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IMPLEMENTING LEAN WAREHOUSING MODEL TO INCREASE ON TIME AND IN FULL OF AN SME COMMERCIAL COMPANY: A RESEARCH IN PERÚ

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Implementing Lean Warehousing model to increase on time and in full of an SME commercial company: A research in Perú

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ABSTRACT

The commercial sector currently has high demands for fast and accurate delivery of orders; however, there is a trend of increasing customer dissatisfaction that directly impacts product returns; this is mainly related to the logistics process of warehouse management. Therefore, a model was developed using the Lean Warehousing methodology and analysis tools, including Poka Yoke, 5S, Standard Work, Multi-criteria ABC, and Kardex. The case study is about an SME footwear importer and trader in Peru. A model was developed to improve the underperformance of correct and on-time delivery orders (OTIF). The research shows the improvement of the On Time index to 80.73%, In Full to 86.46%, and OTIF to 69.80%. The proposed model was implemented through a pilot and simulated through Arena software. This research demonstrates that the application of the Lean methodology together with analysis tools is viable for the improvement of processes in the warehouse area with optimal results, so this research can contribute as a guide to lay the foundations for improvement in SME trading companies with similar problems in the quality of delivery of orders, which by the growth they need to improve their level of service continuously.

CCS CONCEPTS

• **Applied computing**; • **Transportation**; • **Supply Chain Management**;

KEYWORDS

Lean Warehousing, Standard Work, 5S, Poka Yoke, Multi-criteria ABC, Commercial company, SME

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1 INTRODUCTION

In the current global competitive environment, trading companies are experiencing increased demands in the quality of delivery of their products by customers, so storage is one of the critical components of the logistics process of a company, as it determines the ability to fulfill orders quickly and accurately [1]. Companies such as those in the footwear sector have an impact on the economy in Latin America; this is demonstrated by the sales value of the fashion and footwear sector, which in 2021 was USD 43,467 million; in the case of Peru, the sales value amounted to a total of 3,318.9 million soles [2]. In the country, this sector has shown an average annual import growth of 13.8% in the last ten years [3]. China stands out as one of the most important suppliers of this industry in Peru, accounting for 49.5% of footwear imports [3]. In the commercial sector, there has been a decline in customer satisfaction, resulting in high levels of order returns [4]. This forces warehouses to manage a better level of performance in order picking processes and warehousing systems, which are vital concerning time spent and costs incurred [1]. In quantity, manual order picking is still dominant over automated warehousing, which causes researchers to constantly develop various improvement models for this system, focusing mainly on cost efficiency [5].

Based on the literature reviewed, the problem identified may be due to inadequate physical distribution of products, poor inventory management, and poor warehouse operations management, resulting in high order returns [4]. This problem is also reflected in a case study in Ecuador, which showed a high level of time spent in order preparation, mainly due to the lack of order of product location in the warehouse, the random determination of SKU codes, and the lack of criteria for the location of similar items, which produced errors and delays in order preparation [6]. Other causes could be inadequate handling of products in the warehouse, inadequate Kardex control, different quantities shipped than required, lack of product identification system, and inadequate space segmentation, according to a case study of a Peruvian manufacturer [7]. From those mentioned above, it is shown that in warehouses, the order preparation process with correct and on-time deliveries is deficient; therefore, industrial solutions are proposed.

The warehouses must be more efficient for the delivery of products according to customer requirements; such is the case study of an importer and trader footwear company that has a problem of low performance of delivery orders corrects and on time reflected in the OTIF indicator at the service level, which is 56.53%. This low performance is due to picking errors, delays in order preparation, manufacturing errors, among others. These generate an economic impact of 2.68% of its turnover in costs. For this purpose, the following warehouse management model was deployed under the Lean Warehousing methodology and analysis tools, including Poka Yoke, 5S, Standard Work, Multi-criteria ABC, and Kardex. It should be emphasized that there is not a considerable number of articles referring to SME companies importing and trading footwear as in this case study, so this model is developed based on articles with similar problems in warehouse performance, offering a new combined model for manual warehouses in the commercial sector.

