Inventory Model Based on Lean Healthcare, EOQ and ABC-VED to Reduce Stockouts in a SME in the Pharmaceutical Sector.

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Abstract

Stockouts occur when an entity runs out of inventory or when the customer cannot find the product at the point of sale. There is a lot of research that focuses on solving stockout problems in different industries; however, the amount of such research is very limited with respect to SMEs in the pharmaceutical sector. The purpose of this study was to analyze the main reasons for the existence of inventory problems in pharmaceutical SMEs and to develop a model to reduce them. The study unit was an SME dedicated to the commercialization of retail pharmaceutical products, which had an inventory availability of 76.5%, well below the industry average of 93%. Tools based on Lean Healthcare (Kraljic Matrix), EOQ and ABC-VED were used to reduce stockouts as the racks available at the SME were repositioned to provide the best distribution of medications in the pharmacy. In order to have better control of the available medications. As a result, inventory availability increased to 87.7%, the rate of unsatisfied orders decreased by 5.6% and the rate of unsatisfied orders decreased by 11.7%, thus increasing the probability of benefits for the entity and the customer. This encourages to implement the tools in similar cases to improve inventory availability in the pharmaceutical industry, especially in SMEs.

Keywords
Inventory, Stockout, Lean Healthcare, EOQ, ABC-VED and Pharmaceutical SME.

1. Introduction
Currently, the pharmaceutical industry is an industrial and business sector dedicated to research, development, production and marketing of medicines for the treatment and prevention of diseases, and health care in general (BDO Argentina 2013). In recent years, it has proven to be the least sensitive to the impact of the pandemic, due to the priority given to personal protection and hygiene, i.e., during the pandemic, several sectors were paused and others did not continue, but this sector continued working to improve the health and quality of people by promoting research, innovation and employment (Tetelboin, C. 2021). It generates jobs and economic contributions to the national GDP. This industry participated of 1.4% GDP of 2018, reflected in 918 million soles (Fiestas L. 2018). In the same year, the industry employed approximately 23 thousand workers on payroll directly and at the same time 140 thousand workers indirectly (Fiestas L. 2018). The value in sales that the industry currently exerts is very large, in the last year the market size was 4 billion soles (Euromonitor International, n.d.).

Globally, there are several types of problems that arise in this pharmaceutical sector, but if we focus on drug supply problems, it is important to emphasize that different definitions are used to define them, among them are drug shortages. This occurs when "supply does not meet demand", taking into account the economic concept angle. However, if we focus on the main recurring problems in the pharmaceutical sector, they are drug shortages and supply interruptions. The first, happens when the supply of medicines does not meet the demand at the level of consumers/patients), the second happens when the supply of medicines fails to meet the demand at the level of pharmacies and wholesalers (Elfii de Weerdt et al. 2017).

In the apothecary shop used as the unit of study, several problems were found, of which the 3 of greatest importance were chosen. Tools such as VSM, SIPOC Diagram, process maps and statistics provided by the company were used to substantiate the low stock availability rate with respect to the market. In this case, the pharmacy had 76.5% while the market required at least 93% to be considered normal. The statistics provided by the company indicated that its suppliers were not optimal, so Lean Healthcare tools were used to organize and improve the supplier purchasing system. Subsequently, the warehouse was found to be disorderly and without future planning; to solve this deficiency, the ABC-VED tool was used to optimize it. Finally, it was decided to have maximum and minimum stocks to support the strategy of reducing stockouts, so the EOQ tool was used.

The present study aims to reduce stockouts and increase stock availability, using the 3 tools together. For this, the problem of the study unit was correctly analyzed, the optimal tools were chosen, and the results obtained by simulating it in an automation and simulation program were validated

1.1 Objectives

The study seeks to demonstrate that applying an inventory model based on Lean Healthcare, ABC-VED and EOQ can improve the availability of stock in the pharmaceutical industry, especially for SMEs, since poor inventory management not only leads to loss of sales, but also goes hand in hand with the loss of customers and potential customers, since when they cannot find the desired product, they will look for purchase options in other pharmacies.

2. Literature Review

2.1 Lean Healthcare

Retailers in the drug trade are focused on satisfying customer needs, as their priority is to make as many sales per day as possible. Stock-outs lead to unattended sales, resulting in lost revenue. (Conislla et al., 2019). Some of them focus on solving the stock-out problem by stocking up on products, acquiring those without some criteria, which generates high purchasing and storage costs. (Abu et al., 2021). It is not necessary to have extra quantities of products when only what is necessary is required, tools related to Lean Healthcare are effective to achieve this (Weinstock 2008).

