Degree project in application mode

[221020] Agile framework for process improvement in value network

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Abstract

In this work, an operations management model was designed and developed based on agile methodologies that integrates four phases, through which an organization goes through a journey that starts with Design Thinking, Lean Startup, Agile (Scrum) and review. In this organization, belonging to the pet food industry oriented to retail sales in Hard Discount channels, called for the purposes of the work "ABC company", a sprint was implemented that resulted in the implementation of an warehouse management system (WMS) and a series of commitments related to the improvement of the physical flow through the 5's methodology based on the habit of cleanliness and order in the workplace, also allowing a definition of a backlog that lays the foundation for what will be the subsequent Sprints (2 and 3). The development of this model allowed the adoption of an agile culture in the company through the roles of Product Owner, Development Team, and Scrum Master, leveraged on collaborative work and with enough tools that allow contextualization, ideation from conditions that limit the problem and consider all those stakeholders and a framework that facilitates the implementation and measurement of these alternatives in an iterative and incremental way.

Keywords: Operations Management, Logistics, Suppliers, Agile Framework, Scrum.

1. Justification and problem statement

The set of activities related to logistics, from communication with suppliers to delivery to customers, are associated with the supply chain. This concept introduces ideas that contribute to the continuous development of a company, such as increasing efficiency (resources), effectiveness (meeting goals), and optimization, through corporate policies focused on resource utilization, performance assessment, indicators, adaptation of the supply chain to changes in the market (flexibility), among others. The creation and monitoring of these policies, as well as the implementation of action plans, is called supply chain management.

Management in the supply chain deals not only with the "Purchases" and "Sales" section of the company, but all the activities that include the fulfillment of the strategic plan and meeting customer needs; the area of quality management and control, inventory management, and even the production area are part of logistics (Logística Dinámica, 2019).

For these reasons, supply chain management is an essential process in the operations of any company, and it is precisely here that many institutions, especially small and medium enterprises (SMEs), have the greatest problems. From quality control inbound logistics, through areas in production logistics such as maintenance and warehousing, to outbound logistics in invoicing dispatch and transportation. According to DANE, in 2021 there was an increase of 9.5% of new SMEs in the country and an increase of 8.5% of employed personnel. These companies are of great importance in the Colombian economy, representing 35% of the national productive sector and generating 65% of employment (ColombiaFinTech, 2021), which makes designing a strategic plan for these companies even more important.

A study by Saavedra (2012) takes factors such as information systems, quality, production, and operations, complemented with indicators to evaluate the level of competitiveness of SMEs in Latin America, where the BID competitiveness map adapted by the Antioquia Chamber of Commerce takes great importance by evaluating a system integrated by nine areas, including strategic planning, quality assurance, production, and operations.

These SMEs can be found in different channels: the hypermarket, which is characterized by wide product assortment and is in peripheral areas; supermarkets, which consist of a wide range of products from the main categories, and the Hard Discount or limited assortment stores, which have a limited supply of products focused on basic categories. The latter was introduced to the market in 2010 with Koba Colombia S. A. S., owner of "Tiendas D1". The model consists of offering the customer products at below-market prices and with the quality of recognized brands, thus implementing the marketing of own-brand products at a lower cost and managing strong negotiations with suppliers.

It is precisely in this channel where the importance of logistics stands out the most since the Hard Discount (HD) model is sustainable thanks to the low costs that are managed in the supply chain, allowing an effective quality control since HD models manage their own brands for the most part and the offer of products with a very low price.

However, this model is prone to failure and can have serious repercussions in terms of fulfillment and quality for the customer or, alternatively, considerable fluctuations in the company's profitability. Logistics problems cause an increase in operating costs, which in turn forces stores in this channel to make one of two decisions: (1) increase selling prices, risking the main feature of HD, and compromising the customer, or (2) maintain prices and compromise profitability; in either case, the model in question is significantly affected, making flexible and effective supply chain management unobjectionable. Another challenge arises from the fact that these stores innovate with new products in short periods of time, which makes the demand planning area play a very important role since there is a certain degree of uncertainty that can lead to shortages. Expiration dates are also an issue to consider. This was the case of "Mercaderías Justo y Bueno", which, due to logistics failures, presented negative reports in 2016, declaring itself insolvent before the Superintendence of Companies in 2021 (Herrera, 2021).

These problems of suppliers in this new modern channel modality (HD) represent a great challenge, which articulated with the above, presents the problem of complying with the Sustainable Development Goals (SDGs), specifically SDG 8, which dictates "Decent work and economic growth" (ECLAC, 2015) that includes goals such as achieving higher levels of economic productivity and promoting development-oriented policies that support productive activities (United Nations, 2015).

Therefore, these challenges make it pertinent to create an operations management model that allows the continuous improvement of HD supplier companies, specifically the company ABC has a main problem in distribution and transportation since inventory monitoring at this point is extremely complicated and brings the main consequence the failure to meet delivery dates, we want to solve this problem based on the characterization of context analysis, problem identification, and feasibility through sprints where improvement opportunities that respond to the main problem that the company has been implemented.

These recommendations are associated with industrial engineering tools that should be inventory management, roles, and responsibilities, and implementation of technology for information flow among other elements, from the three approaches that are articulated which are Design thinking, Lean Startup, and agile frameworks.

In order to understand and have a better adaptation of suppliers in the market in this modern HD channel, it is essential to take into account the main challenge mentioned (solve the problems in distribution and transportation presented by the ABC company in terms of in-transit inventory), the goals and objectives of sustainable development to answer the question: how to improve management in the supply chain, specifically in the distribution and transportation sector focused on the inventory management and warehousing, of a supplier of HD stores under an iterative and incremental approach.

2. Background

Continuing and delving deeper into the question posed above, it is necessary to consult and compile various sources that provide updated and varied information on the different issues involved in the question. This entails researching the known panorama through approaches that have been taken in relation to the problem posed. On this occasion, the different sources of information consulted are consolidated in Table 1, where the author, title, and type are specified for each case, as well as a brief description of the source. Next, categories related to the subject matter were established to specify which one(s) are developed within the source consulted.

Supermarkets must evolve day by day to provide a better quality of the service they offer, and the same is true for HD models. In the article "perception of the quality of service provided by HD type supermarkets (D1 and Justo & Bueno) in the city of Medellin from the Servqual model", it is evident that the most critical factors with the highest impact on the perception of the quality of service of HD formats in the city of Medellin are empathy and security, with a rating of 70.8% (Caderon, J. Restrepo, E. 2019). Additionally, Hamidreza Navidi and Masume Messi Bidgoli have investigated how demand can fluctuate in two cases when a discount model is presented, achieving an optimal point by implementing a mathematical model. In 2, a study was conducted to find out the cause of the shrinkage that occurred in Justo & Bueno supermarkets. Research showed that primary, the problem is concentrated in logistical failures, in the lack of use of technologies and information systems. (Hernández, M. Quintero, F. 2021), since demand management is one of the main problems in HD models, it was decided to investigate it.

In 2011, an optimization model was implemented in inventory management using genetic algorithms, in which the whip effect (an important phenomenon in the study of supply chains, as it has consequences on the efficiency of the flow of materials and information in supply chains) was attacked. The result was that “the use of genetic algorithms in the optimization of inventory management generated a decrease in operating costs, as well as the regularization of orders when demand was variable" (Valencia, C. 2011). "Forecasting is a tool that provides a quantitative estimate of the probability of future events. The relevance of incorporating forecasts in storage demand in perishable products within the cold chain derives from its economic and social importance" (Juárez, A. 2016). With the research of "time series analysis in the forecast of storage demand for perishable products" and its positive result when forecasting demand through goodness-of-fit techniques, the importance of a good demand forecast can be identified in the case of perishable products, obtaining benefits of inventory decrease and loss of products in stock.

On the other hand, another relevant category is supplier management, which focused on how supplier development contributes significantly to the supply chain of the company or organization in question. In 2016, Mendoza and Ceballos define suppliers as strategically, emphasizing the importance of maintaining a good long-term relationship with them. Thus, according to Mendoza and Ceballos: "relationships are very important in sourcing as ties are established with the supplier in order to create a win-win strategy for both parties." It was also found that this development should be considered a long-term business strategy and that the main strategic purchasing practices that facilitate this development are the selection of suppliers, the maintenance of buyer-supplier relationships, and the operational integration of the supplier to the firm's activity (Miglierini and Treviño, 2021). Likewise, development with suppliers makes it possible to work jointly on the impacts of the chain, linking them to the production process with actions aimed at the social, environmental, and/or economic sphere (Rodríguez, E. G, 2018).

Among the greatest challenges presented in the operational management of the supply chain are the problems of distribution and transportation focused on in-transit inventory and warehousing. In accordance with the justification described above, and considering that, although the challenges and opportunities for improvement that arise in the ABC company are diverse, emphasis will be placed on the state of the art of this section, which contains the problem main to be addressed.

In 2004, a study in the Netherlands discovered that, by estimating demand updated in daily periods, logistics costs can be reduced in a supermarket by up to 12%, highlighting the relevance of solving problems of routing (Gaur and Fisher, 2004). This statement is strengthened in 2015, when new routing optimization methods are found where there are time windows, and it is also known that retailers have deterministic demands. In this way, a mixed model (heuristic) is proposed that results in a 6% decrease in costs (Pérez and Guerrero, 2015).

Source					Category						
Number	**Autor**	**Title**	**Type**	**Description**	**Hard Discount Model**	**Demand management**	**Suppliers ' management**	**Inventory control and management**	**Distribution / transportation**	**Quality**	**Sustainability**
1	Navidil H, Messi M	An all-unit quantity discount model under a Cournotcompetition with incomplete information.	Paper	Study of the behavior of a retailer in the Hard Discount model and prediction of the size of a lot for a retailer.	✓		✓		✓		
2	Borja A, Monsalve E, Bermúdez J	Percepción de la calidad del servicio prestado por los supermercados tipo hard discount (D1 y Justo & Bueno) en la ciudad de Medellín a partir del modelo Servqual.	Paper	Determine critical factors in the quality of the D1 and Justo y Bueno service through a quantitative methodology and the ServQual model in the city of Medellín, Colombia.	✓					✓	
3	Hernández M, Quintero A	Las mermas y su impacto en la gestión de inventarios de tiendas Justo & Bueno.	MBA project	Causes of economic losses related to inventory losses in Justo & Bueno stores, analysis of the inventory results of Justo & Bueno.	✓	✓		✓			
4	R. Mohammad Ebrahima, J. Razmia, H. Haleh	Scatter search algorithm for supplier selection and order lot sizing undermultiple price discount environment.	Paper	Demand forecast for suppliers of hard discount models through a mathematical model.	✓	✓					
5	Juárez C, Zúñiga C, Martínez J, Sánchez D	Análisis de series de tiempo en el pronóstico de la demanda de almacenamiento de productos perecederos.	Paper	Case study that estimates the storage volume to anticipate the necessary requirements for the mobility of products.		✓		✓			
6	Valencia C, Cáceres S	Modelo de optimización en la gestión de inventarios mediante algoritmos genéticos.	Paper	Design of a Genetic Algorithm to optimize inventory management in supply chains, as well as the minimization of the Bullwhip Effect.		✓		✓			
7	Gaur V, Fisher M	A Periodic Inventory Routing Problem at a Supermarket Chain.	Paper	Create a schedule that forecasts a weekly delivery and specifies the times each store must be replenished from a central distribution center and determine vehicle routes.		✓		✓	✓		
8	Miglierini, F. M., & Treviño, E. J.	Factores que Afectan el Desarrollo de Proveedores en una Cadena de Valor Integrada.	Paper	Study that proposes a comprehensive scheme identifying the main factors that lead to the development of suppliers.			✓				
9	Mendoza M, Cevallos N	El abastecimiento estratégico y su aplicación en las empresas.	Paper	Study about the implementation of a strategic supply method to provide supplies and materials in a timely manner and at a lower cost.			✓		✓		
10	Mauricio H, Mejía C, León R	Diseño de una red de distribución a través de un modelo de optimización considerando agotados.	Paper	Research that presents a integer programming model that minimizes the costs of the logistics network.				✓			
11	Kuei C, Madu C, Lin C	Implementing supply chain quality management.	Paper	Describes a strategic framework for the development of supply chain quality Management (Supply Chain Quality Management).						✓	
12	Rodríguez E	Identificación de prácticas en la gestión de la cadena de suministro sostenible para la industria alimenticia.	Paper	Describes the practices implemented in the management of the sustainable supply chain in the food sector at an international level.			✓				✓
13	Peña C, Torres L, Vidal C, Marmolejo R	La logística de reversa y su relación con la gestión integral y sostenible de residuos sólidos en sectores productivos.	Paper	Article that shows the relationship between reverse logistics and comprehensive and sustainable management of solid waste in productive sectors.							✓
14	González L, Beltrán J	Lean para la Sostenibilidad en la Cadena de Suministro.	Investigation project	Development of a methodology that has sustainability in the supply chain and lean manufacturing as an integrating element.							✓
15	Carrasco R, Ponce E	Mejora de la eficiencia de una central logística mediante el resideño del reaprovisionamiento de la zona de picking	Paper	Analyze the case of a renowned luxury cosmetics firm, in which the shortage of products in piece picking racks brought-			✓		✓		
16	Poon T, Harry K, Chow H, Henry C, Felix T, Ho K	A RFID case-based logistics resource management system for managing order-picking operations in warehouses	Paper	An RFID case-based logistics resource management system (R-LRMS) is proposed to improve the efficiency and effectiveness of order picking operations in a warehouse.			✓		✓		
17	Holguín J, Ramírez D	Estudio de la gestión de almacenes e inventarios mediante un WMS inteligente	Investigation project	Know advantages and barriers that arise when automating logistics processes through the use of WMS				✓	✓		

Table 1. Literature review. Source: authorship.

In addition, Improvement of the efficiency of a logistics center through the resupply redesign of the picking area, this through the search for policies for the grouping of orders to put them in the rack with the objective of proposing a new resupply procedure for the area of picking. (Carrasco, R, 2008).

It is necessary to allocate warehouse resources efficiently and effectively to improve productivity and reduce warehouse operating costs. In addition, RFID technology makes it easy to collect and exchange data in a warehouse. (Chow, K, 2008). It is also very important to evaluate the implementation of these new technologies such as WMS in SMEs, and what future recommendations can be made with this system. (Holguín, J, 2018)

Finally, and encompassing the categories developed, there is sustainability and, with it, the relevance of the implementation of a green supply chain that works as a strategic point for the growth of companies. According to the literature review investigated, it is stated that reverse logistics is a strategy that improves productivity in environmental management schemes since it optimizes utilization activities and generates the adaptation of a proactive profile in the company (Peña et al. 2013). Similarly, it was found that practices in sustainable supply chain management for the food industry at the international level focus on three major categories: strategic direction, collaborative work with stakeholders, and risk management (Rodríguez, E. G, 2018).

In summary, all these categories are framed in the search for increases in efficiency and the service level of companies; however, these two objectives are usually in opposition and are variables in which increasing one causes the other to decrease. This is demonstrated by Alvarez, Rodriguez, and Jimenez in their paper "Agile Supply Chains: Challenges and difficulties in their implementation", where they compare supply chain management models such as Agile, Lean, and similar models, to conclude that "if the focus is efficiency the most relevant is the lean chain, but if the focus is the high level of service and responsiveness the direction should be agile". This analysis becomes increasingly important since it is carried out in the context of supply, storage, and distribution of perishable products, moreover, it considers determining variables, like the level of service, quality, and flexibility, and links within the supply chain, such as suppliers, final consumer, and processes such as transportation, storage, quality management and machinery.

