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DEVELOPMENT OF THE SCOR MODEL IN THE EFFICIENCY OF AGROINDUSTRY INVENTORY MANAGEMENT: CASE STUDY OF THE AGROINDUSTRY LYOPHILIZER COMPANY, AREQUIPA

Aylen Ayme Choque Llerena [1]
Alexis Paul Salinas Rojas
Jose Alberto Aguilar Franco
Carmen MariaelenaVillanuena Delgado
Marcia Shantal Caipo Huacasi

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A B S T R A C T

This study implements the SCOR Model (Supply Chain Operations Reference) to optimize inventory management in a freeze-drying agro-industrial company in Arequipa, Peru. Using a methodological approach based on the SCOR questionnaire, an analysis of key supply chain macro processes such as planning, sourcing, and return was conducted, identifying inefficiencies that required intervention. Specific inventory policies were applied, significantly reducing stockouts and optimizing inventory levels, which decreased storage costs and improved operational efficiency. The results demonstrate that implementing the SCOR Model is viable and an effective tool to enhance the competitiveness of the agro-industrial supply chain.

1. INTRODUCTION

Efficient inventory management is critical to ensuring sustainability and competitiveness in the agroindustry, especially due to the perishable nature of products and the fluctuating market demand. The Freeze-Drying Agroindustry Company in Arequipa, one of the leading exporters in southern Peru, faces significant challenges in managing inventories of dehydrated fruits and vegetables. This study proposes the implementation of the SCOR Model as a solution to improve supply chain efficiency in the processes of planning, sourcing, and return.

To address these challenges, the SCOR Model is widely recognized as an effective tool for identifying critical deficiencies and proposing improvements in inventory management. According to the Council (2012), SCOR provides a standard framework for optimizing the supply chain through five macro-processes: Plan, Source, Make, Deliver, and Return. This tool is essential for addressing challenges in modern supply chains, where coordination

[1] Corresponding author: A.A. Choque Llerena
Email: active email adress

and optimization of information and material flows are critical to business success.

Vargas Moreno (2014) highlights that effective supply chain management significantly enhances relationships between suppliers, companies, and customers, generating competitive advantages and reducing costs. In this context, Chopra and Meindl (2008) emphasize the importance of adequately planning the design, planning, and operational phases of the supply chain to maximize the value generated by the company, taking uncertainty in decision-making into account. This integrated approach, according to Arana-Solares et al. (2014), increases operational efficiency, differentiating the company from its competition and ensuring uninterrupted customer service. The implementation of the SCOR model also requires the definition of clear objectives and an in-depth analysis of the Competitive Bases, as noted by Lama & Esteban (2012), to achieve optimal supply chain performance. In this regard, Díaz Curbelo and Marreno Delgado (2014) consider the use of key performance indicators (KPIs) within the SCOR model essential for analyzing and evaluating strategies, providing critical data that facilitates informed decision-making and operational optimization. Similarly, Georgise, Thoben, and Seifert (2012), along with Fontalvo, Cardona, and Morelos (2014), agree that the SCOR questionnaire is a fundamental tool for diagnosing the state of processes in the supply chain and inventory management, allowing for a precise evaluation of areas requiring improvement.

Finally, ABC classification, as suggested by Sánchez Semprún and Martínez Garcés (2021), is a useful strategy within the SCOR model to prioritize resources and minimize safety stock levels, ensuring that the company can operate efficiently and meet customer needs without interruption. Additionally, Spina et al. (2016) emphasize that precise planning and proper inventory management not only optimize resource management but also significantly drive operational efficiency and competitiveness in the market. Together, these approaches underscore the versatility and effectiveness of the SCOR Model in addressing contemporary supply chain challenges, integrating optimization strategies that tackle both operational efficiency and customer satisfaction, thereby ensuring superior performance in business operations.