Optimization of pharmaceutical service requires a thorough understanding of resource use (Zanotto, 2020). Lean Healthcare is based on the principles of Lean for healthcare delivery and its true power, lies in continuously uncovering those hidden opportunities for improvement (ELS, 2019). The application of Lean Healthcare tools helped to improve purchasing decisions to supply stock to an SME in Peru, managing to increase inventory availability from 82% in its initial state to 89% after its implementation (Conislla et al. 2019).

2.2 ABC-VED

In a pharmacy there can be a large number of drugs and it can be complicated to manage and control the quantities of these. However, in order to consider an effective pharmacy, it must guarantee the stock of drugs federated as critical (Ceylan 2017). A correct and effective stock control is directly related to the pharmacy's revenue, quality of service and prestige (Dursa 2022).

ABC-VED analysis provides access to efficient management of pharmaceutical products in hospitals and health-related supply stores and can improve ordering systems and purchasing costs (Mfizi, 2023). Using and applying the tool to BCB is the best possible option, as it provides optimal and correct control of the supervision of different items in a pharmacy. (Hazrati 2018).

In Turkey, it was possible to manage correctly and efficiently the inventory of a pharmacy, qualifying them according to their economic contribution and criticality in order to give greater importance to the control of these products, managing to supply the needs of patients who acquired Products in that study unit and improved the satisfaction index of them (Ceylan 2017). However, it is considered of utmost importance to periodically perform the analysis to BCB in order to update the information related to the drugs marketed in any pharmacy (Mfizi 2023).

2.3 EOQ

When the necessary importance is given to a budgeting and procurement of medicines, there is a risk of causing revenue losses, but even worse it could jeopardize the availability of medicines (Dewi, 2019). EOQ

analysis allows establishing the ideal replenishment time per product, in required quantities and in set amounts (Sivan 2021).

3. Methods

The present study is a case study based on a specific topic, in this case the pharmaceutical industry, where tools such as ABC analysis, VED analysis, EOQ and others are used to analyze the pharmaceutical industry. To meet its endless demands, global supply chain management (SCM) requires a lot of tracking, visualization, and advanced management principles. For this purpose, effective supply chain mapping and visualization should be proposed for knowledge transfer among managers and other stakeholders (Abideen, A., Fazeeda, M., 2020).

Regarding the diagnosis of the drug purchasing process in the pharmacy, it was found that the stock availability of the SME was low, being below 93% of the average of the pharmaceutical sector. In order to identify the tools to be used to solve the company's main problems, a comparison matrix was made of the literature reviewed, particularly articles on Lean Healthcare, EOQ and ABC-VED analysis.

The proposed model seeks to eliminate inventory management problems, optimize orders and inventory control. Consequently, it seeks to increase sales and thus profits by defining the tools as mentioned above.

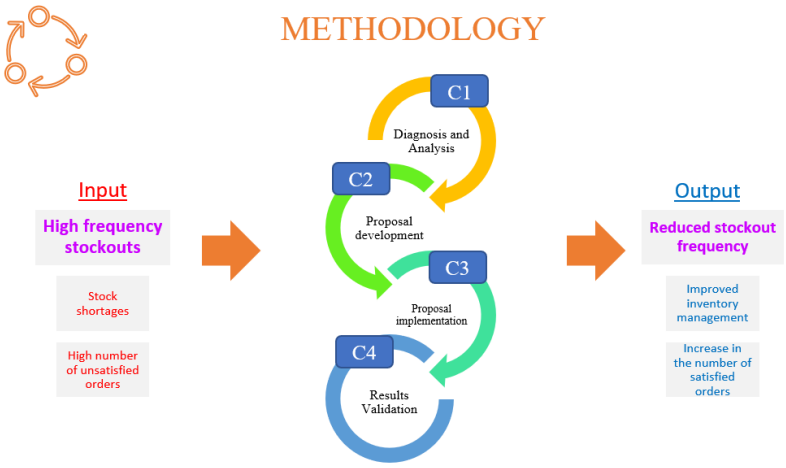

Figure 1. Proposed model

For the third component, implement the model with the ABC-VED analysis as a first step to improve the management of products in stock, followed by an EOQ to determine the appropriate quantity to purchase for the products. Since the owner did not use any criteria to select the quantity to be purchased, there was an overstocking of products in low demand or essential products, while products in high demand were out of stock, causing losses to the company. As a fourth component, a pilot test to validate the results to confirm that the proposed model improves inventory management, with the intention that other companies in the sector can replicate this model in their businesses and reduce the frequency of stockouts they may incur.