2 STATE OF THE ART

2.1 Lean Warehousing

Commercial companies dedicated to the retail distribution of products commonly present problems caused by inadequate performance of operations within the warehouse, which generates noncompliance with customer needs; an efficient and effective operation in the warehouse management system allows for optimizing costs and improving the level of customer service [4]. In previous research, the use of Lean Warehousing tools such as 5S, visual management, and Standard Work used mainly in the first stage of their implementations as the basis of this methodology is highlighted [4, 8]. In addition, implementing Lean tools has direct results in the warehouse environment since they optimize the area and provide a standard in the processes [9], these are also perfect for introduction in traditional warehouses mainly because of their affordability and systematic simplicity [8]. Furthermore, the 5S tool allows for improvement and control of processes within the warehouse and the physical space in which its various processes occur [10]. This tool consists of the application of five steps and, together with other tools, can improve the level of service within a company [11].

2.2 Multi-criteria ABC

Retail and distribution companies often have a problem with low productivity in order preparation since the search for items contributes to high preparation time [6, 12]. Therefore, ABC analysis is performed on a demand driven basis based on historical data, sales frequency, contribution margin, existing inventory, and multicriteria evaluation [6, 13]. The products are classified into three levels: A, B, and C, which depend mainly on their turnover rate; that is, those classified in A have a higher flow of movement, those in B an intermediate level, and those in C a low level in their turnover [6, 12, 13], in addition, other criteria should be taken into account when relocating SKU codes within the warehouse such as the similarity of products to each other, either by item or presentation, since this can generate errors when preparing orders [6].

2.3 Kardex

Implementing Kardex is essential in warehouses to register incoming and outgoing products, which contributes to the proper control of inventories; this is necessary to properly code items [14]. Moreover, using this tool digitally is a viable option since it avoids waiting times to receive stock information [15]. On the other hand, it reduces misplaced merchandise [16] and the time used in the search for items [14]. In addition, when implemented with other tools, whether Lean or multi-criteria ABC, it helps to reduce logistics operating costs [6, 15].

2.4 Poka Yoke

The increase in the frequency of customer complaints due to errors in delivered orders, either for wrong products, quantities not ordered, or wrong shipping destination, implies the use of new improvement methods, such as the Poka Yoke tool, which is used for the prevention of errors in the work environment and their detection in the order preparation process [9, 17]. This tool can be used in several ways, one of them is to use it as a signal, meaning that it can be implemented in the form of signs for shelf marking in order to obtain a quick and correct recognition when picking products in the warehouse [18]; another way to implement it is through the use of barcodes, which optimizes the time used for the registration of merchandise and order information since it can be done quickly and efficiently [19].

3 CONTRIBUTION

3.1 Rationale

The model was developed based on case studies of the same and similar sectors that made proposals for the improvement of their warehouses, which solved problems in the preparation of orders and inventory control [4, 6, 8, 9, 14]. Most of the articles consulted used Lean Warehousing tools, in which the 5s and standardized work stand out since this form the basis for problem solving, helping to organize work areas and standardize processes [4, 8, 9]. Also, for inventory control and product location systems, tools such as Kardex and multi-criteria ABC are emphasized [4, 6, 9, 14]. Finally, the use of the Poka Yoke tool to reduce errors in the processes is emphasized [9].

3.2 Proposed Model

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.

Due to the small number of articles focused on the improvement of SMEs through engineering tools and the nature of the Peruvian company under study, this research will contribute as a support guide for growing companies in the commercial sector with warehouses of finished products that present common problems in the picking process and order deliveries. Furthermore, this proposed model of lean warehousing methodology combined with analysis tools, including Poka Yoke, 5S, Standard Work, Multi-criteria ABC, and Kardex, is focused on functioning as a basis or first stage for the development of improvements in the logistics area, so its application aims to improve the quality of similar companies in the sector and their level of service.

