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Reduction of Storage Costs in a Livestock Feed Trading Company through the Application of 5S and SLP within a Kaizen Environment

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Abstract

The inadequate use of storage capacity becomes relevant in SMEs due to the direct consequences it generates in the organizations' value chain. The main objective of this research is to propose techniques that optimize the use of the warehouse space to reduce the overhead costs generated by storage activities, through the application of engineering tools SLP and 5S in a Kaizen environment, using the DMAIC methodology, for a Peruvian company that trades livestock feed. Profitable results were achieved for the organization in terms of workspace utilization efficiency by 16%, an improvement in finished product productivity by 21%, and a projected annual cost reduction of 10%.

Keywords
Storage, Lean Management, 5S, cost efficiency, time reduction, SLP.

1. Introduction
The business sector engaged in commercial activities in Peru accounted for 45% of all enterprises in 2018 (INEI, 2018). Despite its relevance, it faces structural challenges that undermine profitability, such as the lack of inventory policies, which leads to sales losses and reduced consumer loyalty (Marqués et al., 2022). Moreover, product returns—ranging from 20% to 40%—generate additional costs in shrinkage, transportation, and packaging (Frei et al., 2020). In response, many companies resort to logistics outsourcing, although this practice reduces control over product management and handling.

This study examines the case of a Peruvian company engaged in the commercialization of livestock feed, which incurs high costs from outsourcing storage due to the inefficient use of its own warehouse. In 2022, 70% of the storage costs for yellow corn—the company's main product—were allocated to external facilities. Previous research supports the potential of continuous improvement tools for enhancing logistics efficiency: Sotelo (2020) applied the PDCA methodology under a Kaizen approach to reduce logistics costs in a food company, while Brahimi and Khan (2014) optimized outsourced storage through linear programming. Building on these insights, the present study addresses the company's situation from the perspective of continuous improvement and operational efficiency.

Adopting a quantitative-descriptive approach, based on observations, document review, and indicator analysis, the research focuses on yellow corn, which between 2019 and 2022 was the company's most representative SKU. During this period, outsourced storage costs (PEN 22,89 per ton) were significantly higher than in-house storage (PEN 11.94 per ton), underscoring the need for a strategic intervention. Within this context, the research question is posed: Can workspace utilization be optimized—and storage costs reduced—through the application of Lean Management methodology in the case company?

1.1 Objectives

The primary objective of this study is to assess warehouse space utilization efficiency in a company and to determine whether storage costs can be reduced through the application of Lean Management tools. By analyzing the value chain and the current logistics process, the study seeks to identify the underlying causes driving the outsourcing of storage activities and to propose improvements aimed at maximizing the use of existing infrastructure. The research is grounded in the collection of real operational data and the design of a simulation model to quantify the impact of the proposed measures. The contribution of this work lies in demonstrating that significant cost reductions can be achieved through effective operations management without compromising logistics service quality. Furthermore, the methodology presented is replicable for other commercial companies facing similar storage-related challenges.

2. Literature review

This research is framed within the optimization of storage space for livestock products in a trading company, adopting a Lean Management approach. Accordingly, the literature review focuses on three thematic axes: distribution management for cost reduction, inventory management, and the use of layout planning tools such as Systematic Layout Planning (SLP).

Several studies emphasize the importance of effective supply chain management for achieving operational efficiency. Teixeira et al. (2021) argue that an efficient supply chain relies on the synergy among its components, integrating processes and stakeholders to respond effectively to market demands. Within this context, reducing operating and transportation costs emerges as a strategic objective.