4. Data collection

The collection of information for the development of the research was done through consultations and visits to the company. The company provided us with information on suppliers, their lead time, list of products to be purchased by each supplier, as well as the quantity sold in a one-year period. Diagrams such as problem tree and Value Stream Mapping were also used. Figure 2 shows the method we propose in diagrammatic form.

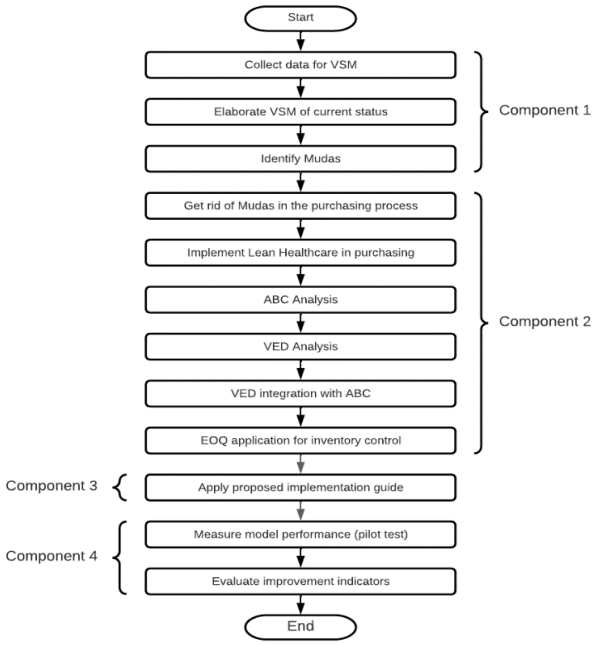

Figure 2. Method explanation

An order is placed based on a need, and in this case study, it is generally always related to the supply of medicines due to lack of stock. The orders are placed and delivered by the suppliers within the time limit set by them; however, we have noticed that there are complaints and inconveniences when the orders are received. The suppliers do not present a high efficiency in the delivery of their products, most of the errors are that the quantity of products delivered that is not related to the quantity of products requested, the presentations delivered are not the presentations requested and the condition of the product is not the desirable one and therefore it is not accepted in this unit of study. When analyzing the data on unsatisfactory deliveries, it was found that they can be volatile. However, when calculating the average, we obtained 18.2% of orders that are not satisfactorily delivered.

4.1. Lean Healthcare implementation

The application of Lean Healthcare is better explained with the figure 3.

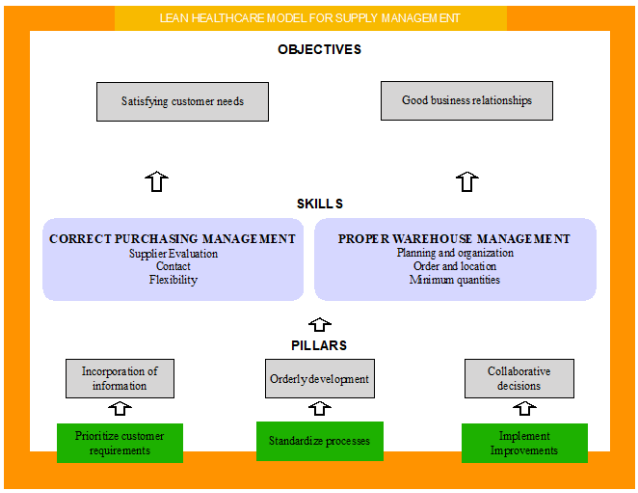

Figure 3. Lean Healthcare model

Figure 3 illustrates the proposed Lean Healthcare model for managing care.

Priority 1
Since customers are the main source of income for the company, the first priority is to know their needs and daily complaints in order to solve them and provide them with fair and deserved service.

