PAPER • **OPEN ACCESS**

Lean Production Model Aligned with Organizational Culture to Reduce Order Fulfillment Issues in Micro- and Small-sized Textile Businesses in Peru

To cite this article: B Martinez-Condor *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **796** 012016

IOP Conf. Series: Materials Science and Engineering **796** (2020) 012016 doi:10.1088/1757-899X/796/1/012016

Lean Production Model Aligned with Organizational Culture to Reduce Order Fulfillment Issues in Micro- and Small-sized Textile Businesses in Peru

B Martinez-Condor[1], F Mamani-Motta[1], I Macassi-Jaurequi[1], C Raymundo-Ibañez[2,4] and M Perez[3]

[1] Ingeniería Industrial, Universidad Peruana de Ciencias Aplicadas (UPC), Lima 15023, Perú.
[2] Dirección de Investigación, Universidad Peruana de Ciencias Aplicadas (UPC), Lima 15023, Perú.
[3]Escuela Superior de Ingeniería Informática, Universidad Rey Juan Carlos, Mostoles, 28933, España.

E-mail: carlos.raymundo@upc.edu.pe

Abstract. This paper proposes an optimization model aimed at increasing production capabilities at a small-sized textile business dedicated to manufacturing polo shirts, while reducing order fulfillment issues, including incomplete orders and late deliveries. Hence, an assessment identified downtimes from unnecessary transportation travel, time spent looking for materials, and excessive losses due to cutting fabric errors. In this light, the study focused on selecting adaptable tools, such as 5S, Plant Layout, and Method Study, which may help improve production capabilities and address these situations. However, to guarantee that the objectives set forth are being met, the organizational culture must also be identified and improved so that it may serve as the foundation for the optimization model. Then, the proposed model will be validated to determine whether the selected operating tools supported by the strengthening of organization culture contribute to increasing production.

1. Introduction

In this globalized age, many countries around the world, led by China, reporting $8,637,540 per month, and followed by Bangladesh and Turkey, have started producing various types of polo shirts. In this industry, Peru only generates $328,638 per month, accounting for only 0.8% of the worldwide production [1]. In recent years, textile production has exhibited a huge decline in contrast to other sectors. The main factor that has affected production for about six years has been the competition with Chinese, Vietnamese, or Indian imports entering the market as their prices are extremely lower than the national production [2]. However, in the last two years, the textile production sector has positively expanded, reporting a 7.53% production increase for the period between January and November 2018 [3]. Despite this positive increase, several micro- and small-sized businesses within this still sector continue to face serious production problems, especially in terms of low production capabilities, which

[4] To whom any correspondence should be addressed.

not only constrain and hinder sector growth but also national production levels. Therefore, their production process must be streamlined.

The textile and clothing industry have become prominent in recent decades as it reports one of the highest export rates overall and exerts a demand from other specialized markets. The sector contributes to creating jobs in other industries, such as agriculture and plastics, based on its use of cotton and other inputs. Moreover, this industry accounts for 12% of the national GDP, with the textile sector accounting for 4.7% thereof [4]. These products are renowned in the international market for their use of high-quality fibers, which has also fostered the increasing production trend recently reported along with their entry in the Peruvian market, thus generating revenue for the textile industry, as well as for the entire nation.

As the textile and clothing sector is a major industry in Peru, it is unfortunate that, in comparison to other sectors, its production had decreased since a few years ago, and that, although the sector is recovering, it has not yet established itself as a stable sector. Therefore, this research study proposes improving the polo shirt manufacturing process at a small-sized textile business in the Gamarra fashion center through the implementation of a model comprising the 5S, Plant Layout, and Study Methods techniques, measured and assessed by means of the Denison Organizational Culture Survey. Another important aspect is that this proposal may also be adopted by companies manufacturing different garments, i.e., shirts, pants, polo shirts, and shorts to address their low productivity issues.