Regarding distribution, Issaoui et al. (2022) highlight that implementing an advanced logistics system can optimize distribution and reduce costs compared to traditional schemes. Similarly, Koszorek and Huk (2020), through a qualitative analysis of perishable product chains, underscore the importance of minimizing logistics times and maintaining quality through informed supplier-related decisions. In turn, Lochan et al. (2021) applied simulations to assess the impact of operational risks—such as demand fluctuations or order delays—and concluded that logistical failures represent a critical threat, particularly in food supply chains. Complementarily, Dündar et al. (2022) employed mathematical models to design more cost-effective distribution networks, thereby improving strategic and tactical decision-making. Along the same lines, Orjuela-Castro et al. (2021) incorporated simulations to manage scenarios of oversupply or scarcity in fruit distribution

With respect to inventory management, numerous authors highlight its impact on logistics efficiency and operating costs. Ramos et al. (2020) argue that low responsiveness in this area is a source of inefficiency and additional expenses. Studies such as De Jesús Pacheco et al. (2020) modeled complex inventory processes to identify structural failures, while Ramos et al. (2020) applied comparative simulations that achieved up to a 75% reduction in logistics costs. Other works have emphasized digitalization. For instance, Li and Li (2021) demonstrated the value of real-time monitoring systems in cold chains for perishable foods, and Nikolicic et al. (2021) significantly reduced inventory levels and storage time for dairy products through digital tools. More broadly, Lalou et al. (2020) and Vorkut et al. (2019) contend that modeling and simulation are essential to avoid common inefficiencies such as fragmented replenishment, idle times, or unnecessary equipment use, thereby improving customer satisfaction and reducing shrinkage.

Finally, the Systematic Layout Planning (SLP) tool has been recognized as an effective technique for improving operational layouts by reducing unnecessary distances between activities and enhancing efficiency through better workspace design (Lista et al., 2021). In a case study applied to a consumer goods warehouse, Figueroa et al. (2022) demonstrated that implementing SLP in combination with pilot tests and simulations increased picking productivity by 26.7% and storage efficiency by 33.8%.

Taken together, the reviewed literature shows that methodologies based on simulation, modeling, and layout redesign, when integrated into strategic inventory and distribution management, enable significant improvements in operational efficiency, cost reduction, and customer satisfaction. These approaches provide the theoretical foundation for the present research, which seeks to optimize storage space for livestock products through the application of Lean Management principles.

3. Methods

The research applies the DMAIC methodology, structured in five stages—Define, Measure, Analyze, Improve, and Control—which enabled the integration of a quantitative analysis (based on cost, space, and operational time indicators) with a qualitative analysis through warehouse observation, the use of Lean tools, and interviews with operational staff.

In the analysis stage, reference was made to the study by Brahimi and Khan (2014), conducted in a lubricants company, where the main logistics costs were concentrated in plant-to-customer transportation (52.31%), warehouse-to-customer transportation (28.33%), and inventory holding (10.82%). Their findings indicated that only 18% of storage should be outsourced to avoid additional costs—contrasting sharply with the 70% outsourcing observed in the company under study. This gap revealed inefficiencies in the use of in-house storage and underscored the need to apply improvement tools.

The diagnosis included a Pareto diagram, which revealed that over 50% of the additional costs were concentrated in three causes: physical disorder, inadequate routing layout, and deficiencies in the bagging process. These were consolidated in a cause-and-effect tree as low space utilization, unnecessary movements, and operational inefficiency. This analysis, shown in Figure 1, structured the problem and guided the design of solutions aimed at reducing time and costs while optimizing the logistics flow.