Although the above approaches were found to be valid to mitigate the problem, there are still challenges that will be addressed in this paper. The challenges addressed result from the need to strengthen the communication mechanisms between the supplier and the HD channel, demand assurance, and supplier execution to reduce the bullwhip effect in supply, as well as the dynamics and execution at the point of sale and the preparation at the production level that the HD must make. All these challenges are associated with quality assurance throughout the product life cycle, from the manufacturing process to the final marketing to the customer at the HD.

3. Objectives

Designing an operations management model for the distribution and transportation process of HD supplier companies based on Design thinking, Lean Startup, and agile frameworks.

- Characterizing the context of HD supplier companies, articulating their physical and information flows throughout the value network.
- Articulating inputs, activities, and outputs through an iterative and incremental process that seeks to diagnose improvement opportunities and define a roadmap for their implementation.
- Implementing iterative and incremental sprints of the operations management model in the distribution and transportation process of the case study company.
- Define a monitoring and feedback scheme for each of the implementation sprints aligned with performance metrics of the distribution and transportation process.

The following four chapters show the different phases through which the operations management model is built in an iterative and incremental manner using Design Thinking, Lean Startup, and agile frameworks. These chapters correspond to objectives 1, 2, 3 and 4 respectively.

4. Phase 1. Context, problem, and ideation: an integral approach for Design Thinking.

4.1. Methodology.

In this initial phase, Design Thinking is used as the first framework contained in the operations management model. Image 1 illustrates this initial phase of the model, as well as the stages contained and developed here. This process starts with the analysis of the context and culminates with the ideation stage. This framework and its relevance to the implementation of the operations management model is discussed in more detail below.

Design Thinking has as its fundamental basis the understanding and solution to the concrete needs of consumers. This is done through the generation of innovative ideas framed in an iterative process consisting of three specific stages. It is important to emphasize that these stages, although they represent a sequence, do not frame a linear process, but allow the management of this process by moving forward, backward or between non-consecutive phases. The first stage is the characterization of the context, which allows for an in-depth understanding of the requirements and demands of the users involved within the environment in which they develop. Subsequently, there is the definition stage where the valuable information that will add value to the emerging scenarios is selected. Finally, the ideation stage generates many alternatives aimed at solving the identified problem (design thinking in Spanish, n. d.).

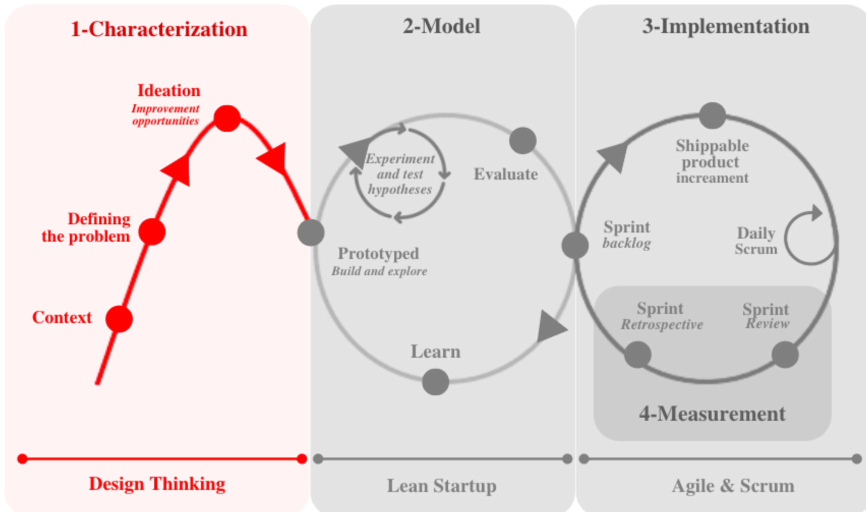

Image 1. Operations management model: phase 1. Source: authorship

Consequently, the characterization stage begins. For the representation of the physical and information flows, the SCOR (Supply Chain Operations Reference) framework will be used to link the planning, supply, manufacturing, distribution and return processes, since these, at a general level, make up a supply chain. In this sense, the planning processes reflect the different information flows, while the other processes are associated with the physical flow of material or service. To this end, the SCOR model will allow the integration of processes, best practices and indicators that will be considered as a first phase in the characterization of the case study company.

These key processes, also called core business, are articulated through elements associated with information, requisitions, requirements, or actions that enable the network to function, connecting, for example, planning and purchasing, purchasing and inventory, inventory and production or inventory and dispatch. These elements, described in *section 4.2*, are important not only to delimit or indicate the end of one process and the beginning of another, but also to mark inflection or critical points, show opportunities for improvement in the value network and, most importantly, allow the study of the information and physical flow along the entire supply chain in an integrated manner, making it possible to see the interdependence of each activity and not by isolated processes.

Additionally, the process will be modeled at a general level using BPMN 2.0 (Business Process Model Notation) to determine visually and clearly what should be done and when it should be done. Likewise, such modeling allows transparency in the processes, as well as the measurement, verification and control of the activities that compose them. This will provide an adequate perspective to analyze, improve and automate the processes involved in the company.

Continuing with the contextualization, some Design Thinking tools will be used. These include a stakeholder map, whose purpose is to have greater clarity regarding which individuals influence the system that encompasses an HD supplier, an empathy map for both the supplier and the customer, a journey map to give greater clarity to the process that takes place within the value network of the ABC company from the customer's perspective and, finally, a service blueprint in order to visualize the relationships between the different components of a business that encompasses the aforementioned system.

On the other hand, in the problem definition stage, the problem and objective bottle tool will be used to visually present the challenge to be solved, its causes and effects, as well as the objective, goals and activities to address the challenge.

Finally, in the ideation stage, methodologies such as brainstorming, the six hats methodology for the creation of different solutions and co-creation will be implemented. Here it is important to highlight that, although some initial ideas are generated, a debugging process will continue to discard some of them, as well as a selection process of these in conjunction with the stakeholders within the ABC company. The ideation stage ends with the last Design Thinking tool to be used, called the impact and effort matrix. In this, the objective is decision making under the prioritization of ideas, maximization of efficiency and impact and alignment of objectives. Ordering the tasks in this way will lead to a hierarchy of these, as well as the reduction of required resources.

4.2. Analysis of results.

Given the above, each of the Design Thinking tools used, belonging to the contextualization, problem definition and ideation phase, which allow a deeper approach to the organization, the customer, and other stakeholders, are presented and explained. These tools will be presented and customized to ABC company as this is the first phase of the operations management model developed in this work.

Context:

The ABC Company was created in 1994 in Bogota, Colombia and is a producer of cat and dog food. In addition to having its own brand, it stands out for producing its own brands for several supermarkets, supplying 96 clients, including neighborhood stores, hard discount, wholesalers, supermarkets, among others, including Jerónimo Martins, D1, Pricesmart and Cencosud, with Jerónimo holding 60% of the company's sales.

Considering the above, the concepts of the methodology were applied to the ABC company's value network, obtaining detailed information about the context in which each process is executed, the people involved, the key activities and even the elements that articulate the core business. In addition, this information allows an in-depth understanding of the company's current situation from different perspectives such as internal processes, external agents, and opportunities for improvement.

In the first instance, a tool of the SCOR model called thread diagram was used, which helps to obtain a global vision of the value network. In SCOR there are five processes: plan, supply, make, deliver, and return. This thread diagram shows the relationship between suppliers, the factory, the DC (distribution center) and the end customer based on these processes. The diagram is based on type 1 and type 2 processes; type 1 are the "to stock" processes, where an inventory is managed and type 2 are "to order", where any of the five processes are performed when the customer requests it. Image 2 includes a fraction of the diagram and shows the plan, source, make, and delivery processes associated with the supplier. In addition to this, it shows that the raw material suppliers respond to the company's request for supply, then the product is manufactured and finally delivered to customers, this synchronously with a planning process. The complete diagram can be found in Annex 1.

Now, within the analysis of the context, it is essential to keep in mind what is the main objective of the company. In this sense, the core business is composed of the activities that allow the fulfillment of the company's mission, where the following are mainly identified: reception of purchase orders, production planning, shipment scheduling, batch traceability and portfolio collection. To accurately understand the processes in the value network and, consequently, to be able to model them, it was necessary to analyze those activities that, although they are not key, do link the company's mission processes and allow for a comprehensive analysis of the network.

To support the Core Business activities of the company, the process was defined in depth from the generation of the order by the HD to its delivery and the subsequent activities for the completion of the order within the company. For this, and as mentioned above, the AS IS process was modeled using BPMN in the Signavio tool (software for business model management). Annex 2 shows the results of the modeling.

According to the process modeling, the HD participates in this process and is involved the ABC company's portfolio, the commercial, financial, and accounting, production and logistics department. Thus, the process starts with the generation of a purchase order (PO) by the HD, followed by its reception by the commercial department of the company through an EDI (Electronic Data Interchange) communication mechanism. Here the order is reviewed and sent to the back office to confirm the customer's status; if the PO is approved or not, the commercial department will notify the customer of the respective update in his order. If approved, the PO is generated internally in the company and sent to the production department and the logistics department, who together perform a review of the current inventory.

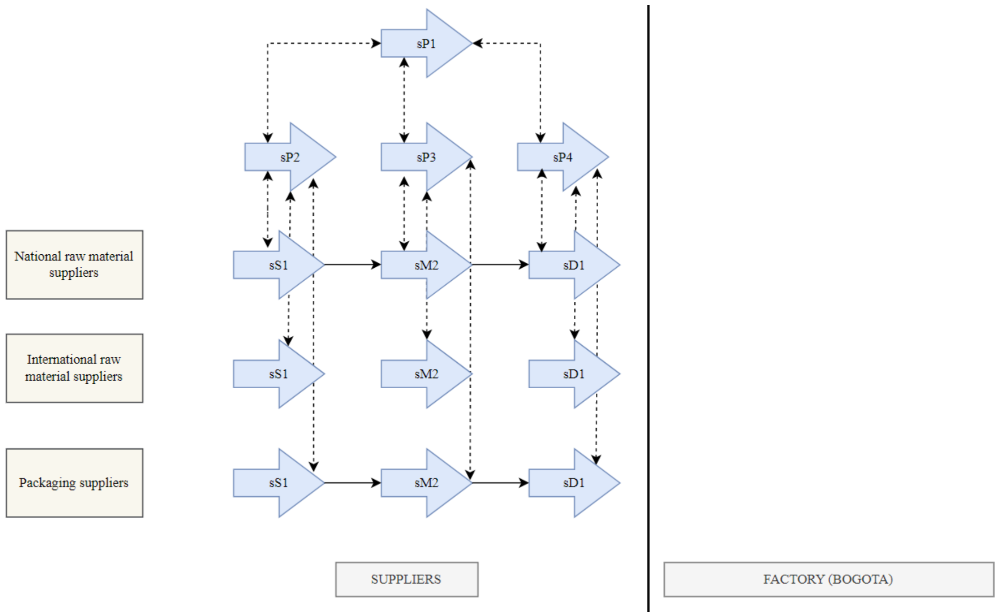

Image 2. SCOR Thread Diagram: suppliers. Source: authorship

Once the production department is notified with the requirements it proceeds to evaluate the possibility of producing the necessary finished goods (FG) in case it is not currently in the DC. Here the option is presented to produce the products or to send to the commercial department new specifications that include changes in the quantity or delivery date agreed with the customer. If the customer approves the new specifications, the commercial department communicates this update to the production department and requests the invoice to the backlog. When the commercial department has the PO and the invoice, it forwards it to the logistics coordinator, who verifies the delivery date or assigns one if it has not been established.

When the delivery date has been verified and/or established, the logistics coordinator proceeds with the procurement of the vehicle, which may be affiliated to the company or sent by a logistics operator (3PL). Then, with the information contained in the invoice and the PO, the dispatch template is generated through an Excel macro that the company has. This macro is in turn connected to the SAP[1] system, resulting in the template that will be used at the time of dispatch. The dispatcher receives the template and makes three copies of it to give to the forklift operator, the watchman[2] and the 'cuadrilla'[3]. Subsequently, he coordinates the loading order of the vehicles if several vehicles are present at the same time.

The forklift operator continues with the process by reviewing the products to be removed and coordinating the loading order according to the requested references. After this, he/she proceeds to look for the product in the racks located in the DC and prepares the order together with the warehouse assistant. Once the pallet or FG units have been delivered, he/she performs a manual check on the template that was given to him/her. When the product leaves the DC and before being placed in the vehicle, the dispatcher performs another manual check

[1] SAP: software used by the ABC Company for process management.
[2] Whatchman: in the case of ABC, currently also manually verifies the inventory issue (fulfills the role of receipt and dispatch assistant introduced below).
[3] Cuadrilla: personnel in charge of loading the merchandise into the truck at the time of dispatch.

of the outgoing inventory to be dispatched. Subsequently, the 'cuadrilla' loads and places the FG units on the vehicle. The product search, outbound check and loading onto the vehicle is repeated until the entire shipment is recorded in the templates of all responsible parties. Finally, the crew verifies the security of the vehicle, and the dispatcher delivers the original invoice to the driver.

On the other hand, the driver signs the receipt of the product to be transported and proceeds to the corresponding route. Once he arrives at the destination, he delivers the order and receives the observations made by the HD. Upon returning to ABC's DC, the driver delivers the non-conforming product (if any) and begins the process of inspection by the quality department and inventory disposal by the finance and accounting department. Likewise, the driver delivers the referral and the observations that will be used by the key account assistant, who reviews them and at the same time verifies and controls the payment table in SAP. Finally, a report is generated while the treasury department makes the payment to the 3PL, thus concluding the process.

Continuing with the characterization of the company and its context, it is necessary to know all the stakeholders involved. In Image 3 these groups were organized according to their power and influence in the company, where power refers to the actors that can alter the outcome of the project and influence has to do with the degree of closeness that the stakeholder has for decision making.

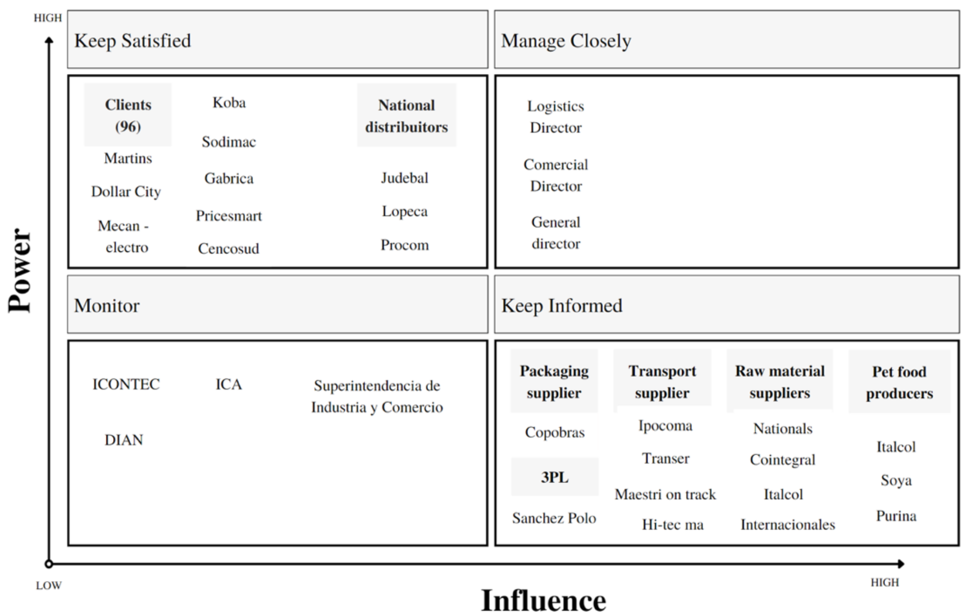

Image 3. ABC Company stakeholder map. Source: authorship

It is observed that customers and distributors have a high level of power because the decisions made by these stakeholders greatly affect the market. On the other hand, suppliers have little power and high influence, which is why these stakeholders are considered as a priority in decision-making. Although government entities such as the DIAN (Dirección de Impuestos y Aduanas Nacionales) and the Superintendency of Industry and Commerce have low influence and power, the company must follow their regulations to the letter, so they do not represent minor requirements to be fulfilled.