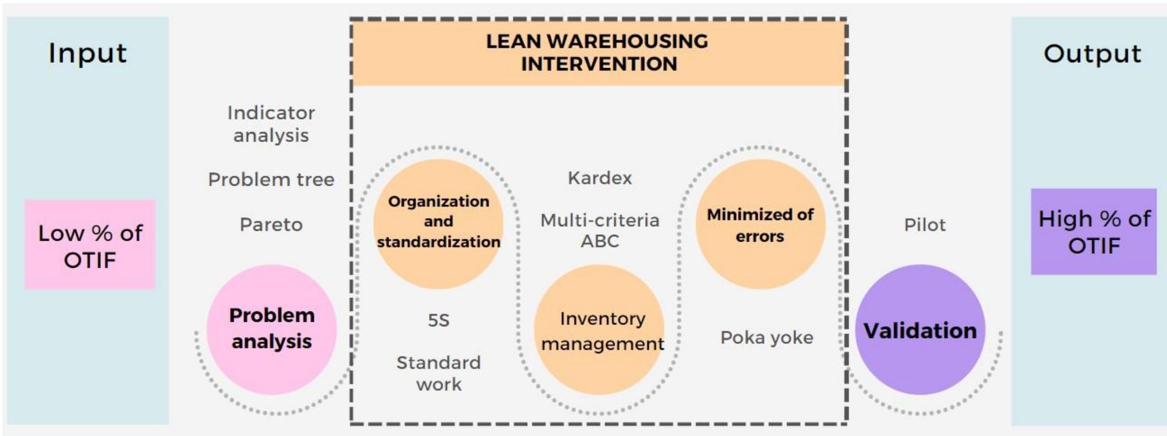

Figure 1: Proposed model

3.3 Model Details

Model details are made up of three components.

3.3.1 Component 1: Problem analysis. For the analysis of the problem, information was collected from the company, allowing the development of indicators subjected to analysis. Problem Tree was created to identify the leading causes and used Pareto to determine their impact. Therefore, a case study was carried out to propose each instrument used in the model.

3.3.2 Component 2: Intervention. This second component was divided into three stages for a better application of the proposal in the company's warehouse, which is traditional and manual. Also, each tool is applied under the Lean Warehousing methodology and visual management.

Stage 1: Organization and standardization. In this first stage, the Lean 5S tool was used, which mainly helps the organization of the area to be improved, in other words, the warehouse. This tool allows the creation of clean, safe, and organized workplaces. This method refers to 5 Japanese words that begin with S and, in English, mean sort, set in order, shine, standardized, and sustain. Also, to apply for Standard Work issuing orders, since this process is crucial for optimal performance in the preparation of orders. The application of this first stage generates stability for the following two steps.

Stage 2: Improvement of inventory management. This second stage focuses mainly on the control and location of inventories since the company does not have a record of incoming and outgoing stocks. Therefore, using Kardex is the base point for identifying stocks; for this reason, we start with the definition of parameters of the internal codes of the products since those are different suppliers in China from where they are imported. Furthermore, using it digitally speeds up the stock queries made by the sales and warehouse area, so its implementation is done through a spreadsheet format, which is available for display in stores and editable for the warehouse area.

Once the movement record is available after applying the Kardex, the next step is the application of the multi-criteria ABC analysis to classify the SKU codes and assign them a more optimal location. The classification is based mainly on inventory turnover and contribution margin.

Stage 3: Minimized of errors. In this last stage, the Poka Yoke tool is used to reduce errors in the picking process. This tool is mainly applied to standardize product labels and mark each shelf to avoid mistakes in the process. As mentioned above, before the proposal, these situations used to cause confusion, which led to human errors by the personnel when picking orders. The confusion was due to the variability of the labels, some of which had similar codes, confusing colors written in English or Chinese, and letters not very visible, among others.

3.3.3 Component 3: Validation. The last component is validating the proposal, which employs the results of the implemented pilot test. Finally, the simulation of the order preparation process with Arena Software, together with the new indicators, help visualize the impact of the proposed model.

3.4 Proposed process

The process to be followed for the implementation of the proposed model is described in Figure 2.

3.5 Indicators

Average order preparation time. This indicator measures the time spent on order preparation. By applying the Lean model, the average order preparation time indicator can be reduced by 30% [4, 8].

$$[illegible]\ ([illegible]) = \frac{[illegible]}{[illegible]} \tag{1}$$

Average product search time. Accordingo several researches based on the proposed Lean model, this indicator can be reduced by 54.83% [9, 14].

$$[illegible]\ ([illegible]) = \frac{[illegible]\,h\,[illegible]}{[illegible]} \tag{2}$$