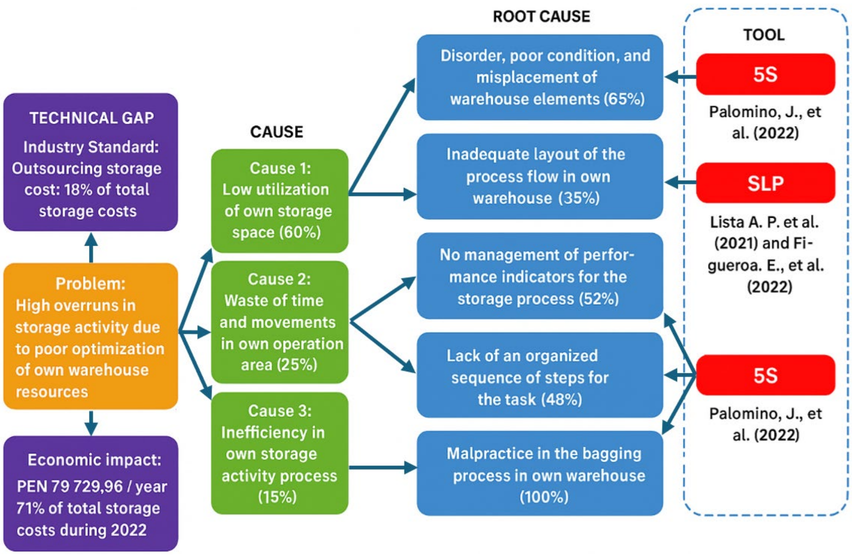

Figure 1. Cause and effect tree

Based on the cause-and-effect tree, specific objectives were established focusing on: increasing the utilization of in-house storage, reducing dependence on third parties, and standardizing the workflow. These objectives are represented in the Figure 2, the "objective tree", which structures the expected outcomes according to the level of intervention.

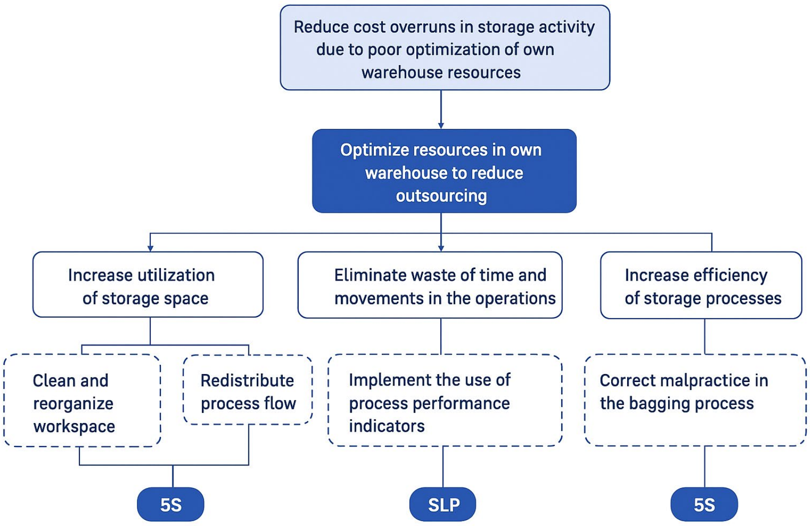

Figure 2. Objective tree

3.1 Key Components of the Proposed Model

The proposed improvement model is structured around the DMAIC methodology, which guides the design and implementation of tools such as 5S and SLP within the framework of the Kaizen philosophy, with the aim of optimizing the storage process of yellow corn.

3.1.1 Kaizen

Following the continuous improvement approach with a low level of investment, practical solutions were proposed to address root causes through simple tools, thereby increasing efficiency without requiring major capital expenditures. These improvements were detailed using a 5W2H matrix, shown in Figure 3, to specify the necessary elements at each stage of the process.

What? (Activities)	Who?	When?	How?	Where?	Why?	How much?
Cleaning	General Manager (purchase), Loaders (use)	28.08.2023	Implementation of mesh frame	Company warehouse	Will improve product quality by reducing impurities, decreasing the number of customer complaints	PEN 390,00
Sewing	General Manager (purchase), Loaders (use)	29.08.2023	Implementation of semi-automatic sewing machine	Company warehouse	Will drastically reduce sewing time, since this activity will no longer be manual	PEN 540,00
Stacking	General Manager (purchase), Loaders (use)	30.08.2023	Implementation of hand truck	Company warehouse	Will drastically reduce sack stacking time, as it can now be done three at a time	PEN 290,00
Final loading	General Manager (purchase), Loaders (use)	31.08.2023	Implementation of metal ramp	Company warehouse	Will reduce final loading time, thanks to the ease of lifting the sacks onto the truck	PEN 372,00

Figure 3. 5W2H Matrix for Storage Process Elements within the Kaizen Framework

3.1.2 5S Methodology

The implementation of the 5S methodology enabled the organization of the operational area and the establishment of sustainable habits of order and cleanliness.

