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Original Article

A Lean Logistics Framework for Enhancing Inventory Management Efficiency: A Case Study in Peruvian Electrical Spare Parts SMEs

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Abstract - *This research addressed the inventory management challenges faced by a Peruvian SME trading in electrical spare parts. Previous studies highlighted inefficiencies such as low turnover and stock discrepancies, yet failed to integrate comprehensive solutions. The study developed a Lean Logistics model incorporating 5S, Kanban, demand forecasting, and inventory control to optimize operations. Pilot implementation yielded measurable improvements: inventory turnover rose from 1.27 to 4.28, MAPE decreased by 68%, and record accuracy increased to 90%. These findings underline the model's potential to enhance SME logistics efficiency and profitability. Further research could adapt this model for other industries or scales.*

Keywords – *Lean logistics, Inventory management, Inventory turnover, Kanban, Demand forecasting.*

1. Introduction

The importance of small and medium-sized enterprises (SMEs) in the electrical spare parts trade sector is undeniable worldwide, particularly in Latin America and Peru. This sector plays a crucial role in economic development and job creation. In Peru, SMEs represent approximately 99.5% of all businesses and contribute around 47% of the Gross Domestic Product (GDP) [1]. Within this group, SMEs that commercialize electrical spare parts are essential for supplying various industrial sectors such as manufacturing, construction, and transportation.

However, these companies face significant inventory management challenges, including low inventory turnover caused by poor planning, inadequate demand forecasting, and errors in reorder points [2]. Additionally, discrepancies between physical stock and system stock are common and often attributed to errors in product identification [3]. These issues result in high storage costs, inventory obsolescence, and lost sales, negatively impacting the competitiveness and profitability of SMEs [4].

Addressing these problems is essential to improve the efficiency and sustainability of SMEs trading electrical spare parts. Existing literature has explored various strategies and tools for inventory management, such as implementing Enterprise Resource Planning (ERP) systems [5], using demand forecasting techniques [6], and applying Lean Logistics methodologies [7]. However, a knowledge gap remains in the literature regarding how to integrate these tools into a production model that enables SMEs in the electrical spare parts sector to improve their operational and financial performance.

This research aims to address this gap by developing a production model based on Lean Logistics tools such as 5S, KANBAN, demand forecasting, and inventory management. This model will allow SMEs trading electrical spare parts to optimize their production planning and control processes, reduce inventory costs, and improve customer satisfaction [8]. Unlike previous studies, this research will focus specifically on SMEs in the electrical spare parts sector, addressing their inventory management challenges and proposing solutions tailored to their needs [9].

2. Literature Review

2.1. The Application of the Lean Logistics Methodology in the Logistical Process of Small and Medium-Sized Parts Traders.

Lean Logistics methodology has been noted to be important in enhancing the efficiency and effectiveness of logistics operations in various sectors [1]. As for the case of SME spare parts traders, some works have reported the usage of this methodology. For instance, Mourato et al. [2] applied lean practices, including 5S and Kanban, in a bus manufacturing company, and this resulted in increased output and streamlining of internal logistics. Hallam and Contreras [3] also surveyed the literature regarding Lean application in health care and found that this methodology can enhance operational efficiency. However, its use level remains very low. Such findings imply that there is a likelihood that the implementation of Lean Logistics will offer competitive advantages to SMEs involved in the trading of electrical parts, as it will enable them to streamline their logistic activities and enhance their general performance.

2.2. Uses of the 5S Methodology in the Logistics Activity of Small and Medium-Sized Parts Traders

The 5S methodology has been defined, and the application of '5S' has been extensively researched in different industrial settings as a component element of Lean Logistics. In the specific case of SME parts dealers, Mourato et al. [2] demonstrated that the 5S, together with Kanban, was put into effect in a bus assembling firm, which resulted in increased standardization and simplification of internal logistics processes. Sucha et al. [3] also implemented 5S within the Pharmaceutical Industry, which reduced configuration changeover times while the reliability of material supply change improved. Such findings imply that the practice of 5S would be important for electrical SMEs if only to enhance the orderliness, neatness and uniformity in the organization of its logistics operations [1],[2].

2.3. Implementation of the Kanban Methodology in the Logistics Process of Small and Medium-Sized Companies for Parts Sales.

The Kanban methodology has been implemented in various areas of study, including the pharmaceutical and construction industries [5]. Considering the case of small and medium SME part traders, Papalexi et al. [5] argued that the implementation of the Kanban system in the pharmaceutical supply chain improved the logistics strategy in terms of the shift from a push system to a pull system. Zeng et al. [6] also broadened the scope of the application of Kanban because they brought it into construction logistics through the linkage with information and communication technologies in order to enhance visibility and demand management. This implies that the implementation of Kanban may enhance the performance of SMEs dealing with electrical parts by enabling them to increase the control and coordination of their logistic systems [6].

2.4. Outsourcing of the Demand Forecasting Method within the Logistics Cycle of Small and Medium Parts Selling Companies.