Priority 2
Considering the client's needs and ranking it as a priority two, the decision was made to standardize the purchasing process based on the classified products. To achieve this, an instructional guide was utilized. Every time customers place an order, they are guided by these instructions. The details of the instructional guide can be found in the following:

Instructional Guide for the purchase process		
No.	**Stage**	**Remarks**
1	Corroborate purchase requirement	If the quantity of products in stock is at risk or does not meet the requirements, a visual review of the quantity of products in stock is carried out, and if it is at risk or does not meet the requirements, go to step 2.
2	Request quotation from suppliers	Review the Kraljic Matrix
3	Evaluate Quotes	Check correct shipping times
4	Create Purchase Order	Ensure that the payment has been made and the order is being processed.

Figure 4. Instructional purchasing guide

The personnel responsible for purchasing should ensure that they meticulously follow all the activities outlined in this guide, without skipping any steps that could impede the purchasing process.

Priority 3
The third priority is to be clear about the collaborative decisions we need to make with our key suppliers. This entails implementing improvements in our procurement process. We decided to create a Kraljic matrix to establish supplier homologation standards and work with them. To achieve this, ABC-VED matrix is required, whose main function is to divide the different products marketed by the company into three different categories, based on different criteria such as criticality of the product and economic benefit.

Using the Kraljic Matrix, it is possible to classify the products according to the financial impact on the company and the supply risk; combining both factors, a table is obtained that classifies the result into four differentiated groups: leveraged, strategic, routine or bottleneck products.
The functionality of this table will be explained later. It should be noted that each category includes a specific number of SKUs, and a Kraljic matrix will be presented for each category.

The ABC analysis revealed that category one consists of 41 SKUs, which account for almost 70% of the company's revenue. These 41 SKUs are classified into different types of products. Figure 5 illustrates the Kraljic matrix with a detailed table showing the placement of each SKU in relation to the matrix. This can guide the buyer in establishing a strategy for product acquisition.

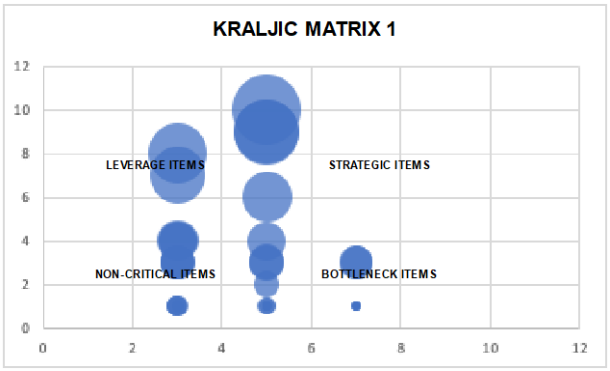

Figure 5. Kraljic matrix – First Category

As previously noted for the first category, the Kraljic matrix was also applied to the second category, as shown in Figure 6. The table detailed the product categories to which each SKU belonged.

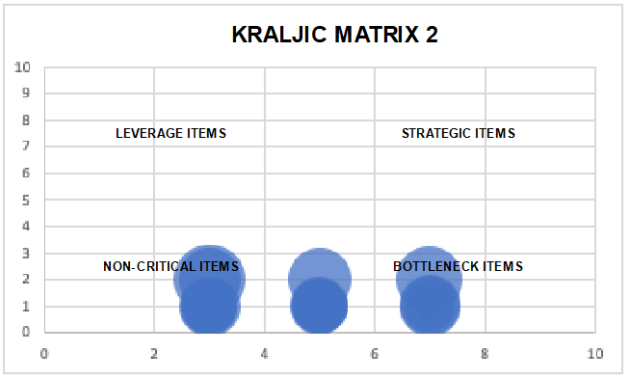

Figure 6. Kraljic matrix – Second Category

Third category also utilizes the Kraljic matrix as a tool and provides a detailed list of each relationship to product categories as shown in Figure 7.

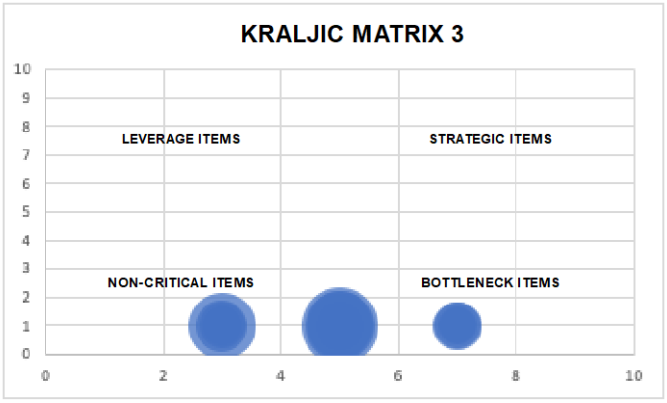

Figure 7. Kraljic matrix – Third Category

4.2 The influence of ABC-VED

Proper management of a warehouse is necessary to optimize the development of the various activities related to the introduction and withdrawal of SKUS. No strategy or support was in place for the distribution and organization of medicines within the designated warehouse space. In order to achieve optimal results, the ABC-VED analysis, which can be seen in Table 1, was chosen, which had been successfully applied elsewhere in the world.