- Seiri (Sort): Unnecessary items such as broken sacks, damaged threads, and deteriorated pallets were removed.
- Seiton (Set in order): Goods were rearranged according to frequency of use, ensuring easy access to key tools.
- Seiso (Shine): Daily cleaning routines were established in operational areas.
- Seiketsu (Standardize): Visual markings were applied to delimit storage zones and height limits.
- Shitsuke (Sustain): Staff were trained, and periodic meetings were scheduled for monitoring and continuous improvement.

3.1.3 Layout Redistribution with SLP

To optimize warehouse layout, the Systematic Layout Planning (SLP) tool was applied during the "organize" phase of the improvement process. The operation covers 1,650 m², of which 1,382.73 m² are allocated to logistics activities. The initial product path was found to extend 61 meters, revealing inefficiencies in the internal flow. Based on proximity value analysis, the relational activity table presented in Figure 4 was developed to define the optimal closeness among key warehouse areas.

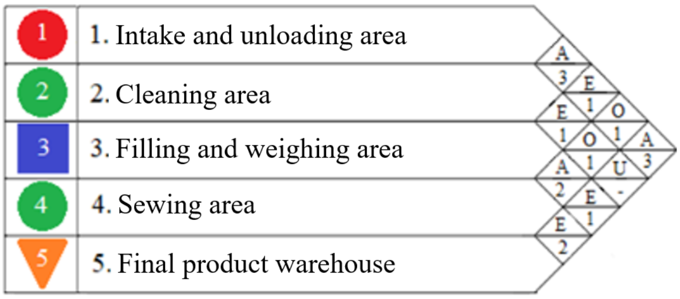

Figure 4. Relational Table

Based on these parameters, the relational activity diagram presented in Figure 5 was developed, which served as the foundation for a redesigned layout. The proposed distribution resulted in a 20% improvement, as the product path was reduced from 61 meters to 49 meters.

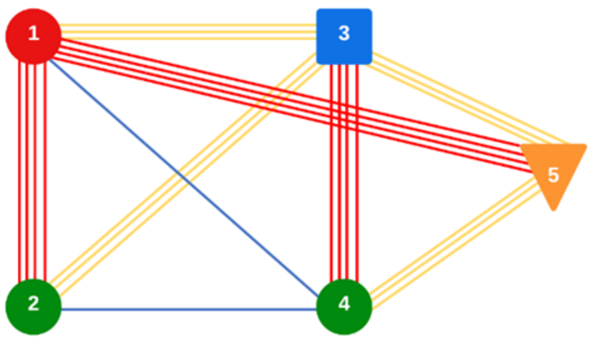

Figure 5. Relational Diagram

The initial and final scenarios were compared to assess how the implemented improvements optimized the use of the operational space. By enhancing the current product flow through the application of the SLP tool, the maximum warehouse capacity for handling corn sacks on pallets was increased, as presented in Table 1.

Table 1. Results of the Proposed Model

Criterion	Current	Proposed
Number of pallets	27	53
Pallet dimensions	1,00 m x 1,20 m x 0,145 m	1,00 m x 1,20 m x 0,145 m
Sack dimensions	1,00 m x 0,60 m	1,00 m x 0,50 m
Number of sacks per pallet	40	40
Utilized Area	275 m^2	540 m^2
Total sacks	**1 080**	**2 088**

The implementation of this proposal was integrated with the 5S methodology and the Kaizen philosophy, incorporating activities such as classification, cleaning, standardization, and area redistribution. These actions were planned using the 5W1H matrix, which specified tasks, responsibilities, and timelines for each stage.

