. It is very important that all plant personnel have adequate training to detect this type of situation.

4.2 Component 2: Jidoka Implementation

One of the reasons why there are delays is due to the reprocessing that is generated by having garments with some type of defect, such as the cooking that is carried out. The first thing to do to incorporate this tool is to analyze the problem.

Identification of the problem

Generation of defective garments.

Development of the Jidoka system

To carry out a follow-up, it is proposed to develop a training plan for operators related to the use of the machines involved in the manufacture of garments, specifically with the sewing machine, which is where it has been verified through a field study that more defective garments are obtained, these trainings will be based on how to use the machines and implementing the knowledge of new technologies involved in the manufacture. In addition, quality controls will be added, these will be: raw material quality control, this to avoid failed fabrics and that defective garments are not obtained as a result of this, there will also be quality control after each manufacturing process, that is, the next operator will inspect the garment to work on before carrying out his work, and finally, a final control, where the final garments will be verified and certain details will be made as required. Finally, as part of improving the confusion with the specifications of each fabric, these specifications will be reviewed through training, since the operator knows the process perfectly, such as the type of sewing that each garment needs, in order to continue avoiding obtaining defective products.

Alert

As part of the alert, baskets/bins will be acquired for each manufacturing process and they will be located in full view of each operator, where after each garment inspection, if they are defective, they will be taken to these bins where the operator will be able to see if he has garments to improve and how much it is in accordance with how the basket is being filled. As part of the implementation of the alert, studs will be purchased so that each defective garment can be separated by process from the one that needs to be improved and will be made after finishing with the batch planned at that time.

4.3 Component 3: Implementation of MPS and MRP

Identification of the standard product

For the Planning of Required Materials, the identification of the product that generates the highest income will be made as a first step in order to gather information for the planning of materials necessary for production.
That is why the standard products will be determined, that is, the most important ones according to their rotation. Below is table 1 that describes the income for each garment and figure 2, the variation of these graphically.

Table 1 Product revenue

Product	Income (S/.)	hi
Sweater	8467.46	18.97%
Jean	7763.82	36.36%
Pants	4956.32	47.47%
jacket	4398.23	57.32%
Shorts	3873.98	66.00%
Skirt	3598.57	74.06%
Dress	3084.16	80.97%
pole	2734.73	87.09%
Coverall	2690.29	93.12%
long sleeved polo	1783.48	97.12%
Blouse	1286.96	100.00%

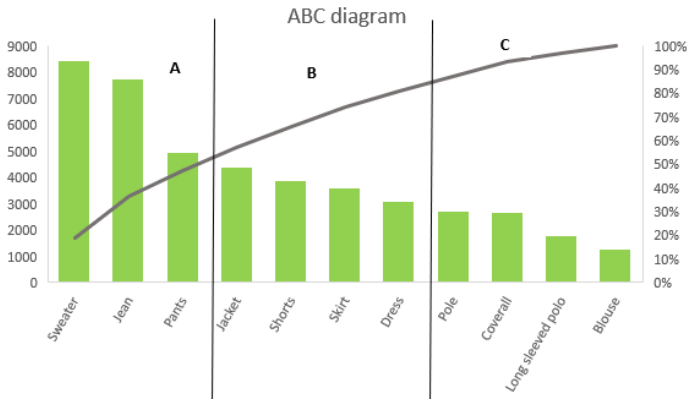

Figure 3. ABC diagram

According to Figure 2 shown, the sweater, jean and pants products represent 47.47% of the total income, belonging to sector A.

4.4 Indicators

Service level: This indicator will be in charge of measuring the level of service through the number of perfect garments over the total number of garments produced.

$$= \frac{\text{Perfect garments}}{Total\ garments\ produced}\ x\ 100\%$$

Availability coverage: This will be defined in days in which it can be covered by production

$$= \frac{\text{Annual demand}}{Average\ inventory}\ x\ 100\%$$

Garments sold/garme sold with respect to the total number of garments available (stock in store + stock in warenouse).

$$= \frac{\text{Garments sold}}{\text{Garments available}}\ x\ 100\%$$

% imperfect prod eliveries of the total number of orders delivered, this is based on the wrong labeling of orders and shipment to wrong addresses or mistakes when packing the orders.

$$= \frac{imperfect\ product\ delivered}{total\ imperfect\ product\ delivered}\ x\ 100\%$$

5. Results and Discussion

5.1 Initial diagnostic

As another test tool, the Software Arena simulation software is used, in which it will present the scheme of the current situation and the improvement proposal, detailing the activities that are carried out and conditions such as the scope of the system, entry of variables to calculate optimal sizes for samples, entities and system elements, test cycle and optimal execution size. Figure 4 shows the initial condition of the process.