2. State of the art

2.1. Organizational Culture-based Production

The production rates are assessed through the organizational culture at a textile company in Portugal with the purpose of evaluating employee performance. Hence, a model comprising an error-detection culture, an error-prevention culture, an organizational culture, and performance rates is created and measured by a survey. In this study, the implemented model successfully improved production management supported by values and attributes [5]. However, in recent years, as organizations evolve within the changing markets, they must start managing learning to remain competitive in the market. Hence, many companies are turning to knowledge management as a viable method for improving their conditions of stability. In this light, the Denison model is used to study organizational culture dimension through the adaptability, mission statement, engagement, and capacity indicators. In fact, managers with greater organizational culture acumen have been able to steer their weakness for awareness and accuracy toward the production area and forecast the process strategies required [6]. However, a study conducted in the finance sector in Kenya determined the influence organizational culture exerted on company performance, thus concluding that organizational culture is also deemed an important source of sustainable competitive advantage within the finance industry [7]. In Malaysia, the PLS-SEM method was used to correlate production to organizational culture at manufacturing companies, as a part of a greater assessment of their organizational culture [8]. Finally, a study applies a theoretical model in Pakistan's manufacturing industry that engages an organizational culture which supports environmental practices for improving production rates. Based on a survey and using Smart-PLS, the study concluded that adaptability, mission statement, and consistency exert a positive impact on environmental performance and, therefore, in its production levels [9].

Within this context, the literature agrees that the Denison model is the best model for assessing organizational culture as it uses four different indicators to take any organization's temperature and determine its current situation.

2.2. Lean Manufacturing-based Production

The following papers discuss different tools and methods of implementing lean manufacturing as a production optimization model. However, all of these papers are consistent when defining the best method used for increasing production rates. For example, in one of these papers, lean manufacturing tools are used to address resource management flexibility at an Indian company, taking employees and machinery as resources [10]. Nevertheless, lean manufacturing is also used to eliminate waste in the packaging area at a small-sized textile company in Perú [11]. Further, value-stream mapping (VSM) is deployed at a car parts manufacturing company in India. In this instance, the 5 Whys method contributes to root causes identification and the implementation of a roadmap for improving productivity within the company in the future. This method successfully increased production in the textile process [12]. However, the different wastes found within a natural fiber garment production line were identified and prioritized using VSM to collect the required data. At the end, seven wastes were identified as per the theoretical model proposed by Taichí Ohno, later using the Super Decision software to prioritize these wastes [13]. As waste must also be removed from the production process, a Lean Six Sigma framework is deployed to improve operational performance in an MRO installation, wherein this methodology is used to dispose wastes and improve production processes by reducing standard production times [14]. Lean Six Sigma benefits are also described, thus evidencing the effective nature of this methodology for identifying and removing waste, and thus improving process flows, strengthening company interactions with suppliers and customers, and fostering faster learning, which were all deemed the main problems to be addressed [15]. Finally, to achieve operational excellence through Lean Six Sigma, a case study was carried out at an automotive company in India using the LSS methodology to improve the performance of the semi-automated transfer line process. The application of the LSS methodology reduced drilling defects by machining injector bodies.

In conclusion, lean manufacturing tools are an effective method for eliminating waste from production processes.

3. Contribution

3.1. Proposed Model

The general model is grounded on lean methodology, which focuses on customer valuation by removing waste to reduce cycle times based on the assurance provided through monitoring and improving organizational culture. Although the model uses lean methodology tools, the supplementary tools are also used to deploy lean production.