In addition to the knowledge regarding the influence and power of all stakeholders involved, an interview was conducted with the logistics coordinator and the commercial director to learn the company's perspective on the current pet food market. With the information collected during the interview, the company's empathy map shown in Image 4 was created. This map shows the exponential growth of the pet food market and how the company tries to take advantage of these opportunities by satisfying the demand through the production of more than 120 references for its 96 clients. The company is also trying to reduce costs by outsourcing transportation and is looking for opportunities to expand the market to countries such as Venezuela. However, one challenge currently facing the company is freight cost overruns. For the time being, the company has tried to reduce this item by outsourcing transportation where large-capacity vehicles such as tractor-trailers are used.

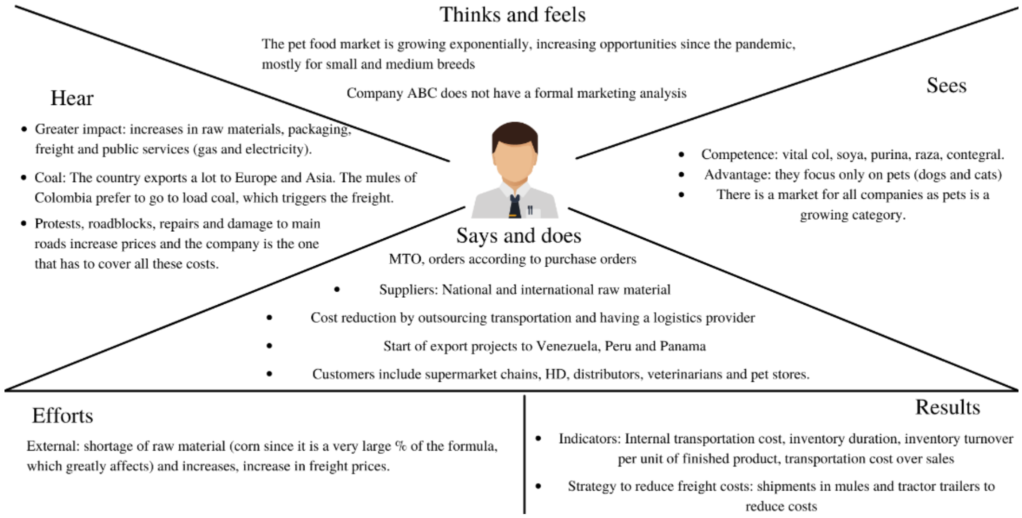

Image 4. ABC Company empathy map. Source: authorship

Similarly, it was identified that the production department in the company centralizes the quality, distribution, maintenance and even purchasing departments. Planning in this department is carried out, in theory, according to the number of existing purchase orders. However, currently it tries to produce according to the maximum capacity of the plant to avoid wasting machine hours, bringing in turn direct repercussions to the logistics department, more specifically in warehousing. Due to the current warehouse design and capacity, the DC repeatedly collapses because of overproduction. In contrast to the above, in other circumstances there may also be shortages of some references when loading vehicles for dispatch. In addition, the company does not have an organized and updated inventory system, which, together with the variation in production and the lack of a safety stock, leads to a lack of capacity to respond quickly to situations of this nature.

Once the empathy map of the ABC company was built and analyzed, the journey map tool was used to identify the moments of friction or high impact in the processes between the company and the HD customer. The diagram constructed is shown in Image 5.

Journey Map ABC Company - HD										
	Phases									
	1		**2**			**3**			**4**	**5**
Description	**HD creates the purchase order**		**Preparation of the purchase order**			**Delivery order**			**Receipt of product**	**Payment**
Positive / Negative	↑	↑	↑	↓	↓	↑	↑	↓	↑	↑
Activities	HD forecasts the amount of dog food you would like to receive in the next 6-8 days	HD uploads the order to the software used by the company, specifying the quantities of units to be received and the delivery date.	Invoicing for HD by the sales department.	Order Processing in Production (MTO)	Product quantity check	Scheduling of dispatch with an outsourced company	Delivery of the product at the stipulated date and time	Return	HD receives the invoice and signs the receipt	Sales team ensures that the HD makes the payment.
Contact points		★					★	★	★	★
Strengths	The EDI system works 100% of the time, which makes the communication between ABC company and HD excellent.			10 tons of stock (always)	The reprocessing rate is 0.8%.	The company always has the invoice at the time the production order is completed.	Regardless of tardiness, when dispatch is scheduled, it always arrives at the stipulated time.			
Weaknesses				There is a 5% late delivery rate.	There is a high return for quality.			Quality returns arrive daily		

Image 5. Journey Map ABC Company – HD. Source: authorship

As can be seen, there is a point of contact at the time the product is delivered and the customer reviews it, since at least 40% of the orders delivered have nonconformities. At the time of visiting the company, it was found that one of the main causes of this is due to human error at the time of picking and loading, where workers frequently do not pack the complete order. At the same time, there is a secondary cause that involves breakdowns in the packaging during the distribution process, causing the food to be completely lost and, therefore, an incomplete order is delivered. Other less frequent causes related to incomplete deliveries have to do with errors in palletization and packaging deterioration. Moreover, the logistics coordinator reported that at the time of picking and loading there are significant shortcomings in the cross-checking between the dispatcher, the warehouse assistant, the forklift operators, the ‘cuadrilla’, and the watchman, because despite this control, there are discrepancies between what is ordered according to the invoices and what is dispatched.

As a complement to the journey map, the service blueprint presents the points of contact and the details of the support activities (off-stage) along the process between the companies. Image 6 shows the development of this between the ABC company and the HD client.

Service Blueprint ABC Company - HD									
Phases	**1**	**2**			**3**			**4**	**5**
Duration	**1 day**	**6 y 8 days**			**1 day**			**1 day**	**2 weeks**
Point of contact	HD uploads the order to the software used by the company, specifying the quantities of units to be received and the delivery date					Delivery of the product at the stipulated date and time	Return	HD receives the invoice and signs the receipt	The sales team ensures that HD makes the payment.
On Stage	**HD creates the purchase order**	**Preparation of the purchase order**			**Delivery order**			**Receipt of product**	**Payment**
Off-Stage	Sales uploads the order to the system	The commercial and purchasing areas generate the invoice.	Production elaborates the product	Logistics creates dispatch order	The order is shipped	Inform the portfolio that the product has been shipped.			
Support processes			The product is made under a Made to Order scheme.		Outsourced transport				

Image 6. Service Blueprint ABC Company – HD. Source: authorship

At first hand, there is evidence of constant communication between the HD client and ABC. At a more detailed level, we observe the "off-stage" section where we find the points of contact that the customer does not necessarily perceive. Here we see several important aspects of what is happening with the high level of returns explained earlier in the journey map. Between six and eight days from the generation of the order to its dispatch, the production department oversees the elaboration and verification of the product, with the possibility that it does not allocate enough resources to the quality review and generates therefore a significant percentage of nonconforming product units. In addition, there are dispatches of products that were not produced less than one week in advance, since when there is an excess of finished product in the DC, support is sought from the sales department to dispatch as much product as possible. This is because the DC is not designed with a FIFO (first in, first out) system, but is a storage warehouse that uses a LIFO (last in, first out) system: the pallets with older product are stored at the back of the rack and the most recent pallets are shipped first.

On the other hand, the company acknowledged the possibility of making forecasts to determine the demand trend and, in turn, the physical flow that logistics processes should follow. However, the logistics department expressed that these forecasts have a very fluctuating and generally low accuracy, so they do not see an added value in this.

Finally, a journey map was made regarding the process in which the final customer acquires the product from ABC in the HDs. Annex 3 analyzes the points of contact, strengths and weaknesses found throughout this situation. In this case, an extremely important touch point for ABC is when the consumer is looking for the product and there is no stock. Here the customer turns to other available products, making the participation of other competing companies more relevant. This leads to a decrease in the number of customers buying from the company, which in logistics is known as a loss due to shortages.

Considering that Jeronimo Martins is currently the company's largest customer, information was collected on deliveries made to its distribution centers during the last 15 days of September 2022. This information was tabulated in a spreadsheet and then uploaded to the Tableu analysis tool, where it is possible to visualize the information in a simpler and more dynamic way. Image 7 shows the graphs created with the information obtained.

A review of the information on these deliveries shows that 41.67% of them are incomplete. In addition, the main cause of these deliveries is missing products, with this factor being present in more than 70% of the cases. Among other relevant causes found were packaging failures, the wrong palletizing, and the deteriorated packaging.

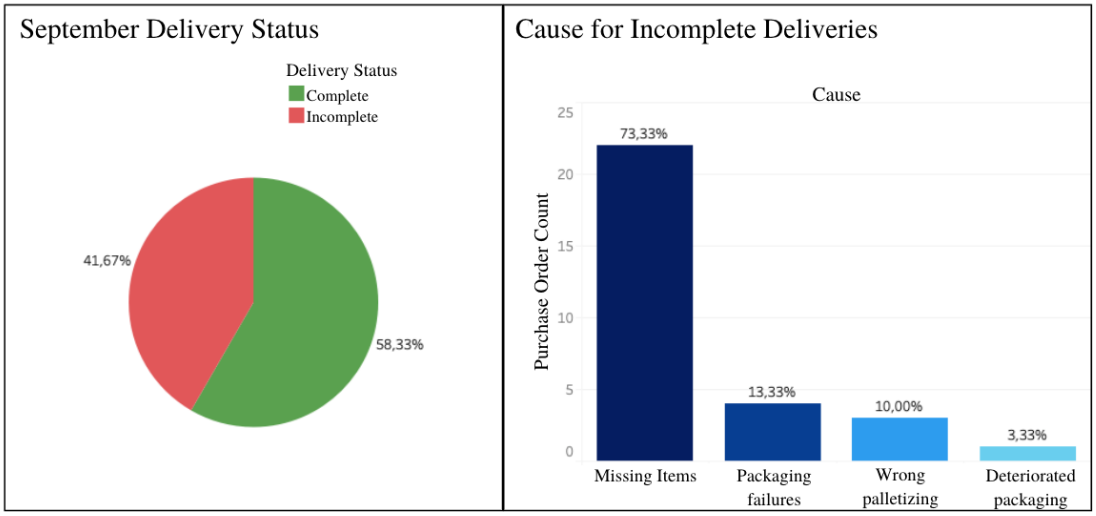

Image 7. Indicator: deliveries to Jerónimo Martins (last 15 days of September). Source: authorship

Defining the problem:

Once the context has been analyzed in its entirety, the second stage of this first phase of the model presented is the definition of the problem. In the framework of operations management at the enterprise level, there is a term called bottleneck, which explains that within a production process there is a station that occupies more time with respect to the others, putting the rest to work under its rhythm. In turn, the theory of constraints defines the bottleneck as a restriction that limits the capacity to meet or satisfy the demand required by the market. This theory also mentions the importance of "exploiting the bottleneck" trying to decrease the times in this station and thus improving the result of the process (Aiastui, 2022).

To define the problem, the management model designed contemplated the definition of a tool called the *'problem bottle'*, which was created in response to the logistical challenge presented by ABC. As its name indicates, the diagram uses the concept of flow and bottleneck. This is how the difficulties in the flow of the value network that cause the main problem identified are illustrated, where the causes and effects of the problem are also discussed, as well as the objectives and goals once the bottleneck is released. This liberation is obtained because of assigning a greater capacity to the restriction and consequently improving its performance.

Image 8. Problem Bottle Diagram. Source: authorship

Image 8 shows the tool adapted to the current situation of the company. In this, causes and effects are visualized that lead to failures in the receipt of orders for customers, resulting not only in problems to meet customer requirements, but also in loss of competitiveness, loyalty, and effectiveness on the part of the company ABC. Due to this and to the in-depth analysis of the company's context, the main problem identified and to be addressed is the ***non-compliance in the level of service against HD due to non-conforming deliveries***. It is expected that, once the causes of the problem have been solved, the effects caused can be reduced, as detailed in the specific objectives, thus *increasing the service level of the HD customer with respect to ABC company*, leveraged on this operations management model and focused on the distribution process.

Ideation:

After identifying the problem, the ideation phase began, which is framed in the methodology created in 1992 by Edward de Bono called the 'Six Hats' technique to approach a context from different points of view. In this case, the context is derived from the definition of the problem previously exposed in the problem bottle. In this way, the hats were distributed among each of the team members: white (facts and data), red (feelings and intuition), black hat (dangers, difficulties, and risks), yellow (optimism), green (creativity) and blue (facilitator). For the purposes of this work and under the criteria used by De Bono, the authors developed the '6 Links' technique in an analogous way, where a brainstorming session was carried out taking the role of supplier, production plant, storage warehouse, 3PL, DC and retailer. Some of the ideas generated and associated with each link are presented in Image 9.

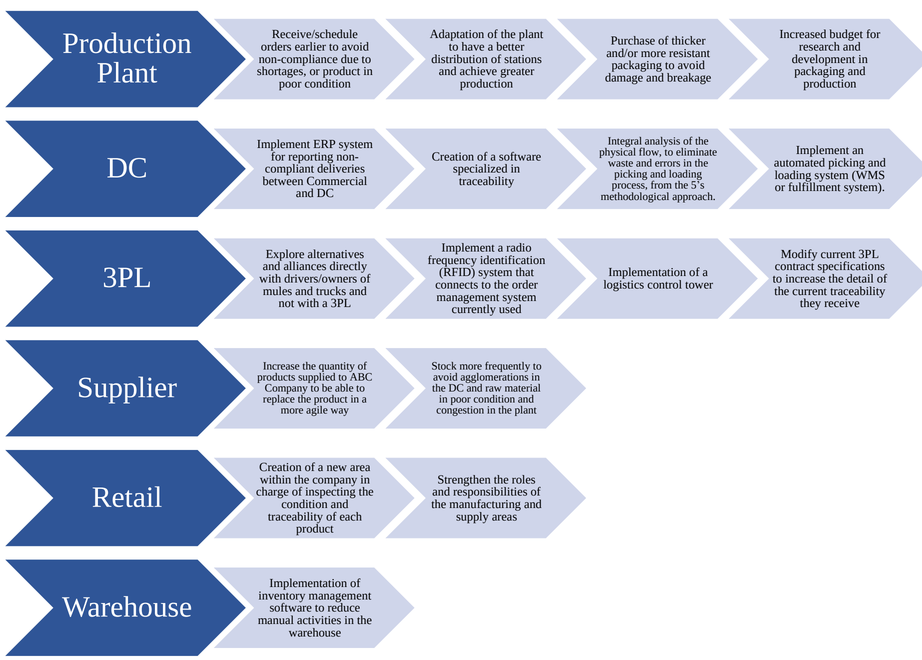

Image 9. Ideas generated by the '6 Links'. Source: authorship.