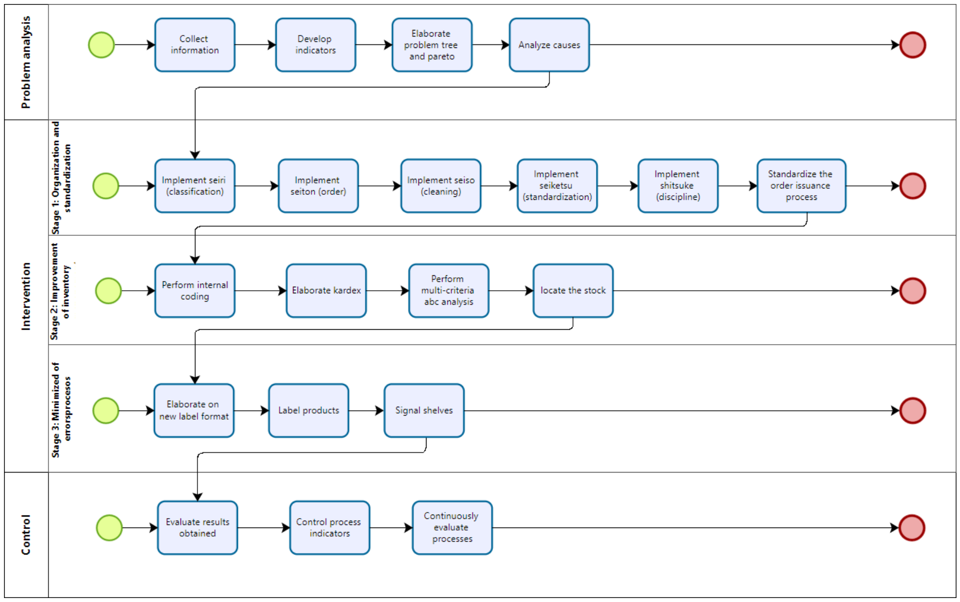

Figure 2: Proposed process

Percentage of returns. Researches indicate that applying a Lean Warehousing model can reduce this indicator by 38.46% [9, 11].

$$\text{[illegible]}\ (\%) = \frac{\text{[illegible]}}{\text{[illegible]}} \tag{3}$$

On Time. Researches indicate that applying a Lean model can improve this indicator by 14.04% [20, 21].

$$\text{[illegible]}\ (\%) = \frac{\text{[illegible]} - \text{[illegible]}}{\text{[illegible]}} \tag{4}$$

In Full. Researches indicate that applying a Lean model can improve this indicator by 7.38% [4, 21].

$$\text{[illegible]}\ (\%) = \frac{\text{[illegible]}}{\text{[illegible]}} \tag{5}$$

OTIF. According to the researches as mentioned above, the target value of this indicator can be improved by 22.47%.

$$\text{[illegible]}\ (\%) = \text{[illegible]} \times \text{[illegible]} \tag{6}$$

4 VALIDATION

This research work was developed in a Peru's footwear importing and trading company. The proposed Lean Warehousing model was divided into three stages, of which stage 1 and part of stage 2 were carried out through a six-month pilot implementation. The 5s, Standard Work, and Kardex tools were developed during the pilot. In addition, the order preparation process was simulated to validate the second part of stage 2 and stage 3.

4.1 Initial diagnostic

In the initial situation, the case study of this company had as a problem the low performance of delivering orders correctly and on time; this was reflected in the initial OTIF indicator at the service level, which was 56.53%, which caused an economic impact of 2.68% of its turnover in costs.

In 30.13% of the cases, the main problem was due to errors made during picking, while in 49.45% of the cases due to delays in the order preparation process; both intermediate causes have as root causes the confusion generated by product labels, items that are out of place, inaccurate order notes, outdated inventory stock, and inefficient product placement system.

4.2 Validation design

In the first stage, the 5s tool was developed, where the work areas within the warehouse were mainly delimited, any excess material that was not necessary for the area was cleaned and discarded, cleaning routines were also established, and work materials were organized and labeled, as well as the shelves and items to be sold were put in order, achieving a 12.65% reduction in ERU and a 27.68% reduction in picking errors.

On the other hand, the order issuing process was standardized, establishing the required data to be completed for each order received, such as customer name, ID number, RUC or another identification document, type of shipment, shipping agency, the total quantity of items, among others, and the verification of data before issuing the order was established, all this under a new sales policy of order confirmation. As a result, an average reduction of 32.73% of the time spent in consultations with the sales area was obtained.

In the second stage, for the development of the Kardex, in the first place, parameters were established for the classification of the articles, which were line, gender, color, and size; these were used to create SKU codes for the company's internal use. After this, the general template was created, which records the input and output of each item and displays the available stock for each SKU. In this way, optimal results of 27.93% ERI were achieved.