The Demand Forecasting procedure has been applied extensively by researchers, particularly within the area of supply chain management [7],[8]. In regard to the specifics of small and medium enterprises dealing in electrical spare parts, even though there have been no studies that have directly addressed this issue, some inferences can be made from studies done in related industries. For instance, Li et al. [7] examined the processes from demand, such as demand management, that SMEs can perform using digital platforms. Parvin et al. [8] investigated the role of e-commerce for small and medium enterprises with a focus on the role of logistics services providers in achieving the goal of the demand. Thus, there are indications that the employment of these advanced demand forecasting techniques would be of considerable advantage to small and medium enterprises in the market for electrical parts since it will enhance the planning and controlling of their logistics operations [7],[8].

2.5. Applications on the Management of Inventories in the Logistic Process of SMEs Trading Spare Parts.

Inventory control is one of the key elements of the logistics of SMEs and more so of the parts dealers where demand for a given product is dependent on stock [9],[10]. While not much has been studied on this topic in relation to SMEs dealing with Electrical spare parts, some insights can be drawn from other industries. For instance, Taschner [9] observed that even though the term "supply chains" is often used in such enterprises, the reality is that these enterprises' interests are still more focused on logistics, and this clenches their strategic development. As well as Soinio et al. [10] and König & Spinler [11], these authors underscored the necessity of creating value-adding logistics service models that respond to the requirements of SMEs and the competencies of the logistics providers. From these findings, it can be deduced that the implementation of inventory management firms in best practice can be of notifiable benefit to the SME's part dealing enterprises since it will enhance their stock availability and the efficiency of their logistics practices [9],[10].

3. Contribution

3.1. Proposed Model

Figure 1 shows a model of inventory management based on the Lean Logistics philosophy, whose objective was to optimize inventory management through the implementation of integrated tools. This approach addressed specific problems such as low inventory turnover, errors at the point of reordering, deviations in demand forecasting and inaccuracy in inventory records. The proposal integrated four lean tools: methodology, kanban, demand forecasting and inventory management. The 5S methodology and the Kanban tool promoted order and cleanliness in the warehouse, facilitating efficient product identification and disposal. At the same time, demand forecasting enabled more precise purchasing planning, reducing surpluses and stockouts. Finally, inventory management optimized product replenishment by establishing clear policies that ensured efficient control of material flow. The proposed model, as a whole, sought to transform the organization's operations towards greater efficiency, applying the principles of Lean Logistics to eliminate waste, improve operational accuracy and ensure optimal use of available resources. This integration addressed the root causes of the problem and laid the foundation for more robust and sustainable logistics management.

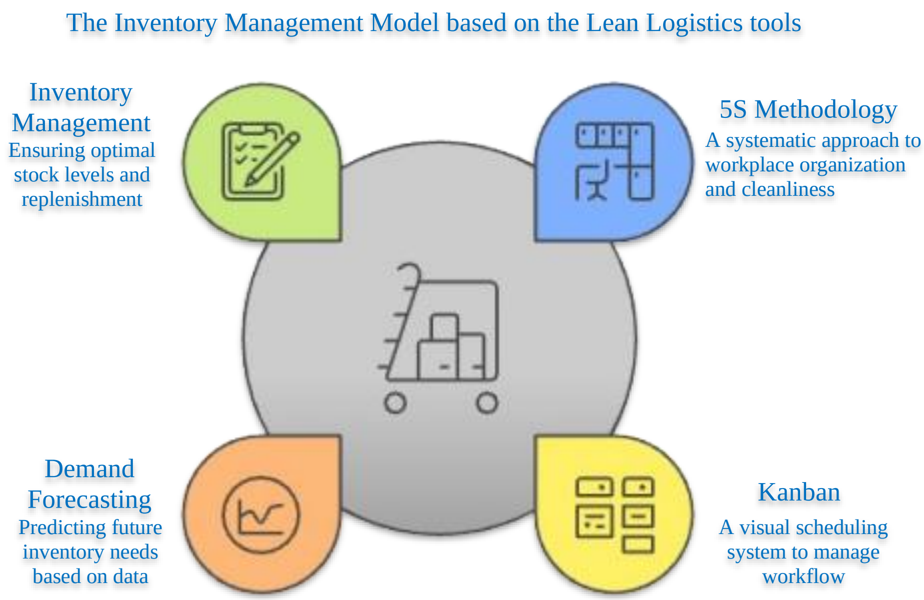

Fig. 1 Proposed model

3.2. Model Components

The model proposed above, as shown in Figure 1, explains a universal remedy conceptualized in accordance with the tenets of Lean Logistics as an enhancement tool to the management of inventory within organizations with low productivity and control over turnover. As a response that focused on the primary structural issues that impeded the optimal movement of materials, it sought the application of tools such as the 5S methodology, Kanban, demand forecasting and inventory management. This model responds to specific concerns of the study but adds value to the literature in that it provides a solution that can be applied in other similar situations, in this case, taking continuous improvement as the focus and integrating various predictive and organizational methodologies. Thus, this study attempted to develop a model that solves the problem of low inventory turnover, reduces errors in reorder points, improves the absolute percentage error of MAPE, and increases the accuracy of the inventory record of ERI. Such deficiencies, previously mentioned as inputs of the processes, were regarded as critical constraints in the performance of the processes of the organization.