Once the brainstorming had been carried out using the methodology described above, the ideas were refined, resulting in 10 prioritized ideas (PI). Table 2 shows the details of each one of them.

Given the consolidation of ideas and starting from the purpose of finding the best solution (or solutions) identified, it was decided to use an impact vs. effort matrix presented in Image 9, where the ten prioritized ideas stipulated above are plotted in a matrix with two axes: level of effort and level of impact. For the effort level, the feasibility of the alternative in terms of processes, human resources, technology, and operational costs incurred by the company was considered, as well as the time it will take to implement this solution, which will later become a Sprint (according to phase 3 of this operations management model, which will be detailed later). On the other hand, in the impact level, it was evaluated whether and to what extent the general objective set out in the problem bottle is fulfilled by implementing this solution. It is expected to implement the ideas in the upper right box, which represents those that, with less effort, obtain a high impact.

PI-1	Receive/schedule orders in advance to avoid non-compliance due to shortages, product in poor condition or directly have more slack in production and responsiveness in terms of available product.
PI-2	Adaptation of the plant to have a better distribution of stations and achieve higher production, which in turn will allow greater responsiveness to unforeseen deliveries.
PI-3	Implement ERP system for reporting non-conforming deliveries between Commercial and DC.
PI-4	Implement a software that records inputs and outputs of finished product to avoid mismatches in the actual and theoretical inventory due to errors in the manual process and thus reduce uncertainty.
PI-5	Integral analysis of the physical flow, to eliminate waste and errors in the picking and loading process, leveraged with the 5's methodology.
PI-6	Implement an automated picking and loading system (WMS or fulfillment system) to reduce technical and systematic errors, as well as human errors, thus reducing the number of incomplete deliveries or deliveries with references other than those requested.
PI-7	Implement a CRM where the client can communicate directly with DC and the commercial area in case of receiving a non-conforming order and achieve a much more effective response (consider variables from Retailer's ideas 1 and 2: software and website respectively).
PI-8	Explore alternatives and alliances directly with drivers/owners of mules and trucks and not with a 3PL, to reduce costs and facilitate communication with the person responsible for deliveries.
PI-9	Modify current contract specifications with 3PLs to increase the detail (location, frequency, timing) of the current traceability they receive.
PI-10	Implement a system of labels containing a QR code leading the person responsible for the product at the time to a short questionnaire asking for details of the shipment.

Table 2. Prioritized Ideas. Source: authorship.

In the first instance, these alternatives were shared and studied with the ABC logistics director, logistics coordinator, and commercial director. The impact and effort were defined with their help and are described below:

Impact:

1- Imperceptible variations in key indicators.
2- Slight variations in a single key indicator (less than 2%).
3- Slight variations in two or more key indicators (less than 2% each).
4- Significant variations in a single key indicator (equal to or more than 5%).
5- Significant variations in two or more key indicators (equal to or more than 5% each).

Effort:

1- Process changes must be made; technological and personnel factors already exist to enable implementation. No investment is required.
2- Changes must be made to the process with an investment of up to COP 700.000; there are already technological and human factors that allow implementation.
3- Changes must be made to the process, an investment of up to COP 1.000.000 is required and basic training in new technological systems is required; the personnel necessary for implementation already exists.
4- Changes must be made to the process, an investment of up to COP 2.000.000 is required and a change in the technological infrastructure is required along with personnel training; the personnel necessary for implementation already exists.
5- Changes must be made to the process that require an investment of more than COP 2.000.000, a change in the infrastructure or the hiring of new personnel for implementation.

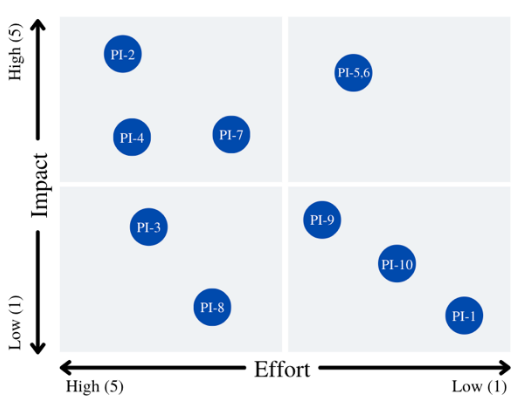

Image 10. Impact vs. effort matrix. Source: autorship

As mentioned above, in the matrix presented in Image 10, the ideas were separated by sections according to the effort required to implement them and their impact in four quadrants. On the one hand, the lower left quadrant contains those fewer effective ideas, which require a high effort and, even so, achieve a lower impact compared to the other ideas. On the other hand, the upper left quadrant contains ideas that require a great deal of effort and can have a major impact on the company. On the other hand, in the lower right quadrant are ideas with low impact and requiring little effort. Finally, in the upper right quadrant are the ideas known as 'Quick Wins', which are proposals that, despite requiring little effort for their implementation, achieve a considerable impact within the process and are therefore prioritized for implementation. These ideas are PI-5, corresponding to the implementation of the 5's to eliminate waste in the process and PI-6 corresponding to the implementation of a WMS. On the other hand, several of the prioritized ideas that are not in this quadrant are likely to be found in the Product Backlog (section 3.2) and, therefore, to be implemented in subsequent Sprints.

Once the matrix was completed and in continuous communication with the director and the logistics coordinator, it was decided to consolidate and implement PI-5 as support for PI-6 to implement the two ideas simultaneously and achieve a result with greater impact on the organization.

5. Phase 2. Lean Startup: continuously iterating to validate hypotheses and generate value.

5.1. Methodology.

In this second phase begins the prototyping of the selected ideas to turn them into improvement opportunities that will address the problems and challenges encountered and involved during the characterization stage. Image 10 illustrates this phase of the model that corresponds to the Lean Startup framework.

Lean Startup is a work methodology whose main objective is the transformation of ideas into products through an iterative process where the fundamental requirements that will take the organization to its target audience are discovered. This methodology is developed in three stages: construction, measurement, and learning. In the construction phase, the idea is transferred to a material product, considering all its priority characteristics. As a result, a prototype is obtained to analyze the information collected from customer feedback. Then, in the measurement stage, the available resources are considered to collect feedback from the prototype. Finally, the learning stage internalizes the valuable information collected throughout the process. It is at this stage where the cycle starts again to elaborate the final product, considering the needs identified in the learning phase with customers and the opinions of stakeholders (Edix, 2022). Image 11 illustrates this phase of the model described above.

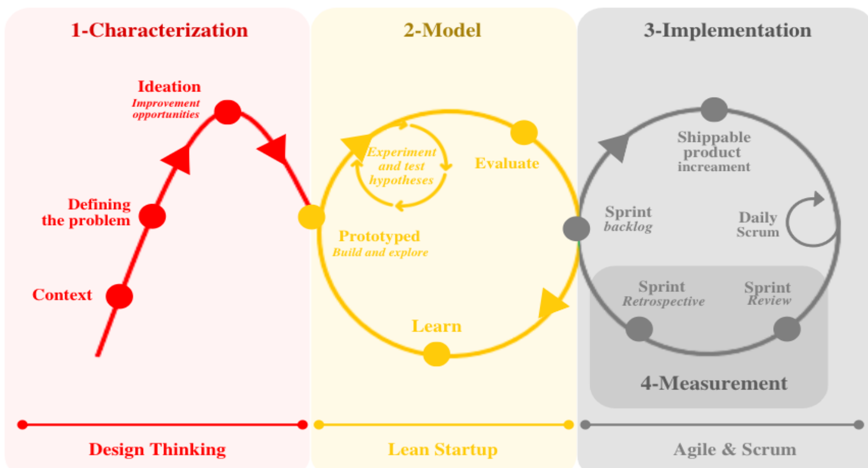

Image 11. Operations management model: phase 2. Source: authorship

According to the moments of construction, measurement, and learning, as a first step, four Lean Startup tools will be used, starting with the Business Model Canvas, where new scenarios that the company is thinking of implementing are captured on a canvas, through the description of nine blocks in a new context, which are customer segments, value proposition, alliances, among others. Similarly, users will be made of the Value Proposition Canvas, which focuses on the customer segment and the value proposition, the most important blocks of the Business Model Canvas. The third tool is Lean Canvas, which, unlike the first, focuses on the product or service with opportunities for improvement through various blocks (problem, solution, and cost structure, among others). Finally, the Validation Board will be used, where different hypotheses about the problem, the customer, and the solution are used to record the iterations and how the hypotheses have changed.

As a complement to the Lean Startup tools implemented, the proposal involving both improvement opportunities will be detailed, as well as some of the requirements for its correct prototyping and implementation. Likewise, emphasis will be made on the definition of the 5's and the action plan for each one of them within the ABC company. Finally, the technical sheet that consolidates both improvement opportunities will be made, and an action plan will be created.

Once this phase of the model is completed, it is expected to have a concrete idea that meets the following hypothesis: the idea chosen by the group helps, through distribution and transportation, to improve the HD customer service level within the ABC company (problem posed in the problem bottle), thus reducing the current KPI of non-conforming deliveries by at least 5%.

5.2. Analysis of results.

According to the impact vs. effort diagram presented at the end of the previous phase, a brief description of each of the ideas is given below in a more grounded way to start prototyping them. On the one hand, and as the main improvement to be developed, is the Warehouse Management System (WMS), which is presented as a software solution that will offer traceability of the existing inventory, incoming and outgoing of the company. This will be implemented in the dispatches generated to Jeronimo Martins (customer HD), with emphasis on the process of enlistment, loading, and distribution of the requested finished product. The solution will eliminate to a great extent the human error existing in the company at the time of dispatching the vehicles that transport the orders.

On the other hand, the 5's methodology will be implemented to support the WMS to eliminate waste within the picking and loading process of ABC. Therefore, the measures must be implemented in the DC. It should be emphasized that the methodology is therefore not a matter of aesthetics, but of culture and work habits, through the planned practice of the basic concepts of total quality and waste elimination. The implementation of this method is a basic pillar to build a firm and lasting continuous improvement process, that is, the hypothesis to be validated is that once all waste has been eliminated and the distribution center has been cleaned, dispatchers will find it easier to carry out cross-recruitment, directly reducing the number of incomplete dispatches.

Now, starting with the tools of the Lean Startup framework, the Business Model Canvas presented in Image 12 shows more clearly the value proposition for the ABC company, which is the increase in the service level of the HD customer. Likewise, the cost and benefit structure for the company can be observed. It is important to emphasize that the key activities are those planned to be performed at the time of running the first Sprint. According to the tool, it is evident that the value proposition is related to the increase of the service level through the deployment of the 5's and the integration of the WMS, this is performed by the key partners indicated in the diagram.

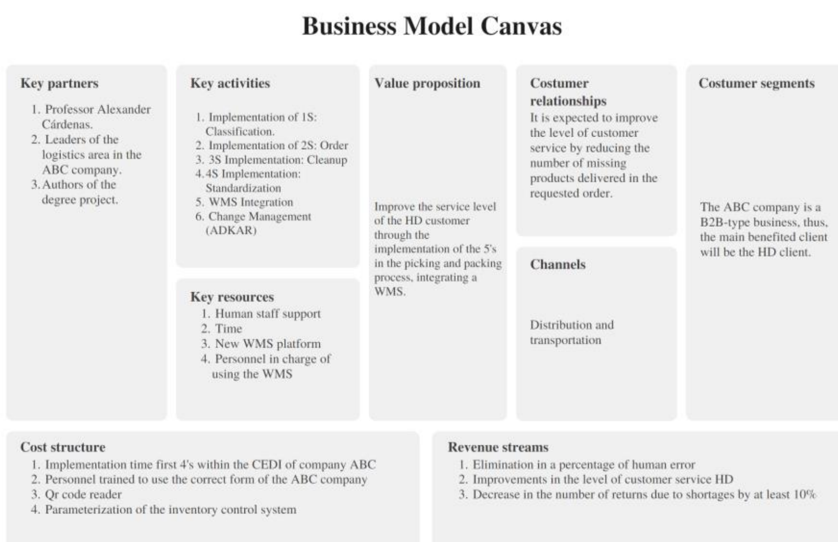

Image 12. Business Model Canvas. Source: authorship

Once the first tool used has been described and analyzed, Image 13 shows the Value Proposition Canvas, which focuses on the Business Model Canvas and the customer segment. This second tool shows the type of product offered by ABC, with the benefits it brings to both the company and the customer. It also demonstrates the reduction of time and processes that implementing the WMS and the 5's would bring, increasing in turn the level of service.

Continuing with the third Lean Startup tool is the Lean Canvas presented in Image 14, which complements the Business Model Canvas by describing in greater detail the proposal, the unique advantage, and the metrics to be improved. With this third tool, it is concluded that the value proposition includes a reduction in costs due to the reduction of activities generated by managing and receiving referrals. Likewise, time and waste are reduced, thus increasing customer satisfaction. Another special advantage resulting from the implementation of the WMS is the reduction in human errors by mitigating manual processes.

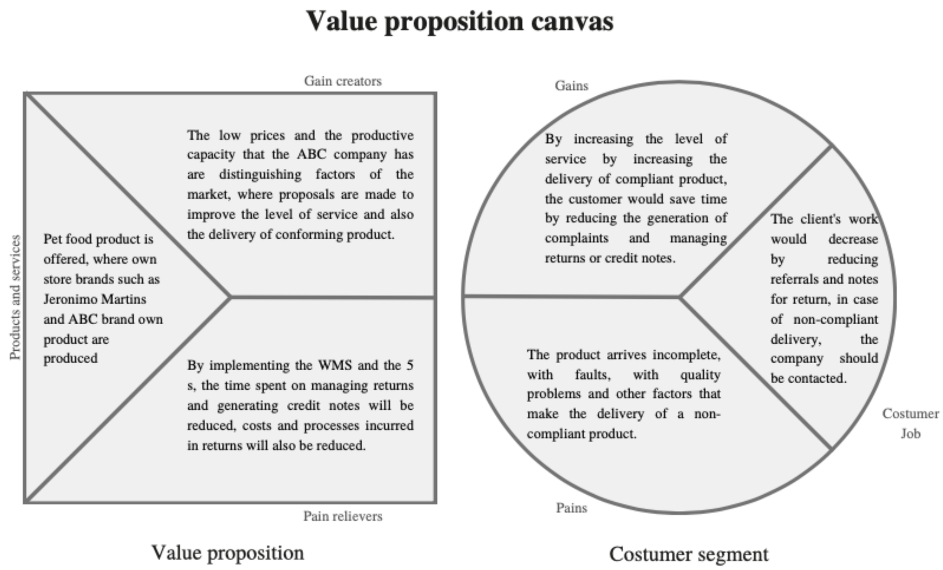

Image 13. Value proposition canvas. Source: authorship

Once the four Lean Startup tools described in the methodology of this chapter have been developed, the proposal involving both improvement opportunities are detailed. First, as part of the WMS for the inventory management system (in the warehouse in transit), it was suggested to change the current scheme, which consists of a dispatcher who manually counts the number of bales[4]/ packages in each batch, recording it in a physical spreadsheet and cross-checking with the forklift operators, the warehouse assistant, the watchman, and the "cuadrilla". It was identified that, during the loading process, all of them reported at the same dispatched inventory, even when the inventory was wrongly counted. This leads not only to serious errors in warehouse inventory and non-conforming deliveries but also in the culture and habit of properly reporting the inventory shipped in this process.

