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Proposal for improvement in warehouse management using Lean Warehousing methodology to increase the service level of a distribution company

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Abstract– The study's main objective was to improve the service level of a distribution and marketing company, surpassing the 93.19% indicator recorded in 2021 and reaching a service level higher than 95%. The improvement proposal focused on the warehouse's veterinary product line, representing the most significant number of income and sales of the distributor (31.63% of the monthly invoicing and a large part of the bills and invoices). Lean Warehousing, inventory management, and Systematic Layout Planning (SLP) methodologies were applied, resulting in a more efficient warehouse system. As a result, the monthly average time of the dispatch process decreased from 574.26 to 429.12 minutes, the daily cases of damaged or broken merchandise were reduced by 75%, and there was an incremental improvement in the cases of expired or soon-to-expire products. In addition, merchandise control improved from 87% to 98.64%, according to the ERI, and there was a 62.63% decrease in costs for total and partial returns, compared to annual losses of S/1,569,859.28 before the improvement. While applying the methodologies, it was found that implementation takes time and requires adequate personnel training.

Keywords-- Lean Warehouse, Warehousing management, Inventory Management, ABC Classification, Service level.

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I. INTRODUCTION

The mass consumption and distribution sector is recovering from the pandemic, and distribution and marketing companies must adapt to the new growth of the sector in order to provide good customer service.

Effective warehouse management is essential for distribution and trading companies to thrive. These facilities play a crucial role in supply chain processes by receiving, storing, inventorying, and shipping goods. [1]. As intermediaries between suppliers and customers, warehouses ensure the timely and efficient delivery of products.

Proper warehouse management is essential to satisfy customer needs, reduce costs and maintain a competitive advantage in the market [2][3]. Therefore, it is necessary to implement specialized methodologies and tools to improve the efficiency and accuracy of warehouse and inventory management processes, thus ensuring timely and satisfactory customer service [4].

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The improvement proposal will include implementing the Lean Warehousing methodology to reduce waste, standardize location management and add value to warehouse operations [5][6]. This methodology can be complemented with other tools, such as Systematic Layout Planning (SLP), to reduce delays in product placement and long goods movements, providing employees with a healthy, safe, and convenient environment [7]. On the other hand, inventory management, which includes cyclic counting and the FEFO method of merchandise distribution, can improve the ERI percentage and reduce cases of expired products [8][9]. These tools, added to the Lean Warehousing methodology, will allow the company to carry out its processes more strategically and accurately, meeting the customer's constant demand for improved service.

This article is organized as follows: Section 2 shows the state of the art of the study; Section 3 will define the difference between the proposal among the others already carried out; Section 4 will detail the current problem contextualizing in the distributor; Section 5 on the method to be used; section 6 will show the results of what was obtained by implementing the improvements. Finally, the conclusions of the research are presented.

II. LITERATURE REVIEW

Different scientific articles were reviewed and analyzed to understand and select the methodology and tools to improve the problem.

A. ABC inventory classification

The ABC analysis forms the classification by criteria based on value and quantity within the Pareto principle, which states that 80% of the effects come from 20% of the population. Regarding inventory management, the Pareto principle suggests that 20% of the SKUs account for 80% of the annual investment.[10]. According to the authors [11], the application of ABC analysis and other inventory indicators was able to classify according to their economic relevance, a method that ultimately manages better storage for subsequent processes such as dispatch. Also, leaving aside the result of the prioritization and relevance of each product, it was possible to identify obsolete products in the warehouse. The research reduced 48% of the inventory value, representing a monetary reduction of $/ 386,614.74.

B. *Management of storage bins*

The placement of warehouse items is a strategic decision with a significant impact on order fulfillment. Thus, considering layout information is crucial.[8].

The more straightforward method is storage signaling, supporting product identification faster and generating a much higher worker learning curve. The authors [12] found that, through their study, product search times were reduced by implementing optimal bin assignments, generating savings ranging from 27% to 62% compared to standard policy solutions. Similarly, the authors [7] generated efficiency improvements for order picking in the picking area, resulting in optimal solutions for approximately 64% of small instances and 5% for medium.