In order to address these shortcomings, an appropriate structured intervention was designed, which comprised order and cleanliness strategies, better purchase planning practices, and optimal inventory pulling strategies. Each stage of the model, described below, was intended to revolutionise the in-house processes so as to facilitate efficacious processes of logistics management.

3.2.1. 5S Methodology Approach and the Kanban System: Cleanliness and Orderliness as Bases for Efficiency

The fifth stage of the proposed model consisted of the enactment of the 5S methodology and the Kanban tool. In this phase, the objective was to eliminate factors that were related to discrepancies caused by disorganization within a workplace. The application of Japanese principles of Seiri (sort), Seiton (set in order), Seiso (shine), Seiketsu (standardize), and Shitsuke (sustain) in the Five S system created an order in which each item stored within the space had a strategic role depending on the frequency of its usage and its class category in terms of demand.

During the first stage of the phase, the sorting stage was applied by removing unneeded supplies that were being stored in the warehouse facilities while reserving adequate space for items that were in high demand. Following this, the ordering stage, which relies on color coded cards and visual signals, was facilitated by the Kanban and used to direct users to the needed items rapidly. The layout made use of the ABC classification, which stored the frequent items in easily accessible areas. Such a strategy resulted in a reduction of time required for searches and eliminated mistakes in order preparation. As part of the cleaning process, regular maintenance schedules were introduced in order to keep the area unobstructed and uncontaminated. In this light, the most definitional of the other 5S introduced throughout the ‘standardization’ phase derived from standardization principles, whereas the last discipline phase encouraged the personnel to develop a vision of and commit to stretching activities. As a result, 5S and Kanban facilitated the harmonisation of inventories and improved the functioning of all the model stages that followed.

3.2.2. Demand Forecasting: Timely and Proper Purchase Planning

The second stage of the model intended to integrate purchase planning in order to reduce reliance on inventories by integrating demand forecasting techniques. It was important to consider this in relation to reorder points or restocking levels, along with the mean absolute percentage error of forecasting, since both influenced product availability levels and the returns owing to overstocking or stockouts.

For this purpose, time series demand data was used with quantitative techniques such as moving average, weighted moving average, and exponential smoothing. These techniques clustered the group's consumers and made forecasts that matched the practical operations of the business. The discussions of these results were directed to finding the method Singapore had the least MAPE, and thus, the prediction was right; future demand was well represented.

Also, demand forecasting enabled the assess of optimal inventory levels in a way that prevented redundant buying or too late supplying of key products. As a result, uncertainties in purchase planning were alleviated, the quality of decisions made was enhanced, and replenishment policies were better formulated, which improved relations with suppliers.

3.2.3. Inventory Management: Optimization of Material Flow

The third and final stage of the model was devoted to the introduction of inventory management techniques in order to optimize product supply and enhance the maintenance of the material flow. This component corresponded to the problem of underestimating the average inventory record (AIR) and the average reorder points, which hampered the organization's aim to achieve equilibrium between the supplied goods and the demand for them.

The policy to ensure availability stock was based on computations of safety stock (SS) and reorder point (RPO') adjusting for supplier lead times and daily demand rates. Such policies permitted the setting up of minimum and maximum investment levels in raw material stocks to satisfy an uninterrupted flow of material without creating superfluous excesses. Also, through the economic order quantity model, it was possible to decide on the number and size of the purchase orders to minimize costs related to storage and buying processes.

Linking inventory management to purchasing in the previous steps of the model ensured more effective control of material flows as well as improvement in the accuracy of inventory records. This strategy improved the effectiveness of the supply chain and operational performance and lowered the logistics costs with respect to inventory management.

3.2.4. Global Reengineering of the Logistics Process

To put it briefly, the suggested model enabled the structural integration of the tools of Lean Logistics in order to deal with the factors that could be considered as the causes of the diagnosed problem. 5S and Kanban are tools that enhance ordering and buying planning. Furthermore, the deployment of various 5S Kanban inventory techniques provided better control of material ordering and use. This model combined organizational, forecasting, and procedural aspects, which created a basis for better and more efficient organization of logistic activities in the company.

3.3. Model Indicators

Specialized metrics were developed to assess the impact of the Lean Logistics-based inventory management model for SME electrical parts traders. These metrics were designed to monitor and evaluate performance throughout the case study, providing a solid basis for analysing critical aspects of the inventory management and control process within an SME environment. This systematic approach facilitated an in-depth review of key performance indicators. This comprehensive evaluation ensured effective monitoring and supported the continuous improvement of processes within the SME.