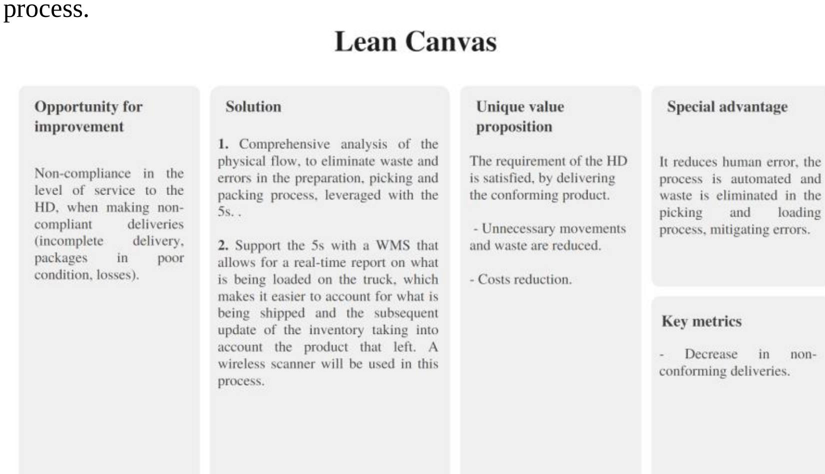

Image 14. Lean Canvas. Source: authorship

[4] Bales: internal unit used within the ABC company, which is equivalent to the number of units packed in a bag.

To reduce manual work, and thus errors, the WMS consists of implementing scanners for the picking and loading process, accompanied by tablets that will update the scanned products in real-time and facilitate cross-checking between those responsible for the process. The dispatcher will be provided with a scanner and a tablet; each lot or unit of the outgoing inventory to be dispatched on the invoice in question will be scanned by him, verifying in turn, references, and quantities to fully complete the dispatch. On the other hand, it is intended that the inventory entry and exit assistant scans the code of the incoming product to the DC by production throughout the day. At all times, there will be cross-checking among those involved, making it possible to identify possible gaps or errors of a systematic or technical nature.

Additionally, the compatibility between the readers and the tablets is leveraged on the ABC company's servers, performing the reading of the information through Excel so that it can easily adapt to the documents where the information on distribution and inventory in transit is currently handled, with a view to scaling this database in the future to SAP software.

Regarding the hardware required to implement the WMS, the company already has two tablets and lacked the three scanners that will be used initially. Therefore, the scanners were purchased by the organization itself. Additionally, the Analytic Hierarchy Process (AHP) was used for the decision to purchase the scanners. This is a multi-criteria method for making decisions among different alternatives, considering a series of guidelines. In this case, the most relevant criteria are price, the number of codes to be stored, battery life, and transmission range in open spaces. Annex 4 presents the process developed and Table 4 shows the options evaluated respectively.

As can be seen in the annex, at the end of the AHP implementation, option 2 for the purchase of the device is obtained as a result. Thus, three scanners of this reference were purchased for the implementation of the WMS. It is important to emphasize that the online platform Mercado Libre Colombia was used both to set the prices shown in the AHP and for the purchase of the devices. To synthesize the information presented in this phase, a technical sheet was designed for the opportunity to be developed, which includes a description, effort, expected impact, context, and scope. This technical sheet is available in Annex 5.

Option 1	Option 2	Option 3
Digital Pos DIG-830W-New	Neoteck Barcode 2D Scanner	NETUM C740 Mini Portable Bluetooth & 2.4G Wireless Image Scanner, 1D Barcode Reader
		

Table 3. Evaluated scanners. Source: authorship

Once the proposal and its requirements were defined, we started with the prototyping of the WMS program, which was designed through an iterative and incremental process, carrying out a series of pilot tests, and implementing the continuous improvement established by the Lean Startup. Here use was made of the Validation Board, the fourth and last Lean Startup tool used. Image 15 is presented as a design alternative to this tool, which allows better visibility of the subject, exposing the iterative process for the WMS that begins once the Design Thinking stage is completed, as well as the iterations carried out until reaching the final product, as defined in the Lean Startup framework.

Based on the hypothesis that a scanner at the time of dispatch could lead to a better count of the inventory to be shipped and thus reduce incomplete orders delivered and based on the alternatives proposed for the first iteration, first, the new WMS was programmed and designed, integrated with inventories and a new dispatch database to improve traceability. It was decided that, on the one hand, the logistics coordinator would create the dispatch orders in their old format and then use the copy-and-paste tool in the Excel application at the time of dispatch. On the other hand, while the dispatch was taking place, the same forklift operator would oversee scanning the barcode to add it to the order output and thus fulfill the main objective: to greatly reduce the probability of shortages at the time of dispatching the order. In a transversal way, it was expected to reduce the outgoing product from the inventory base. On the other hand, when the finished product was received, the forklift would scan the barcode and it would be automatically added to the inventory. Once this first product was presented to the company, the copy-and-paste tool option was rejected, due to the complexity, it would represent for the person performing this task.

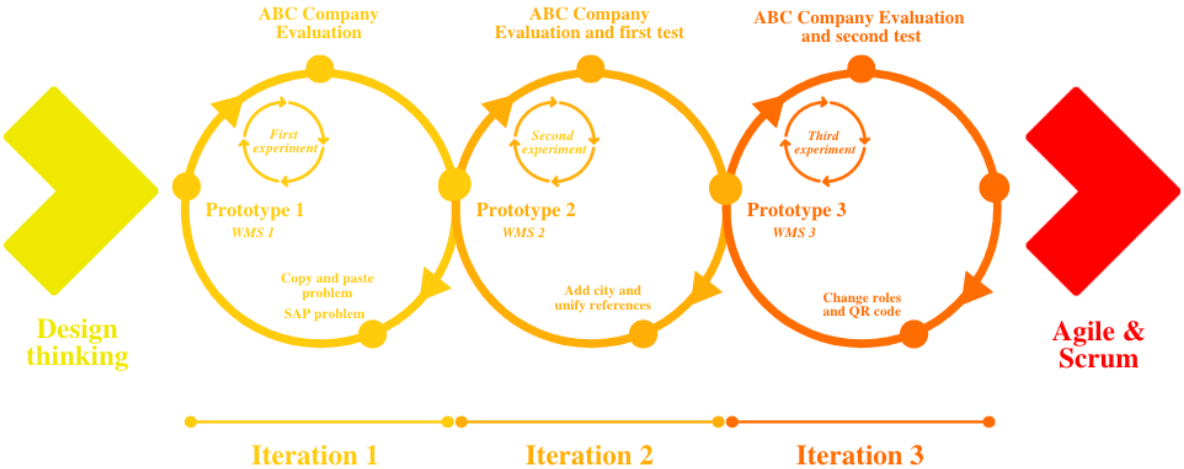

Image 15. Validation Board (WMS's Lean Startup Iterations). Source: authorship

Due to the previous challenges encountered, a second program product was developed to include information generated by the SAP system for the creation of the dispatch order with the newly established format. It was also decided to add to the program a function that searches for the products that first entered the DC to inform the forklift operator of the location of the stowage to be brought, thus creating a FIFO system. This addition, together with the changes already mentioned, complements the first iteration. Additionally, Image 16 presents the information sources required for the proper functioning of the WMS.

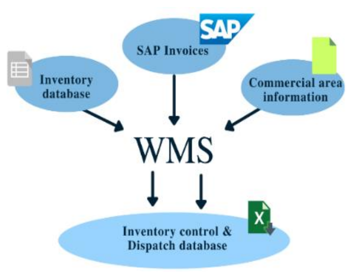

Image 16. WMS information flow. Source: authorship

For the second iteration, the changes stipulated above were made, allowing the development of the first pilot test within the ABC company. This test made it possible to identify new challenges. On the one hand, due to the age of the tablet, the program took longer to run than planned, which greatly delayed the process and the dispatcher's task. On the other hand, on several occasions, the company dispatched different invoices in the same freight, i.e., one dispatch may or may not include different orders. As a result, the program did not consolidate the units of the same reference, but only recorded the output of the finished product from the first invoice containing that reference. As a result, after registering the dispatches of these units, the notification generated by the program showed missing negative units to be dispatched. Finally, some dispatches were occurring erroneously because the city did not come directly from the purchase order generated in SAP, but through direct communication between the logistics and commercial areas.

As a solution to the difficulties mentioned above, the creation of dispatches was delegated to the logistics coordinator the day before, who at the time of dispatch, together with a computer with greater computational capacity, uploads the dispatch orders to the WMS. It was also necessary to change the program code to unify the same references of the different invoices for each dispatched order. Finally, the option to add the city manually when generating the order was added to the program to eliminate the automatic destination assignment error (coming from SAP).

Once the above problems were solved, the WMS pivoted again. This time the program was working correctly, however, several opportunities for improvement were found related to the labels containing the barcodes of the finished product references coming from production. Among the difficulties in printing the labels, it was first found that the size of the different codes contained in the labels was very small, so the need to increase their size was recognized. Once this change was made, a new challenge was identified due to the scanner's reading range and the closeness of the barcodes, where the individual reading of each one of them implied errors where the information was tripped up, resulting in an erroneous registration of the data required for the WMS. As a solution to the above, the different codes were interspersed on both sides of the label, thus avoiding finding the column of codes that were previously handled and therefore, the erroneous reading of data.

Although the modifications reduced the most immediate problems encountered, there was still the need to perform three scans for each outgoing finished product stowage (reference, quantity, and batch). This implied the permanence of a significant human error in this process, which is why a QR code containing all the relevant information was proposed as the last improvement to the label. As a result, the finished product pallet labels were changed to facilitate the process by reducing the number of scans from three to only one per pallet. It is very important to highlight that all the changes mentioned above were possible thanks to the collaboration of the company's technology area, which considered the recommendations made, and provided solutions that responded to each of the requests. Annex 6 shows each of the label versions mentioned.

For the analysis of the physical flow in the chain by means of the 5's, a tour of the DC was conducted in which all the members of the chain were asked about the process, from the warehouse assistant, through the forklift operators and the dispatcher, to the leader and the logistics director, as well as their opinions regarding what they would eliminate or change. In addition, the picking and loading process was observed in real-time, as well as the performance of cross-checking. In this analysis, the 5's were divided and presented as follows:

Seiri – eliminate waste within the DC and the process: the goal is to eliminate from the warehouse a scale of more than 66 $\boldsymbol{m^2}$ at the entrance of the DC, limiting the movement of forklifts and helping the proliferation of rodents and other contaminating agents. This is expected to reduce the number of accidents such as damage to packaging or material, damage to pallets, and mistreatment of packages of the finished product, and most importantly, it is expected to drastically reduce truck waiting time thanks to the creation of a staging area in this area. In addition, it is proposed to eliminate old signs and signage that should no longer be used.

Seiton - organize workspace, in this case, the distribution of the warehouse and finished product: it was decided to make a separation by product family or references, considering factors such as the most requested references, the lots or product in heavier pallets, the sizes of the racks and the location in the warehouse. In addition, a staging area will be set aside for cross-checking at the time of loading to facilitate the implementation of the WMS. An area of the warehouse will also be set aside for pallets with incomplete lots, which will facilitate picking and maintaining the order of the lots, avoiding having several pallets or open lots of the same reference, which would also encourage errors and make inventory measurement more difficult. Finally, it is proposed to remove raw materials that are in the warehouse due to low capacity in the production plant warehouse, placing them away from the finished product and even in closed rooms, trying to comply with Good Manufacturing Practice (GMP) and other regulations in force.

Seiso – clean the workspace, articulated to a root cause analysis of the dirt: HR personnel was asked to clean the warehouse to remove dirt, plastic residues, bags, and boxes, and to rearrange the products. Three operators with heights training were required to perform the work. During the cleaning, an excess of pallets with incomplete batches was identified, as they were opened by forklift operators and assistants to pick small orders or orders that required bales or independent packages. However, many lots of the same reference number were found to be open, which causes inventory problems in the warehouse and in transit, resulting in non-conforming deliveries due to shortages or even surpluses.

Seiketsu - keep the workspace clean, standardizing the process: to keep the workspace clean, training and interventions will be planned with forklift operators to explain the importance of keeping only one batch of each reference open.

Shitsuke – encourage habits and discipline in the process: the manual of functions of the process of the operators will be intervened where the requirement mentioned in the S of Seiketsu will be added.

6. Phase 3. Scrum: implementing sprints under an agile framework.

6.1. Methodology.

Continuing with the methodologies, Agile formulates the development of projects where the early delivery of value for the client and the improvement of results are the priority. According to its frameworks, the emphasis is on periods called Sprints, where the product or project evolves based on feedback loops. Generally, each Sprint has a duration of 2 or 3 weeks, during which time each team member performs a series of tasks, including the continuous improvement of the product that was decided, this being an iterative and incremental operation. The progress is delivered once the sprint has been completed and it is here where the process starts again. This allows updates and new developments to be received gradually, making it possible to identify priorities and introduce new changes. Image 17 illustrates this phase of the model described above.

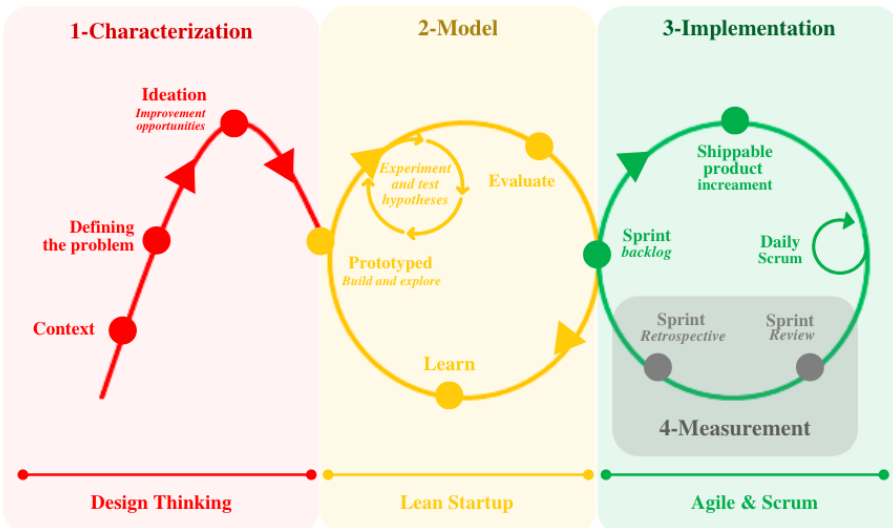

Image 17. Operations management model: phase 3. Source: authorship

Scrum is derived from the Agile framework. Being bounded within the Agile frameworks, Scrum is based on flexibility, the human factor, collaboration, and iterative development. Also, in this framework, teams are self-organized and cross-functional to ensure that the entire team always delivers value without the need for help or detailed supervision from other members of the organization. Among the most important roles of the team is the Product Owner, the Scrum Master, and the development team. The Product Owner maximizes the value of the work and is the customer's representative. The Scrum Master is responsible for removing impediments to the group during a sprint and assists in the adoption of the framework. Finally, the development team performs the tasks that were prioritized by the Product Owner, being the estimators of the work and avoiding external influences (Abellán, 2020). For this work, these roles will be established in the following subsection.

For the implementation, the proposal will be presented to the work team, authorities in the area, and anyone else involved in the processes to define roles and responsibilities in the articulation between AS IS and TO BE status. At the same time, an initial test will be carried out in which data on deliveries and non-conformities will be taken and compared with the data obtained by the company before the implementation; data from the last 15 days of October will be compared with the last 15 days of September, considering the seasonal behavior of the demand. The data collected and contrasted belong to the dispatches made only to Jerónimo Martins, since, as mentioned before, it is the client that has the highest percentage of the company's current sales.