C. *Cyclic counting method*

The dynamics of inventory record inaccuracy (IRI) still need to be explored in a distribution center. The authors [9] address within their research a multi-method approach to understanding the nature and existence of IRI among cycle counts in a multi-channel environment based on daily and constant observations feeding the IRI indicator, concluding that the human factor significantly influences the IRI dynamics. Along the same lines, the authors [13] could detect, employing the cycle counts performed, that the medical company studied discovered 50% of waste in inventory, as well as different negative variations. By detecting such variations and waste, they were able to subsequently manage their elimination, which resulted in economic savings of $/165,000 in one year.

D. *Storage management*

Warehouse management is an essential part of the merchandise supply chain, where manufacturers, distributors, and retailers connect with customers. Therefore, it significantly affects the operation and development of companies [1]. For the authors [14], the first step in efficient warehouse management should be to have reasonable estimates using a database that can offer improved solutions in various situations. By obtaining this data, it will be possible to predict the optimal results, offering an increase of five performance points over the previous one in the author's case.

III. CONTRIBUTION

A. *Basis*

The improvement model was based on Deming's cycle because this method has brought different benefits, such as productivity and profitability in different sectors [15][16]. In addition, to improve the results of this model, the use of tools found in the literature review was introduced [17][18][19][20][21][22]. Lean Warehousing, inventory management, and plant layout are practical solutions to tackle the root causes of poor service levels in different situations.[23]. The Lean Warehousing tools selected were VSM, 6S, and Gemba Walk [24] to reduce waste and add value to warehouse operations. Some inventory management methods were cycle counting, FIFO, LIFO and FEFO inventory management models and the ABC inventory classification method. [11]. These tools aimed to obtain better inventory management results and reduce time and activities that did not add value in this area. The Systematic Layout Planning (SLP) tool, specifically designed for plant distribution, was considered to improve the efficiency of picking times and reduce the time spent searching for products in the warehouse.[25]. In order to achieve the highest level of customer satisfaction, it is crucial to fully understand the relationship between each tool and the root problem that requires resolution, as illustrated in Figure 1.

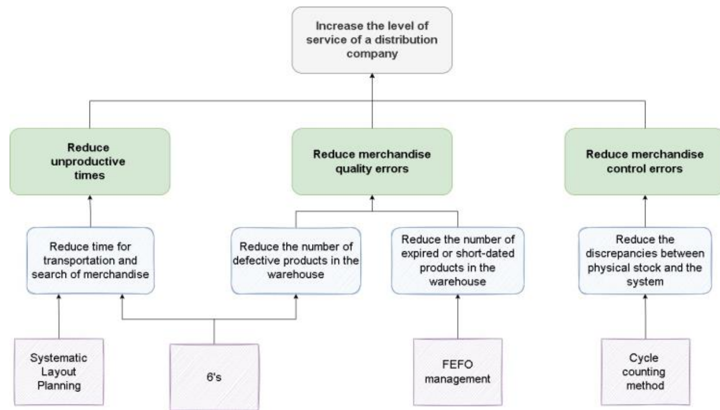

Fig. 1 Case linkage.

B. *Proposed model*

The proposed model recommends a structured approach with differentiated phases that improves service levels in a distribution and marketing company. First, we reviewed the literature and collected data from the target company to identify technical standards that may impede the proposed solution and assess the initial situation using diagnostic tools. Afterward, we presented a step-by-step methodology to minimize losses from these problems and improve their root causes to obtain more significant benefits. Then, we verify the expected versus actual results and evaluate the procedures of each operation in the warehouse. Finally, we developed new procedures, documented training, and created control mechanisms to ensure the sustainability of the solution.

IV. CASE STUDY

This study examined a distribution company in Peru that handles various products, including food, pharmaceuticals, and veterinary items.

