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Lean Warehouse Model to Improve the Level of Service in a Distribution Center of a Commercializing Company in the Beverage Industry

Cristhian López Barrantes [1], Celso Torero Toche [2], Alberto Flores Pérez [3], Juan Quiroz Flores [4], Martín Collao Díaz [5]

[1] Facultad de Ingeniería y Arquitectura
[2] Universidad de Lima

Abstract. This research article is developed in one of the warehouses of a commercializing company belonging to the beverage industry, which is the legal basis of every distribution center to execute the contribution developed. It is known that storage is the protagonist within the supply chain with 80% of the business budget; therefore, a set of engineering tools was defined to optimize operations in this area. This improvement arises from implementing the Systematic Layout Planning methodology accompanied by Lean, Kanban, and 5S tools, aiming to optimize the level of service, increase the inventory turnover rate and maximize productivity and storage efficiency. After the simulation in the Arena Simulation software, the investigation results were announced, being favorable in each of the evaluated indicators. The level of service increased from 95% to 98,246%; on the other hand, the order fulfillment efficiency was maximized to 95.73%. Regarding productivity, this improved from 285.9 Boxes / H-H to 329.5 Boxes / H-H, and finally, inventory turnover was optimized, increasing its value by 9%.

Keywords: Systematic Layout Planning, Kanban, 5S, Warehouse, Picking, Service level.

1. Introduction

Warehouses are part of most companies, especially manufacturing and trading companies; this helps safeguard supplies, materials in process, and finished products [1]. However, there are different types of products that require different storage systems; such is the case of the beverage industry. For the most part, they are products that expire in months, so picking and packing times must be efficient.

For those mentioned above, various engineering tools, such as 5S, Kanban, Heijunka, JIT, or Kaizen, can be applied to storage logistics to optimize times and eliminate waste [2]. This article aims to implement the SLP, Kanban, and 5S tools to propose a new layout that helps improve the time of extraction and assembly of orders [3][4] to increase the level of service for the company.

2. State of the Art

2.1. Level of Service

Orders are served, and customer satisfaction is measured through the level of service that a company possesses. Concerning the beverage sector specifically, the optimal levels in a company are three: 84.135%, 97.725%, and 99.865%, taking into account that the warehouse area is the most influential to the mentioned indicator [5]. In addition, the service level is fundamental, as it is strongly associated with safety stock, warranty policies, delivery facilities, rework facilities, and gift policies [6].

2.2. 5S

The purpose of this tool is that the work center is orderly and safe; in this way, it would reduce the rate of product defects and optimize work times [7]. It also generates a continuous improvement system whose objective is to optimize processes seeking high standards of quality and competitiveness [8]. According to Bevilacqua, the second (order) and fourth (standardization) "S" are intended for warehouse and inventory management [9].

2.3. Kanban

This tool, proposed for the supply chain, has several benefits within warehouse management, such as reducing downtime, order, and better logistics control [1]. Implementing the Kanban and 5S tools in storage starts from the theoretical to the practical using other engineering resources such as the proposal of a layout, Kanban cards, and boards, or a routing policy that determines the sequence of picking up products in the warehouse tour [10]. In addition, this tool allows seeing the level of importance of each task, contributing to the solution of orders that require extra support [11].

2.4. Systematic Layout Planning

The purpose of the SLP methodology is to improve the organization of the distribution of the production plant, in the case of industrial companies, or warehouses, in terms of commercial companies, seeking to ensure the fluidity of work, materials, people, and information through the operations of the production system [12].

Currently, companies consider warehouses as the area of connection and transit of purchases, production, and sale, so opting for an improvement in its design will bring benefits throughout the supply chain and its time. It will increase the efficiency and capacity of the operators in the distribution center [13].

Due to the significance of the warehouse, it is essential to have an initial design to save on future restructuring costs. This tool helps to analyze the logistic, non-logistics processes and the relationship between them, assigning a weight of importance in the sequence of activities in a range from -1 to 4, which are represented by letters and the proximity of each of the areas. The letters mentioned are A, E, I, O, U, and X, with A being the highest value and X the lowest [14] [15]

3. Contribution

3.1. Model Basis

Currently, companies seek to be more competitive by diversifying their product portfolio or expanding their markets. For this, many of them seek to improve their assets either by increasing the quality or by giving it added value to increase their sales and thus the profitability of the business. However, as mentioned in the research, this no longer attracts customers like it used to [10].