To guarantee the correct implementation of the proposed solutions and, above all, the sustainability of these good practices, it is necessary to develop a new process, which includes modifications to the manual of functions of all the actors involved in the logistics department. These modifications also include the addition of new required positions and the creation of the process manual, where the activities performed within the logistics department will be defined. In addition, the new process flow in the company (TO BE status) will be presented, emphasizing the roles of the personnel in the department in question. All these changes involve the current quality management system, so any change will require an approval flow from the requesting area (logistics) to the production department. The requesting area will work on a joint proposal with the human talent area.

Regarding the improvement of the physical flow by means of the 5's methodology, the alternatives corresponding to eliminate, organize, clean, maintain and create the habit were discussed with the logistics team, where the feasible options to be carried out within the two weeks covered by the first Sprint were defined. Among them, the options related to organize, clean, and maintain can be developed without any problem in the determined period; their implementations will be carried out and the results will be recorded in the following section.

To ensure the generation of the habit of cleanliness, order and care of the work space, it will be proposed to train the operators, as well as to complement their functions manual with the objective of not only including the management of the WMS, but also to standardize and establish the good practices that are expected to be carried out in order to maintain a certain order in the racks and respect the areas destined for the storage and preparation of finished product by packages.

In the case of the "s" of Seiri (eliminate), the deadlines for eliminating the scale from the entrance of the DC may take several weeks in addition to those set for the first iteration. Due to the above, a simulation will be carried out to show and detail the picking and loading process in the DC without the scale, also allocating this space for a staging area. This is expected to further facilitate cross-checking and, mainly, to reduce truck waiting times.

For the simulation, the main elements of the DC will be replicated in two cases: with and without the presence of the weighbridge. Both scenarios will have parameters associated with distances, speeds, waiting times and loaded pallets based on average results obtained from a real data survey, differentiating both scenarios from each other in that the first representation will have the space occupied by the scale and waste stored on it, and the second scenario will have this space reserved for the pallets that will be loaded later. It is important to emphasize that it is in this staging area where the cross-checking is expected to be carried out with greater precision. Based on the result of the comparison between both models, the convenience of implementing the proposal in subsequent Sprints will be defined.

The simulation seeks to obtain and compare the picking and total loading times in both scenarios, as well as the truck waiting time in such cases, to then demonstrate the approximate savings in terms of operation time. For its correct development, the information contained in Table 4 is available.

PARAMETERS	Forklift speed (stochastic).
	Distance between racks, scale/staging area, and loading area (deterministic).
	Total scale area/staging area (deterministic).
	Size of pallets (deterministic).
	Average number of pallets shipped (deterministic).
	Dispatch order to be simulated (deterministic).
	Size and levels of racks (deterministic).
	Average loading time per stow (stochastic).
	Average unloading time per stow (stochastic).
VARIABLES	Average total picking and loading time.
	Average truck waiting time.
GENERAL CONDITIONS	The parameters must be the same in both scenarios.
	The main difference is in the process, where in the first model (scale present) the picking is done immediately after the truck is loaded, while in the second scenario the picking is done and the entire order is ready in the area designated for this purpose before the truck arrives, to finally load it with the ready product.
EXPECTED RESULTS	Total picking and loading time: an increase in total picking and loading time is expected, as an additional station and thus an additional process will be added.
	Truck waiting time: it is hypothesized that truck waiting times will decrease drastically, since the order will be ready before its arrival.

Table 4. Information for the simulation model. Source: authorship

In addition, the implementation of this station and the habit of picking well before the arrival of the truck, will allow the operators and the dispatcher to make a more accurate cross-checking of data, having the total of the dispatch order in the same area. This will provide a greater capacity to respond to defective and/or damaged units in the picking process or directly to shortages, with the possibility of requesting the units to the production area.

6.2. Analysis of results.

According to phase 3 of the operations management model and in accordance with agile frameworks and with Scrum, the following roles are assigned as a first step. Next, the different elements and moments belonging to the framework were developed.

- *Product Owners:* logistics manager and coordinator.
- *Scrum Master:* director of the degree work.
- *Development team:* authors of the degree work.

Sprint Backlog:

According to the Scrum framework, the Sprint Backlog is built where the objective of the Sprint and the elements of the Product Backlog are gathered, generating an action plan to establish a strategy for the creation of the product increment. Therefore, the Product Backlog shown in Image 18 is built for the three proposed Sprints, where the activities required in each one of them are detailed. These activities have been prioritized according to the importance for the Product Owners. Once this prioritization has been done, the development phase begins, in which the Shippable Product Increment is found, where the results obtained after the implementation of the Backlog are exposed.

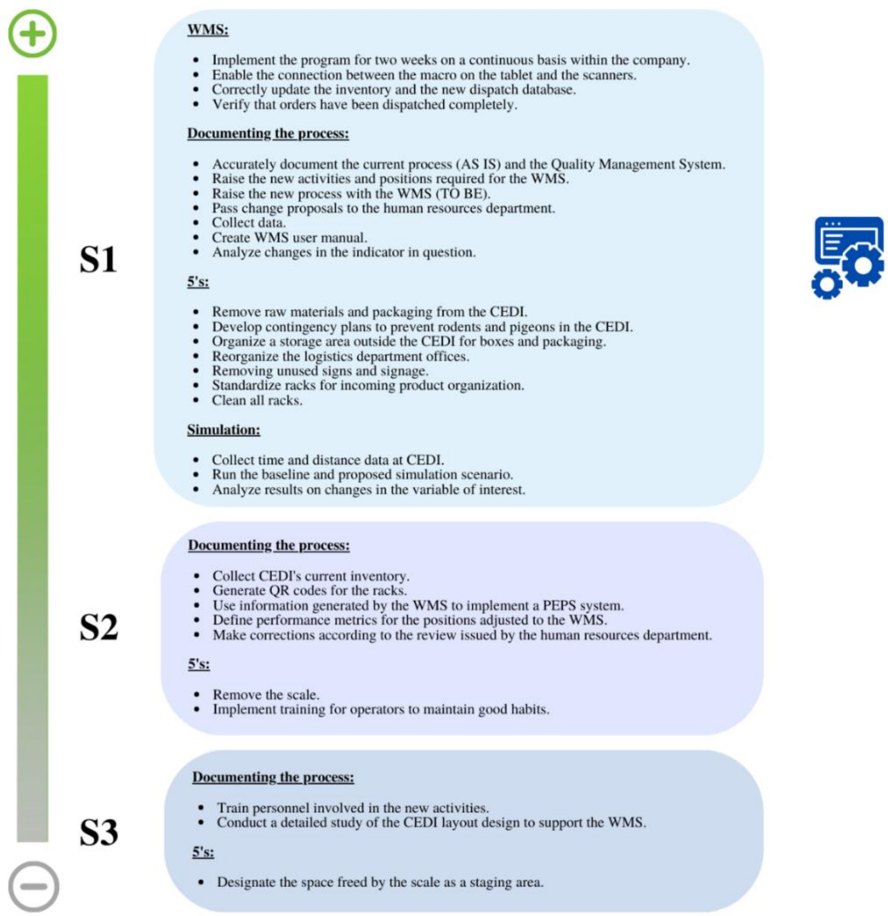

Image 18. First Product Backlog. Source: authorship

Shippable Product Increment:

The increment in Scrum is the result of the sum of all the elements presented in the Product Backlog that were completed during this Sprint (S1). In this way, each one of the increments works in an integral way to achieve the proposed objective. The increments created during Sprint 1 are presented below.

1. *WMS:*

To begin the implementation stage of the WMS model, applied specifically for the client HD Jeronimo

Martins within the ABC company, through a meeting of the development team and the Product Owners it was concluded that to correctly implement the model without affecting the operation within the company, it was essential that the development team be present at the time of dispatch, so as not to interrupt the company's operation. The development team was divided into groups of two people to cover all the dispatch orders and implement the WMS.

As the implementation progressed, new opportunities for improvement were found for ABC. Among the main ones were that on several occasions the truck did not have the capacity to transport the complete order, so that even though the WMS was working correctly, the order would be dispatched with shortages. Also, since the two tablets are not synchronized, the inventory must be balanced at the end of the day, which is an operational cost incurred by the company. Finally, it was observed that within the company there is a habit of working the references through the measure "bales", unlike the program that works with units (measure that is the same for all references), so it is advisable to capacitate the personnel to start working in units. It is recommended that these three opportunities be worked on in subsequent Sprints and will be detailed later in the Product Backlog update. Once the implementation stage was completed, we proceeded to observe the results, emphasizing the metrics of interest.

On the other hand, to integrate the system to the company's current processes, it was necessary to create the WMS instructions, which show step by step the manual for the use of the system for the different positions involved. The instructions are consolidated in Annex 7, and the final WMS program can be seen in Annex 8.

2. *Documenting the process:*

Likewise, it was necessary to modify the company's current process where the changes requested in the quality management system mentioned above are presented. These changes are reflected in the new process diagram (see Annex 9), which represents the desired state (TO BE) that includes all the modifications for the correct implementation of the WMS. Image 19 details the process that integrates the WMS, as well as the incorporation of new profiles and activities involved in it for the correct operation and management of the system within the company. Thus, the new profiles required, and the new activities involved are shaded in green.

According to the model shown in the image, the process begins with the receipt of the invoice and the PO the day before dispatch by the logistics coordinator. Also, while the coordinator verifies the existence of a delivery date, the dispatch and inventory receipt assistant scans the finished product coming from the production department at the DC entrance. It is important to note that this activity is performed throughout the day if the finished product enters the DC. Once the dispatch date has been verified or assigned, the logistics coordinator takes the invoices generated by the SAP system and enters them into the WMS system. Thus, the invoices to be dispatched the following day are already registered in the system.

On the day of dispatch, three copies of the template generated by the WMS are made and delivered to the different people in charge (forklift operator, warehouse assistant and the ‘cuadrilla’). Once the forklift operator receives the dispatch template, he coordinates the vehicle loading order according to the requested references. These product references are searched according to the information provided by the inventory receipt and dispatch assistant, who, in turn, gives his scanner to the forklift operator coming from production to scan the code of the corresponding rack where the product will be placed. In this way, the order is being prepared by the forklift together with the warehouse assistant. Once the forklift passes through the DC door with the product, the dispatcher scans the QR code containing information about the product reference, the number of units that will leave the inventory and the lot. Once the validation is completed, a zero notification is displayed to confirm that there is no discrepancy between the references requested in the dispatch.

During the whole process a cross check is performed between the dispatcher, the forklift operator and the ‘cuadrilla’ to verify that the manual accounts are in accordance with the information available to the dispatcher obtained from the WMS. Finally, the dispatcher completes the order in the system and the “cuadrilla” verifies that the vehicle is securely locked.

As part of the desired state of the process with the implementation of the WMS, the new positions, functions, and activities required within the logistics department, as well as the modification of existing parameters within the current roles, were surveyed. For this purpose, the company's current quality management system was used, and the corresponding modifications were made. As previously mentioned, the adjustments were formally requested to the human resources department with the endorsement of the current logistics director (Product Owner).

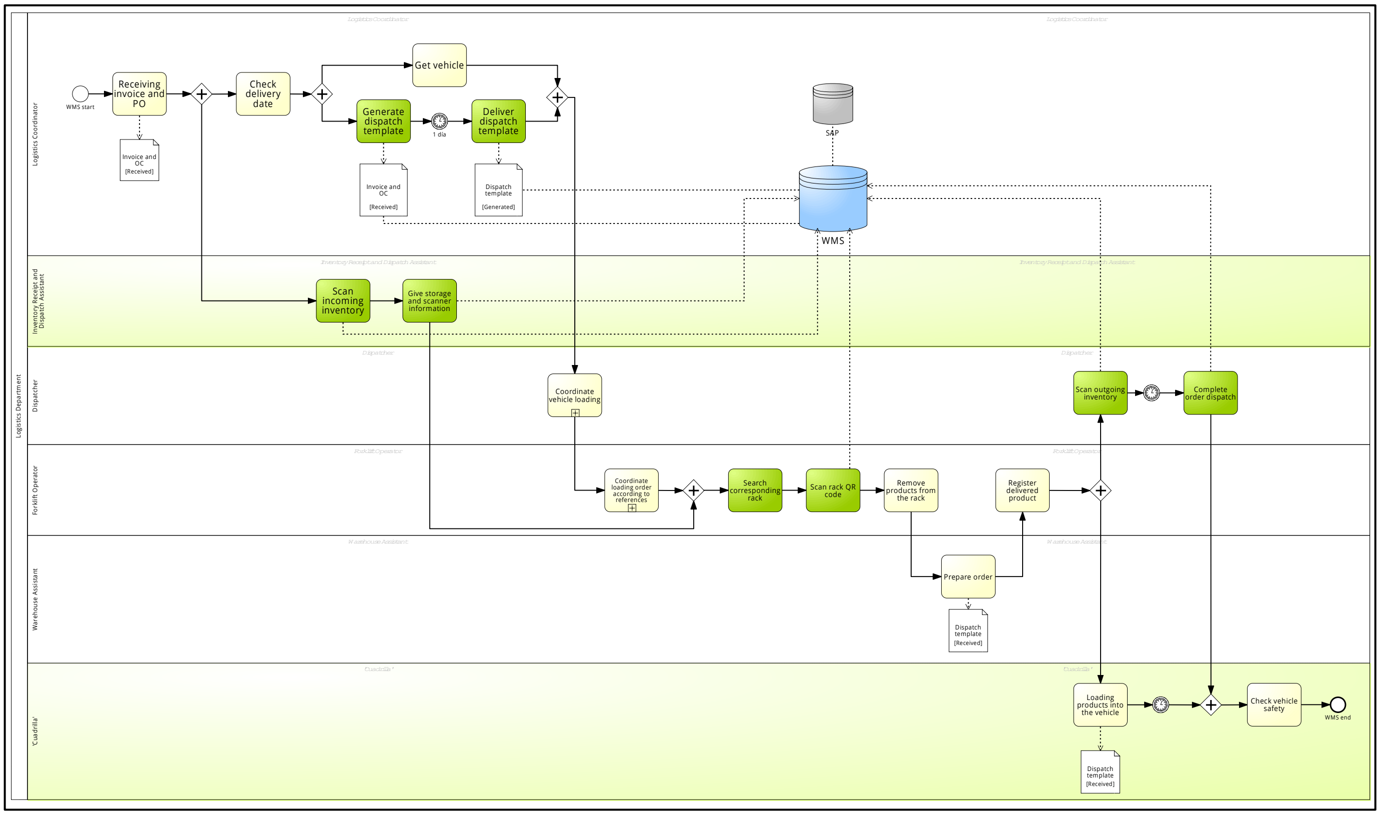

Image 19. WMS Process Model. Source: authorship

Among the most important changes was the addition of the new position of inventory receipt and dispatch assistant. Likewise, modifications were made to the manual of functions of the existing positions in the logistics department (logistics director, coordinator, warehouse assistant, "cuadrilla", key account assistant, logistics assistant, and receipt and dispatch assistant), updated with the information from the WMS. This was done in a round table with the seven actors involved as follows: for the positions that already had an established functions manual, the document was read and the changes were adjusted to the current system; for the positions that did not have their functions established in a document, the first step was to establish the activities performed in the position and then these positions were followed up during a workday to verify that the activities established in the manual were consistent with the functions performed by each position. This manual of functions is recorded in Annex 10.