The veterinary line stood out as having the highest sales but also caused the most problems, with 41.43% of documents resulting in returns.

The company is responsible for storing and delivering products for all clients, but they have struggled to maintain their service level goal of 95%. Over the past year, they have had around 5,196 documents rejected monthly, resulting in a service level of 93.19%.

After analyzing the situation (see Fig. 2), it was discovered that late delivery accounted for 34.42% of the issues, poor quality for 29.77%, and incomplete delivery for 23.33%.

The distribution company experienced a total loss of S/. 1,569,859.28 due to several reasons, including delays in the delivery of products, caused by unproductive process times, the search for merchandise, delays in the transfer and routing, as well as reprocessing.

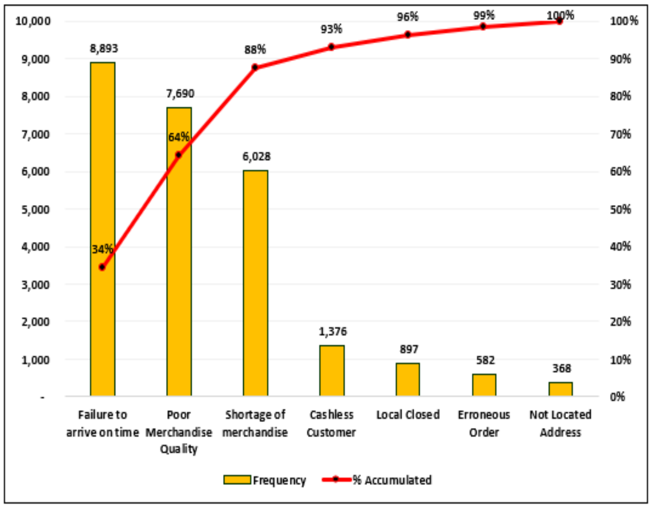

Fig. 2 Pareto of the main reasons that cause problems in the veterinary line.

V. METHOD

The model proposed in Fig. 3 contains several phases organized to carry out the process effectively. First, a literature review is conducted, data is collected from the company under study, and relevant technical standards that could constrain the proposed solution are reviewed. Then, an initial diagnosis is performed using various tools to identify the main problems

A. Plan

Important information was collected with stakeholders, such as initial indicators, recent sales and inventory turnover time. In addition, various tools, such as the Problem Tree, Ishikawa, ABC analysis and Value Stream Mapping (VSM), were used to diagnose the current situation and identify root causes and points for improvement.

B. Do

Before implementing improvements in the warehouse area, the piloting methodology was used to identify possible errors and necessary adjustments.

Once the proposal has been validated, the necessary resources will be allocated for its full implementation.

1) Systematic Layout Planning (SLP): This tool has significantly reduced unproductive times during dispatch since personnel travel distances to deliver the products sold daily have been reduced and the timely supply of customers has been prioritized.