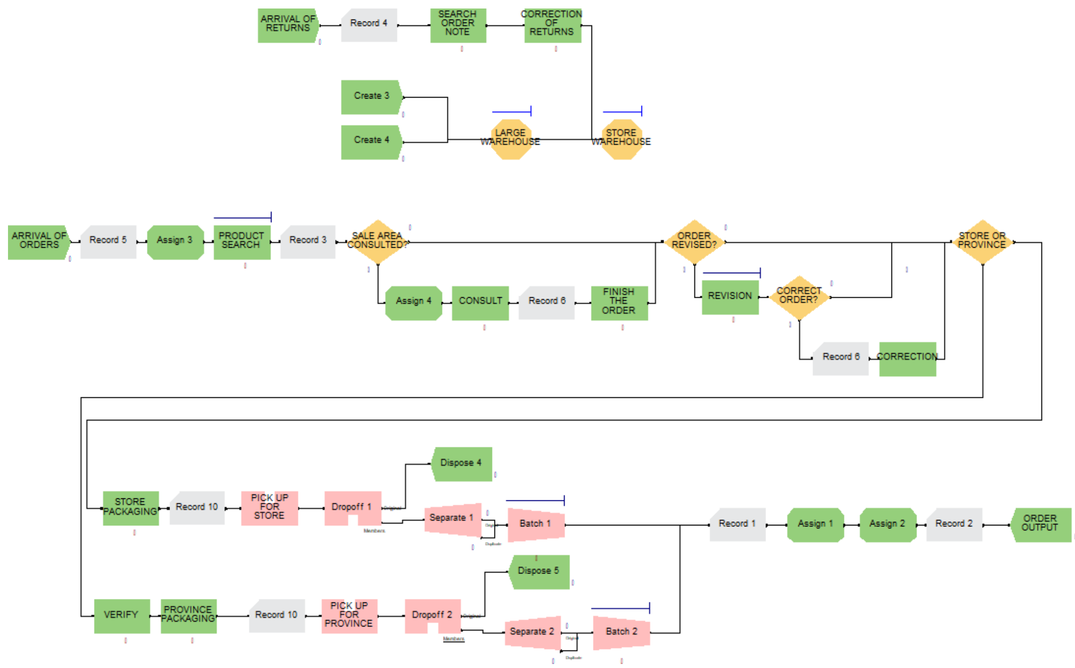

Figure 3: Simulation of the process

Table 1: Results comparison

Indicator	Initial value	Target value	Final result
Average order preparation time	17 min	11.9 min	11.37 min
Average product search time	6.05 min	5.08 min	4.29 min
Percentage of returns	11.26%	6.93%	7.25%
On time	72.48%	82.66%	80.73%
In full	78%	83.76%	86.46%
OTIF	56.53%	69.24%	69.80%

For the second part of stage 2 and stage 3, the process was simulated using Arena Simulator software (see Figure 3), starting with the data from the pilot implementation and then making the projected changes in a new improvement scenario. The process begins with the arrival of the orders, which continues with the search for items, which then includes consultations with the sales area, review of orders, and packing according to their destination, either store or province. The simulation was carried out for the time of one working day, equivalent to 11 hours. The average number of orders handled in a day is 64. The improvement took into account the variation in the number of returns, the percentage of incorrect orders due to picking errors, and the decrease in time spent searching for products, which led to a decrease in the average order preparation time.

As a result of the pilot implementation and the process simulation, the average product search time indicator decreased by 61.87%, the order preparation time improved by 33.12%, and the percentage of returns decreased by 35.64%. With the above results, the on-time indicator was determined with a percentage of 80.73% and the in-full indicator with a percentage of 86.46%; therefore, a final OTIF of 69.80% was obtained (see Table 1).

5 CONCLUSIONS

Logistics processes impact the quality of delivery orders to the target customer, which is why the proposed model focuses mainly on optimizing the processes occurring within the warehouse area using tools under the Lean Warehousing methodology.

By implementing multi-criteria ABC, Kardex, and Standard Work, the order preparation time was reduced by 33.12% since they had a direct impact on the consultation time with the sales area, improving the index by 24.30%, and on the order search time, improving the index by 61.87%, maintaining a better stock control within the warehouse. On the other hand, returns were reduced by 35.64% with the 5S and Poka Yoke tools since they prevent picking errors during the order process. Furthermore, with the development of this model, the On Time indicator was improved by 11.38%, In Full by 10.85%, and OTIF by 23.46%, which means that the percentage of on-time orders increased and the number of incorrect orders decreased. Finally, working permanently with the established changes is necessary not to lose their effectiveness and to compare results constantly.

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