The SCOR Model is widely recognized for its ability to optimize operational processes by identifying critical inefficiencies and introducing corrective strategies. This study aims to analyze the impact of the SCOR Model on the operational efficiency and profitability of the agro-industrial company, providing a practical guide for its implementation.

2. METHOD

To analyze the macroprocesses of the supply chain of the Freeze-Drying Agroindustry Company, a situational analysis was conducted to evaluate its current state, and the SCOR Model questionnaire was utilized. Radial charts were employed for clear visualization of each macroprocess, inventory policies were reviewed, and improvement proposals were formulated. Additionally, an economic assessment was performed to analyze the financial impact of the improvements.

2.1 Situational Analysis

In recent years, the Freeze-Drying Agroindustry Company, dedicated to the production and export of freeze-dried and dehydrated foods to both domestic and international markets, has faced various problems in its supply chain, leading to dissatisfaction and excess costs in management. One of the main issues lies in the lack of a proactive balance between the customer service provided by the company's warehouse and the production or storage of inventories, resulting in high storage costs. Furthermore, the product life cycle is not adequately considered when planning production and marketing, which exacerbates these problems. For better visualization and understanding of the issues, see Figure 1.

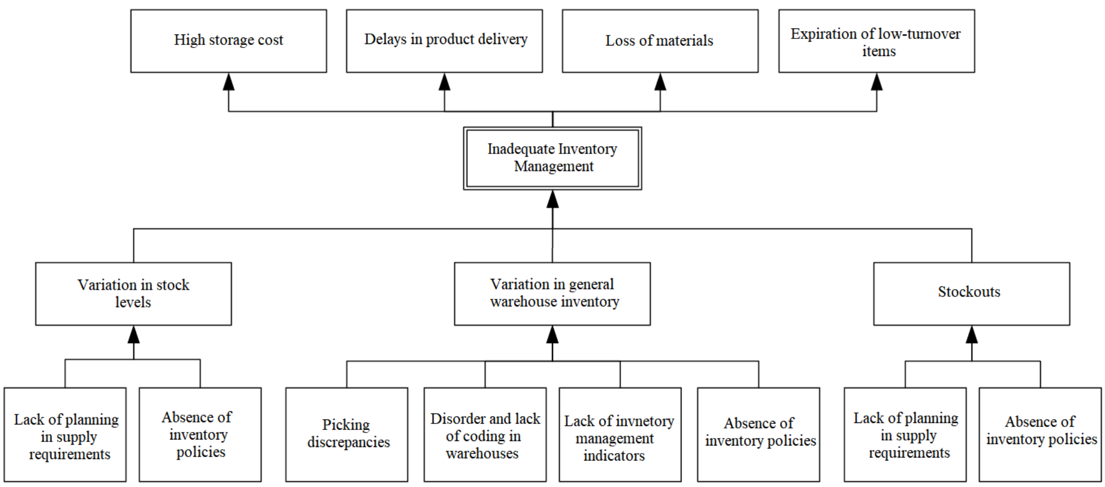

Figure 1. Problem Tree of the Agroindustry Lyophilizer Company

Among the most prominent issues are the high cost of storage, delays in product delivery, loss of materials, and the expiration of low-turnover items. These problems stem from inadequate inventory management, which is reflected in variations in stock levels and overall inventory. Specific causes include a lack of planning for input requirements, the absence of inventory policies, discrepancies in picking, disorganization in warehouses, and a lack of management indicators. This analysis is essential for the development of the SCOR Model, as it allows for the identification of areas for improvement in the efficiency of agro-industrial inventory management, thereby optimizing processes and reducing costs in the freeze-drying agro-industrial company.

The development of the SCOR model in the agro-industry allows for a clear visualization of the processes involved in inventory management. The strategy of processes can be seen in Figure 2. By focusing on the continuous improvement of each stage, from raw material selection to distribution, greater operational efficiency, cost reduction, and improvement in the quality of the final product can be achieved. This comprehensive approach is essential to address challenges in the agro-industry and ensure sustainability and competitiveness in the market.