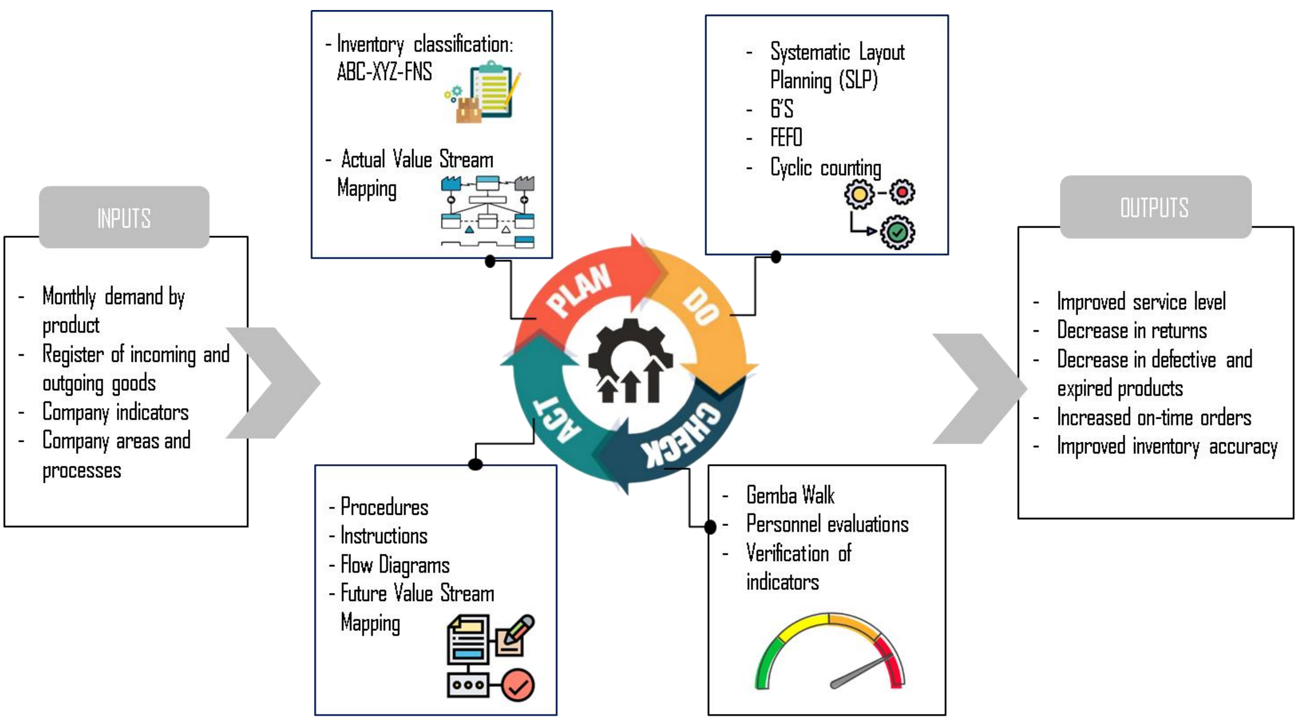

Fig. 3 Proposed Model.

In the implementation, priority was given to the location of the products with the highest demand and rotation, placing them close to the exit.

2) 6'S: This tool has improved inventory organization and control by eliminating non-value-added items and reducing the risk of damage and product expiration. It also facilitated the application of the 6S methodology, which includes transporting products based on their ABC classification, identifying them with signs, improving warehouse cleanliness, establishing clear rules for operators, and monitoring improvements. All personnel received training and field practices to ensure effective adoption and seamless adaptation to the tool's use. This tool also fostered a safety culture, reducing the risk of accidents and facilitating daily operations.

3) FEFO Management: The picking process was carried out by prioritizing the oldest product and the most recent, which helped avoid product expiration.

4) Cyclic counting: An updated inventory was maintained, which facilitated counting for the operators.

C. Check

This phase focused on verifying that the proposed model is efficient according to the expected results of the indicators.

The Gemba Walk technique was also used. It involves observation of the process and communication with supervisors and collaborators to identify possible problems and determine their root causes to generate corresponding improvements.

D. Act

This phase focused on improving what had already been implemented in the company to promote stability and constant improvement in its organizational culture.

VI. Results and Discussion

A. Validation scenario

In order to obtain adequate and reliable results, we will work with the veterinary line of the warehouse. This product line directly affects the level of service since it represents the most significant number of income and sales of the distributor (31.63% of the monthly turnover and a large part of the bills and invoices).

B. Proposal

1) Phase 1: Plan

In order to ascertain which products experience consistent, frequent, or fluctuating demand, we conducted an ABC analysis, as shown in Table I.

TABLE I
ABC Analysis

	AX	*BX*	*CX*	*CZ*	*Total*
F	35	32	46	1	114
N			5		5
S			1		1
TOTAL	35	32	52	1	120

After analyzing the data, we have determined that most products have a consistent demand, resulting in increased sales and rapid turnover.

Also, we employed the Value Stream Mapping technique to evaluate the current state of the warehouse processes, as shown in Fig. 4.