3.3.1. Inventory Turnover (IT)

This indicator reflects how quickly inventory is sold or used within a specific period, assessing the efficiency of inventory management. A higher turnover indicates optimal utilization and reduces holding costs, while a lower turnover suggests overstocking or slow sales.

$$IT = \frac{\text{Cost of Goods Sold}}{\text{Average Inventory Value}}$$

3.3.2. Mean Absolute Percentage Error (MAPE)

This indicator evaluates the accuracy of forecasting models by calculating the percentage deviation between actual and estimated demand. Lower values signify higher prediction precision, which is crucial for inventory planning and minimizing stockouts or excess inventory.

$$MAPE = \frac{|\text{Actual Demand} - \text{Estimated Demand}|}{\text{Estimated Demand}} \times 100\%$$

3.3.3. Inventory Record Accuracy (IRA)

This indicator measures the reliability of inventory records by comparing accurate physical counts to total counts performed. It reflects operational discipline in inventory control; higher accuracy enhances decision-making and avoids discrepancies in stock levels.

$$IRA = \frac{\#\ \text{Correctly Conducted Counts}}{\text{Total Counts}} \times 100\%$$

4. Validation

4.1. Validation Scenario

The validation scenario was conducted in a case study corresponding to a company specializing in the commercialization of electrical spare parts. This organization began its operations with sales based on customer orders and later expanded to include two physical points of sale. Its product catalogue is comprised of a wide variety of items differing in size, material, and brand, and it is sourced from both local suppliers and international providers, notably from countries such as China, Argentina, and Italy. The lead time for local suppliers was approximately one day, while imported products required longer delivery times. The company's primary process focused on receiving, storing, and dispatching products; however, deficiencies in inventory planning and discrepancies between physical and theoretical stock were identified. These issues adversely affected inventory turnover and generated additional costs due to overstock, thereby compromising the operational and financial efficiency of the organization.

4.2. Initial Diagnosis

The findings of the case study are that there is a low rate of inventory turnover with respect to the first turnover of 1.27 times vis a vis the industry’s benchmark of 4 times. It was estimated that this difference caused an annual economic loss due to surplus inventories amounting to 56,496.00 PEN, which represented about 14.06% of the year’s income. Significant Inventory planning, which accounted for 55.14% of the losses, represented the main reason for the low inventory turnover.

On this particular issue, 20.12% was attributed to the poor demand forecasting tool, while 35.02% related to the guesstimates used to come up with reorder points. In addition, 44.86% of the reduced turnover of stocks was due to the differences between the actual stock and the theoretical stock, which was solely incurred due to product misidentification. The established root causes illustrated the absence of systems that were aimed at effective inventory control and the consequences of this regarding the operations and profitability of the entity.

4.3. Validation Design

The proposed production model, which integrates the Lean and SLP tools, was validated by the pilot validation method. The application of this method lasted four months in the case study, covering all the techniques proposed. These include the 5S methodology, Systematic Layout Planning and work standardization. Each of these tools is detailed below.

The application of the suggested model within the case study fulfilled, in total, the deficiencies that were established in the inventory management system of one of the electrical spare parts trading companies. This elaborate solution consisted of three basic systems that were designed and implemented – forecasting demand, managing inventory and the 5S system supplemented with Kanban. These linkages were designed in a consecutive order that would prevent any deterioration of the long-term outcome, enhance the KPIs of the processes and make the use of the operational resources more efficient. The improvement of these components has been founded on accurate quantitative measures and the development of appropriate methodology, leading to remarkable changes in the turnover and the accuracy of inventory records.

4.3.1. Optimization through Demand Forecasting

The first component involved applying forecasting of demand in order to decrease the volatility that is associated with inventory control and restocking decisions. In this regard, demand data for the year 2023 for the respective firm was collected for analysis. For this phase, three prevalent forecasting techniques were used: simple moving average, weighted moving average, and exponential smoothing. It was so done because the latter was employed aiming for 3 to 4 cut periods in order to ascertain which model yielded the most accurate results. The evaluation results were assessed by calculating Mean Absolute Percentage Error or MAPE and selecting the lowest one obtained for each product family as a reference point. For instance, bearings had a MAPE of 4.35 when using a weighted moving average, while fans moved down its error to 26.65. The above-mentioned optimization allowed for increasing the reliability of demand estimates and assisted in devising more accurate and inventory control-oriented demand policies. In Table 1, the MAPE comparison for eight product families using Simple Moving Average, Weighted Moving Average, and Exponential Smoothing is shown. The Weighted Moving Average achieved the lowest MAPE for most families, such as Bearings (4.35), while Exponential Smoothing generally yielded higher errors, especially for Fans and Motors.

Table 1. Comparison of the MAPE obtained from 3 types of forecasts

Forecasting Type	**Simple Moving Average**	**Weighted Moving Average**	**Exponential Smoothing**
Families	**MAPE**	**MAPE**	**MAPE**
Bearings	4.86	4.35	5.07
Collectors	26.88	23.48	27.15
Terminal Blocks	7.45	9.12	9.55
Fans	28.29	26.65	29.73
Carbons	15.81	14.56	15.77
Switches	31.21	27.7	30.83
Armatures	38.72	35.39	38.95
Motors	29.15	26.13	29.8

4.3.2. Design and Implementation of Inventory Policies

The second component aimed to establish an inventory management policy, which in turn aimed at maintaining a balance of timely replenishment and overstock being minimized. In this phase, an in-depth study of the daily requirements of the product and supply lead times was done. Using this information, the reorder point (ROP) and the safety stock (SS) were calculated according to the predefined equations. The ROP was determined using the formula:

$$ROP = D_{daily} \times LT + SS$$

The safety stock calculation followed the formula:

$$SS = Z \times \sigma \times \sqrt{\{LT\}}$$

Where Z represents the desired service level, σ is the standard deviation, and LT is the lead time.

