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Original Article

Lean Logistics and BPM Applied to Inventory Management in a Peruvian SME: Evidence from a Technology Sector Case

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Abstract *-.Inventory management remains a persistent challenge for SMEs in the Peruvian technology sector, where empirical decision-making often leads to stock imbalances and financial losses. Prior studies have addressed these issues using isolated tools, but few have proposed an integrated and replicable model. This research aimed to resolve inefficiencies in inventory control by designing and implementing a model that combines Lean Logistics, BPM, EOQ, ABC classification, and statistical forecasting. The model was applied in a Lima-based SME, involving process standardization, demand forecasting, and optimal order quantity calculations. As a result, average inventory decreased by 50%, turnover improved by 142%, and forecast accuracy increased, with the mean absolute error dropping from 37.5% to 18.7%. These improvements contributed to cost savings and greater service efficiency. Academically, the study offers a structured framework for operational enhancement. Socioeconomically, it empowers small firms to professionalize supply chains. Further exploration is encouraged to adapt the model to other sectors and integrate advanced analytics.*

Keywords *- Lean Logistics, Inventory Management, Business Process Management, SMEs, Demand Forecasting, EOQ Model.*

1. Introduction

Small and medium-sized enterprises (SMEs) in the high-technology retail sector play a pivotal role in economic growth and digital access across the globe. These firms, which sell products such as laptops and desktop computers through both physical and online channels, constitute most businesses and a major source of employment in many economies [1]. In Latin America, especially in Peru, their importance is even more pronounced—Peruvian SMEs account for 99.5% of registered companies and employ approximately 59% of the workforce [2]. Moreover, the tech retail segment has shown strong growth worldwide; global revenue in consumer electronics, including computer peripherals, is projected to reach US$5.65 billion by 2025, with steady annual growth above 3% [3]. In Peru, the consumer electronics sector experienced a notable 5.9% growth between 2020 and 2021, even amid pandemic challenges [4]. These figures highlight tech-product SMEs' critical economic and social contributions as last-mile technology providers.

However, despite their importance, these SMEs commonly face serious operational issues—especially in inventory management and supply chain processes—that hinder performance. A major concern is low inventory turnover, where slow-moving products tie up capital and risk obsolescence [5]. Research on Peruvian SMEs revealed high rates of excess stock accumulation due to inefficiencies in inventory control and demand planning [6]. This issue is exacerbated for tech goods with short life cycles and rapidly depreciating [7], leading to direct financial losses. Another study found that just 2 in 10 Peruvian retailers had functional inventory management systems, with many also suffering from disorganized warehouse operations and poor stock layout [8]. These demand forecasting and replenishment deficiencies result in unaligned inventory levels, prolonging coverage times, and increasing holding costs [9].

Addressing these issues is essential for SME competitiveness and survival. Prolonged inventory ties up working capital, leading to storage overheads and product deterioration [7]. At the same time, inadequate stock control leads to stockouts and lost sales, damaging customer satisfaction and retention [10]. SMEs, operating with limited resources, cannot absorb these losses easily, as studies show that operational inefficiencies often precipitate SME failure [2]. Conversely, improving inventory turnover and adopting lean stock strategies can significantly reduce costs and increase responsiveness, which is crucial in tech retail and e-commerce environments [3].

Even though large enterprises have adopted Lean Logistics and BPM for inventory optimization, there is a lack of integrative models suited to tech-product SMEs. Reviews identify a notable gap: few frameworks combine forecasting, EOQ, ROP, safety stock methods, and BPM in a unified model tailored to SME contexts [11]. While some studies tackle elements like EOQ or layout planning in isolation (a Peruvian distributor reported an 85% drop in stockouts after EOQ implementation) [5], and others apply BPM or Lean Six Sigma independently [12], none systematically integrates all these components. Our research addresses this gap by proposing and validating a comprehensive Lean–BPM inventory model, showing simultaneous turnover, service level, and process efficiency improvements. This integrated approach offers new contributions to operations management for technology-product SMEs, helping transform inventory from a liability into a competitive asset.

2. Literature Review

2.1. Lean Logistics for High-Tech Retail SMEs

High-tech product retailers often struggle with waste and inefficiency in their supply chains, prompting interest in Lean Logistics as a solution. Lean Logistics eliminates non-value-added activities to speed up deliveries and cut costs. For example, Quiroz-Flores et al. [13] showed that combining Lean practices with Big Data analytics improved last-mile delivery performance for Peruvian light logistics SMEs, addressing late deliveries in e-commerce through data-driven route optimizations. By organizing and cleansing shipment data and assigning delivery probabilities, their integrated Lean-Data methodology enhanced supply chain efficiency and profitability even amid post-pandemic disruptions. This innovative approach of merging Lean and Big Data to bolster productivity is novel in the literature and highly relevant for high-tech retail SMEs that face rapidly changing demand.