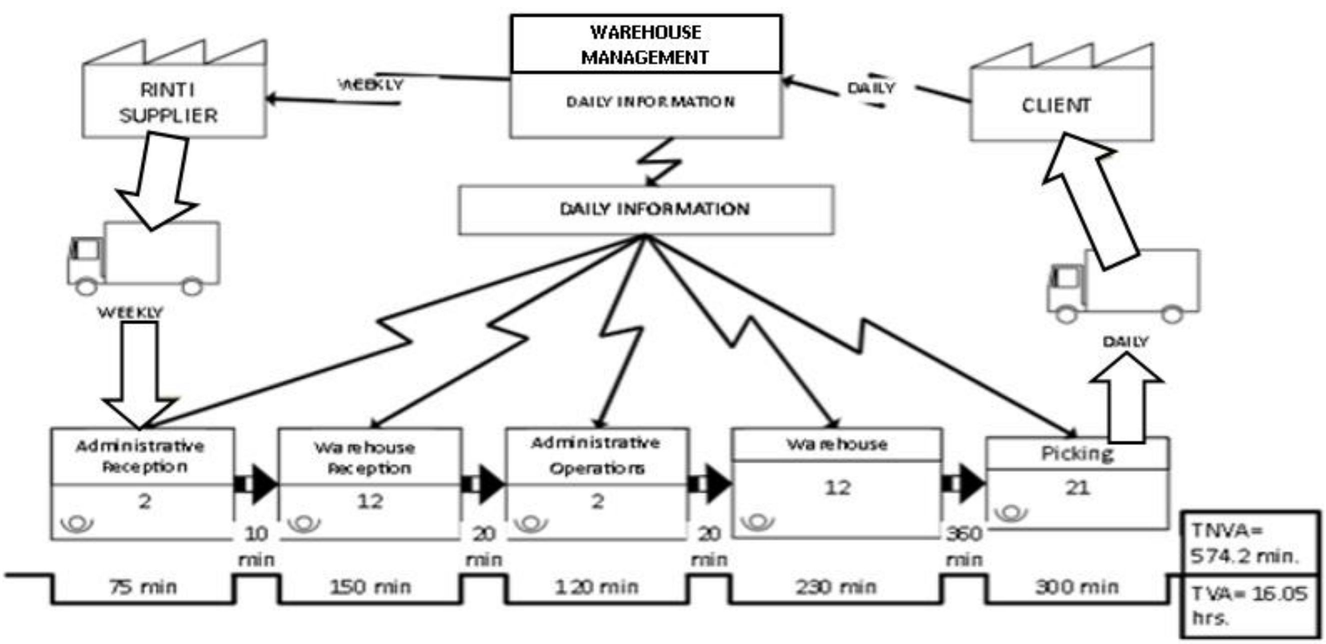

Fig. 4 Actual Value Stream Mapping.

2) Phase 2: Do

Step 1: Application of the Systematic Layout Planning Tool. The initial step for implementing this tool is to review the information obtained from the ABC method to identify the products with the highest turnover and monthly predictability.

Once the products were identified, we evaluated their association level with the activities. A proximity table was used to assess how product placement could be improved, as illustrated in Figure 5.

Code	Information	Color
A	Absolutely necessary	
E	Especially necessary	
I	Important	
O	Ordinary	
U	Not important	
X	Not desirable	

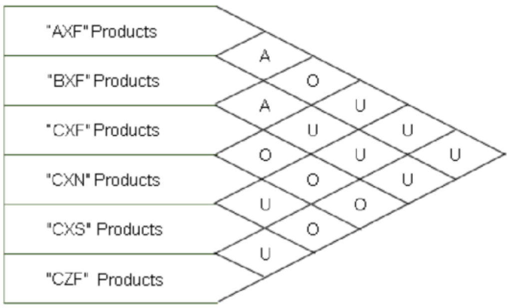

Fig. 5 Relationship diagram.