Storage and ordering costs were considered for the calculation of Economic Order Quantity (EOQ). First, the ROP was adjusted for the bearings family from 28 units to 16 units, and this resulted in minimizing the surplus stock while accommodating the stock level. It was found that these equations helped optimize the values of stock level and order quantities so as to avoid non-fulfillment of orders and the cost of holding too much stock.

Furthermore, it should be accentuated that the adjustments "worked up" with the warranted accuracy of earlier prepared forecasts, which improved the management in terms of genuine product consumption.

In Table 2, the calculations for Safety Stock (SS) and Reorder Point (ROP) are presented for eight product families. For example, Bearings have an SS of 4 units and an ROP of 16 units, while Fans show an SS of 71 units and an ROP of 310 units.

Table 2. Calculations for SS and ROP

SS (units)	ROP (units)
Bearings	4
Collectors	52
Terminal Blocks	5
Fans	71
Carbons	33
Switches	91
Armatures	54
Motors	49

Table 3. Calculation of EOQ, Number of Orders, and Time between orders

Families	EOQ (units)	N (orders)
Bearings	42	9
Collectors	469	2
Terminal Blocks	217	2
Fans	527	2
Carbons	386	2
Switches	443	2
Armatures	356	2
Motors	326	2

In Table 3, the calculation of the Economic Order Quantity (EOQ) and the Number of Orders (N) is presented for eight product families. For example, Bearings have an EOQ of 42 units with 9 orders, while most families require 2 orders with varying EOQ values.

4.3.3. Execution and Continuous Improvement Process through 5S and Kanban

The third component dealt with the implementation of the 5S method along with the kanban system, which were critical in controlling order, cleanliness and uniformity of all the processes within the warehouse.

The implementation of the 5S methodology was performed over five phases, one after the other. The first phase, Seiri or Sorting, was aimed at identifying and getting rid of unnecessary items that were taking up space in the warehouse. In this step, 43 non-availability value-added items were eliminated, while 59 items were rearranged in order to make their placement more advantageous.

The second stage was related to inventory management and was called Seiton or Set in Order, and this was done through the Kanban system, which used the ABC classification of products. The first one (A) was placed near the exit of the warehouse and marked with green tags, while the B and C, which were marked with yellow and red tags, respectively, were placed further away from the exit. This was because they were slow turnover goods. This arrangement greatly decreased the amount of time needed to find and pick up items from the warehouse.

Eliminating dirt and upkeeping the warehouse's surroundings while creating working conditions was intertwined in the third stage, Seiso or Shine, whereby a custom cleaning routine was formulated. In the fourth stage, Seiketsu or Standardization, the procedures applied in the previous stages were documented and formalized, and clear standards for the placement of the products, their label and cleanliness were established.

Lastly, Shitsuke or Sustaining, a system for weekly inspections, was introduced by the 5S committee to ensure compliance with the standards established by the committee. Compliance had been a major concern since all measures taken to improve the situation had to be permanent and not just a one-off event. Severally, the auditors had established an outstanding compliance achievement of 97 percent and up, in comparison to the pre-improvement score of thirty-two percent all time.

In Figure 2, the 5S Map is displayed, organizing the warehouse into zones labelled A to Q for product categories. High-turnover items like Bearings and Fans are in green near the Exit, while less critical items, such as Catalysts and Metal Plugs, are in red, positioned further.