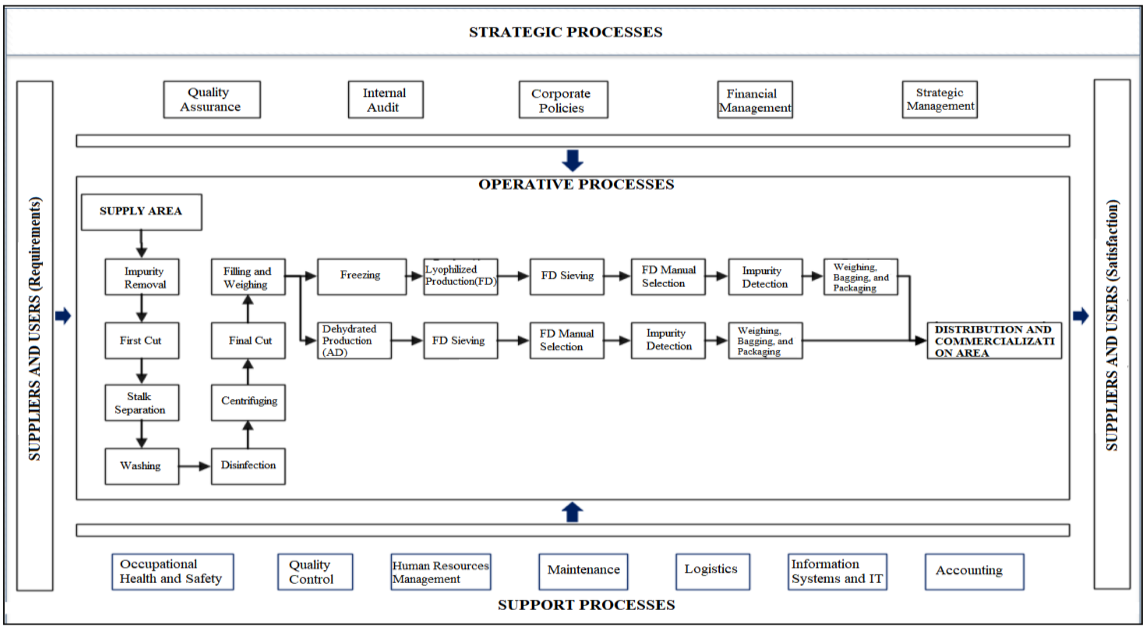

Figure 2. Process Map of the Agroindustry Lyophilizer Company

The study focused on five macroprocesses: planning, provisioning, production, delivery, and returns. The logistics manager of the company completed the questionnaire, assigning a score of 0 to negative responses and 3 to affirmative ones. An average was calculated for each macroprocess and subprocess, with a target score of 2 points.

To conduct the situational analysis of the supply chain of the Agroindustry Lyophilizer Company, the SCOR Model questionnaire was applied to the Logistics Manager to evaluate each of the macroprocesses: planning, sourcing, production, distribution, and returns, assigning a score of 0 to negative responses and a score of 3 to affirmative responses. An average was calculated for each macroprocess and subprocess at Level 01.

The results were as follows: in the planning process, the average score obtained was 1.60 points (Table 1), which is below the average of 2 points according to the SCOR Model, indicating a critical situation. Similarly, in the sourcing process, an average of 1.74 points (Table 1) was achieved, also below the average of 2 points, reflecting a critical state. In contrast, the production process obtained an average of 2.29 points (Table 1), exceeding the average of 2 points, indicating that this process is in optimal condition. The distribution process showed adequate performance, with an average of 2.09 points (Table 1), slightly above the expected average, suggesting that it is being managed correctly. Lastly, in the returns process, an average of 1.89 points (Table 1) was obtained, again below the average of 2 points, highlighting another critical area.