Once the relationships were known, we proceeded to analyze the current status of the products in order to proceed to make changes. This analysis is shown in the following Fig. 6.

A	Absolutely necessary	
E	Especially necessary	
I	Important	
O	Ordinary	
U	Not important	
X	Not desirable	

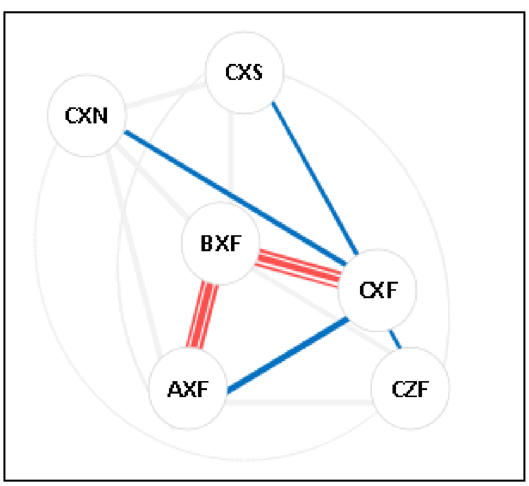

Fig. 6 Future relationship map.

Finally, after analyzing the current distances and relocating the location of the products within the warehouse according to their degree of importance, the following layout was obtained (see Fig. 7).

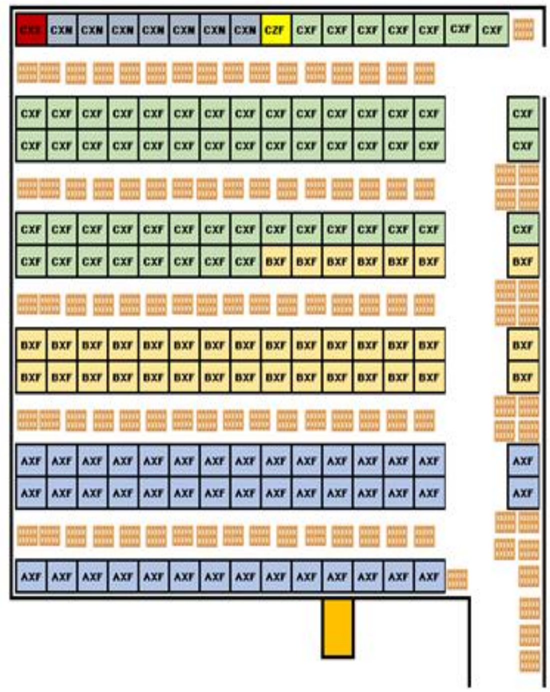

Fig. 7 Warehouse layout proposal.

Step 2: Application of 6'S. In the initial stage, personnel was trained in the 6'S methodology through examples and applications in other companies, followed by an initial audit and implementation of the steps:

I. Organize. The printing and placement of red cards (Fig. 8) will be managed to identify products that are not in their respective place according to their rotation and products that do not follow a correct FEFO order, as well as an indicator of bad practices within the warehouse. In addition, the products with the highest turnover were identified through the ABC classification.

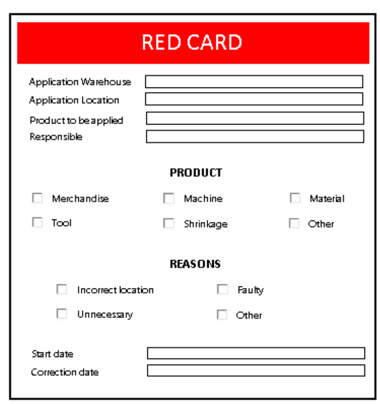

Fig. 8 Red Card

II. Order. A coded area was established using the location management tool and a unique SKU ID was assigned to the SKU with expiration date and product type information. (See Fig. 9).

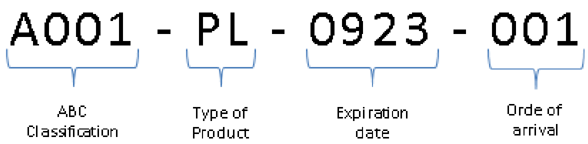

Fig. 9 Product code.