Table 1. ABC-VED matrix

Category	SKU's quantity	% SKU	Value	%Value
I (AV,AE,AD,BV,CV)	41	28.67%	385,942	**70.11%**
II (BE,BD,CE)	78	54.55%	142,932	**25.96%**
III (CD)	24	16.78%	21,611	**3.93%**
Total	**143**	**100.00%**	**550,485**	**100.00%**

4.3 EOQ implementation

Effective inventory management is crucial in a product marketing company like a SME pharmacy to meet customer demands regarding product quantity and presentation. The competition in the market is tough due to the high standards and effective strategies employed by the competitors. To ensure accurate ordering and frequency, we can use the EOQ (Economic Order Quantity) Mira application process. Using the EOQ application process enables us to maintain safety stock levels and to have the right quantity and presentation of the product required by the customer. The tables below, separated according to the ABC-VED category, list the exact product quantities mentioned above.

5. Results and discussion

The described improvement model was implemented and applied in a pharmaceutical company. As mentioned previously, the company is based in Lima's Villa El Salvador district. The company specializes in the sale of pharmaceutical products such as capsules, ointments, and treatments.

The study's validation was executed over a four-week period in which the suggested tools were put into action.

The pilot test comprised three phases:

- **P1: Identify suppliers that do not comply with the established Lead Time.**
- **P2: ABC-VED classification**
- **P3: Maintain continuous order.**

Once the suppliers were classified as unsatisfactory and incomplete, we recommended two optimal suppliers per product for consultation of proformas based on the purchasing instruction manual. These suppliers were provided by the drug brands that have competing distributors as shown in Table 2.

Table 2. New Suppliers

Code	Supplier 1	Supplier 2	Code	Supplier 1	Supplier 2	Code	Supplier 1	Supplier 2
69990	CAPON F.	BIOMEDIC	63740	DICAR	DROKASA	73320	DICAR	EFILA
48100	BIOMEDIC	DROKASA	71620	JOBAL F.	CAPON F.	36600	FARMACOM	CAPON F.
64530	EFILA	CAPON F.	29670	CORVAL P.	JOBAL F.	67050	CAPON F.	EFILA
45420	BIOMEDIC	FARMACOM	12100	JOBAL F.	CAPON F.	85420	FARMACOM	CAPON F.
65820	CAPON F.	FARMACOM	64430	BIOMEDIC	CORVAL P.	56810	DROKASA	FARMACOM
51220	EFILA	DICAR	60300	EFILA	DICAR	26150	DICAR	CAPON F.
37380	CORVAL P.	JOBAL F.	64660	DICAR	JOBAL F.	96050	BIOMEDIC	DROKASA
75120	CAPON F.	FARMACOM	28820	CAPON F.	DICAR	25620	DROKASA	DICAR
95310	CAPON F.	FARMACOM	21210	BIOMEDIC	FARMACOM			
62150	DICAR	JOBAL F.	26940	FARMACOM	CORVAL P.			
84070	EFILA	FARMACOM	24620	BIOMEDIC	JOBAL F.			
69000	DICAR	CORVAL P.	32870	JOBAL F.	BIOMEDIC			
64840	CAPON F.	EFILA	76850	JOBAL F.	CAPON F.			
85930	DICAR	CAPON F.	81560	DICAR	DROKASA			
37710	BIOMEDIC	DICAR	32750	EFILA	BIOMEDIC			
62410	CORVAL P.	DICAR	57950	CORVAL P.	FARMACOM			
39230	EFILA	DROKASA	99630	DROKASA	BIOMEDIC			
48210	CORVAL P.	DICAR	21110	FARMACOM	CORVAL P.			
50390	DROKASA	BIOMEDIC	17060	EFILA	CAPON F.			
66980	DICAR	JOBAL F.	77130	DICAR	EFILA			
54960	CAPON F.	EFILA	40500	CAPON F.	CORVAL P.			
34730	CORVAL P.	FARMACOM	83620	DROKASA	JOBAL F.			

