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Layout Lean model of production management based on change management to improve efficiency in the production of packaging in auto parts sector SMEs

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Abstract. This investigation proposes a lean model of production management for a small and micro enterprise (SME) dealing in packaging production in the auto parts sector, with the purpose of increasing efficiency in its production line. To this end, this model integrates study method tools and SMED, seeking to reduce waiting times and unnecessary operations, which have been identified as causing the problem on the basis of an initial diagnosis of the situation. Furthermore, to support and guarantee success in implementing these tools, John Kotter's Change Model is used. After two months of implementation, the results showed a 50% reduction in setup operation time and a 32% decrease in filing operation time, which are bottlenecks in the production process. Thus, with the new indicators, the line efficiency increased by 7% from the initial situation, thus showing improvement.

1. Introduction

In recent years, the auto parts sector has grown commercially around the world. The exports in this sector rose to US $953661 million during 2016, with the United States, Germany, and China as major exporters accounting for exports worth US $413947 million. In Latin America, Mexico, Brazil, and Venezuela are the largest suppliers, totaling US $150320 million. In terms of auto parts export ranking, Peru ranked 52nd in the world and 5th in Latin America, with total sales of US $107 million in 2016 [1]. Later, in 2018, despite the Peruvian automotive trade falling by −3.79% as a result of fewer vehicle sales in the production line of cars, buses, and heavy vehicles, auto parts exports recorded an increase of 90.97% from the sale of tires and spare parts [2]. However, small and micro enterprises (SMEs), who are responsible for most of the exports in this sector, continue to have efficiency and productivity problems in their processes, resulting in low competitiveness and hard business growth. [3]

The SMEs in the auto parts industry together with SMEs from other industries generate roughly 40% of the national GDP, meaning they are the largest drivers of economic growth in Peru [4].

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Furthermore, they contribute significantly to generating employment for approximately 80% of the labor supply [5] because currently 96.5% of existing companies in Peru belong to the SME sector [6].

This study aims to enable the MSEs of the auto parts sector to solve or reduce problems with respect to production line efficiency. Currently, these problems are caused by high levels of wastage in down times and unnecessary operations that are generating hidden production costs. Moreover, in this sector, employers and workers generally have low qualifications [7]; this situation results in a lower probability of generating profits that provide the possibility of reinvestment in process improvement, thus contributing to an increase in the MSE mortality rate [8]. Therefore, through this article, a production management model based on the use of change management and lean tools is proposed, which through their integration seeks to generate new work methods based on understanding the importance of the need for change for improving economic indicators. As a consequence of this, activities that do not add value can be reduced using the SMED technique and studying the methods will allow reducing the setup time and the time of the filing operation, the latter being bottlenecks in the production process because it is poorly performed.

2. State of the art

2.1. Production management models based on change management.

Many organizations fail to position themselves better in the market because of the lack of a development program within their improvement policies. In addition, when it is implemented, in some cases, expectations are not met because the most ideal method or strategy of change management is not adopted for that organization, resulting in unwanted change [9] [10]. Other results explain that the organization managers differ significantly in their transformational leadership and management parameters with respect to their type of approach to change and organizational structure, the latter being those who will define the degree of contribution of the former in the organization [11] [12]. However, although change management practices have a significant impact on fulfilling objectives in the change program, they do not appear to have an impact on organizational results such as financial results, operational productivity, etc. [13]

2.2. Production management models based on lean manufacturing

Some researchers claim that the implementation of the lean manufacturing philosophy is more successful in larger companies than in SMEs, especially in less developed countries. This is attributed to factors such as the lack of commitment and management leadership, poor communication, and scarce resources. These are considered as barriers to lean adaptation in SMEs [14] [15] [16]. However, other researchers claim that although these factors are present and they represent difficulties in using lean tools, the adaptation of techniques such as TPM, statistical process control, SMED, production leveling and others have a more positive impact on operational performance, obtaining good results even if partially implemented [17] [18]. Furthermore, it has been suggested that in order to propose a successful production model based on lean methodology, it is essential to have as a starting point the elimination of wastage, that is, activities that do not add value to the process. For this purpose, the implementation of the value stream mapping (VSM) technique is recommended; it is a tool that analyzes process inefficiencies and serves as a basis for a lean transformation in the company [19] [20]. However, there are those who consider that the use of overall equipment efficiency (OEE), which is an approach that focuses on operations rather than on the process, serves as an orientation indicator for prioritizing the improvements to be made and the operational control [17].