III. Cleaning. A cleaning policy was established and a format will be used to track this activity over time. (See Fig. 10).

WAREHOUSE CLEANING												
AREAS TO BE CLEANED	DAY:			DAY:			DAY:			DAY:		
	YES	NO	NA	YES	NO	NA	YES	NO	NA	YES	NO	NA
Wall Cleaning												
Corridor Cleaning												
Cleaning Entrance Door												
Floors												
Walls												
Roofs												
Doors and Partitions												
Racks												
Lighting Switches												
Staff wears coveralls												
Personnel wear nitrile gloves												
Personnel wear waterproof gear												
Personnel wear eye protection												
Time Cleaning and Disinfection	TIME			TIME			TIME			TIME		
Name and Surname of Person Responsible												

Fig. 10 Cleaning Procedure.

IV. Standardize. In this step, standard models were selected, such as photographs illustrating how the warehouse should look before and after working hours. (See Fig. 11).

Fig. 11 Warehouse standard

V. Maintain. Internal audits were conducted to promote the implementation of the standards proposed by the methodology and are planned to be conducted quarterly.

VI. Safety. Two engineering standards were applied to develop preventive measures to ensure employee safety. These standards will enable a safe office and a more productive work environment, improving ergonomics and employee visualization and reducing cases of mishandling and broken products.

The first of these is related to the weight of the load. A load limit of 25 kg was established for untrained operators and up to 40 kg for trained ones. The second standard focuses on lighting. 540 LUX spotlights were installed to achieve optimal illumination during nighttime picking.

Step 3: FEFO Management Application. The products were reordered according to their expiration date. The traffic light rule was used to classify the products according to their shelf life (see Table III). There are 120 types of products in the veterinary line and 150 locations on the first level to store them, so the second and third levels should serve as an extension of storage for products that are purchased in quantity in order to enable and feed the first level in case everything is dispatched.

TABLE II
FEFO TRAFFIC LIGHT RULES

Levels	*Months*	*Indication*
First Level	1-5	Dispatch first
Second Level	6-8	Dispatch only if there are no products on the first level
Third Level	9 -12	Dispatch only if there are no products on the first or second level.

The morning and night shift supervisors validated and encouraged compliance with the assigned locations. Product picking was performed sequentially, starting with the pallet closest to the exit and ending with the next pallet in case there were two pallets of the same product. Fig. 12 shows the results after implementation.

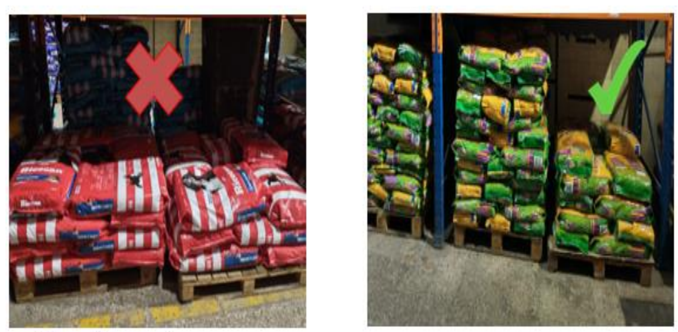

Fig. 12 Improving picking with FEFO management

Step 4: Cyclic Counting Method. According to international standards, A products undergo 12 counts annually, B products have 6 counts, and C products have 1.2 counts. The total counts per category are divided by the overall annual counts for all categories. See Table III.

TABLE III
CLASSIFICATION OF ITEMS TO BE COUNTED ANNUALLY

CLASSIFICATION	*# ARTICLES*	*FREQUENCY*	*TOTAL COUNTS*
A	*35*	*12*	*420*
B	*32*	*6*	*192*
C	*53*	*1.2*	*63.6*

After that, the number of products to be counted per day is calculated according to the category, as shown in Table IV.