Lean techniques have been applied successfully in similar retail contexts to reduce lead times and improve service. Quiroz-Flores et al. [14] implemented a Lean logistics model (using cross-docking and barcode poka-yoke) at a Peruvian home electronics/furniture retailer, achieving 92% on-time delivery service level and cutting in-store pickup times by nearly 49%. These results underscore how Lean tools can streamline distribution processes and boost customer satisfaction in retail SMEs. Likewise, a study by Caso-Vicente et al. [15] applied 5S, ABC classification, and Kanban in a warehouse of an industrial supplies SME, targeting unfulfilled orders. The Lean interventions yielded a 38.8% reduction in picking time, a 12.3% reduction in system registration time, and a 47.2% reduction in total process time, allowing the company to meet a stringent order fulfilment target of only 5% unmet orders. By attacking root causes like disorganization and lack of visual management, the Lean toolkit in the SME eliminated delays and improved on-time deliveries dramatically. These outcomes parallel the needs of high-tech product retailers, where many SKUs and fast product cycles demand efficient handling to avoid outdated inventory.

Lean logistics speeds up operations and cuts cost drivers that plague SMEs. Asencios Soria and Miñan Olivos [16] documented a case in Lima where an electronics retailer saw logistic costs rise 9% in one year due to poor storage practices, disorganized warehouses, and frequent errors and delays. By introducing Lean principles – Value Stream Mapping (to identify bottlenecks and reduce overtime), ABC analysis (to prioritize expensive items), 5S (to organize and reduce holding costs), and Kanban (to minimize picking errors) – the company projected an immediate economic benefit of $289 and a potential upside of up to $911 under various scenarios. While those dollar figures seem small, they represented significant percentage improvements in that SME's margins.

The lean interventions curtailed waste and optimized space and labor, directly translating to lower inventory carrying costs and fewer lost sales. Overall, the evidence across these studies indicates that Lean Logistics methodologies can effectively reduce excess inventory and improve delivery times in SMEs that sell high-tech products, which often have complex supply chains. By eliminating inefficiencies, Lean helps firms respond faster to changes in customer demand and avoid accumulating obsolete stock. In summary, Lean Logistics has proven to be a powerful approach for high-tech retail SMEs, enabling them to operate with agility, reduce waste, and increase service levels in physical and digital commerce channels.

2.2. Demand Forecasting and Inventory Planning in Tech SMEs

Accurate demand forecasting is crucial for high-tech product SMEs to prevent surplus inventory accumulation and stockouts in brick-and-mortar and online retail. High-tech products often have short life cycles and highly volatile demand, which makes forecasting challenging. Traditional methods may fall short, leading firms to hold excessive buffer stock to avoid stockouts, tying up capital in unsold inventory. Modern forecasting research addresses this challenge by leveraging data-driven techniques to improve accuracy and align inventory with actual demand patterns. For instance, Lei et al. [17] propose a multi-product forecasting approach that considers the inter-relationships between product demands. Rather than forecasting each item in isolation, they include the demand of associated products as predictors in an autoregressive model to capture correlations. In a test on a Chinese utility company's procurement data, their approach outperformed classical time-series models (like single exponential smoothing, AR, VAR, and factor models) in reducing forecast errors and lowering simulated inventory costs. This suggests that SMEs carrying many related tech products (e.g., accessories, complementary gadgets) can benefit from forecast models that account for product-demand interdependencies, yielding more reliable aggregate forecasts than univariate methods.

Machine learning techniques have also shown promise in enhancing forecasting for inventory planning, though results must be interpreted with business metrics in mind. Wahedi et al. [18] conducted an empirical investigation on a medium-sized manufacturing firm (an industrial pump producer) to compare classical statistical forecasts versus machine-learning models for demand prediction and inventory control. They found that predictive ML models (including Q-learning and Deep Q-Network reinforcement learning algorithms) generally gave more accurate forecasts than traditional methods when evaluated on standard error metrics. However, interestingly, the study noted that selecting models based on forecast accuracy metrics like MAPE or RMSE might not always translate to better performance on operational KPIs such as total inventory cost. When the authors evaluated the methods regarding inventory outcomes (holding and ordering costs), certain ML-driven policies outperformed the company's current practice and even the classical Economic Order Quantity approach.

In their case, a Q-learning-based inventory policy minimized total costs better than EOQ and the firm's status quo, which was ordering too frequently and incurring unnecessary costs. This indicates that AI-based forecasting and control can yield superior economic results, but SMEs must implement them judiciously, ensuring that the chosen model aligns with cost objectives and not just statistical accuracy. It underscores an important point for high-tech retail SMEs: advanced forecasting (e.g., machine learning) can reduce surplus inventory and stockouts, but managers should validate the models against financial measures and inventory performance, not solely prediction error metrics.