Table 1. Summary of Results

	Process	Value
1	Planning	1,60
2	Sourcing	1,74
3	Production	2,29
4	Distribution	2,09
5	Returns	1,89

To clearly and concisely visualize the scores obtained from the SCOR Model questionnaire and the performance of the macroprocesses in the supply chain of the Agroindustry Lyophilizer Company, a radial graph was used. Through this graph, it is possible to quickly identify critical areas that require improvements and those that are in optimal condition, thus facilitating strategic decision-making to optimize the supply chain.

This provide a comprehensive analysis of different aspects of the supply chain, allowing for the identification of critical and optimal areas for improvement. The (Figure 3), focusing on supply chain planning, reveals that inventory management is an area needing attention, while the alignment between demand and supply is relatively strong. The (Figure 4), centered on strategic sourcing, shows that supplier management is a key point for optimizing procurement, although the scores are generally positive. In the (Figure 5), which addresses relationships and collaboration, the need to improve the support process is highlighted, suggesting that a more robust infrastructure could facilitate more effective collaboration. The (Figure 6), focused on order management, indicates that while transportation management is strong, delivery infrastructure and customization require improvements to enhance efficiency. Finally, the (Figure 7), related to receiving and storage, points out that communication and customer expectation management are critical areas needing attention, despite transportation being a strong point. Overall, these images provide a clear view of areas that require improvement and those that are functioning well, facilitating strategic decision-making to optimize the supply chain.