3. Contribution

This stage will show the contribution according to the papers chosen for each type, where the integration of the contributions for each one of them will be graphed and explained for the construction of the proposed model.

3.1. Proposed Model

The proposed model shown in Figure 1 is based on the lean philosophy complementing the study methods to reduce the wastage during the production process in auto parts SMEs using John Kotter's change management as a methodology for its implementation with a view to improving efficiency in the production line, through worker leadership.

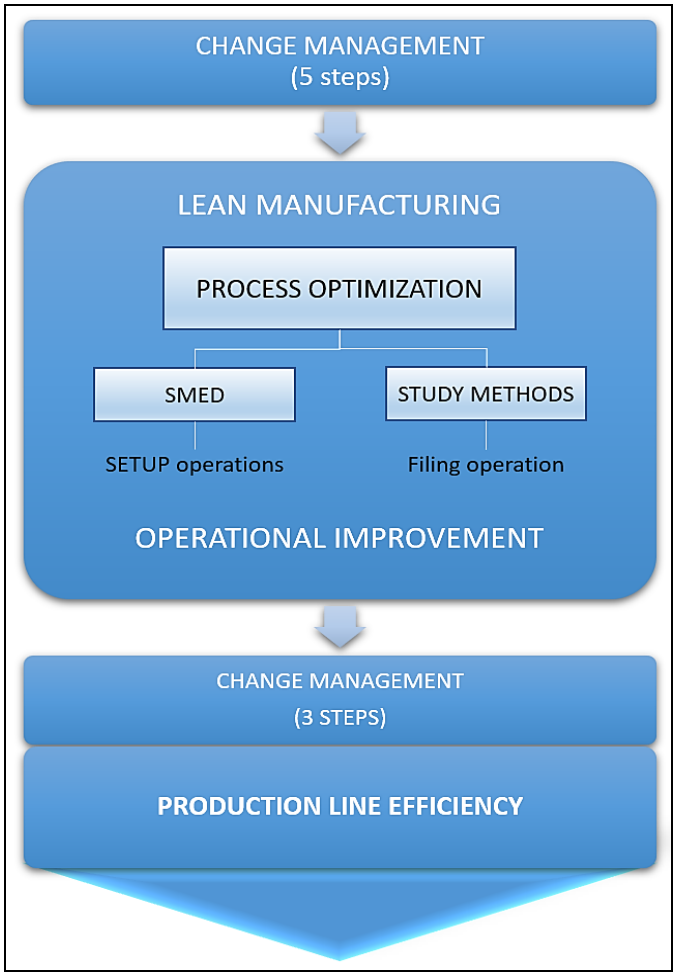

Figure 1. Lean model for production management based on change management by John Kotter

Phase 1 involves generating change in the company through John Kotter's Change Model, whose first five steps are used to create a sense of urgency, form a coalition, develop a vision, communicate the vision to the whole organization, and eliminate obstacles because in order to implement the lean methodology it is essential that workers are convinced about accepting it.

Once the obstacles are eliminated and the workers' acceptance has been achieved, Phase 2 of lean manufacturing will be implemented. The status of the current situation must first be ascertained through VSM and OEE, among other tools, in order to analyze the causes of the inefficiency in the process line. Although this model only applies one lean technique, SMED, the proposed model can be applied to all techniques and its choice will depend on the analysis of causes.

Finally, after Phase 2, in which operational improvement is carried out, the last three steps of change management are implemented, which are to ensure short-term goals and build on the change achieved to ensure a cycle of continuous improvement and anchor the culture of change in the company.

3.2. Proposed Process.

To implement the proposed model, follow the steps shown in the implementation guide, see Figure 2.