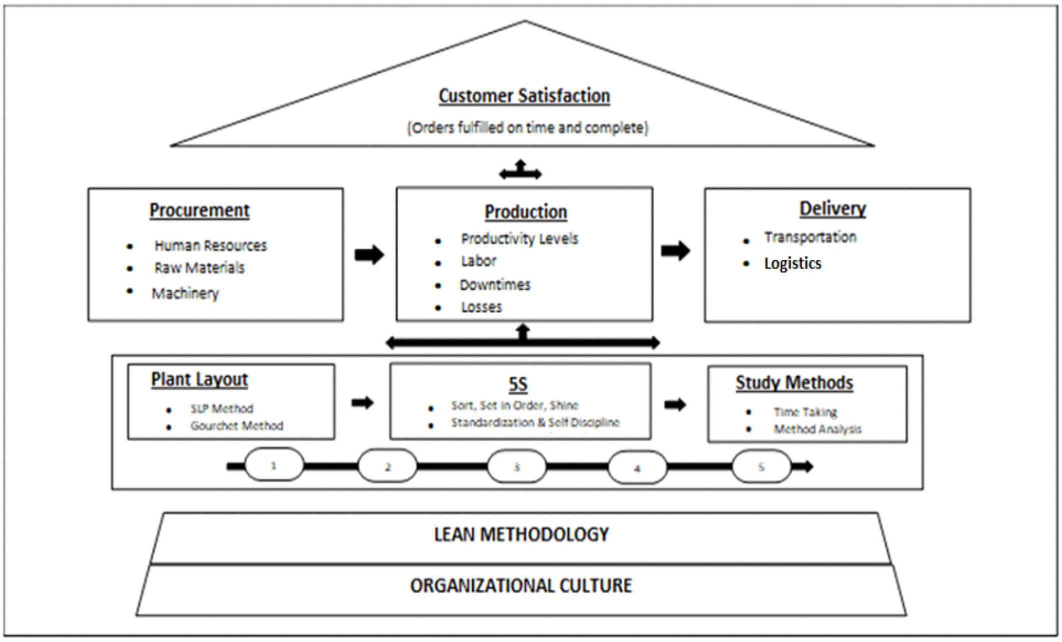

Figure 1. Proposed model

3.2. Proposed Method

The following flowchart shows the activities performed in each implementation stage.

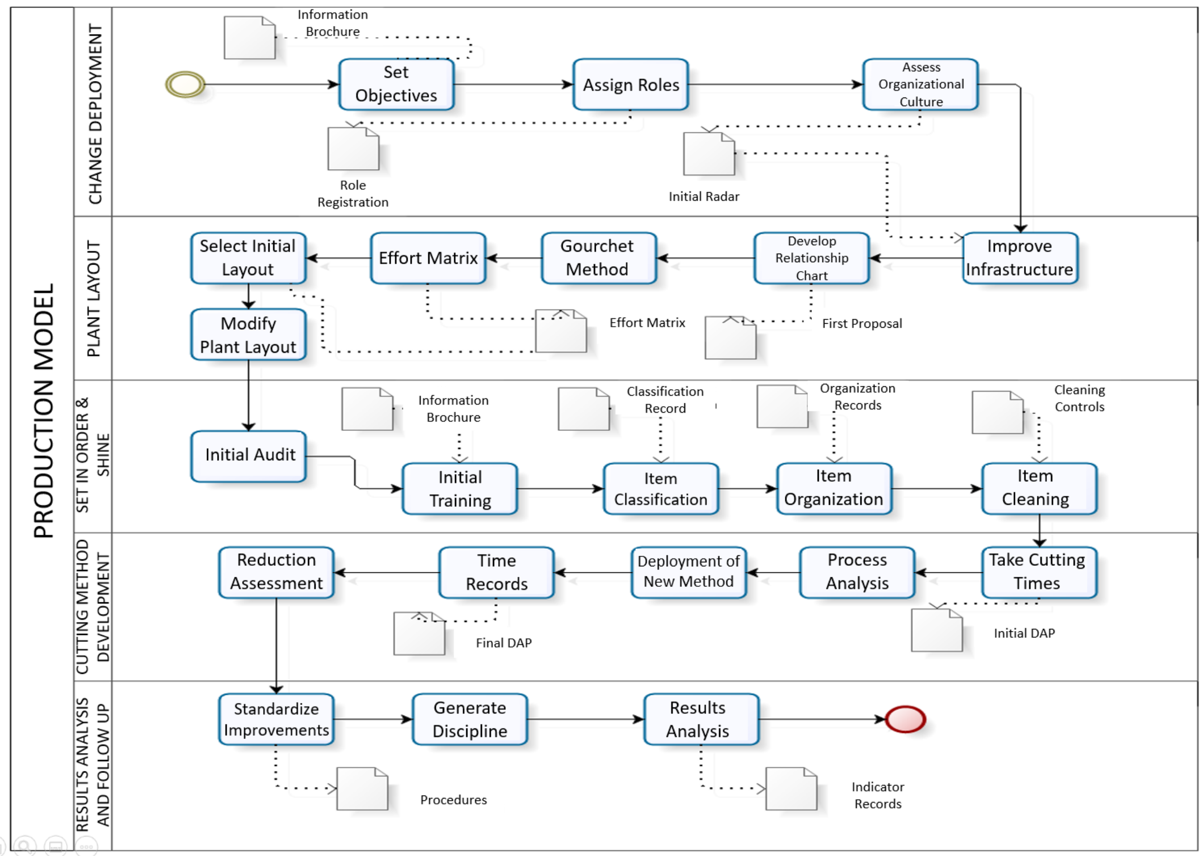

Figure 2. Proposed method

Therein, the process input and output records are the artifacts included in the different model components, which provide information required to determine optimum development levels.