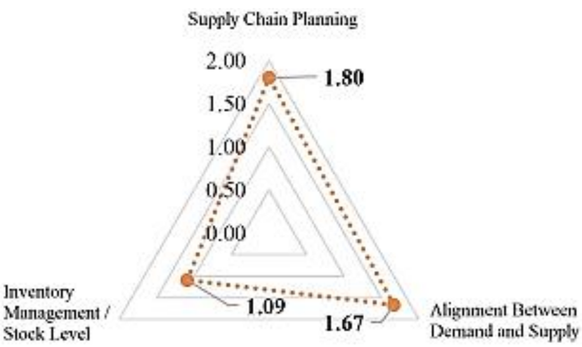

Figure 3. Sub-processes of level 2 of the planning process

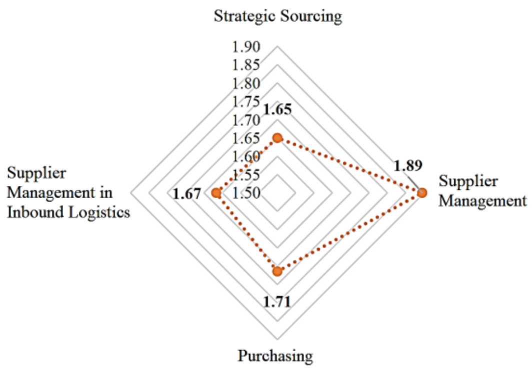

Figure 4. Sub-processes of level 2 of the supply process

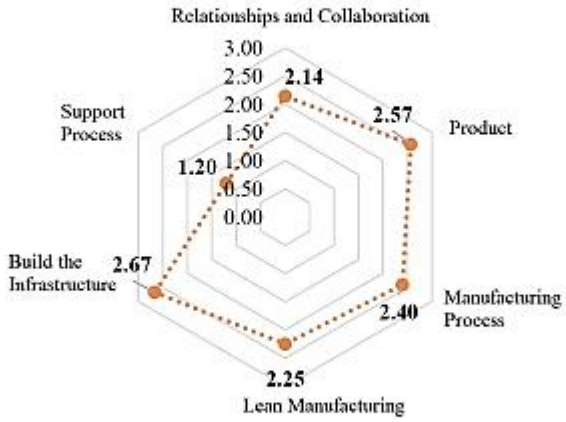

Figure 5. Sub-processes of level 2 of the production process

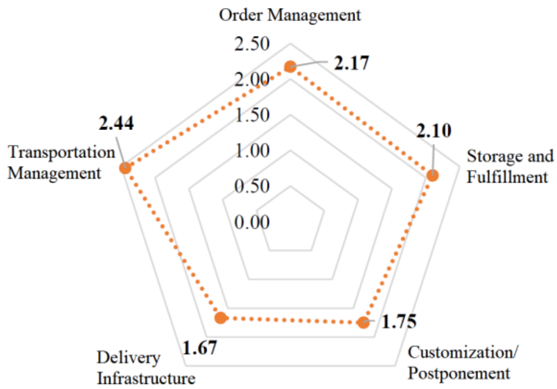

Figure 6. Sub-processes of level 2 of the distribution process

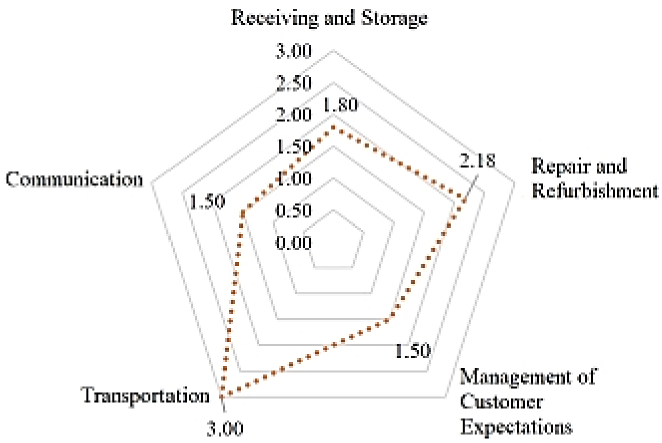

Figure 7. Sub-processes of level 2 of the returns process

2.2 Implementation of Inventory Policies

The ABC classification for the Agroindustry Lyophilization Company was developed since it did not have the indicators in the SYS system. First, the most important items, such as raw materials, packaging supplies, and EPPS items, were identified and classified as type A. Safety stock was determined with a 95%

confidence level to prevent stockouts and minimize the risks of shortages. After calculating the safety stock, the total inventory of the items in the general warehouse of the Agroindustry Lyophilization Company was determined by adding the average monthly inventory to the safety stock.

The optimal order quantity (economic order quantity or EOQ) represents the optimal number of items per order to reduce storage costs in the general warehouse of the Agroindustrial Lyophilization Company. Additionally, the administrative cost for the storage process includes salary, packaging materials, office supplies, basic services, equipment depreciation, social benefits, and 5% for contingencies. The administrative purchase cost covers the issuance of orders and management with suppliers for type A items. To obtain the administrative cost per product for type A items, the total cost of placing orders is divided by the total number of orders made (purchase orders), which was 2,053 orders in 2022.

To calculate the economic order quantity, the administrative cost of ordering and the preparation cost of an order are added together, resulting in a total preparation cost of 32 soles (17 soles for administrative costs and 15 soles for preparation). The formula used to calculate the Economic Order Quantity (Qo) is the square root of two times the annual demand (D) multiplied by the preparation cost of an order (Cp), divided by the annual storage cost per unit (Ca).

To determine the expected number of orders per year (N), the annual demand (D) is divided by the total number of optimal units per order (EOQ). The time between orders (To) is calculated by dividing the number of days in a year by the expected number of orders per year (N). Once the economic order quantity has been established for the most relevant items in the general warehouse of the Agroindustry Lyophilization Company, the total annual inventory cost can be calculated. This total cost is computed by adding the expense of maintaining the inventory to the cost associated with the orders, expressed as follows: The optimal quantity of units per order (Qo) squared, multiplied by the annual storage cost per unit (Cm), plus the annual demand divided by the optimal quantity of units per order (Qo), multiplied by the preparation cost of an order (Ca).

2.3 Improvement Proposals

Optimization of the Returns Macro-Process

The need to improve the returns macro-process within the Agroindustry Lyophilization Company has been identified. Currently, the return processes for both defective products and excess inventory of supplies and products are not well managed, resulting in disorganization and increased storage costs. The proposal involves better structuring the activities related to return planning, focusing on defective products, excess inventories, and products under repair, ensuring efficient supply chain management.