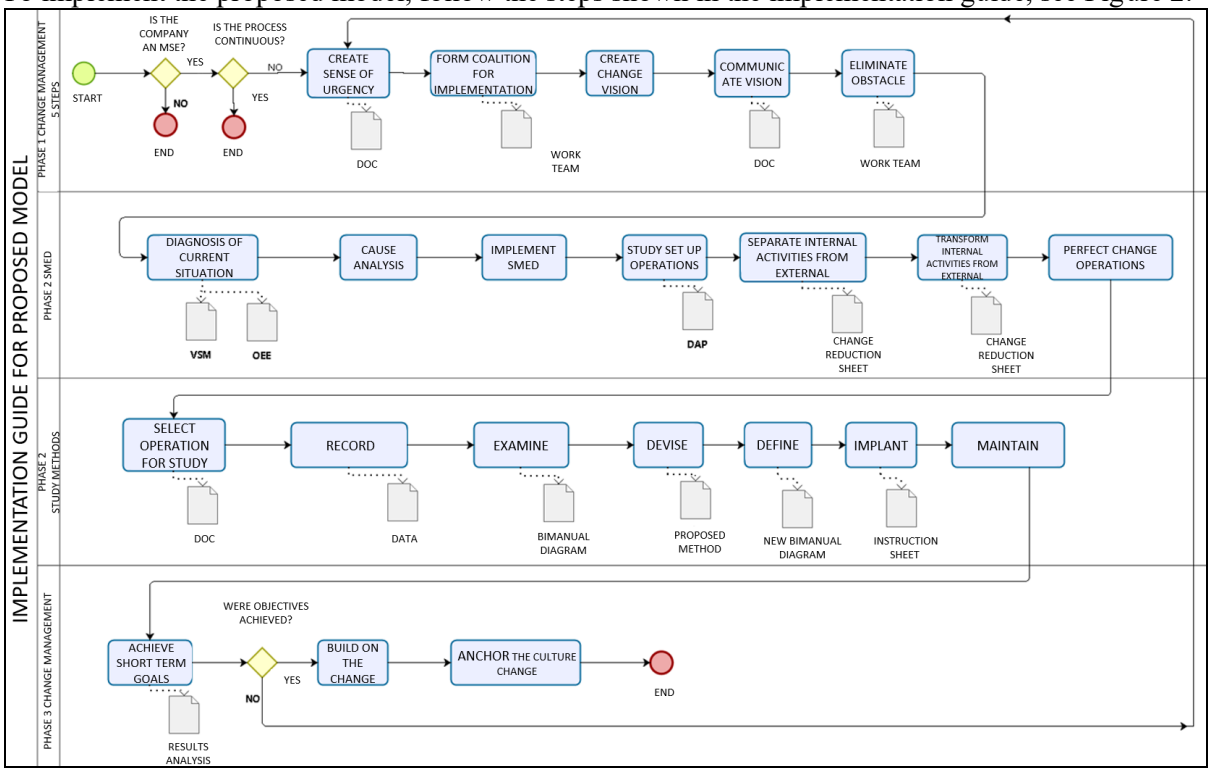

Figure 2. Implementation guide for proposed model

3.3. Indicators

3.3.1. Resistance to change. The purpose of this indicator is to assess the degree of resistance to change existing in the company.

$$Resistance = \frac{change - resistant\ answers}{Number\ of\ workers} \quad (1)$$

The result will indicate the percentage of workers who resist the implementation of the proposed model.

3.3.2. Reduction in filing time (%). The purpose of this indicator is to compare the data before and after the improvement to see the variation in the time it takes to execute the bottleneck operation.

$$Reduction = \frac{Previous\ time - current\ time}{Previous\ time} \times 100\% \quad (2)$$

The result indicates the percentage by which the time of the filing operation has been reduced with respect to its initial value before the improvement occurred.

3.3.3. Reduction in setup time. As in the previous case, this indicator will compare the initial and final values to see the variation in setup time before and after the improvement.

$$Reduction = \frac{Previous\ time - current\ time}{Previous\ time} \times 100\% \quad (3)$$

The result indicates the percentage of time taken for the filing operations that has been reduced compared to its initial value before the proposed model was produced.