3.4 Data collection

3.4.1 Description of the Experimentation (Simulation)

After selecting the Lean Management tools to address the company's problems, the validation stage was developed with the purpose of demonstrating scenarios aligned with the reduction of outsourcing costs in storage. To evaluate the process and support the proposed improvements in the value chain, a time sampling study was conducted, with the sample size calculated using the following formula:

$$n = \frac{N * Z_{\alpha}^{2} * p * q}{e^{2} * (N-1) * + Z_{\alpha}^{2} * p * q}$$
$$n = 38.72$$
$$n \approx 39$$

Where:
N = 1200 bags (population)
Z = 1.96 (confidence level of 95%)
p = 50% (probability of occurrence of the studied event)
q = 50% (probability of non-occurrence of the studied event)
e = 15.50% (maximum accepted estimation error)

An average of 40 samples was obtained per activity, representing 26.32% of the daily sacks produced. Furthermore, the time distribution, for each activity within the process was determined using the Input Analyzer tool, as shown in Table 2.

Table 2. Distributions for Each Activity

Activity	Fitted distribution
Cleaning, filling and weighing 1 sack	UNIF (0,075; 0,083)
Sewing 1 sack	UNIF (0,25; 0,33)
Stacking 3 sacks	UNIF (0,40; 0,56)
Loading truck 3 sacks	UNIF (0,49; 0,62)

3.4.2 Functional Validation and Discussion of Results

Arena software was employed to simulate both the current scenario and the proposed one following the implementation of improvements. The 48-hour simulation, as presented in Figure 6, encompassed the arrival of corn, bagging, sewing, and stacking. Of the total output, 55.63% was sent to an external warehouse and 44.37% to the internal facility, with process times uniformly distributed.

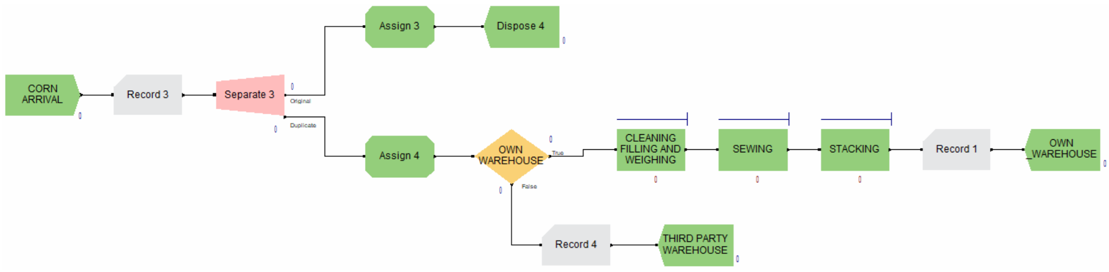

Figure 6. Simulation Model of the Proposed Improvement

The current and proposed scenarios were compared to assess the impact of the improvements on the value chain. A 24% reduction in total process time was achieved, corresponding to 1 minute and 22 seconds saved, as illustrated in Table 3.

Table 3. Timing Comparison

Activity	Area	Mean (initial)	Mean (final)	Change (%)
Cleaning, filling and weighing 1 sack	Unloading	0:25	0:41	-64%
Sewing1 sack	Unloading	1:26	0:22	74%
Stacking 3 sacks	Unloading	0:53	0:37	30%
Loading truck 3 sacks	Loading	1:14	0:56	24%
Total		3:25	2:36	24%

Figure 7 presents the final VSM with the optimized times. The following section details the sequence of processes with the implemented improvements that enabled these results.