The implementation of an improvement will enable the company to map out the returns process, which is part of the planning phase. Five subprocesses at level 3 were identified to address this. To manage the excess of freeze-dried or dehydrated products, the SR3 category has been implemented. This macro-process is divided into three key stages:

Planning Elements: These manage the resources necessary to meet projected needs, such as raw materials and packaging. Four essential subprocesses have been defined:

1. Requirements for returning excess production inventory and field area are evaluated.
2. Necessary resources for this process are identified, and specific requirements are established.
3. A balance is achieved between what is needed and the available resources, managing the excess in a designated space in the warehouse.
4. 4.A detailed action plan for the return is developed and communicated, including training for staff to overcome the lack of standardized procedures and avoid delays in replenishment.

Efficient Management of Excess Products

The company is experiencing excess inventory, both of fresh raw materials and production supplies, such as polyethylene bags, cardboard boxes, and labels. The proposal establishes a designated area in the general and process warehouses to manage these excess products appropriately. This involves creating specific spaces in the raw materials warehouse for fresh products, as they require particular storage conditions. This way, the identification, labeling, and arrangement of materials and products that will not be used immediately are facilitated, preventing losses and damages.

Improvements in Return Planning

The planning of the returns process includes several phases that help structure the return of excess products. First, the requirements for returns are evaluated, based on the quantity of leftover inventory of raw materials, supplies, or packaging that must be returned from the production area to the general warehouse. Additionally, the necessary resources to carry out the return process, such as available staff and storage capacity in the warehouse and process areas, are identified and assessed.

This planning process also proposes mechanisms to balance available resources with return requirements, such as allocating specific spaces for product returns. This step is crucial to ensure that supplies are returned efficiently without congesting storage areas.

Implementation of Return Policies

The returns process is implemented through clear operational phases, such as identifying the conditions of excess products, requesting return authorization, and scheduling their shipment to the general warehouse. The return of defective products, MRO (maintenance, repair, and operations) products, and excess products is managed by evaluating the condition of the products and their proper disposal.

Execution Elements: These focus on meeting demand and managing returns, considering the condition of the product. In the Agroindustry Lyophilization Company, excess products are identified during the production of freeze-dried vegetables and herbs. These include excess fresh raw materials and packaging materials. A specific area has been established in the general warehouse to manage these return products, while fresh raw materials are returned to the process warehouse. The return request, coordinated by the process supervisor, includes a detailed schedule for picking up and returning the supplies. Returned products are properly stored and labeled to avoid disorder and deterioration. These steps ensure efficient management of excess inventory and compliance with the returns process.

Enabling Elements: These support the planning and execution processes by organizing and analyzing information. The planning and execution of the inventory returns process in the Agroindustry Lyophilization Company are organized into four main elements. First, requirements for returning leftover supplies and packaging materials are identified and recorded, ensuring they are physically verified and coordinated with the appropriate staff. Second, available resources to manage returns are assessed, considering inventory levels and storage capacity while ensuring alignment with the company's environmental policies. Third, a balance is achieved between resources and process requirements, establishing specific storage zones for returns and ensuring their proper condition. Finally, a return plan is established and communicated to all involved areas, coordinating and training staff as necessary. In the execution phase, returns are authorized through documents signed by supervisors, the returns process is scheduled, materials are received and verified in the general warehouse, and the condition of the products is classified to determine their reintegration into inventory or their destination for recycling or scrap.

2.4 Economic Evaluation

Direct costs include materials such as scaffolding, signage, sheets, paint, acrylic boards, and plastic crates, totaling 8,549.00 soles, as well as direct labor, represented by a continuous improvement coordinator with an annual cost of 33,302.88 soles, resulting in a total direct cost of 41,851.88 soles per year over three years. Indirect costs encompass materials such as uniforms and safety equipment for new staff, costing 1,160.00 soles, and indirect expenses such as asset depreciation and basic services, totaling 1,960.00 soles per year, resulting in a total indirect cost of 3,120.00 soles annually. Administrative expenses include staff training and administrative materials, amounting to a total of 1,837.50 soles per year.