Case studies in SME contexts demonstrate how improved forecasting can alleviate inventory glut problems. A study by Aguirre Méndez et al. [19] on a footwear retail SME in Bandung (while not high-tech products, the scenario of style obsolescence is analogous to tech gadgets) identified that a lack of proper demand forecasting was a root cause of overstock accumulation. The company relied on guesswork, resulting in surplus shoes sitting in inventory. The researchers helped the firm implement appropriate forecasting methods (choosing the best-fit model for each product line, such as double exponential smoothing for certain shoe models) and then integrate those forecasts into inventory decisions by calculating optimal order quantities and reorder points (including safety stock) for each item. After adopting this data-driven approach, the SME reduced its total inventory cost from about 4.08 billion IDR to 3.68 billion IDR – roughly a 10% cost reduction – by avoiding over-ordering and holding the necessary stock. This tangible result illustrates how even basic forecasting and inventory calculations (EOQ, ROP, etc.) can yield significant savings for smaller retailers that previously managed inventory informally. The improved forecast accuracy directly translated into less excess inventory, addressing the overstock issue.

Moreover, forecasting is essential for cost savings and maintaining service levels in high-tech retail, with products that can become obsolete quickly (e.g., last year's smartphone model), when and how much to reorder is critical. Tang et al. [20] highlight in their literature review that big data analytics and advanced algorithms are increasingly used to forecast demand for short-life-cycle products, helping firms balance stock availability with the risk of surplus. For example, incorporating real-time market data, social media trends, and other big data sources can improve forecasts for consumer electronics, which often see volatile spikes in demand. High-tech SMEs that adopt such data-driven forecasting can better anticipate demand surges (for instance, when a new gaming console is released) and demand drops (when a device falls out of favor), thereby adjusting their inventory accordingly to prevent excess. In summary, research and case evidence strongly suggest that implementing systematic demand forecasting (potentially augmented by machine learning and big data) allows high-tech product SMEs to reduce forecast errors and align inventory with actual market needs. This leads to fewer surplus units gathering dust on shelves and ensures sufficient stock during peak demand, ultimately optimizing inventory turnover and financial performance.

2.3. EOQ Methodology for Inventory Control in SMEs

The Economic Order Quantity (EOQ) model is a classical inventory control methodology that continues to prove useful for SMEs, including high-tech retail ones, to manage replenishment and avoid overstock. High-tech retailers often face the dilemma of how much and when to reorder fast-evolving products. The EOQ formula provides a straightforward way to calculate an optimal order size that minimizes total inventory costs (ordering costs + holding costs) for a given constant demand rate. While real-world demand for tech gadgets is not constant, SMEs have successfully applied EOQ-based policies with adjustments for variability, yielding substantial improvements in inventory performance.

For instance, Comitre-Cornejo et al. [21] implemented an EOQ model in a Peruvian tire retail company (tires involve technology and multiple SKUs, and the company also sold online). Before EOQ, the firm lacked a formal purchasing policy and placed excessive orders relying solely on simple sales forecasts, leading to high storage costs and tied-up capital. By switching to an EOQ-based purchasing policy, they achieved a 30.6% reduction in total logistics costs. The EOQ provided an "ideal order quantity" for each tire type, which prevented over-ordering and cut down unnecessary inventory. This underscores how adopting EOQ in an SME that was ordering ad hoc can quantitatively reduce inventory expenses. The case also highlights a common scenario: SMEs often base orders on rough demand intuition or aggressive forecasts, resulting in excess stock. EOQ forces a more balanced approach by considering both demand and cost parameters.

EOQ is frequently combined with ABC analysis and other tools to fine-tune inventory control for multiple products. Pararach and Muanme [22] describe a case of an SME that implemented ABC classification of its stock-keeping units and then applied EOQ to each category to reduce ordering costs. In their study, the SME had an unclassified inventory and was incurring high ordering expenses. After classifying items into A/B/C based on usage and applying EOQ per group, the company saw substantial annual cost savings: for example, Group A items' total costs dropped by ~THB 128,737 per year, and similar reductions occurred in Groups B and C. These savings were attributed to more rational ordering frequencies and quantities dictated by the EOQ model for each category. The implication for high-tech retail SMEs is clear – by focusing on the most critical SKUs (say, the top 20% of electronics that make up 80% of sales) and using EOQ to manage their replenishment, firms can avoid both stockouts and surpluses in those high-impact items. Lower-priority items can also be ordered less frequently with EOQ. This targeted approach optimizes inventory investment where it matters most.