3.3.4. Online eficiency. The efficiency of the production line indicates the percentage of time in which value has been added to the product, that is, the total added value time.

$$L.Efficiency = \frac{total\ time\ of\ all\ operations}{No.\ stations \times cycle\ time} \quad (4)$$

The result will indicate the variation of the initial and final values, after having implemented the model.

4. Validation

4.1. Description of the case study.
To validate the proposed model, the company Empaquetaduras Montalvo EIRL, which is an SME dedicated to the manufacture and commercialization of parts, pieces, and accessories for vehicles has been taken as a case study. This company is located in Tablada de Lurín, district of Villa María del Triunfo in Lima, Perú.

Figure 3. Stamping station of the company

4.2. Initial Diagnosis

When making a diagnosis about the situation of the company, it was found that production line efficiency was 52% and that of the sector was 64% as shown in Figure 4; this difference put the company at a disadvantage with its competitors with respect to its ability to deliver to its customers on time, given that the takt time or the rate at which the market demanded products is 3.50 min / packaging time. On analyzing the causes of this problem, there was evidence that the main reasons were wastage in production; for example, the filing operations were at 32.8%, being carried out with a deficient method along with bottlenecking with a very high time of 36.67 min / lot packing, as well as setup time being 30.33%, recorded as 30 min / batch change. The time in which value was not added to the product in these operations was 12 min / lot packaging in the finished product and 20 min / batch change in setup, according to the ideal of 10 min / batch change. Given that the company works in a single 8-hours shift and the amount of batch changes on average is 6 lots per day, the time lost due

to all causes, represented approximately 2.8 hours / day. Each unit is sold at S /. 2.00 on average. The scenario described meant that the company kept production costs hidden, entailing an opportunity cost of approximately S /. 44,000 per year, where the economic impact of causes referred to as "others" with a lower percentage was also considered.

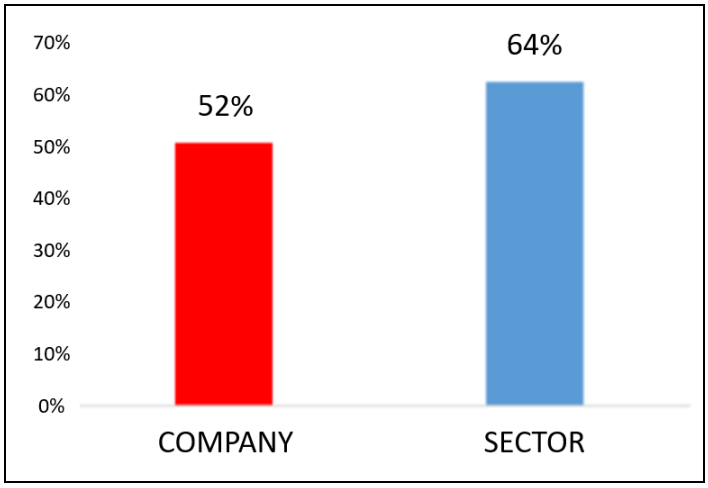

Figure 4. Production line efficiency versus sector

4.3. Application of model to the case study.

4.3.1. Change management

The start of the proposed model, applied in the company under study, was carried out through change management based on John Kotter's plan. Establishing a sense of urgency, workers were trained with the vision of being a benchmark company in the sector through process efficiency and communication with the organization. A coalition was formed by three workers who were in charge of leading the change. Training was carried out to eliminate or reduce resistance to change, which was considered as an obstacle to implementation, based on an understanding of the importance of the issues that the company had and how these affected it, see Figure 5

Figure 5. Kotter's change management skills

We sought to ensure success, implementing SMED improvement tools and study methods for which a milestone diagram was developed in order to control the results achieved.

4.3.2. SMED

To implement the SMED tool, a work duo was formed that received training on the tool and that was responsible for carrying out the exchange operations. After studying the setup operations through a DAP, internal and external operations were identified with the time that each of them took. Following the steps of SMED, both types of activities were separated and then the internal and external activities that were possible were transformed. To reduce setup time, a new operator joined the process, having previously analyzed his workload. This allowed the internal activities to be reduced from approximately 30 minutes to 15 minutes. Specifically, the second operator helped with the activities of finding tools, stamps, cleaning materials, and change, for which he used the help of a transporter cart, see Figure 6.