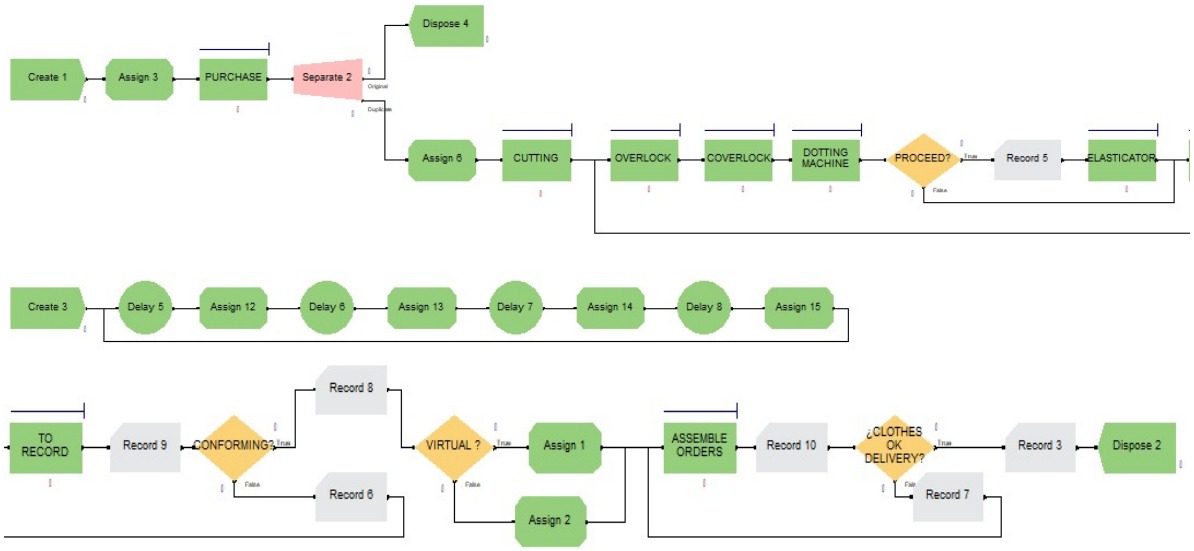

Figure 4. Initial model

5.2 Validation design

The scope of the system to be simulated involves the processes from the purchase of raw materials through the manufacturing process and culminates with the delivery of orders to customers. After implementing the improvements, the final model of the process is shown in Figure 5. Table 2 shows the comparison of both scenarios and the percentage of difference that represents.

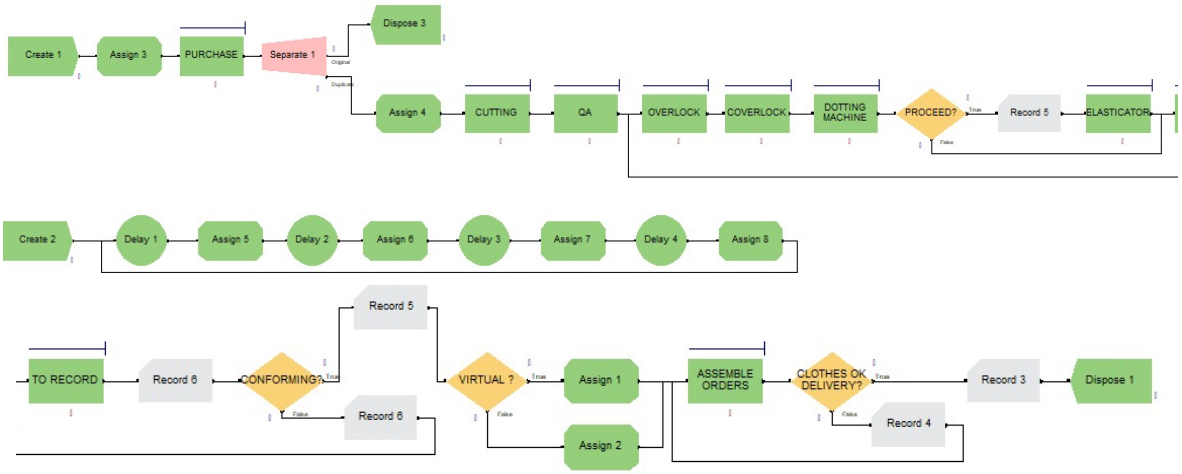

Figure 5: Simulation of the process

Table 2: Results comparison

Losses (1 month)	Actual situation	Improvement Proposal	Diference (%)
Return of garments (5S)	10,932.56	3,061.12	71.99%
discarded garments (Jidoka)	13,119.07	3,061.12	76.67%
unrealized sales	8,746.04	4,373.02	50%
Total	32,797.67	7,434.14	77.33%

6. Conclusion

After this investigation, we can conclude that the application of the Lean Manufacturing method can increase productivity in a production area in the textile industry. The results show that all the indicators have improved significantly based on the current situation of the company. Using the Pareto diagram and the root cause analysis, it can be seen that indicators such as stockouts (65%), low product quality (25%) and missed deadlines (10%), are the three main reasons for the low level of service (70%). The correct application of the 5s in the finished product warehouse managed to reduce the number of imperfect orders delivered. In summary, the percentage of orders delivered in an erroneous way was 25% thanks to the 5S philosophy, reduced to 7%. The economic losses presented by the company are based on, which generates losses of material and orders. Therefore, it is sought that through the implementation of MRP, 5S and Jidoka it will be possible to save a total of 25,363.53 soles with respect to the current situation monthly. Which represents an improvement of 77%.