In addition, there was a lack of a process manual establishing the procedures for the correct execution of all the activities of the logistics department, including distribution and transportation. Because of this, a process manual was created in the logistics department, and implemented in the quality management system, where 10 sub-processes are established, including dispatch, product readiness for picking, management, and receipt of non-conforming products, among others. Each of the procedures documents the objective, the people responsible, the activities with a level of detail of the subprocess, and whether it is governed by any existing document or standard of the company. This process is recorded in Annex 11.

3. *5's methodology:*

As part of the 5's approach, some changes were made in the organization of DC, including activities supported by changes in the function's manual and training for those responsible. The following is a description of the changes made and Annex 12 shows the photographic evidence of the results.

Seiton - organize workspace: in this case, for the distribution of the finished product in the DC, training was provided on where the finished product entering the DC should be stored. The first step was to store the product according to the client, where Jeronimo Martins was close to the exit since he is the client with the highest product turnover. Later, this idea was discarded because the forecast of many customers increases in certain seasons and assigning racks to a specific customer was not feasible, so it was decided to store the finished product according to reference and history.

The warehouse storage system was changed, before each rack was assigned a customer, but because many customers order large quantities according to their demand and the production department does not strictly follow the forecast, since the warehouses are organized in this way racks did not have the capacity according to the client. Due to this, it was decided to organize the DC according to product category, first it was divided into two, dog category and cat category, then to know the location of each product in these two categories, the rotation was looked at, the greater the rotation the product had, the more Nearby was stored from the DC output. Through training, the forklift operator was instructed to store the product, making sure that the oldest product was not at the bottom of the rack. In the following images it is evident how before in the warehouse it was necessary to store a lot of products on the ground because the rack for the designated customer was already full, in the other image the organization can be seen according to category

Images 20 - 21. WMS before and after DC organization of storage. Source: authorship

Seiso - clean the workspace, articulated to a root cause analysis of the dirt: elements that caused dirt such as old signs, packages without product, boxes, among others, were eliminated.

Seiketsu - keeping the workspace clean, standardizing the process: training was provided to both the forklift operator and the warehouse assistant on how to reduce the number of bales that are unpacked. In addition, a nonconforming product area was added, where the forklift operator is trained to place the product there.

Shitsuke - to encourage habits and discipline in the process: the functions manual was modified by assigning each employee the functions of organizing his or her workspace. The tools used, among others, were functions that encourage habits to have a clean workplace. In addition, procedures such as product loading and unloading and vehicle readiness were added to the process manual, where instructions are provided so that all activities are carried out in an organized and standardized manner.

4. *Simulation:*

Seiri - eliminate waste within the DC and the process: to simulate the proposed scenarios, two warehouse layouts will be modeled: (1) with the scale occupying space at the entrance of the DC and (2) with the space previously occupied by the scale available to occupy as a staging area. For each case, the model layout will be presented, the main components will be described, and the parameters used, as well as the variables of interest, will be summarized.

The distributions of the stochastic variables were found by means of Expertfit software based on data taken in the warehouse and available in the annexes; the times (output variables) were calculated by means of global tables and labels in inputs, outputs, process endings and restart. Although the model is intended to coincide as closely as possible with reality, there are parameters and variables that, since they are recorded the same in both models, do not directly affect the objective of the model, which is to compare general process times and truck waiting times.

Model 1 (with the presence of the scale): in the first model, the forklift picks up the corresponding pallet or products from rack 1 with a speed based on a random variable shown in Table 5. After loading the pallet on the truck, the forklift goes through another pallet in rack 1 and repeats the process until the entire dispatch order is exhausted. Image 22 shows the distribution of the warehouse with the main elements and their respective names. It is important to note that for convenience and for better visualization, some elements of the DC theoretical model were not considered, and the characteristics of some physical resources were edited.

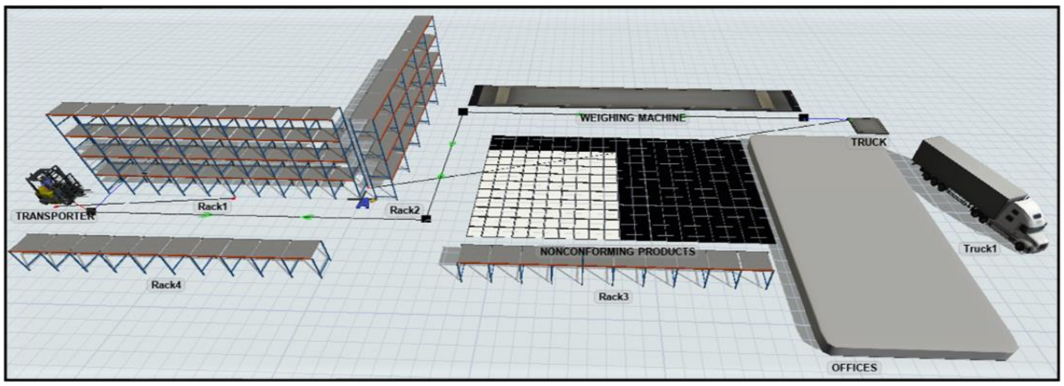

Image 22. Simulation Model 1. Source: authorship

Model 2 (with available enlistment zone): for this second model, the elements that do not interact in the process were removed and represented with a gray barrier indicating that operators cannot cross that zone. In this case, a processor was used that allowed the transport one by one of the pallets or products to be loaded onto the truck. This processor received the material from the staging area, which was configured with batching to receive all the product to be dispatched before continuing with the loading, ensuring that the entire dispatch order was ready in advance of the truck's arrival. The use of a second forklift is purely representative.

After analyzing both situations, the simulation results are presented in Table 5. The model parameters can be found in Annex 13. The FlexSim files can be found in Annex 14 and Annex 15.

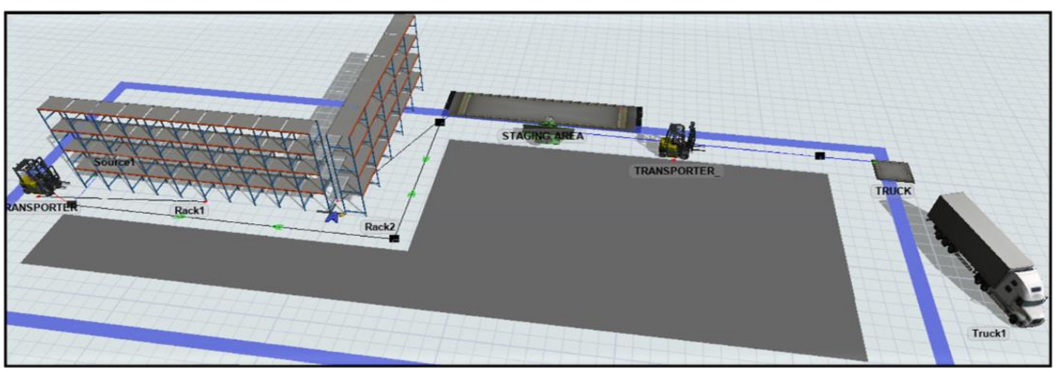

Image 23. Simulation Model 2. Source: authorship

RESULTS			
Total picking and loading time (seconds)	Total time (1)	Mean (95% Confidence Interval)	Sample Std Dev
	Scenario 1	5039.3 ± 25.7	68.9
Total picking and loading time (seconds)	Total time (2)	Mean (95% Confidence Interval)	Sample Std Dev
	Scenario 1	6091.2 ± 34.9	93.5
AVERAGE DELAY (seconds)	1051,9		

Savings in truck´s waiting time	Mean (95% Confidence Interval)	Sample Std Dev	Min	Max
Scenario 1	2400.9 ± 29.5	79.0	2213.2	2540.1

Table 5. Simulation Results. Source: authorship

As shown in the results and as expected in the simulation approach, the total time of the picking and loading process increased (1051.9 seconds on average), however, the truck waiting time decreased by more than 2,400 seconds on average. It reaffirms the hypothesis, which saves considerable time waiting for the truck and allows operators to have more slack in the picking process because they do not have to load the products at the same time. The simulations were done through Experimenter, using the Performance Measure as the total process time in both simulations, in addition to the difference between the total process time in the second model and the loading time (equivalent to the time saved waiting for the truck). To summarize the designed products and differentiate between those that were implemented and those that were simulated, the Image 24 is presented.

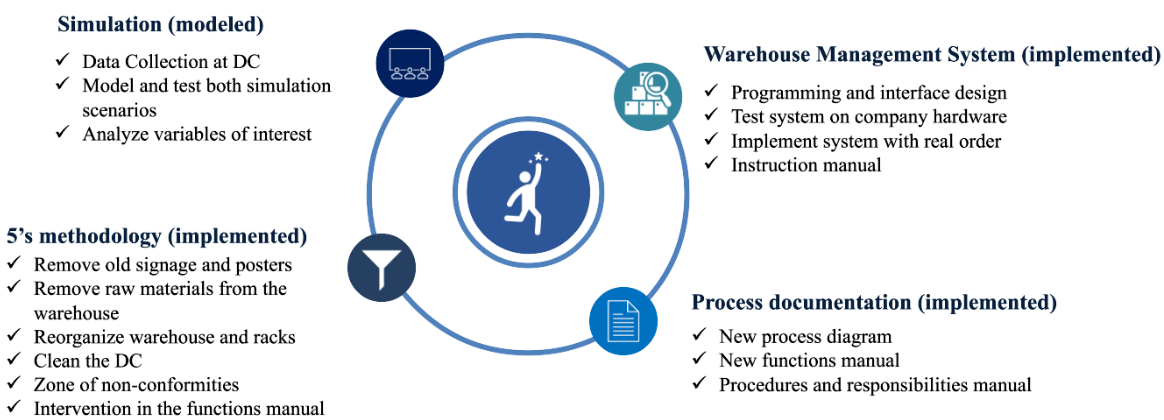

Image 24. Synthesized products. Source: authorship

Daily Scrum:

During the development of the Sprint, the work team together with the Product Owners held constant face-to-face and virtual meetings with a maximum duration of 15 minutes to learn what was done the previous day, what is being done now and the improvements or progress to be made. In this way, the team generated a broad overview to remove impediments, generate greater synchronization and articulate the development teams and Product Owners. Annex 16 summarizes the sessions along with the relevant findings to be solved in each one of them.

7. Phase 4. Define a monitoring and feedback scheme per Sprint.

7.1. Methodology.

To evaluate the fulfillment of the objectives defined in this problem and, in turn, ensure the sustainability and continuous improvement of the product, it is necessary to receive feedback from the project stakeholders, identify which conditions or characteristics of the product defined in the DoR were met (DoD) and receive approval from the Product Owner (Done Done). For this, another stage of the Scrum framework will be carried out, which consists of two meetings, Sprint Review and Sprint Retrospective. In these meetings, all the conditions defined at the beginning in the Product Backlog will be reviewed, which features were applied, which ones are yet to be applied, what impact this implementation had and how the designed product can be sustained and improved for future occasions. Image 25 shows the fourth and last phase of the operations management model.

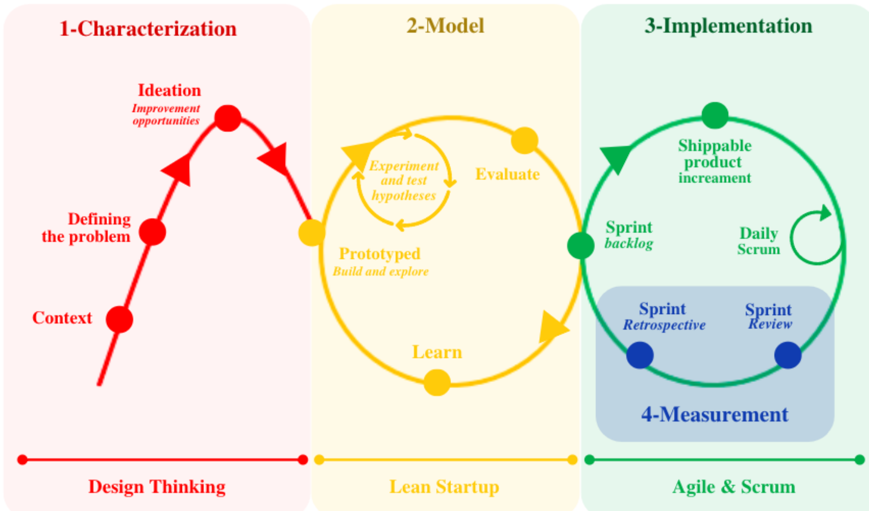

Image 25. Operations management model: phase 4. Source: authorship

Accordingly, the Sprint Review will focus on understanding and making explicit the characteristics of the operations management model designed, as well as the WMS and the physical flow analysis through the 5's to highlight which conditions of these products, from those defined at the beginning, were carried out and what changes occurred throughout the implementation of this first Sprint. Additionally, this meeting seeks to compare by means of key indicators what was the main impact evidenced after the implementation of the model (that frames the WMS and the 5's).

In this meeting, the following topics should be covered point by point:

- Completed features (DoD based on the DoR).
- Key indicators that support the impact of the first Sprint.
- Status and projection of the backlog.
- Analysis of the Sprint plan and release plan, which seeks to close the implementation and feedback of the first Sprint with the necessary information for the Sprint retrospective, where the planning of the second iteration will begin.

In turn, from the Sprint Review, the Sprint Retrospective seeks to perform an analysis and understanding of what has been developed throughout the project, identifying the main strengths, weaknesses, opportunities for improvement and results of each of the products or designs carried out, not only with the purpose of looking back and evaluating the past, but also to establish a solid starting point for subsequent implementations and sprints. For this point, analogies will be used to explain each point, moment, or relevant feature of the development of each product. The specific feedback from the stakeholders and the Product Owner in the Sprint Review, as well as the requirements of the company for the second and third iterations and the features agreed upon in the Sprint Retrospective, will be detailed and explained in the results obtained from these meetings.

7.2. Analysis of results.

Sprint Review:

To give continuity to what was defined in the previous description, a Sprint Review was held with the participation of the Development Team, the Product Owners, the Scrum Master, and other stakeholders such as the company's commercial director. In this meeting, the agreed items were worked point by point.

Finished features: to have a full understanding of the features of the model and its results, the information contained in the Sprint approach (and therefore in the Sprint Backlog) was synthesized in Table 6. This table was presented to the stakeholders to summarize and explain how the initial proposals have evolved with reference to what has been achieved up to the end of the first Sprint. Each item was detailed step by step to receive comments and contextualize the whole team on how each alternative was applied.