87870	DROKASA	DICAR	79120	DICAR	FARMACOM
55740	JOBAL F.	FARMACOM	94010	JOBAL F.	BIOMEDIC
68380	FARMACOM	DROKASA	72230	EFILA	DROKASA
63300	DICAR	DROKASA	70710	FARMACOM	EFILA
68830	CORVAL P.	DICAR	59390	DROKASA	BIOMEDIC
21710	EFILA	CORVAL P.	87150	DROKASA	DICAR
93410	CAPON F.	JOBAL F.	22150	CAPON F.	DROKASA
90460	DROKASA	BIOMEDIC	62700	DICAR	BIOMEDIC
47230	CAPON F.	FARMACOM	76310	FARMACOM	CORVAL P.
66370	FARMACOM	EFILA	36480	BIOMEDIC	CORVAL P.
40950	EFILA	CAPON F.	56660	DICAR	FARMACOM
27950	CAPON F.	CORVAL P.	41090	JOBAL F.	BIOMEDIC
74900	BIOMEDIC	EFILA	74450	BIOMEDIC	CORVAL P.
58960	CORVAL P.	FARMACOM	73360	DICAR	CORVAL P.

Phase 2

During this stage, the products were sorted into distinct categories using the AVC-VED tool and arranged on the drugstore shelves. To carry out this procedure, the store's floor plan was analyzed in Figure 8, allowing observation of the diverse areas designated for product storage.

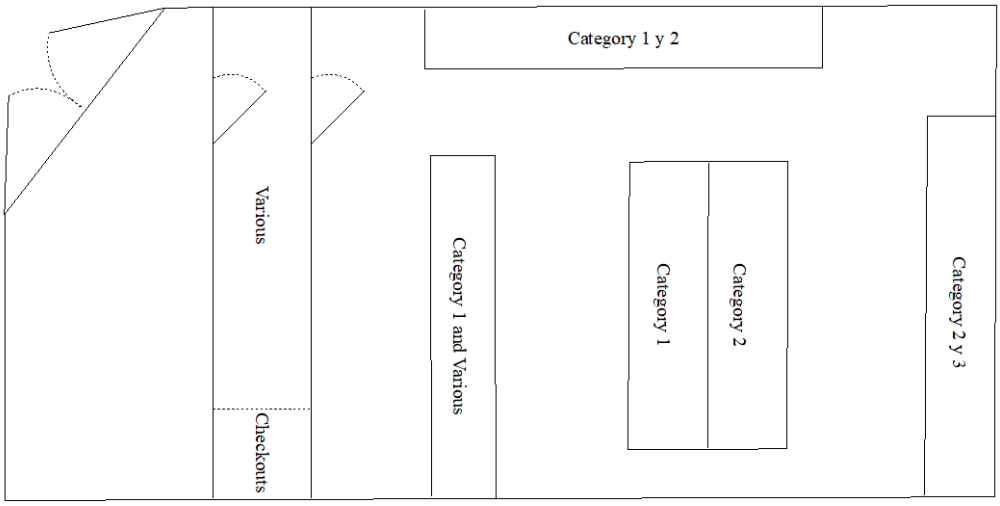

Figure 8. Pharmacy dimensional drawing

Figures 9 and 10 are some of the photos sent to us by Botica Marlene's manager before we started to reorganize the medications in the new place.

Figure 9. Racks available

Figure 10. Operating racks

Phase 3
Sales information was handled with continuous order, which ensured daily attachment of data on products sold. Having this information, the purchasing manager could make decisions to program purchases for the upcoming days. Note that the above table employed the economic order quantities (EOQ).

Suggested improvements

The company's initial situation can be compared to model indicators:

Table 3. Comparison table of indicators

INDICATORS	Initial status	Current status	Improvement
Stock availability	76.50%	87.70%	11.20%
Unsatisfied orders	27%	21.40%	-5.60%
Incomplete dispatches	18.20%	6.50%	-11.70%

5. Validation

Comparison 1

In this first comparison, the data obtained each week from the implementation of the Inventory Management Model was used.