References

Ahmed, S., Amin, M., Ishtiaq, P., & Galli, B., Application of continuous improvement techniques to improve organization performance: A case study. *International Journal of Lean Six Sigma, 2019*. doi: 10.1108/IJLSS-05-2017-0048

Argumedo, K., Pumahuare, A., Aparicio, E., Altamirano, E., & Nunura, C., Proposal to Improve the Inventory Management Model in a Textil SME based on the Plan for Every Part. *Proceedings of the LACCEI International Multi-Conference for Engineering, Education and Technology, 2021*. doi: 10.18687/LACCEI2021.1.1.498

Banco Central de Reserva del Perú., PBI por sectores. Bcrp.gob.pe, 2022. https://estadisticas.bcrp.gob.pe/estadisticas/series/anuales/pbi-porsectores

Carrillo, A., Tarazona, E., Quiroz, J., & Viacava, G., Lean Process Optimization Model for Improving Processing Times and Increasing Service Levels Using a Deming Approach in a Fishing Net Textile Company. *Smart Innovation, Systems and Technologies, 2021.* doi: 10.1007/978-3-030-75680-2_50

Chong, Y., Puvanasvaran, P., & Chin, F., Exploring critical success factors for the implementation of lean manufacturing in machinery and equipment SMEs. *Engineering Management in Production and Services, 2020*. doi: 10.2478/emj-2020-0029

Cuellar, S., Gongora, A., Altamirano, E., & Aderhold, D., Application of lean manufacturing in a peruvian clothing company to reduce the amount of non-conforming products. *Advances in Intelligent Systems and Computing, 2020*. doi: 10.1007/978-3-030-55307-4_73

Guzman, P., Montalvo, F., Carballo, E., & Raymundo, C., Implementación de un modelo de gestión por procesos y control de inventarios para incrementar el nivel de servicio en el área de postventa de equipos industriales. *Latin American and Caribbean Consortium of Engineering Institutions, 2019*. doi: 10.18687/LACCEI2019.1.1.147

Ibujés, J., & Benavides, M., Contribución de la tecnología a la productividad de las pymes de la industria textil en Ecuador. *Cuadernos de Economía*, 41(115), 140–150, 2018. doi: 10.1016/j.cesjef.2017.05.002

Kumar, N., Shahzeb, S., Srivastava, K., Akhtar, R., Kumar, R., & Kumar, V., Lean manufacturing techniques and its implementation: A review. *Materials* Today: Proceedings, 64, 1188– 1192, 2022. doi: 10.1016/j.matpr.2022.03.481

León, G., Marulanda, N., & González, H., Factores claves de éxito en la implementación de Lean Manufacturing en algunas empresas con sede en Colombia. *Tendencias*, 18(1), 85, 2017. doi: 10.22267/rtend.171801.66

Marulanda, N., & González, H., Objetivos y decisiones estratégicas operacionales como apoyo al lean manufacturing. *Suma de Negocios*, 8(18), 106–114, 2017. doi: 10.1016/j.sumneg.2017.11.005

Muthukumaran, V., Hariram, V., & Padmanabhan, K., A research on implementation of lean tools across verticals in manufacturing. *International Journal of Engineering and Advanced Technology, 2019*. doi: 10.35940/ijeat.F1119.0886S19

R. Singh, M., & Rathi, R., A structured review of Lean Six Sigma in various industrial sectors. *International Journal*

of Lean Six Sigma, 2019. doi: 10.1108/ijlss-03-2018-0018
Singh, J., Singh, H., & Singh, G., Productivity Improvement using lean manufacturing within manufacturing Industry of Northern India- A Case Study. *International Journal of Productivity and Performance Management, 2018*. doi: 10.1108/IJPPM-02-2017-0037
Sociedad de Comercio Exterior del Perú, Las micro y pequeñas empresas en el Perú Resultados en, 2020. https://www.comexperu.org.pe/upload/articles/reportes/reportemypes-2020.pdf
Sociedad Nacional de Industrias, INDUSTRIA TEXTIL Y CONFECCIONES, 2019. https://sni.org.pe/wp-content/uploads/2021/03/Presentacion-Textil-yconfecciones-IEES.pdf

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