TABLE IV
CLASSIFICATION OF ITEMS TO BE COUNTED DAILY

CLASSIFICATION	*TOTAL DAILY COUNTS*	*% COUNTS*	*N° ITEMS TO BE COUNTED DAILY*
A	*2*	*62.13%*	*2*
B	*2*	*28.40%*	*1*
C	*2*	*9.41%*	*1*

During the count, compliance with engineering standards was verified, establishing a minimum distance of 60cm from the ceiling, 20cm from the floor, and 50cm from the walls to prevent cross-contamination between products. It is essential to have enough storage space for non-perishable foods and veterinary products to maintain the quality and safety of these items.

3) Check

In order to ensure excellence in our development of new tools, we regularly reviewed the change that may occur in the process. The Gemba Walk method will help observe the process and talk to the supervisor and team members to identify the root cause of any potential future issues.

To ensure progress and learning are being tracked effectively, staff members will be asked randomized questions by their supervisors and team members. This collaborative approach will facilitate the implementation of beneficial improvements for the company.

Finally, the indicators were continuously evaluated to achieve the expected results and optimize efficiency and productivity in the warehouse.

4) Act

A policy and procedure format was established to monitor the progress of the enhancements made over time, which was regularly revised. An updated value stream map (VSM) was utilized to gauge the process durations in the warehouse after implementing the improvements to assess their efficacy. This afforded us an overview of the progression and evolution of the processes over time.

C. Results

Five indicators were used to compare the results obtained after implementing the proposal, detailed in Table VI. The level of service, which is the most relevant indicator, increased from 93.19% to 95.25%.

The SLP tool was used to reduce the dispatch time, which decreased from 574.20 minutes to 429.12 minutes, shortening merchandise transfer and search times to achieve the target service level. In addition, the cyclic counting method was implemented, which increased the ERI by 11.64%. FEFO management was applied to reduce the number of cases of merchandise about to expire or already expired from an average of two cases to zero. Finally, the 6'S tool was used to reduce lousy handling practices, and the norms and standards established for proper dispatch were followed. As a result, the average number of cases reported for merchandise in lousy condition was reduced from 16 to 4.

TABLE V
INDICATOR RESULTS

Summary Table	*Before*	*After*	*Goal*
Service Level	93.19%	95.25%	95%
Delivery time	574.20 min	429.12 min	512.72 min
Merchandise in bad condition	16 units/day	4 units/day	4 units/day
Merchandise expired or about to expire	2 units/day	0 units/day	0 units/day
Inventory record accuracy	87%	98.64%	98%

VII. CONCLUSION

After implementing the pilot in the veterinary product line, the studied distributor recorded an average monthly service level increase from 93.19% to 95.25%. This result was achieved thanks to the implementation of SLP, and 6'S, which reduced transportation movements by 60% for "A" products and improved the culture of quality and safety in picking, increasing staff motivation and productivity.

Regarding inventory management, applying the FEFO method and cyclic counting improved inventory management and reduced cases of expired or about-to-expire merchandise. By implementing this method, operators have a clearer understanding of the picking process, which results in improved planning and control. This also ensures quality in customer delivery. For areas with high rotation and demand for products A and B, it is advised to prioritize the FEFO method.

Furthermore, the proposed improvement reduced the costs of total and partial returns by 62.63%, compared to the annual losses of S/1,569,859.28 before the proposed implementation.

It is important to note that while applying the improvement proposal throughout the warehouse is recommended to obtain more substantial benefits and improve service levels, staff adaptation will require time as the implementation of tools is done gradually. Therefore, it is suggested to provide training to ensure that all staff is committed to implementation and understands how to use the new tools.

In conclusion, the tools implemented in the proposal are suitable for any company. Their objective is to improve product control and tracking, resulting in better customer service, especially in a highly competitive environment. Additionally, this study can significantly help continuously improve storage management in companies, regardless of their sector of activity.

VIII. Acknowledgment

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