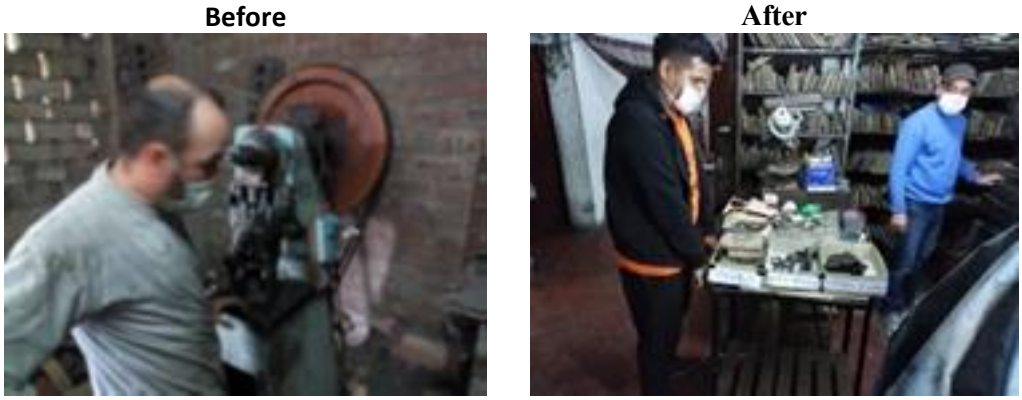

Figure 6. Before and after improvements in setup

4.3.3. Study of methods

The tool for the study of methods in the finished product operation was also implemented. When performing the 7 steps of this technique, the above operation was selected because it was a bottleneck; its activities were examined and recorded and time delayed by a bimanual diagram, as they were activities that did not add value to the product but were done because they believed that higher quality was added. These activities were basically repetitive but unnecessary, such as turning the ring around the filing axis and re-holding it. However, by not having a clear and defined method for this operation, the person in charge of performing this task obtained high and variable times. Therefore, a new method was developed, where unnecessary activities were eliminated and implanted in that workstation, see Figure 7.

Figure 7. Before and after filing process improvements

4.4. Results

4.4.1. Resistance to change

$$Resistance = \frac{0}{5} \times 100 = 0\% \quad (5)$$

The proposed model obtained positive results, the resistance to change was eliminated because initially, according to the survey conducted, there was a resistance of 15%, but after providing the training, the workers accepted the change completely.

4.4.2. Reduction in filing time (%)

$$Reduction = \frac{(37 - 25)}{37} \times 100 = 32.4\% \quad (6)$$

After implementing the model, by means of the study methods the bottleneck timings and the filing operation were reduced by 32.4%. This allowed the cycle time to be reduced as waiting time.

4.4.3. Reduction in setup time

$$Reduction = \frac{(30 - 15)}{30} \times 100 = 50\% \quad (7)$$

Likewise, with the implementation of SMED, the setup time was reduced by 50%, with respect to the start of the model implementation. This improvement allowed to streamline the process of setting up the press, thereby making the machine more available to produce more work orders.

4.4.4. Production line efficiency

$$New\ production\ line\ efficiency = \frac{74}{5 \times 25} \times 100 = 59\% \quad (8)$$

Finally, as a result of the improvements achieved by the implemented model, the production line increased 7% with respect to its initial condition. However, it still differs from the sector but by a lower percentage, 5%.

5. Conclusions

- The proposed model allowed the efficiency of the production line of the case study to increase by 7% through a 32% reduction in filing time, the bottleneck process, and 50% setup time.
- It is estimated that the improvement achieved will generate savings for a sum of approximately S / 30,000 per year by reducing wastage due to waiting times in the production area.
- The four scenarios that were validated show a general improvement in line efficiency, which allows the feasibility of the proposed model to be applied to other organizations in a similar condition.
- The success of the proposed model is based on the integration of two models, the lean model and change management by John Kotter that focus on operational techniques and on the promotion of human development with growth perspectives, which together make up a strong model.

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