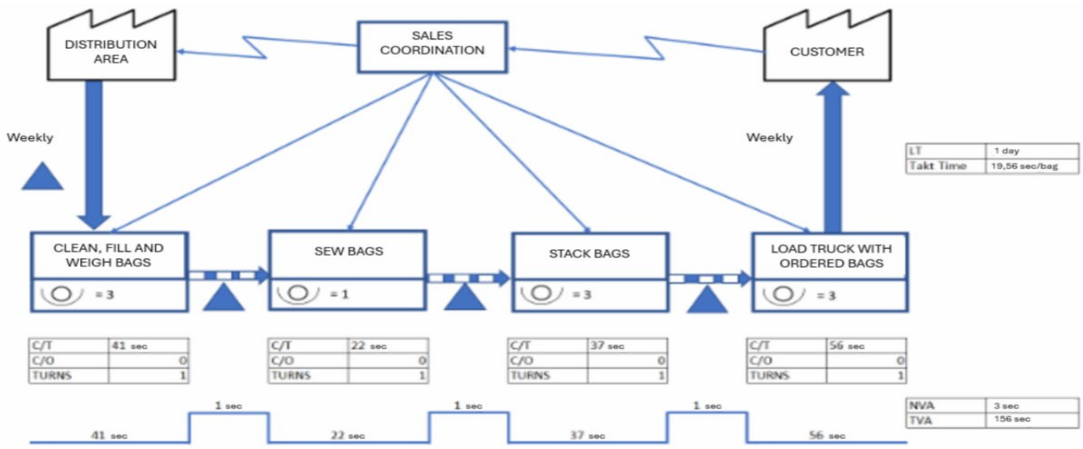

Figure 7. Proposed Value Stream Mapping

3.5 Economic Validation and Discussion of Results

In order to meet customer demand, the company relies on outsourcing approximately 55.63% of its operations due to limited storage capacity, as presented in Table 4.

Table 4. Annual Allocation of Storage Tons

Stored Tons	2019	2020	2021	2022	Share % (Avg)
In-house	4 082,0	2 691,8	1 432,0	2 847,5	44,37%
Outsorced	3 064,8	4 701,8	2 810,6	3 466,5	55,63%
Total	7 146,80	7 393,58	4 242,62	6 314,02	100%

Moreover, due to limited in-house capacity, 71% of the operational storage budget was allocated to outsourced services, as shown in Table 5.

Table 5. Annual Allocation of Stored Tons (PEN)

Storage Costs	2019	2020	2021	2022	Share % (Avg)
Own	PEN 48 984,38	PEN 32 301,76	PEN 17 183,94	PEN 34 169,98	29%
Outsourced	PEN 70 489,73	PEN 108 140,66	PEN 64 644,34	PEN 79 729,96	71%
Total	PEN 119 474,1	PEN 140 442,42	PEN 81 828,28	PEN 113 899,94	100%

In response to this issue, the study implemented engineering tools that enabled the expansion of the company's operational area and the optimization of execution times along the value chain. Significant improvements were achieved in both workspace utilization and the performance of daily operational activities, as presented in Table 6.

Table 6. Comparison of In-House Storage Utilization

Status	Area Used (m^2)	Utilization (%)
Own Warehouse - Current	275	16,7%
Ideal Scenario	1 382,73	83,4%
Own Warehouse – Improvement	540	32,7%

With the implementation of engineering tools, the available space was reorganized, increasing storage capacity to 2,088 sacks, representing 74% of total demand. Furthermore, when comparing pre- and post-implementation capacity for the same 60-ton batch over an 8-hour shift, a 21% improvement in bagging productivity was observed, as shown in Table 7.

Table 7. Productivity Indicator (sacks/day)

Concept	Scenario	Value
Productivity (sacks/day)	Before	152
	After	184

Table 8. Storage Cost Indicators

Concept	Amount 2022	Share	Projected Amount	Share
Own Storage	PEN 34 169,98	30%	PEN 60 134,40	60%
Outsourced Storage	PEN 79 729,96	70%	PEN 39 811,47	40%
Total	PEN 113 899,94	100%	PEN 99 945,87	100%

As shown in Tables 8 and 9, thanks to the improvements implemented through the Lean Management methodology, a 5.1% reduction in annual operating costs was achieved, corresponding to savings of almost

PEN 25 000, as shown on table 9, without the need for additional investment. Of this total, PEN 13 954.07 resulted from reduced storage outsourcing costs, demonstrating an efficient and sustainable improvement.