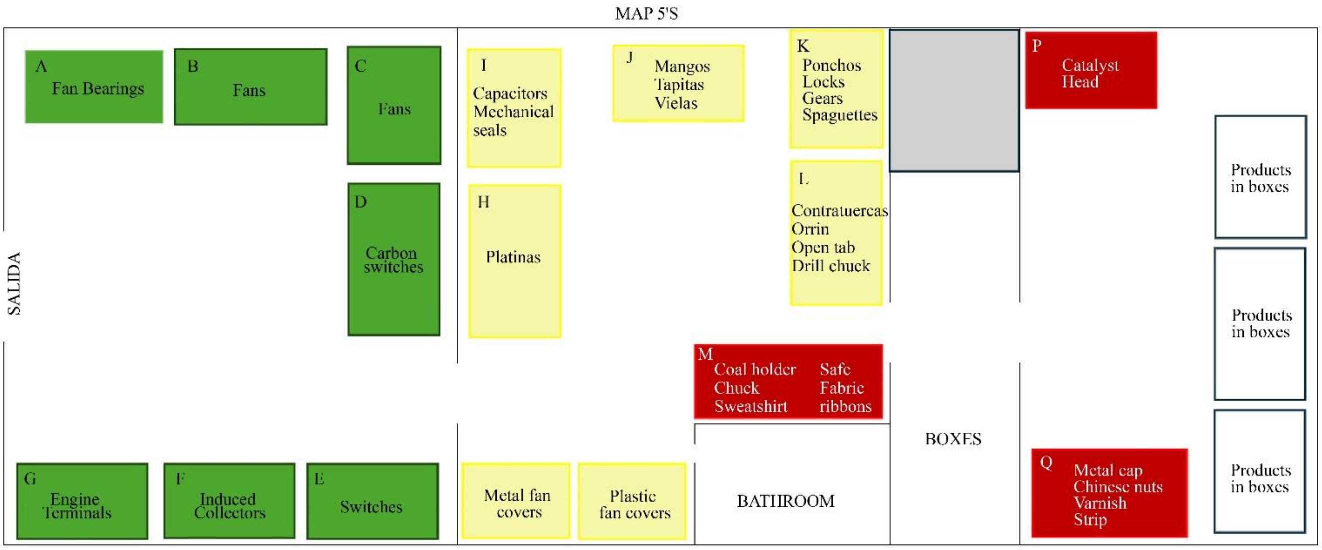

Fig. 2 5S Map

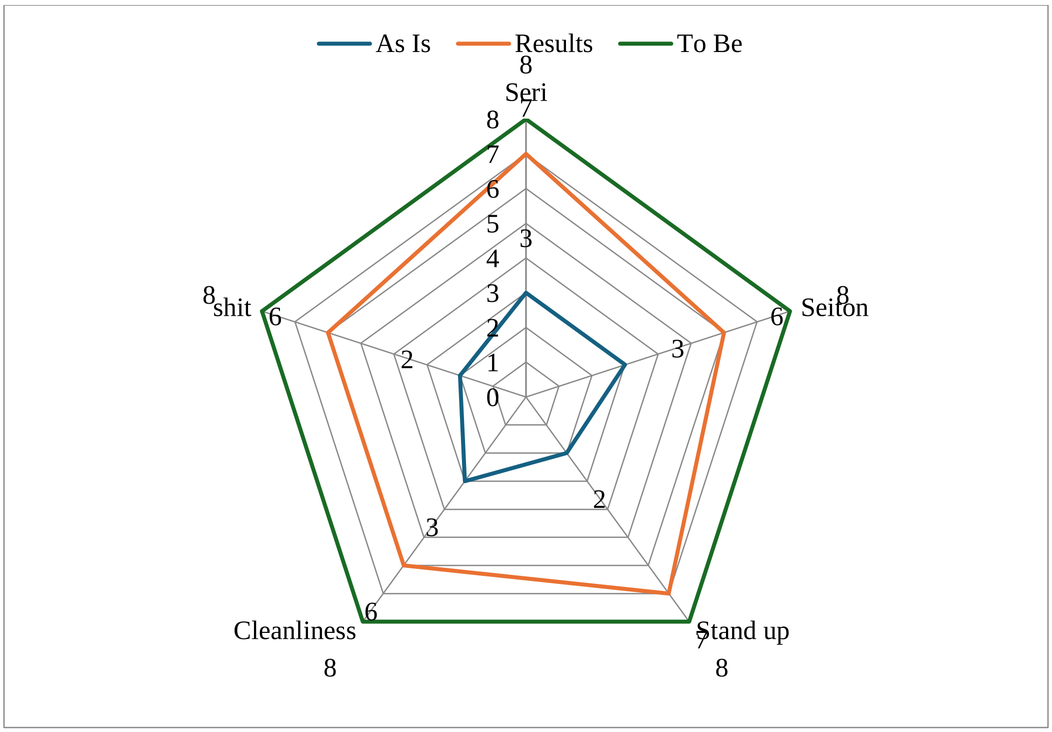

Fig. 3 5S Audit

In Figure 3, the results of the 5S Audit are displayed, showing the progression from the As-Is stage (13 points, 33%) to the Results stage (32 points, 80%) and the To Be target (40 points, 100%). Significant improvements are observed across all 5S pillars: Seiri, Seiton, Seiso, Seiketsu, and Shitsuke.

4.3.4. Overall Results and Visual Aids that are Relevant for Improvement.

There was a very remarkable improvement in the identified key process indicators owing to the existence of these three components. In terms of turnover, inventory levels rose to four point zero two from one point two seven levels as advocated in the literature. The rotational demand forecast error decreased from a standard of thirty-two percent to twenty percent or lower through the mean absolute percentage error technique. The same increased inventory record accuracy during the reporting period from sixty-four to eighty-five percent estimation index, suggesting many improvements, especially in records accuracy and reliability in the warehouse. The outcomes justify the claims of the solutions implemented and further show that the solutions enhanced the company's operations management.

It is best to include tables showing the summary of MAPE computations, such as ROP, SS, and EOQ computations, in addition to graphs that show products by ABC classification and 5S audit graphs. Such illustrations will further help in comprehending the improvements made and the tangible results attained.

4.4. Results

In Table 4, the results of the pilot implementation of the inventory management model based on Lean Logistics tools—integrating 5S, Kanban, demand forecasting, and inventory management—are presented. This model was applied through a pilot in the case study, demonstrating significant improvements across three key performance indicators. Inventory turnover increased from 1.27 in the "As-Is" stage to 4.28 in the "Results" stage, achieving a 237% variation, surpassing the target of 4.02. The mean absolute percentage error decreased from 32% to 10.11%, achieving a 68% reduction, aligning closely with the expected 10% target. Finally, inventory record accuracy improved from 64% to 90%, exceeding the goal of 85% with a 41% variation. These results highlight the model's effectiveness in enhancing inventory efficiency and operational accuracy in the pilot application. These results demonstrate the effectiveness of the proposed inventory management model in addressing initial challenges and increasing the operational efficiency of the case study.