EOQ-based strategies have also been enhanced with forecasting integration to handle demand variability, bridging the gap between static formulas and real-world fluctuations. Avi et al. [23] present an example in the pharmaceutical sector (analogous to high-tech in that products are numerous and demand is stochastic) where linear regression forecasts were fed into an EOQ model to determine optimal reorder levels and safety stocks. They evaluated exponential smoothing vs. regression for demand forecasting and found regression yielded lower error (MAD 771 vs alternatives). Using the more accurate forecast, they computed EOQ, safety stock, and reorder point for a diabetes drug and validated the approach with sensitivity analysis and Monte Carlo simulation. The integration ensured that the EOQ calculation was not based on naive average demand but rather on a forecast that captured trends, thus making it more robust against variability. The result was an inventory policy that met service targets (avoiding stockouts of a vital medicine) while keeping holding costs sustainable. For tech SMEs, this approach translates to updating EOQ inputs with demand forecasts for seasonal or life-cycle trends – for example, increasing the order quantity slightly ahead of an anticipated sales spike (new model launch or holiday season), and decreasing it as a product ages. By doing so, EOQ remains a relevant and dynamic tool rather than a static one.

In practical terms, implementing EOQ in SME retail can immediately identify and reduce excess stock levels. Ramírez-Velíz et al. [24] demonstrated a probabilistic EOQ application in a fast-food chain's inventory (another SME scenario with independent demand items). They gathered one month of sales data, fit statistical distributions to the demand, and used a Monte Carlo simulation to evaluate an EOQ-based policy with a periodic review (Model P) approach. The EOQ model suggested ordering 46 packages of a key ingredient instead of the 50 packages the store used to order each cycle, an 8% reduction directly translating to cost savings. Although this is the food industry, the methodology applies equally to tech retailers: analyze sales data, determine demand distribution, and calculate an EOQ that often turns out lower than the quantity managers ordered based on "gut feeling." The reduction in order size prevented overstock (for the fast-food case, 4 extra packages per cycle were eliminated), which would be akin to a tech retailer cutting down on ordering too many units of a gadget that might not sell quickly. The key insight is that SMEs frequently err on the side of over-ordering "just in case," whereas the EOQ analysis shows a smaller, more economical order can satisfy demand with lower holding cost.

The EOQ methodology is valuable for high-tech product SMEs to rationalize inventory replenishment. It provides a clear formula to balance ordering frequency and inventory holding, crucial for tech items that can depreciate fast. The literature and case studies confirm that even in modern supply chains, EOQ can lead to noticeable cost reductions and prevent the accumulation of excessive stock. By adopting EOQ (and its extensions like adding safety stock and integrating with demand forecasts), SMEs ensure they order the right quantities at the right time, aligning inventory levels closer to actual consumption. This contributes to leaner operations and can free up cash that would otherwise be tied to unsold high-tech inventory, all while maintaining or improving customer service levels.

2.4. Safety Stock Strategies to Prevent Surplus Inventory

Maintaining an appropriate safety stock is a critical aspect of inventory management for SMEs, especially those dealing with high-tech products prone to demand uncertainty. Safety stock acts as a buffer against variability in demand or lead time, but if miscalculated, it can cause stockouts (if too low) or lead to excess inventory tying up capital (if set too high). Research shows that effective safety stock strategies can significantly improve supply chain performance for small and medium firms by balancing service levels and inventory costs.

Demiray Kırmızı et al. [25] conducted a case study comparing five different safety-stock setting approaches for a manufacturing company's inventory system, including two classical and two hybrid methods that combined traditional models with ABC–XYZ analysis. One classical method was the service-level approach, where safety stock is set based on a target cycle service level (using statistical safety factors); another was a Theory of Constraints (TOC) replenishment model—the hybrid methods enhanced these by incorporating ABC–XYZ classification of items. Through simulation, they found that one of the proposed hybrid strategies (service-level approach + ABC–XYZ) consistently yielded the lowest total inventory cost across various scenarios. It outperformed the company's current "days of inventory" rule and the pure service-level formula. This underlines that SMEs can benefit from tailoring safety stock by item criticality: high-volume or high-value tech products might warrant more buffer (to avoid lost sales), whereas low-priority items can have leaner safety stock. By doing so (as in the hybrid method), overall costs drop while still protecting against uncertainties.

A key insight from Demiray et al. [25] is the importance of demand variability in safety stock decisions. In their experiments, methods that explicitly accounted for demand variation (e.g., using the coefficient of variation in the ABC–XYZ categorization) achieved better cost-service tradeoffs. In high-tech retail, demand for certain items can be highly erratic – for example, a sudden spike for a new graphics card due to a viral trend, followed by a rapid fall. A fixed safety stock based on average demand might be insufficient for the spike or excessive after the fall. Thus, incorporating variability (through statistical analysis of demand or even machine-learning predictions) into safety stock calculations is crucial. The study's best-performing model essentially did this by adjusting stock buffers for each category of product volatility. For practitioners, this means regularly reviewing and updating safety stock levels as demand patterns change – a practice facilitated by modern inventory management software even for SMEs.