3.3. Indicators

To measure post-implementation results, the following indicators will be used to track lean model implementation and its alignment to organizational culture:

- Organizational Temperature, which provides an initial assessment of the alignment exhibited by staff members with company policies.
- % Decrease in Travel Time, which shows the amount of time reduced in travel time within the production process.

$$\frac{Time_{\ after} - Time_{\ before}}{Time_{after}} \times 100 \qquad (1)$$

- % Downtime Reduction, which specified the amount of downtime reduced throughout the polo shirt production process.

$$\frac{Downtime_{\ after} - Downtime_{\ before}}{Downtime_{\ after}} \times 100 \tag{2}$$

- % Losses, which identifies the fabric losses per fabric roll used in polo shirt production.

$$\frac{Losses\ per\ Roll\ in\ Kg}{Roll\ Used\ in\ Kg} \times 100 \tag{3}$$

- % Orders Fulfilled, which measure customer satisfaction levels in terms of successful order fulfillment.

$$\frac{Orders\ fulfilled}{Total\ orders\ accepted} \times 100 \tag{4}$$

- % Plant Capacity, which shows the overall growth in productive efficiency based on the number of products manufactured within a given period of time.

$$\frac{Standard\ Time}{Average\ Time} \times 100 \tag{5}$$

4. Validation

4.1. Description of Test Scenarios

Model implementation was validated though a case study conducted at Monper's, a textile MSE located at the Gamarra fashion center in downtown Lima. However, its manufacturing workshop is located at 201, Ave. Del Aire, in the district of San Luis, Lima. This company manufactures different varieties of polo shirts, with long- and short-sleeved round-neck t-shirts being its flagship product.

Figure 3. Case study

4.2. Initial Values

In the recent years, the company has reported that 20% of its orders are being fulfilled late. To verify these numbers, a sample of 12 orders with different quantities were taken. For each of these orders, the committed lead times against the actual lead times were recorded, thus determining an approximate gap of one day and a half between the two.

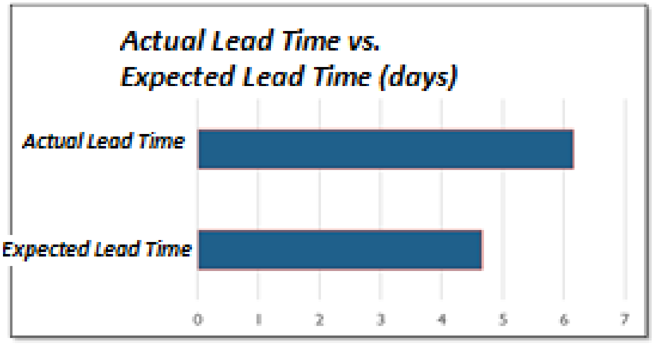

Figure 4. Actual lead time vs. Expected lead time

Actual plant efficiency is at 67.74% as daily production was originally calculated at 31 shirts per day, while the actual production rates only account for 21 shirts per day. Therefore, the company is currently losing 150 soles per day as each shirt is sold at 15 soles.

In terms of downtimes, an average downtime of 2.012 minutes per shirt was recorded. To determine surplus travel times, we recorded standard production times, yielding an average of 0.44 minutes of unnecessary travel time per shirt. Finally, the losses due to inadequate cuts, expressed in percentages, represent between 20% and 30% of the total weight of the roll.

4.3. Contribution Application

4.3.1. Change Deployment. In the first stage, a Denison Organizational Culture Survey is applied to measure current organizational culture levels. Further, staff members receive informative sessions and are assigned roles as part of the new organizational culture deployed.