The projected total cost, which sums direct, indirect, and administrative costs, amounts to 46,809.38 soles annually over three years. Projected revenues, based on improvements that prevent previous losses from 2022, include inventory improvements, savings from penalties, revenue from returned products, and sales, totaling 118,199.00 soles. The total investment of the proposal is broken down into tangible assets, such as infrastructure improvements and equipment acquisition costing 10,752.00 soles; intangible assets, primarily the development of the study, at a cost of 9,450.00 soles; and working capital necessary for the first month of implementation, costing ,900.00 soles, resulting in a total investment of 24,102.00 soles.

3. RESULTS AND DISCUSSION

The technical evaluation of the study compares the results obtained from the application of the SCOR model questionnaire in the situational analysis of the Agroindustry Lyophilization Company and the projection of the results that can be achieved with the implementation of improvements, such as the inventory policies and metrics proposed by the SCOR Model in the returns macro-process. The improvements are realized in the following macro-processes.

Improvements Implemented in the Returns Macro-Process of the SCOR Model for the Agroindustry Lyophilization Company (Figure 8).

The implementation of inventory policies has allowed the Agroindustry Lyophilization Company to optimize its processes, improving efficiency in the returns management and reducing operational costs.

The total storage cost, which includes an annual storage cost of 32,628.67 soles and an administrative cost for the storage process of 29,151.15 soles, has risen to 61,779.82 soles. However, by using the optimal order quantity (EOQ), the total cost is reduced to 47,695.54 soles, representing a significant savings of 27,898.46 soles compared to the cost reported by the logistics area in 2022, which was 75,594.00 soles.

With an investment of 24,102.00 soles over a period of 3 years, economic indicators such as the benefit-cost ratio (B/C), capital cost (KC), net present value (NPV), and recovery price (PRI) were evaluated, projected over a 3-year horizon. The following results were obtained (Table 2, 3)

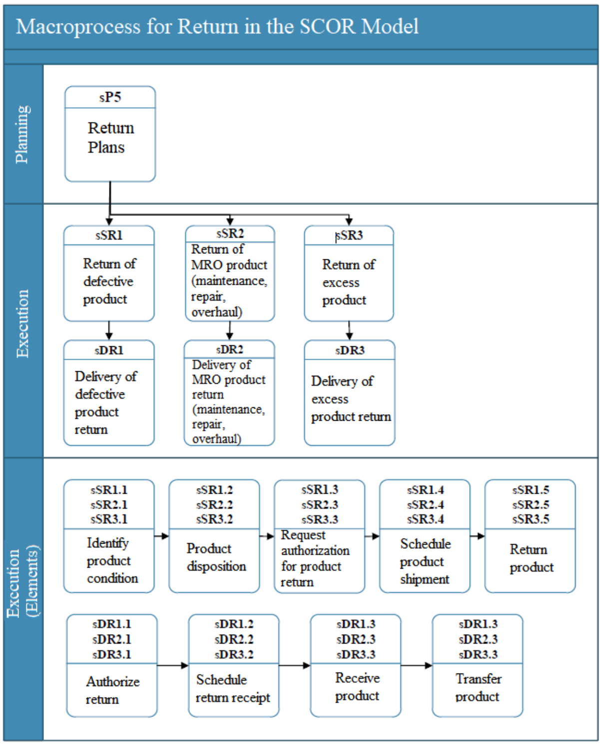

Figure 8. Structure for the macro process of returns in the supply chain of the Agroindustry Lyophilization Company

Table 2. Summary of Results

Processes	**Implemented Improvement**
Planning	Documented procedures for handling returns and improved management of inventory and purchasing costs.
Sourcing	Identification of critical products, analysis of supplier lead times, and determination of optimal order quantities.
Production	Implementation of improvements based on the disposition of human talent and the ability to adapt to changes.
Distribution	Improved inventory management allows for a quick and efficient response to customer orders, meeting agreed timelines.
Returns	The returns process was documented and formalized to control inventory and optimize the use and storage of materials.