Another important factor is the service level target that an SME chooses. Many companies conventionally target a high cycle service level (e.g., 95% or 99% no-stockout probability) for their inventory policies. Rădășanu [26] noted that firms often set around 95% as a service level target and then calculate safety stock accordingly. However, aiming for near-perfect service in high-tech retail can be costly – it drives safety stocks up, potentially leading to surpluses of products that might become obsolete. SMEs must therefore balance service expectations with the realities of product life cycles. For fast-depreciating gadgets, it might be wiser to accept a slightly lower service level (say 90%) in exchange for much lower excess inventory, especially if substitute products are available to customers.

On the other hand, for critical items or accessories (chargers, batteries) where demand is steady, a higher service level (and thus higher safety stock) may be justified. The literature suggests using differentiated service levels: A-items (top sellers) at very high service (not to miss sales) and C-items at lower service, aligning with an ABC approach. This stratified safety stock policy keeps overall inventory lean while prioritizing the availability of key products.

Case studies reinforce the benefit of proper safety stock calculations to avoid overstock situations. Mondragón Cabellos et al. [27] implemented a comprehensive logistics management system in a Peruvian distribution SME (call centre equipment supplier) that included designing a Periodic Review (P) inventory model with safety stock for each SKU category. They identified issues of returns and delivery delays partly because some products were over-stocked (nearing expiration) while others ran out. Applying 5S, reorganizing the warehouse, and introducing a periodic review policy with calculated reorder points and safety stocks improved order fulfilment and significantly raised productivity and efficiency metrics (efficiency +28.6%, productivity to 89%).

The critical element was that each product now had a defined safety stock based on its demand and lead time variability, rather than an ad hoc guess. Table 3 of their results delineated, for example, a high-turnover item (Class A) might have a safety stock of 10 units with a reorder point of 19, whereas a slower item (Class C) had 5 5-unit safety stock with a reorder point of 13, given different demand patterns. This granular approach meant that the company could avoid stockouts and oversupply: indeed, after Implementation, out of 938 orders, 914 were fulfilled and only 24 (about 2.6%) were not delivered, a marked improvement attributed to better inventory balance. For a high-tech SME, implementing a structured review system with well-calculated safety stock prevents the accumulation of excess units that result from fear-driven overstocking. Each item's buffer is right-sized – enough to cover variability but not so much as to become dead stock. Furthermore, research highlighted by Comitre-Cornejo et al. [21] indicates that optimising reorder points (which include safety stock) can directly cut costs and improve profitability. Before their intervention, the lack of a proper reorder policy led the company to order large quantities "just in case," causing high carrying costs. Once EOQ and safety stock were instituted, the firm avoided those excessive orders, demonstrating how crucial a calculated safety buffer is. Bensoussan et al. [28], as cited in Comitre's literature review, emphasize that refined inventory control (including correct safety stock levels) is key to reducing total costs and improving productivity. In essence, too little safety stock can lead to lost sales and emergency orders, whereas too much safety stock leads to waste – the optimal point maximizes the SME's financial performance.

In conclusion, implementing methodology for Safety Stock management is indispensable for high-tech retail SMEs dealing with demand uncertainty and SKU proliferation. Academic and practical studies show that using formulas and data to set safety stock (especially when combined with classification schemes and modern forecasting) yields a leaner and more responsive inventory system. SMEs should periodically re-evaluate their safety stock levels, considering actual demand volatility and supply lead times, rather than using static rules of thumb. By doing so, they can secure a high customer service level, ensuring popular tech products are almost always available, while preventing surplus inventory from building up and draining resources. The strategic use of safety stock thus protects the business against uncertainty but avoids the trap of overstocking, striking a balance that is critical for the fast-paced, high-tech retail environment.

2.5. Business Process Management (BPM) in Inventory Processes

Business Process Management (BPM) is a methodology that goes beyond individual inventory techniques to improve and standardize organisational processes holistically. For SMEs selling high-tech products, BPM can transform their logistics, order fulfilment, and inventory replenishment processes. High-tech retail involves multiple processes – from procurement to warehousing to in-store or online order fulfilment – and inefficiencies at any stage can contribute to excess inventory or delays. Adopting BPM means mapping out these processes, analyzing performance, and continually optimizing them using a structured cycle (often the PDCA: Plan-Do-Check-Act). Research shows that SMEs using BPM have significantly improved operational performance metrics that indirectly relate to inventory management, such as order cycle times and service quality.