Therefore, in this context, to seek greater economic profitability and a better competitive position against other companies, it was obtained that the improvement in the level of service is what modern companies need to face competitors and satisfy the needs of customers, obtaining a higher profit margin. Various tools such as Systematic Layout Planning (SLP), Kanban, and the 5S methodology can be used. They help solve order assembly time, classification, and order in warehouses or processes and contribute to the search for continuous improvement [16].

Table 1: Matrix of Comparison of Objectives vs. State of the Art

Scientific articles	Objectives		
	Continuous improvement	**Organization, standardization, and classification**	**Distribution, reorganization of plant and warehouse**
B. Chandrayan, A. K. Solanki, and R. Sharma. [1]	5S	5S	5S
S. Ahsan Ali, D. Z. Memon, Ali, D. S. Ahmed Sheikh, and M. Haris Khan. [2]		WMS + Kanban	WMS + Kanban
M. Bevilacqua, F. E. Ciarapica, and	WMS + 5S	WMS + 5S	WMS + 5S

Scientific articles	Objectives		
	Continuous improvement	Organization, standardization, and classification	Distribution, reorganization of plant and warehouse
S. Antomarioni. [3]			
Y. Bai. [4]		SLP	SLP
Proposal	**5S**	**5S + Kanban + SLP**	**5S + Kanban + SLP**

3.2. Proposed Model

The model involves implementing Lean Warehouse tools in a beverage commercializing company.

First, a preliminary analysis of the company was carried out using SIPOC, FMEA, and the Pareto Principle. Thanks to this, it was possible to determine which tools were the ideal ones to apply. Later, the SLP methodology was implemented, with which a new Layout was proposed.

In the second phase, the 5S tool was used, which consisted of two parts. The first was to train workers about its benefits, while the second was the direct application in the new Layout. Then, in the third phase, the Kanban tool was implemented through the use of cards and boards in order to improve order extraction times. Finally, a control, and a continuous improvement was carried out using checklists.

3.3. Components of the Model

3.3.1. Component 0: Initial Diagnosis

In this phase, the company's current situation was analyzed to obtain an overview of it through a SIPOC matrix, to then determine the possible problems, which, through an FMEA, were quantified and those with the highest impact for the company were addressed. After that, the principal and secondary root causes were determined.

Thanks to the diagnosis, proposals for possible solutions were generated, determining the Lean tools that would be used in the process, so this phase concluded by making the tools known to the workers and the work plan for the following months.

3.3.2. Component 1: Systematic Layout Planning

After Component 0, the proposed model's execution began by implementing the Systematic Layout Planning methodology. This method was applied to obtain a proposal for a warehouse distribution design that ensures correct product location, guarantees free spaces in case of dangers, and demonstrates fluidity in operator traffic at all times.

The SLP implementation consisted of seven steps: product-quantity analysis, product path analysis, analysis of the relationships between activities, development of the activity relational analysis diagram, analysis of needs and space availability, relational diagram of spaces, and finally, evaluation of alternatives considering costs, advantages, and disadvantages.

In order to obtain the new layout, the following steps were taken. First, the product was identified (returnable and non-returnable bottles), which arrived in pallets of 30 boxes per pallet, with a unit load of 24 bottles of 8 ounces each one, the monthly demand is 961 boxes. Regarding the second step, the products' processes according to the old layout were identified.

After identifying the materials and their flow, the relationship between activities was analyzed, determining the importance of proximity using letters A through X. The relational analysis diagram was then carried out to visualize a possible distribution of the warehouse. Next, a proposal was made for each area, where the truck and administrative service areas were reduced by 10.35%. Finally, the proposals for a relational diagram of spaces were made, and the one that best suited the order service process was chosen.

3.3.3. Component 2: 5S

In the second phase, we worked with the 5S methodology consisting of five stages: Seiri, which is based on classifying and separating unsuitable products and materials; Seiton, is based on the ordering of the elements in the spaces previously assigned from the new Layout, 20 stands of capacity were installed for 72 pallets each, this based on the average demand per product; Seiso, consists in the cleaning that will be done in the warehouse daily; for this, verification sheets and cleaning inspection will be used.