Table 3. Summary of Indicators

Indicator	**Value**	**Interpretation**
VAN	79.635	The NPV is 79,635, indicating that the project will generate a positive net value.
B/C	1.58	A B/C of 1.58 has been obtained, which is a good indicator.
KC	12%	The minimum required return rate for the project to be viable is 12%.
PRI	1 year	The payback period for the investment is one year.

4. CONCLUSION

Inventory policies and metrics based on the SCOR Model were proposed to optimize the supply chain management of the Agroindustry Lyophilization Company, demonstrating both economic and technical viability. Indicators were designed to enhance planning and procurement processes, preventing stockouts and shortages. These tools will enable a reduction in inventory investment and improve resource efficiency, ensuring optimal supply for production plants and complementary areas.

The implementation of the SCOR Model allowed for the evaluation of macro-processes in the supply chain, such as planning, procurement, production, distribution, and returns. Based on this analysis, improvement opportunities were identified, and specific policies and metrics were suggested, demonstrating their technical and economic feasibility to optimize supply chain performance.

By applying the SCOR Model questionnaire, it was identified that the most critical processes in the supply chain of the Agroindustry Lyophilization Company are planning (1.60), procurement (1.74), and returns (1.89), which require immediate attention compared to production (2.29) and distribution (2.09) processes.

The analysis of inventory policies in the general warehouse revealed the absence of necessary indicators in the SYS system to optimize procurement, reduce storage costs, maintain adequate safety stock, and make more informed decisions, such as economic order quantity, reorder point, and order quantities. Additionally, ordering and storage costs were evaluated, and an ABC classification of products was conducted to implement inventory policies for type A items. The total storage cost for these products was calculated at 75,594.00 soles based on 2022 data.

It was demonstrated that the implementation of inventory policies in supply chain management significantly improved the macro-processes of planning and procurement, preventing stockouts and shortages. The final storage cost for type A items was also reduced, from 75,594.00 soles in 2022 to a projected 47,695.54 soles. Furthermore, the implementation of SCOR Model metrics for the returns process in the excess inventory category was proposed, enhancing the planning and execution of returns.

After applying the inventory policies and metrics for the returns process, the new values for the macro-processes of the supply chain were evaluated, showing improvements in planning (from 1.60 to 2.13 points, a 33.1% improvement), in procurement (from 1.74 to 2.13 points, a 22.4% improvement), and in returns (from 1.89 to 2.14 points, a 13.2% improvement). Moreover, the economic evaluation yielded positive indicators, with a

Net Present Value (NPV) of 79,635.00 soles and a Benefit/Cost (B/C) ratio of 1.58, with a discount rate of 12%.

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Aylen Ayme Choque Llerena
Universidad Católica San Pablo
Arequipa,
Perú
aylen.choque@ucsp.edu.pe
ORCID 0009-0000-0221-4289

Alexis Paul Salinas Rojas
Universidad Católica San Pablo
Arequipa,
Perú
alexis.salinas@ucsp.edu.pe
ORCID 0000-0002-5008-9846

Jose Alberto Aguilar Franco
Universidad Católica San Pablo
Arequipa,
Perú
jaaguilar@ucsp.edu.pe
ORCID 0000-0001-5080-8428

Carmen MariaelenaVillanuena Delgado
Universidad Católica San Pablo
Arequipa,
Perú
cvillanuevad@ucsp.pe
ORCID 0009-0007-7031-0476

Marcia Shantal Caipo Huacasi
Universidad Católica San Pablo
Arequipa,
Perú
marcia.caipo@ucsp.edu.pe
ORCID 0009-0005-0265-4117