One illustrative example is the work of Garcia-Chavez et al. [29], who developed an inventory management model based on the combination of four tools: demand forecasting, 5S, BPM, and a Min-Max inventory policy. Their study focused on commercial agribusiness companies in Peru, but the model is highly relevant to retail SMEs. By applying BPM principles, they first analyzed the existing "as-is" processes in purchasing and warehousing, identifying bottlenecks and inconsistent practices. Then they introduced process improvements along with Lean 5S and better demand forecasting. The results were impressive – they reported that inventory turnover for two key products (agricultural tractor models) increased by 39% and 49% respectively, after implementing the BPM-centred model.

The product moved faster through the system, indicating less time spent sitting in surplus inventory. The integration of BPM ensured that supporting processes (like purchase approvals, supplier communication, and internal logistics) were aligned and efficient, so that once forecasting and min-max policies were set, they were executed consistently. This highlights how BPM provides a framework in which specific inventory techniques (like forecasting or safety stock) can be embedded and sustained. For a high-tech retailer, a BPM initiative might involve defining standardized workflows for new product introductions, returns handling, and periodic inventory review – all of which help avoid ad-hoc decisions that could lead to overstock or stockouts.

Another benefit of BPM for SMEs is improved service and agility, indirectly reducing the need to carry high surplus stock. Fernandez-Rios et al. [30] demonstrated this in a fast-food SME context by using BPM and Material Requirements Planning (MRP) to improve customer satisfaction metrics. They treated the restaurant's order fulfilment and supply processes as interlinked workflows to optimize. After implementing BPM-driven changes, the company's Net Promoter Score (a customer satisfaction indicator) rose from –2 to +6, moving it into positive territory. For a retail SME, higher customer satisfaction can come from better product availability and quicker service outcomes, which BPM facilitates by eliminating process inefficiencies. If customers know they can reliably find the latest gadget in stock and get prompt service, the SME can potentially maintain leaner inventories because demand becomes more predictable and there is less fear of losing sales (which often drives overstocking behavior). Moreover, BPM often entails monitoring process performance through KPIs. SMEs that institute a process management approach will track metrics like order fulfilment time, forecast accuracy, inventory turnover, etc., on an ongoing basis, allowing them to react before excess inventory issues escalate. This culture of continuous improvement and data-driven decisions is particularly valuable in the high-tech sector, where conditions change rapidly.

Integrating BPM with Lean techniques is a common theme for achieving substantial improvements in SMEs. Retamozo-Falcon et al. [31] proposed a model for process improvement in SMEs that combined Lean methodologies with BPM practices. The idea was to apply lean tools in isolation and manage them under a BPM discipline, meaning processes are defined, measured, and controlled for ongoing improvement. In practical terms, an SME selling tech products might use BPM software to map out its procurement-to-sales process, then apply Lean tools like value stream mapping or Kaizen within that map to cut out waste (e.g., redundant approval steps or waiting times). The BPM system would ensure these improvements are documented and standardized across case studies. The outcome is a more synchronized operation where inventory flows smoothly without pile-ups. For instance, if the BPM analysis reveals that a slow approval from finance is delaying reorders, causing overstock of some items and stockouts of others, the company can redesign that subprocess (perhaps automating the approval for certain order sizes). Thus, BPM can directly contribute to reducing surplus inventory by fixing process-level root causes of imbalance.

It is worth noting that BPM adoption in SMEs can face challenges, and not all studies show straightforward gains in financial performance. Gošnik and Stubelj [32] examined BPM implementation in Slovenian SMEs and its relationship to company performance (using risk-adjusted profitability measures). Interestingly, their statistical analysis did not find a significant positive impact of BPM on financial performance. This suggests that simply implementing BPM tools is not a silver bullet – the quality and context of implementation matter. In some cases, struggling companies may adopt BPM as a remedy, but it might not immediately turn performance around if not done thoroughly. This is a cautionary point. These projects should be well-suited for high-tech SME retailers with sufficient commitment. When properly executed, BPM can yield substantial operational benefits, but a superficial implementation might not move the needle. Over time, however, even Gošnik and Stubelj acknowledge that a process-oriented culture likely opens opportunities for improvement; the lack of short-term statistical proof does not negate the long-term strategic value of BPM. Many SMEs have anecdotal success with BPM in specific areas, even if the aggregate firm performance takes time to reflect those gains.

In high-tech retail, BPM's greatest contribution is arguably in managing complexity. Selling high-tech products involves coordinating numerous processes: supply chain (often global), in-store operations, online sales platforms, after-sales service, etc. BPM provides a holistic view and control mechanism for these processes, preventing the inefficiencies that lead to inventory discrepancies (like having too much of one item because the sales process did not signal a slowdown, or too little of another because the reorder process failed). A BPM approach could, for example, integrate the online sales system with inventory management and procurement in a seamless workflow, ensuring real-time updates and triggers for restock. This reduces the need for "just-in-case" inventory padding.