Table 9. Cost comparison

Concept	2022	Projected Scenario
Pachacamac Rent	PEN 174 000,00	PEN 174 000,00
Own Storage	PEN 34 169,98	PEN 60 134,40
Outsourced Storage	PEN 79 729,96	PEN 39 811,47
Parking	PEN 9 880,00	PEN 4 933,37
Labor Fees	PEN 65 020,50	PEN 63 088,45
Fuel	PEN 45 280,65	PEN 45 280,65
Truck Maintenance	PEN 13 361,32	PEN 6 806,51
Tolls	PEN 16 211,01	PEN 16 211,01
Weighing Service	PEN 3 374,24	PEN 3 374,24
Depreciation	PEN 61 971,54	PEN 63 315,54
Electricity and Water	PEN 1 881,34	PEN 3 310,90
Others	PEN 1 437,02	PEN 1 437,02
Total	PEN 506 587,57	PEN 481 623,56

Finally, a comparison of the initially defined KPIs was conducted against the original objectives and the results obtained based on the implemented improvement proposal, as shown in Figure 8.

Problem	Equation	Before Improvement	Objective	After Improvement	Cause	Indicator	Equation	Before Improvement	Objective	After Improvement
High storage activity costs or outsourcing of services	(Storage Outsourcing Costs / Total Storage Costs) × 100	71%	18%	40%	Low utilization of own storage space	Distance Traveled	Distances (m) from the travel diagram	61	48	49
						Land Utilization	Area used / Total available area	16.70%	83.40%	32.70%
					Inefficiency of own storage activity processes	Loading Time	Working hours loading (1 lot)	18:36	14:30	11:01
						Sewing Time	Working hours sewing (1 lot)	25:41	10:00	6:24

Figure 8. Key Performance Indicators

4. Discussion

The main objective of this study was to optimize the use of the company's in-house warehouse space by eliminating unnecessary items and improving organization with minimal investment. The implementation of Lean Management tools, specifically 5S and SLP, within a Kaizen environment, significantly enhanced storage processes, achieving efficiency in time, costs, and space.

The proposed approach achieved a 24% reduction in operation time per sack through process standardization and improved arrangement of materials, allowing operators to travel shorter distances and handle larger volumes per action. Additionally, the warehouse's supply capacity increased from 35% to 74% of demand, reducing dependence on outsourcing to 40% of storage costs.

Arena software was used to simulate the proposed improvements and project their operational benefits. This provided a clearer basis for future implementation. However, resistance to change was identified as a key challenge, and it is recommended to train personnel and apply incentives to facilitate adoption.

The results support previous studies such as Sotelo (2020) and Palomino et al. (2022), which demonstrate the effectiveness of these tools in enhancing the value chain with minimal investment. The estimated annual savings amounted to PEN 25 000, without requiring additional investment, highlighting a sustainable and replicable impact for other SMEs.

In conclusion, this study demonstrates that applying Lean Management with low investment can substantially improve storage efficiency, optimizing resources, reducing costs, and increasing customer responsiveness.

5. Conclusions

Following the simulation of the proposed inventory management improvements and the assessment of their impact on the value chain, it is confirmed that the research objective was achieved. The application of Lean Management methodology, guided by Kaizen principles, enabled the optimization of costs, space, and time, demonstrating that efficiency can be increased with low investment, even in SMEs with limited resources. The results confirm that the methodology is scalable and applicable to other logistics processes while maintaining a low level of investment. Furthermore, this case study provides practical evidence that operational efficiency can be attained with limited resources and agile methodologies, making it replicable for companies in the same sector facing similar challenges in optimizing their storage processes.

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