After those mentioned above, the fourth S, Seiketsu, was worked. This phase is executed to consolidate the work previously carried out with the previous 3S. It is achieved with the help of defined regulations and visual evidence (boards, instructions, and manuals, zone markings). Finally, Shitsuke refers to labor discipline to maintain the philosophy of continuous improvement. Operators were trained and evaluated in each S, emphasizing Seiton and Seiketsu; this is expected to help reduce operating times.

3.3.4. Component 3: Kanban

After the first two phases, training was carried out in applying the Kanban tool. First, the workers were instructed on the use of the cards. The objective is to classify the types of products and standardize some types of orders. The number of total cards was obtained based on the daily demand (1,378 pallets), the circulation time (8 hours), the safety factor (5%), and the capacity of the container (72 pallets/rack). The final value was 161 cards in the 20 stands.

Finally, the joint use of the previous tool with the board was taught to maintain the order of processes and activities by operators in the picking and packing orders. The dashboard helps operators visualize which tasks are pending, in process, or completed.

3.3.5. Component 4: Control and Follow up

Finally, the respective monitoring and control of the workers were carried out through internal audits and labor court surveys, which charted the optimization of the storage processes in the company. In addition, as helpful tools, business diagnostic topics were developed, such as Ishikawa diagrams, affinity diagrams, and the Thibaut model.

Concerning the subjective area, the employee's behavior was considered fundamental to improving the company. From this factor, incentives are given, whether economic or non-economic, to assume full responsibility and interest when performing their work based on the tools applied.

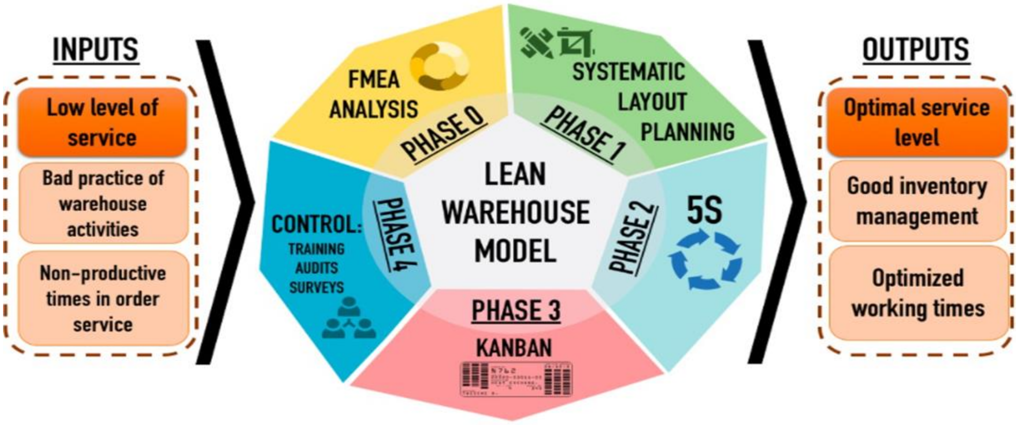

Fig. 1: Proposal Model.

3.4. Indicators

For the evaluation of this implementation, the following indicators were used:

Service level: It is the percentage of the number of orders attended by the company over the total orders made to it.

$$\% SL = (\text{Orders attended})/(\text{Total orders}) \times 100 \quad (1)$$

The initial value of the service level is 95% below the optimal level of 97.725% [5].

Productivity: This allows to view the number of boxes that will be attended from numerous orders in a given time.

$$\text{Prod.} = \text{(Number of dispatched boxes)}/\text{(Cycle time)} \quad (2)$$

The current level of productivity is 285.9 Boxes / H-H, this should increase by 50% when using Lean tools [17].

Efficiency: The indicator shows us the percentage of boxes dispatched over the real capacity that the company has to carry out this action.

$$\%\ E = \text{(Number of dispatched boxes)}/\text{(Real dispatch capacity)} \times 100 \quad (3)$$

The current value of order fulfillment efficiency is 88.2%, which is below the optimal value of 96.07% in warehouses [18].

Inventory Turnover: This is the capacity to rotate the inventory every month. It will be optimal the higher it is since it symbolizes the product's speed from the warehouse.

$$IT = \text{(Sale cost)}/\text{(Average inventory)} \quad (4)$$

Inventory turnover should increase by 0.1617% [19] once the new warehouse is implemented and the training in 5S and Kanban is completed.