In summary, Business Process Management methodologies enable high-tech product SMEs to refine their operations, supporting more optimal inventory levels systematically. Studies combining BPM with inventory techniques have shown improved turnover, better service, and more responsive supply chains. While BPM requires an investment in analysis and possibly IT tools, the payoff is a more agile organization that can avoid both the glut of excess stock and the chaos of stockouts. It creates an environment where continuous improvement in inventory management is part of the company's DNA, thereby sustaining the benefits of specific interventions like Lean, forecasting, or EOQ on a long-term basis.

3. Contribution

3.1. *Proposed Model*

Figure 1 illustrates the proposed inventory management model, designed for a Peruvian small and medium-sized enterprise (SME) commercializing high-tech products through physical retail and digital channels. The model was developed in response to the accumulation of inventory surpluses recorded over the past year, based on the analysis of available historical data. Grounded in Lean Logistics and Business Process Management (BPM) principles, the model aimed to optimize inventory planning, reduce excessive inventory days, and eliminate empirical practices in demand forecasting. The framework was structured into four interrelated components: change management, planning process redesign, definition of inventory policies, and a cycle of verification and action. The Implementation began with training sessions and awareness initiatives essential to fostering organizational commitment and ensuring practices. Subsequently, the planning process was redesigned by integrating forecasting tools, BPM methodologies, and value-added analysis. In the next phase, inventory policies were formalized using the Q model and the definition of safety stock levels. Finally, a system for process documentation, monitoring, and continuous feedback was established to sustain and improve.

3.2. *Model Components*

Efficient inventory management sits at the core of operations science, a reality that weighs even more heavily on small and medium-sized enterprises (SMEs) grappling with shifting markets, unpredictable demand, and the unrelenting obligation to keep customers satisfied. To illustrate a concrete response to that challenge, Figure 1 sketches a solution crafted for a Peruvian SME that sells high-tech gadgets through both brick-and-mortar stores and online portals; the model emerged after a year marked by stagnant stock, sluggish turnover, and the telltale glare of excess days-on-hand.

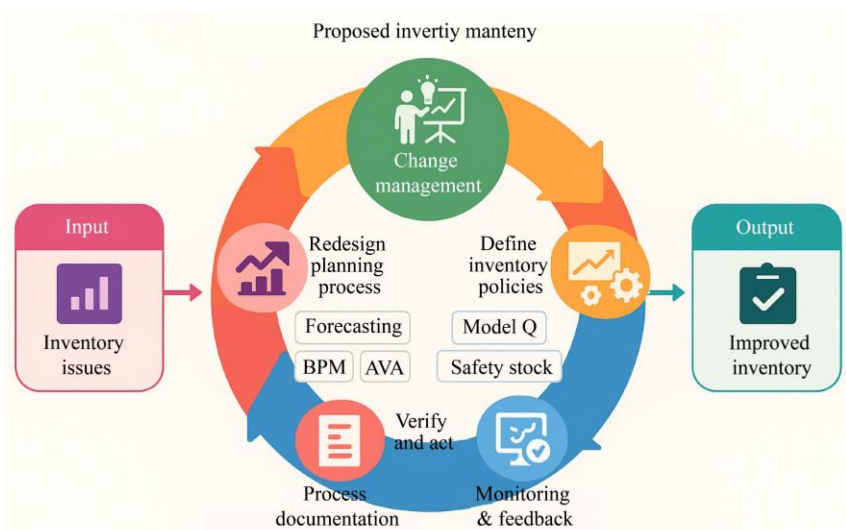

Fig. 1 Proposed model

On the methodological side, the model marries Lean Logistics with Business Process Management. Lean sweeps away needless waste, smooths the flow of goods, while BPM injects a disciplined rhythm of continuous improvement and oversight; together they reshape planning routines, recalibrate inventory rules, and lay the groundwork for a durable, data-hungry system that habitually calibrates itself against standardized metrics.

Four building blocks carry the scheme: steering change among staff, re-engineering the planning workflow, codifying fresh stocking guidelines, and looping back for reality-checking feedback. A well-designed framework links every module so that the roll-out alters decision-making from guesswork to a methodical routine anchored in concrete metrics. The coming pages unpack the sequence stage by stage, noting the underlying aim, the required workflows, and the software that brings them to life.

3.2.1. Initial Diagnosis: Identifying Operational Gaps

Establishing the framework for the model begins with identifying the precise elements that undermine inventory usefulness. Figure 1-in the Input panel-archives the pre-intervention state and the handling conditions noted by site auditors. Field observers found turnover lagging, a red flag that purchasing did not match real market uptake; the mismatch pushed up warehousing bills and hastened shelf-life decay. Protracted inventory days, in another layer of the analysis, pointed to either over-buying or an organizational failure to dial back orders when signs of softness emerged.