4.3.2. Plant Layout. Based on the results from the Organizational Culture Survey, work conditions are improved for staff members, as a way to strengthen their engagement and commitment to changes implemented. Moreover, the plant layout is modified based on the SLP model, which identifies optimum Plant Layout based on quantitative and qualitative criteria.

4.3.3. Sort, Set in Order, and Shine. The first three principles of the 5S tool are implemented. First, an initial audit is performed. Then, staff members receive induction and information toolbox talks. Next, the Sort, Set in Order, and Shine principles are implemented.

4.3.4. Cutting Method. To reduce losses and reuse surplus fabric to manufacture more shirts, a new and improved methodology for cutting fabric was introduced. Then, the corresponding reviewed information gathered from shirt manufacturing manuals and guides will be shared with staff members through a Process Analysis Chart. For these purposes, the new material proposed is sulfite paper.

4.4. Results Summary
The study reported improvements in all the items addressed; however, these results must be periodically monitored and recorded so that they may continue to improve over time.

IOP Conf. Series: Materials Science and Engineering **796** (2020) 012016 doi:10.1088/1757-899X/796/1/012016

Table 1. Results summary.

Phases	Indicator	Initial	Final
Change deployment	Organizational Culture Index	41%	72.5%
Plant layout	Travel Time Reduction	27%	
Set in order & shine	Reduction of time spent searching for materials	**54.87%**	
Cutting method development	Production losses	15%	11.5%
Results monitoring	Order Fulfilment	70.5%	88.5%

5. Conclusions

As there are three main reasons for late order fulfillment (shortages of raw materials, machine downtimes, and low productivity), this study focused on addressing the latter, which represented 95.86% of the issues reported. In this regard, the shirt manufacturing workshop evidenced an insufficient production rate that did not allow it to fulfil 100% of the orders received. Therefore, this study proposed the implementation of a model to reduce unnecessary travel times and downtimes, as well as to find a suitable fabric cutting method for increasing round-neck t-shirt productivity rates.

6. References

[1] M. Trade 2018 T-shirt and polo shirt production.

[2] Management 2018 Economy of Perú.

[3] INEI 2018 Information Technology, Landscape of Peruvian Economy.

[4] INEI 2018 Information Technology, Landscape of Peruvian Economy.

[5] Araujo R 2019 The Quality Management System as a Driver of Organizational Culture: An Empirical Study in the Portuguese Textile Industry *Qual Innov Prosper - Kvalita Inovacia Prosperita* **23** 1-24.

[6] Gholam A A 2017 Effect of organizational culture on knowledge management based *Soc Behav Sci* **23** 387–395.

[7] Joseph O O 2019 Organizational Culture and Performance: Evidence from Microfinance Institutions in Kenya *Sage* **11** 112-200.

[8] Lee W L 2018 Organizational culture and performance of Malaysian manufacturing firms *Int J Adv Appl Sci* **5** 59-66.

[9] Bakhsh Magsi H, Ong T S, Ho J A and Sheikh Hassan A F 2018 Organizational Culture and Environmental Performance *Sustainability* **10** 2690.

[10] Chauhan G 2016 An analysis of the status of resource flexibility and lean manufacturing in a textile machinery manufacturing company *Int J Organ Anal* **24** 107-122.

[11] Portocarrero V, Quispe G, Nuñez V, Raymundo C, Moguerza J M 2018 Model for the implementation of a waste recycling plant in small and medium-sized companies in the textile industry *CISCI 2018 - Decima Septima Conferencia Iberoamericana en Sistemas, Cibernetica e Informatica, Decimo Quinto Simposium Iberoamericano en Educacion, Cibernetica e Informatica, SIECI 2018 – Memorias* **1** 52-57.

[12] Kumar S, Dhingra A and Singh B 2018 Lean-Kaizen implementation *J Eng Design Tech* **16** 143-160.

[13] Behnam D 2018 Value stream mapping approach and analytical network process to identify and prioritize production system's Mudas (case study: natural fibre clothing manufacturing company) *J Text I* **109** 64-72.

[14] Hill T 2018 The implementation of a Lean Six Sigma framework to enhance operational performance in an MRO facility *Prod Manuf* **23** 22-44.

[15] Randhawa J 2017 Examining the role of 5S practices as a facilitator of business excellence in manufacturing organizations *Meas Bus Excell* **21** 191-206.