4. Validation

The modeling was carried out in the Arena software, using the company's current data, allowing to obtain probabilistic distributions, resulting in simulated data and indicators that show the improvement under an ideal context. In addition, the simulator was run based on various factors such as system scope, input variables, sample size, and entities or elements. As a result, the company's service level is expected to increase from 95% to 97.725%.

4.1. Initial Diagnosis

In the initial diagnosis, a problem was found in the company's service level mentioned above, which was 95%, with productivity of 285.9 boxes / HH, and efficiency in the order service process of 88.2%. Finally, an inventory turnover of 11 times per month.

The level of service costs the company $ 0.39 million annually. Currently, companies seek to survive in business competition, and the way to do it is by providing a good level of customer service. Therefore, this is one factor that motivates consumers to prefer a company since they prefer to have the more outstanding facility in the availability of products, thus increasing the demand for these [6].

In addition, the company has four forklifts, twelve operators in the warehouse area, of which four operate the forklifts, three classify the products, four are in charge of assembling orders, and one performs the repacking of the products.

4.2. Validation design and comparison with initial diagnosis

For the development of the model, data was taken from the company on the times in activities such as truck unloading, product classification, storage, repacking of products, order assembly process, and dispatch of orders to trucks. An initial sample of 20 data was taken for each of the activities. Then, using the statistical formula for determining the sample, how many were required to determine a data distribution was identified. Said samples were completed in Excel using the Random formula concerning the initial behavior of the data.

Once the data was finished, the Arena software extension, Input Analyzer, was used to determine the distributions that best fit the data, and it was completed in the model. Then, with the data of workers and forklifts, a new layout was drawn up for the activities and their order. Finally, the model was evaluated for a workweek (6 days) using the necessary replications to obtain the expected results. The impact of the 5S on the manual activities of the process was also considered, reducing times by 39.76% [20].

To continue, Table II compares the current values and the values expected from the implementation.

Table 2: Indicators

Indicator	Current Value	Expected Value
Service Level	95%	97.725%
Productivity	285.9	428.85
Efficiency	88.2%	96.07%
Inventory Turnover	11	12

4.3. Improvement – Proposal Simulation

To measure the company's level of service, the number of delivery truck orders that arrived per day and the attention were given to each of them were taken into account. Second, to measure the workers' productivity in the picking area, the dispatched pallets were used (each pallet has 30 boxes) and the hours worked by the workers. Third, to measure efficiency, the total capacity available to attend to orders and the actual quantity dispatched by the operators was used. Finally, the cost of sale per box ($ 1.45) and the average inventory were used for the inventory turnover.

Table 3: Actual vs. Improved Situation

Indicator	Current Value	Improved Value
Service Level	95%	98.246%
Productivity	285.9	329.5
Efficiency	88.2%	95.73%
Inventory Turnover	11	12

As can be seen in the results, the main objective was met and exceeded expected. However, the other indicators did not comply with the predisposition, they did achieve a substantial improvement concerning the initial situation of the company, except for the inventory turnover that, although it is true it fulfilled the expectation, it did not exceed it.

5. Conclusions

The implementation of the Systematic Layout Planning methodology, together with the Lean Kanban and 5S tools, obtained favorable results that, for the most part, met the predefined expectations. In addition, it was noted that the level of service increased from 95% to 98.246%, exceeding the agreed target, which was 97.725%. This increase means that the distribution center increased the number of orders it can handle; This optimization complies with a 3.42% increase. Despite those mentioned above, the level of service can be further improved in a warehouse with similar characteristics to the case, obtaining 99.865%.

Regarding the other indicators, the efficiency of order service was taken as a measure of improvement, optimized from 88.2% to 95.73%. The actual dispatch capacity was maintained throughout the implementation; however, the number of units shipped increased. On the other hand, productivity was also improved to reach 329.5 boxes / H-H. Although the objective was not reached, there was an improvement of 15%. Finally, the PT inventory had a better rotation, reaching 12 times per month.

In a numerical scope, everything obtained was due to the simulation that originated based on attributes, entities, and factors. It was concluded that only the SLP tool could be simulated, based on the proposal of the new Layout, but not the 5S methodology since it is subjectively focused on the behavior of the employer and collaborator. The redistribution of the plant had a positive impact along with the other tools applied in order of application. It should be noted that if the order of the phases is not followed, there is no guarantee that success is likely.

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