Table 4. Comparison 1

INDICATORS	Initial status	Situation Week 1	Situation Week 2	Situation Week 3	Situation Week 4
Stock availability	76.5%	63.1%	78.3%	85.1%	87.7%
Unsatisfied orders	27%	25.4%	20.8%	22.3%	21.4%
Incomplete dispatches	18.2%	11.3%	7.1%	8.1%	6.5%

It is worth noting that, although the first week did not produce such encouraging results, the Model has begun to become embedded in the daily development of the company. It is assumed that there will always be resistance to change when a new improvement tool is implemented in a study unit.

Comparison 2
This second comparison used the data from the fourth week and the data from Conislla and colleagues.

Table 5. Comparison 2

INDICATORS	Improved situation	Situation Case Conislla et al.
Stock availability	87.7%	89.5%
Unsatisfied orders	21.4%	17.78%
Incomplete dispatches	6.5%	17.27%

At the end of the four-week implementation timeframe set for the pilot, we see that the results for the first two indicators are very similar, but our implementation performed better on the final indicator.

Comparison 3
Finally, this third comparison is made between the six weeks of observing the results of the pilot test; the proposed plan for the pilot test is four weeks, but so far we have data from the fifth and sixth weeks of implementation. Figures 11, 12 and 13 show the evolution of the results over time.

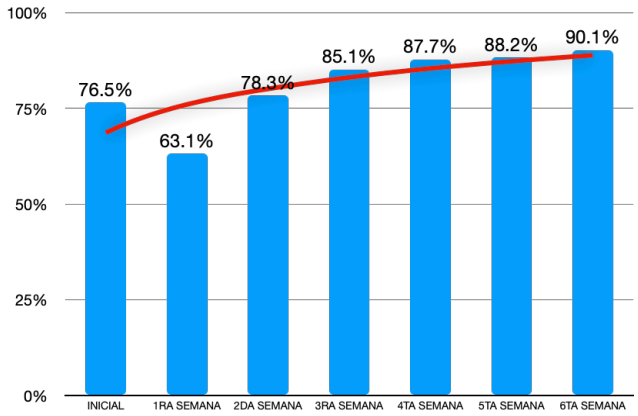

Figure 11. Stock availability

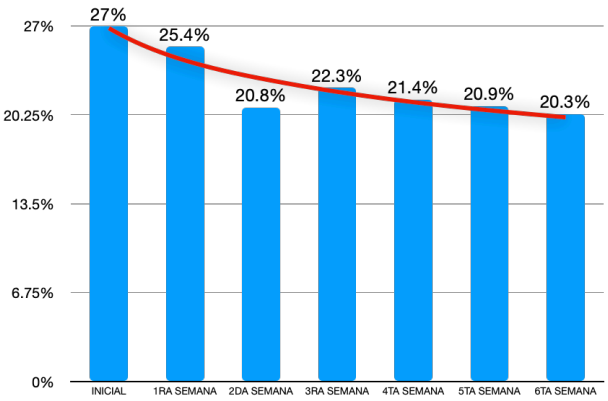

Figure 12. Unsatisfied orders

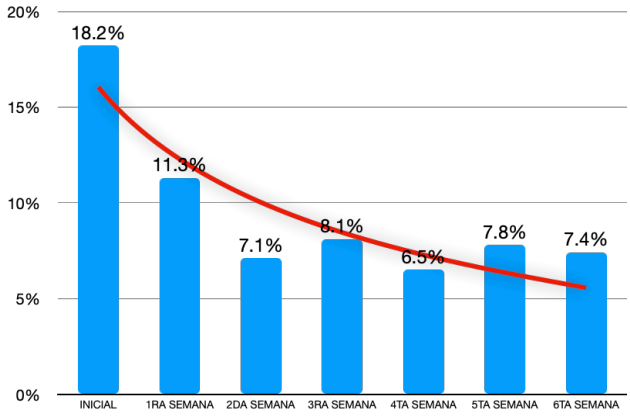

Figure 13. Incomplete dispatches

In these three graphs, which show how the indicators have evolved over the weeks that the Pilot has been running, we can see that the results tend to get better as time goes by. We believe that the results obtained in the future will not be as volatile as they are now, since there will be a stabilization of the results that will be managed over time.

6. Conclusions

The tools used helped to meet the objectives of improving the initial statistics, even if market standards could not be reached during the pilot test, it is evident that they were part of the positive change obtained in the previous statistics.

Commitments to implement new strategies that are agents of change should be adopted by all managers and operators of the company, in this way better results are obtained.

It is considered important to have access to critical information of the company to be studied, regardless of its complexity, this must be understood in order to select the main needs for improvement.

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