Table 4. Results of the pilot

Indicator	As-Is	To-Be	Results	Variation (%)
Inventory Turnover (IT)	1.27	4.02	4.28	237%
Mean Absolute Percentage Error (MAPE)	32%	10%	10.11%	-68%
Inventory Record Accuracy (IAR)	64%	85%	90%	41%

5. Discussion

This study highlights the effective integration of Lean Logistics tools, including 5S, Kanban, demand forecasting, and inventory control, to address inventory management challenges in SMEs. Unlike previous research that often focuses on individual Lean tools, this study demonstrates the synergistic impact of combining these methodologies within a single framework. For example, Hallam and Contreras [12] emphasized the scope of Lean practices in healthcare, but their application to SMEs in the electrical spare parts sector remains underexplored. Similarly, Papalexi et al. [14] examined Kanban in pharmaceutical supply chains but did not investigate its integration with broader inventory strategies.

This research bridges the gap by tailoring Lean Logistics to an SME-specific context, demonstrating improvements in inventory turnover and record accuracy. However, unlike studies by Zeng et al. [15], which incorporate advanced technologies, this work relies on manual implementation, suggesting future exploration of digital tools to enhance results. These comparisons enrich the understanding of Lean Logistics in SMEs.

5.1. Study Limitations

This research is limited by its focus on a single SME in the electrical spare parts sector, which restricts the generalizability of the findings. The context-specific nature of the proposed Lean Logistics model may require adaptations for application in different industries or larger-scale organizations. Additionally, the implementation was conducted as a pilot over a short period, which may not capture the long-term sustainability of the improvements. The study primarily relied on quantitative metrics such as inventory turnover and MAPE, leaving qualitative aspects like employee adoption and satisfaction underexplored. External factors such as supplier reliability and market fluctuations were considered static, which could influence the outcomes in real-world scenarios.

5.2. Recommendations for SMEs Based on Results

SMEs in the electrical spare parts sector should adopt Lean Logistics tools like 5S, Kanban, demand forecasting, and inventory control to address inefficiencies. Implementing 5S ensures workplace organization, while Kanban optimizes stock levels. Accurate demand forecasting minimizes stockouts and overstock, improving operational efficiency.

Training employees in Lean principles and piloting solutions before full-scale deployment reduce risks and ensure sustainability. Integrating technologies like IoT and AI further enhances forecasting accuracy and efficiency. Regularly tracking metrics such as inventory turnover and record accuracy supports continuous improvement.

By applying these strategies, SMEs can reduce costs, improve customer satisfaction, and strengthen their market competitiveness.

5.3. Future Works

Future research should extend the scope of the proposed model to a broader range of SMEs across different sectors and geographic locations to validate its adaptability and robustness. Incorporating advanced technologies such as artificial intelligence and IoT could enhance demand forecasting accuracy and streamline logistics operations further. Longitudinal studies are recommended to evaluate the long-term impact and sustainability of Lean Logistics implementations. Additionally, exploring the interplay between quantitative improvements and qualitative factors like organizational culture and employee engagement could provide deeper insights. Comparative studies with other inventory management methodologies would also help identify best practices and refine the model for broader applicability.

6. Conclusion

This research demonstrates the improvements achieved by an SME, referred to as the case study, engaged in the trading of electrical spare parts following the application of Lean Logistics tools such as 5S, Kanban, demand forecasting, and inventory control within its operations. The task of the proposed model focuses on the underlying problems of low inventory turnover, reorder point errors, and stock discrepancies between physical and records. In particular, demand forecasting was able to minimize forecasting errors in inventory planning, while 5S and Kanban techniques improved orderliness and operations. There was a 237% increase in inventory turnover, a 68% drop in MAPE and 41% improvement in inventory record accuracy; all these factors attest to the model's practicality.

The merit of this research is that it focuses on the peculiar problems of the SMEs operating in the electrical spare parts industry. This paper approaches Lean Logistics strategies with the aim of improving operational performance while minimizing costs and satisfying the customers. These observations validate the necessity of having efficient inventory systems as one of the strategies to enhance the profitability and operational performance of SMEs. This research adds to the already existing body of knowledge by providing a comprehensive inventory management model that integrates Lean tools for the optimization of logistics processes. While the previous research considered the separate contextual application of these tools in the prior studies, this study considers them as being interrelated, seeking to provide a solution that is adjustable and useful to other industries. It contains relevant information for Small and Medium Enterprises on how to simplify their operations, reduce waste and enhance their inventory record accuracy. Future studies can widen the scope of this model to bigger firms or to other industries to test its versatility. Also, the predictive ability of inventory could be improved, and logistics processes could be streamlined further by incorporating sophisticated technologies like IoT and AI. This research serves as an impetus for future research focused on the enhancement of the logistics and inventory management operations of SMEs.