PRODUCT	DoR	DoD	
WMS	1. Ask for the indicator of nonconforming product for the sells made to the client used as a reference	1. Attend to the main dispatches for the reference customer	DD
		2. Create the program/code in Excel	DD
	2. Buy barcode scanners	3. Collect data	DD
	3. Test windows-based tablets	4. Design WMS user manual	DD
	4. Coordinate assistance on days when dispatches were made to the reference customer	5. Test the WMS and measure variables	DD
		6. Analyze changes in the KPI	DD
PROCESS DEVELOPMENT	1. Periodically visit the company for three weeks	1. Obtain detailed description of the process (As Is)	DD
	2. Know and describe the process (As Is)	2. Detail the new and necessary processes for using the WMS (To Be)	DD
	3. Describe the new activities and roles required	3. Design a user manual for the WMS and redesign the operations manual of the company	DD
	4. Describe the new process with the WMS (To Be)		DD
	5. Share the proposals to the HR department	4. Share the change proposal and ask for approval with the HR department.	DD
IMPROVEMENT OF THE PHYSICAL FLOW WITH THE 5's METHODOLOGY	1. Talk to the operators and stakeholders to know their perceptions and thoughts about the actual process	1. Model and test simulation with the warehouse without the weighing machine (Seiri)	DD
	2. Make a diagnose in the warehouse to identify useless things or opportunities to reorganize the zone	2. Remove useless signs and boxes from the warehouse (Seiri)	DD
	3. Ask several times "why" against cases in which something seem useless	3. Take out all the raw material from the warehouse where the finished product is stored (Seiton)	DD
	4. Visit all the places in the warehouse: racks, weighting machine, offices, parking lots, entry	4. Define a space to store nonconforming product (Seiton)	DD
		5. Standardize racks according to the type of product (not according to the client) (Seiton)	DD
	5. Record the places where was pollution, waste, unnecessary material or products, damaged products/racks/posters	6. Organize and clean all the offices (Seiton-Seiso)	DD
		7. Clean all the racks (Seiso)	DD
	6. Talk with the operators to understand why some things are so damaged and how this affected their operation	8. Include new rules, processes and advice in both WMS user manual and operations manual (Seiketsu)	DD
	7. Read and understand some guidelines and legal regulations to validate if there was anything to improve to meet the legal demands		
SIMULATION	1. Define the main parameters and measure them	1. Collect data: time, distance and speeds in the warehouse	DD
	2. Understand and define the main restrictions and conditions	2. Model and test the simulation	DD
	3. Define the main variables (output variables)	3. Analyze changes in the variables previously defined	DD

Table 6. DoR, DoD, and DD. Source: authorship

The "Product" column shows each product to be delivered because of the operations model used. Each product required a set of activities that enabled the subsequent completion of the tasks defined in the Sprint Backlog. Each of these main activities are listed in the DoR (Definition of Ready) column and were performed by the Development Team. As a result of these activities, the data and information necessary for the achievement of the previously defined commitments were obtained, which are listed in the DoD (Definition of Done) column, which indicates that this event (deliverable or product) has already been successfully completed according to the team's criteria. For validation and approval, these were exposed in the Sprint Review, where the Product Owners were asked to validate each of these commitments and approve/reject according to whether it was performed and delivered or not. This is called Done Done and can be identified in the table as "DD" to the right of each item.

Following the review of these commitments and following the order proposed for the meeting, a review of the key indicator to measure and support the impact of the measures implemented was carried out: non-conforming deliveries. This information was obtained during visits and measurements at DC and validated by the logistics team and the Product Owners. The results are displayed in the graphs shown in Image 26.

A comparison between the indicator obtained before and after the implementation shows a decrease in the KPI of 5.44%, along with more relevant information such as the total elimination of wrongly packed deliveries (erroneous references), which was one of the purposes of the WMS, in addition to the reduction of shortages.

With respect to the latter, the missing parts indicator increased its percentage of relative interference (compared to the other causes of nonconformities), which is evident because other reasons for nonconformities were eliminated. However, the total number of deliveries with shortages also decreased, causing this drop in the KPI.

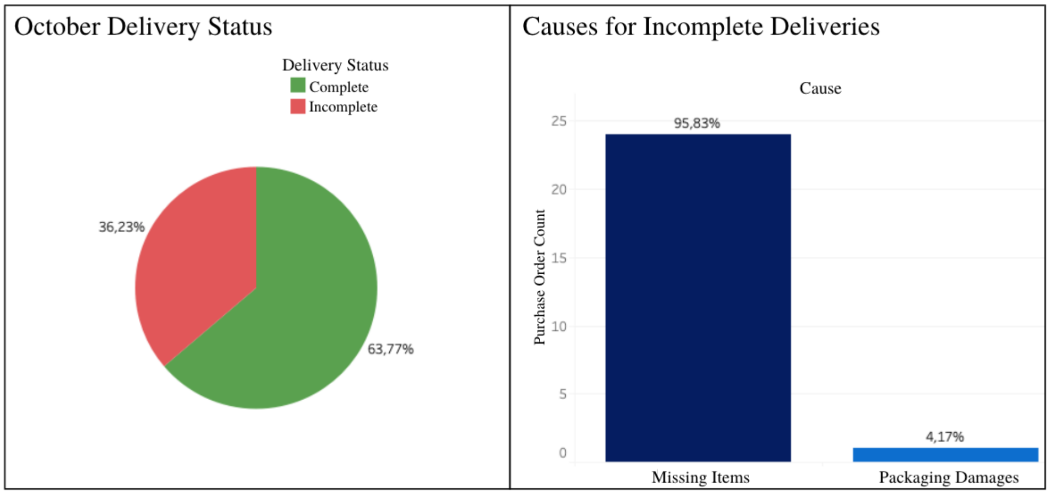

Image 26. Indicator: deliveries to Jerónimo Martins (last 15 days of October). Source: authorship

When discussing with the logistics team the reasons why there are still a considerable number of shortages, considering the guarantee of inventory control, it was stated that, although a significant number of non-conformities are due to shortages resulting from manual errors in the picking and loading process, there are multiple factors that can also cause errors. Thus, failures in the analysis of truck capacity were mentioned, making it impossible to load the entire order (in cases where the logistics team opted to deliver incomplete and generate a credit note and assume the impact of the shortage on the indicators), as well as sporadic failures in production or enlistment. Therefore, this information allows us to glimpse even more improvement opportunities for subsequent Sprints using this model, which facilitates the understanding from a holistic and detailed point of view of the possibilities within each process, and details in an explicit and much more disaggregated way the possible consequences of each measure or alteration in the operation, as well as its implications.

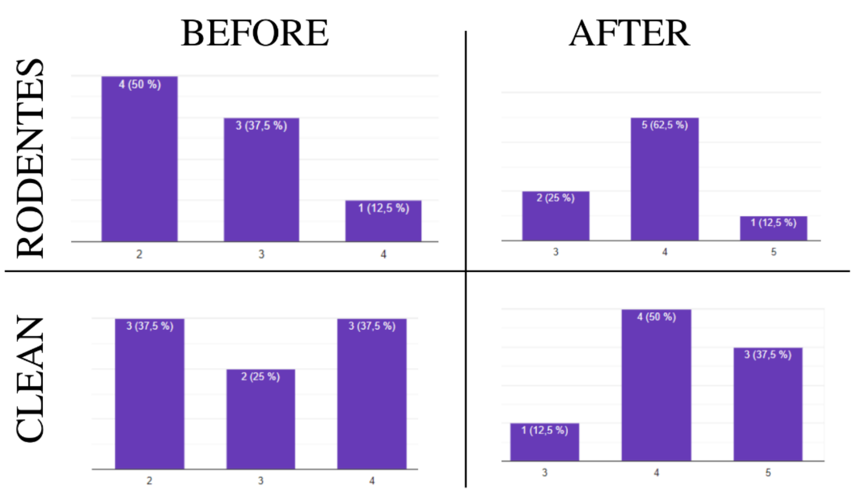

Image 27. Change in the perception of logistics workers. Source: authorship

In order to measure the impact caused by implementing the 5's methodology, specifically the cleanliness of the center and the reduction of rodents within it (Seiso and Seiketsu), a survey was applied to workers in the logistics area to see how their perception was regarding these two variables before and after having applied the implemented methodology, as can be seen in Image 27, the perspective of both variables after implementation, improved compared to the same before implementation. It should be noted that in this case a scale of 1 to 5 was used for each question, where in the case of rodents 1 meant the presence of a large number of rodents that greatly compromised the condition and quality of the product and 5 meant the absence of rodents in the CD, while for cleanliness 1 meant large amounts of waste, garbage and dirt in the CD that limited the processes of each function and, on the contrary, 5 meant a CD with cleanliness and protocols to maintain it.

Once the first Sprint had been run and the Sprint Review had been performed, Image 28 shows an update of the Product Backlog refined at the beginning. In red are detailed the additional activities that are required for a future second and third Sprint identified in the implementation of the first Sprint. Thus, for Sprint 2, it is required to generate a WMS connection between the tablets and the logistics coordinator's computer to update in real time the information being managed. Also, the purchase of portable batteries for tablets is required to prevent the WMS from pausing if the devices are discharged. Sprint 3 requires the purchase of additional equipment for the forklift operators coming from production to avoid passing scanners among the different operators and to ensure optimal inventory control once the finished product is placed on the racks. Finally, and as an important finding during the first sprint, it was found that several orders are sent incomplete due to the lack of capacity of the contracted vehicle, so a more detailed programming of the transportation fleet is essential to further reduce incomplete orders and in turn, increase the level of service to the company's customers.

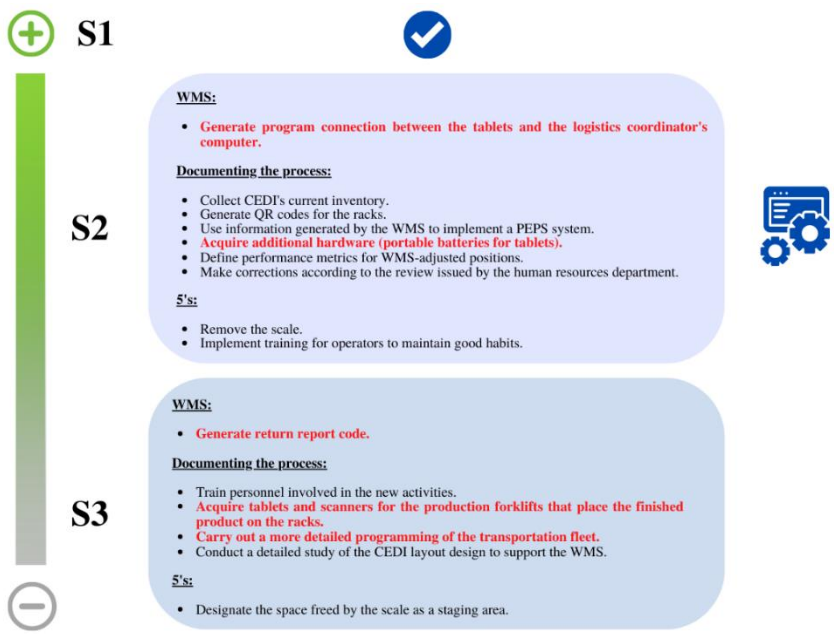

Image 28. Second Product Backlog. Source: authorship

Sprint Retrospective:

During the sprint retrospective, the development team met with the Scrum Master to verify what went well in the Sprint, what can be improved and how to improve it in the next opportunities, emphasizing the intrinsic opportunities within the ABC company and the Scrum team. To perform a good retrospective, the team decided to divide it by each segment, as was done in the first sprint: WMS, process review, 5's, and simulation. At the same time, tools were used to better visualize the retrospective (Donuts, Island, Popeye, and Genius), within each tool there were questions such as: what is good, but could be improved, what was found as hidden value, what caused more work, among others. Image 29 shows the results obtained for each of the stipulated segments.

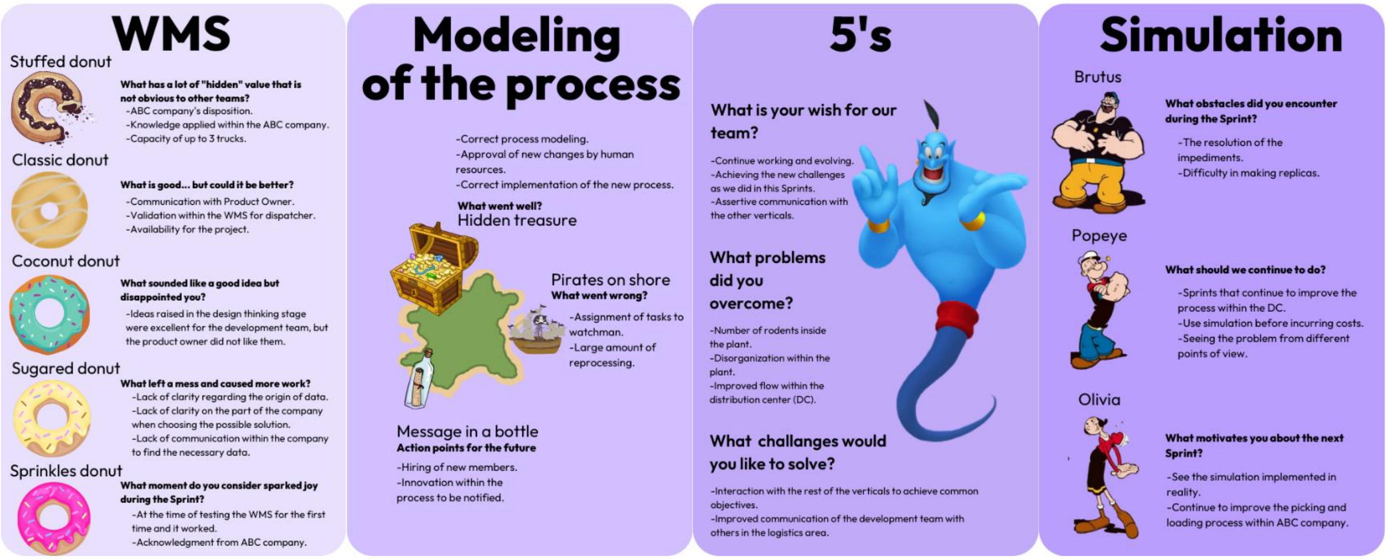

Image 29. Sprint Retrospective. Source: authorship

8. Conclusions, recommendations, and limitations

Also, the importance of a contextualization based on integrated product development or concurrent engineering, where tasks or functions are developed in a collaborative and parallel way, taking advantage of the available resources, and facilitating the intervention of all the actors present in the process, is highlighted. In this phase, the agile methodologies tools used were essential to provide an understanding of the current situation of the company from an integral point of view, including all stakeholders (both internal and external) and laying a clear foundation on what would be worked on in the ideation.

It is precisely in Lean Startup where the effort invested in Design Thinking materializes; the generation of alternatives through tools such as the six links established clear opportunities that were directly oriented to the problem posed related to the low level of service. In addition, having external stakeholders such as customers in mind, and understanding tools such as the service blueprint or the journey map, facilitated decision-making by being clear about the consequences of each alternative and their expected impact. Finally, prototyping was essential to achieve a general understanding not only for the Development Team but for all the actors of the process involved and the importance of each role within the development of this model; setting the message that the Development Team, although for the purposes of this project are the authors, for future interventions and implementations, this team should be composed by the members of the process to be improved within the organization, committing to develop opportunities and relevant alternatives in a collaborative and agile way.

The implementation and measurement phase served to reaffirm what was developed in previous phases. It is at this moment that it was possible to understand the impact in quantitative and "tangible" terms of all the effort dedicated in the previous phases and even more important, the understanding of the difficulties and possible improvements that are exposed and must be worked on in subsequent Sprints, how they should be carried out and why they were not solved in the work that was already made. In the development of this model, the implementation and measurement validated hypotheses related to the problems exposed at the beginning of the project and even enabled the understanding of other causes or problems that were not covered in the first Sprint.

For ABC company, it is recommended to carry out Sprints two and three in a cautious manner, adding what is deemed necessary at the time of carrying out the same and at the same time the refinement to which it is subject. Also, it is suggested to apply this in companies where they may exist within the industrial sector as well. Finally, it is proposed to analyze if other industrial engineering tools can be articulated with this model of operations management, and it is suggested to implement this model on future occasions, to continue unifying two branches such as agile frameworks and the logistics area within manufacturing industries. In turn, it is open to continuing with the implementation of the model structured in this degree work, in order to continue improving its implementation on an ongoing basis.

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