References

[1] Ann I. Ogbo, and Wilfred I. Ukpere, "The Impact of Effective Inventory Control Management on Organisational Performance: A Study of 7up Bottling Company Nile Mile Enugu, Nigeria," *Mediterranean Journal of Social Sciences*, vol. 5, no. 10, pp. 109-118, 2014. [CrossRef] [Google Scholar] [Publisher Link]

[2] Sibusiso Mabizela, Hilma N. Nakambale, and Varsha Bangalee, "Evaluation of Pharmaceutical Inventory Management Challenges at Public Healthcare Facilities in King Cetshwayo District, KwaZulu-Natal, South Africa," *BMC Health Services Research*, pp. 1-16, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[3] Sibusiso Mabizela, Hilma N. Nakambale, and Varsha Bangalee, "Predictors of Medicine Redistribution at Public Healthcare Facilities in King Cetshwayo District, Kwazulu-Natal, South Africa," *BMC Health Services Research*, vol. 23, no. 1, pp. 1-9, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[4] Inga Kartanaite et al., "Financial Modeling Trends for Production Companies in the Context of Industry 4.0," *Investment Management and Financial Innovations*, vol. 18, no. 1, pp. 270-284, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[5] Carla Goncalves Machado et al., "Digital Organisational Readiness: Experiences from Manufacturing Companies," *Journal of Manufacturing Technology Management*, vol. 32, no. 9, pp. 167-182, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[6] Habib Zare et al., "An Integrated Fuzzy Goal Programming—Theory of Constraints Model for Production Planning and Optimization," *Sustainability*, vol. 13, no. 22, pp. 1-15, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[7] Li Ailin, and Jennifer Fronda, "Analysis on the Inventory Management Practices of Guizhou Liansheng Pharmaceutical Co. Ltd. in China: Basis for Strategic Plan," *The Quest Journal of Multidisciplinary Research and Development*, vol. 2, no. 3, pp. 1-8, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[8] Ashutosh Sheel, and Vishnu Nath, "Effect of Blockchain Technology Adoption on Supply Chain Adaptability, Agility, Alignment and Performance," *Management Research Review*, vol. 42, no. 12, pp. 1353-1374, 2019. [CrossRef] [Google Scholar] [Publisher Link]

[9] Sanjoy Kumar Paul, Ruhul Sarker, and Daryl Essam, "Managing Disruption in an Imperfect Production-Inventory System," *Computers & Industrial Engineering*, vol. 84, pp. 101-112, 2015. [CrossRef] [Google Scholar] [Publisher Link]

[10] Joash Mageto, Gerrie Prinsloo, and Rose Luke, "The Extent of Logistics Outsourcing among Small and Medium-Sized Manufacturing Enterprises in Nairobi," *Journal of Transport and Supply Chain Management*, vol. 12, no. 1, pp. 1-9, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[11] Jose Mourato et al., "Improving Internal Logistics of a Bus Manufacturing Using the Lean Techniques," *International Journal of Productivity and Performance Management*, vol. 70, no. 7, pp. 1930-1951, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[12] Cory R.A. Hallam, and Carolina Contreras, "Lean Healthcare: Scale, Scope and Sustainability," *International Journal of Health Care Quality Assurance*, vol. 31, no. 7, pp. 684-696, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[13] Maurizio Bevilacqua et al., "A Changeover Time Reduction through an Integration of Lean Practices: A Case Study from Pharmaceutical Sector," *Assembly Automation*, vol. 35, no. 1, pp. 22-34, 2015. [CrossRef] [Google Scholar] [Publisher Link]

[14] Marina Papalexi, David Bamford, and Benjamin Dehe, "A Case Study of Kanban Implementation within the Pharmaceutical Supply Chain," *International Journal of Logistics Research and Applications*, vol. 19, no. 4, pp. 239-255, 2015. [CrossRef] [Google Scholar] [Publisher Link]

[15] Ningshuang Zeng et al., "BIM-Enabled Kanban System in Construction Logistics for Real-time Demand Reporting and Pull Replenishment," *Engineering Construction & Architectural Management*, vol. 31, no. 8, pp. 3069-3096, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[16] Liang Li et al., "Digital Transformation by SME Entrepreneurs: A Capability Perspective," *Information Systems Journal*, vol. 28, no. 6, pp. 1129-1157, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[17] Morsheda Parvin, Soaib Bin Asimiran, and Ahmad Fauzi Bin Mohd Ayub "Impact of Introducing E-commerce on Small and Medium Enterprises – A Case on Logistics Provider," *Society and Business Review*, vol. 17, no. 3, pp. 469-484, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[18] Andreas Taschner, "Improving SME Logistics Performance through Benchmarking," *Benchmarking: An International Journal*, vol. 23, no. 7, pp. 1780-1797, 2016. [CrossRef] [Google Scholar] [Publisher Link]

[19] Juho Soinio, Kari Tanskanen, and Max Finne, "How Logistics-Service Providers Can Develop Value-Added Services for SMEs: A Dyadic Perspective," *The International Journal of Logistics Management*, vol. 23, no. 1, pp. 31-49, 2012. [CrossRef] [Google Scholar] [Publisher Link]

[20] Alexander Konig, and Stefan Spinler, "The Effect of Logistics Outsourcing on the Supply Chain Vulnerability of Shippers: Development of a Conceptual Risk Management Framework," *The International Journal of Logistics Management*, vol. 27, no. 1, pp. 122-141, 2016. [CrossRef] [Google Scholar] [Publisher Link]