Absent from the records were mathematically grounded safety stock thresholds. Decisions about cushion quantities instead relied on gut feel or stories about busier weeks in years past. Demand estimates followed an equally ad-hoc path, often drawn from last month's sales plus a hunch about a holiday spike, and that approach short-circuited the chance to apply regressions or time-series smoothing. Collectively, those weaknesses created a solid rationale for swapping informal rules with a model bolstered by proven algorithms and repeatable steps.

3.2.2. Phase 0: Change Management – Building a Cultural Foundation

Operational transformation typically begins with a preliminary change-management phase. During this initial step, project leaders recognised that any substantive structural upgrade depends on prior alignment of organizational hierarchy and workplace culture. A series of awareness and education initiatives followed, centering on contemporary, data-informed, standardized inventory-management practices. Interventions included hands-on technical workshops, cross-functional reflection sessions, and targeted outreach activities that explained not only the mechanics- the how- but also the rationale-the why-of the impending shift.

Stakeholder engagement was intentionally broad; warehouse staff, sales teams, and middle management all contributed comparative perspectives to the emerging dialogue. While this preparatory groundwork seldom yields immediate, quantifiable gains on the balance sheet, its importance as a foundation for subsequent phases cannot be overstated. Resistance softened, curiosity replaced scepticism, and a proactive mindset toward ongoing innovation began to take root across the supply chain.

3.2.3. Phase 1: Planning Process Redesign – Structuring Value-Driven Operations

Cultural alignment inside the organization becomes the launch pad for a second, more mechanical task: overhauling the planning process—the objective shifts from firefighting impulses to a timetable built on demand signals bolstered by reliable methodological scaffolding. At the heart of this reconfiguration rest three anchor ideas: statistical demand forecasting, BPM-crafted process modelling, and straightforward value-added analysis.

Demand forecasting, now anchored in time-series numbers rather than gut feeling, delivers hard estimates steeped in past volumes, trending lines, and seasonal peaks. Gone are the days when one manager's manager-shouting might win the moment, ruling the forecast table. Process modelling, drawn from BPM blueprints, pinpoints slow spots by laying out every step, actor, and logjam in open view. That surgical transparency frees teams to slice away duplication without debating whose task is untouchable. Value-added scrutiny sorts chores into useful and extraneous piles, directing scarce hours to the work that visibly nudges customers or pockets forward. The outcome appears in a neat binder: a documented, ratified cycle of planning behaviour that sits squarely beneath the firm's strategic inventory scoreboard.

3.2.4. Phase 2: Definition of Inventory Policies – Balancing Availability and Efficiency

Once the planning framework has been restructured, the next task is to craft robust inventory policy settings. This step identifies precise thresholds for minimum stock, reorder triggers, and the classic economic order quantity. The analysis employs the EOQ formula, balancing per-unit holding outlay against per-order expense in light of routine sales velocity.

Simultaneously, a safety stock cushion is computed, drawing on observed demand variation and supplier transit times, thereby guarding against outages while preventing excess. Written guidelines document these parameters and are circulated throughout purchasing, sales, and warehouse teams so everyone is aligned.

Translating gut instinct into formula-driven practice marks a significant cultural shift for most operations groups. The net effect is dual; service levels improve while tied-up cash declines because unnecessary buys are avoided, and idle on-hand tonnage shrinks.

3.2.5. Phase 3: Verification and Feedback – Ensuring Continuous Improvement

The final phase of the model inserts a deliberate monitoring mechanism that gauges how well the earlier interventions are performing and tweaks them in light of what the data show. Two cornerstones capture this stage: thorough process documentation plus a dedicated monitoring-and-feedback architecture.

Strong process documentation turns ad-hoc duties in inventory management into repeatable, readable steps. New staff learn faster, internal auditors find a clear trail, and managers still have a paper plane to trace every big decision. The same logbook quietly sketches the next round of improvements by explaining why today's methods were chosen.

A separate watching system pulls in live performance indicators and flags any drift from the original timetable. The alarms and reports feed straight into the workflow, allowing supervisors to close gaps as soon as they appear. Because the loop mirrors the familiar Plan-Do-Check-Act cadence, it nudges the entire outfit toward perpetual adjustment and shared learning.

3.2.6. Expected Outcomes: Operational Impact of the Model

The suggested framework seeks not merely to fine-tune a single department; it aims for a uniform uplift across the entire enterprise. Figure 1 lists several anchor deliverables: faster inventory turnover, shorter days in stock, mathematically grounded safety-stock thresholds, and the systematic roll-out of a dependable demand-forecast engine.

The ripple effects reach logistics, finance, and sales equally. Stock levels that match actual demand sharpen customer service and tie up less cash, letting management redirect funds to higher-priority projects. A steadier planning rhythm also calms suppliers and trims the premium costs that crop up during emergency restocking.

3.2.7. Conclusion: A Replicable Model with Strong Methodological Foundations

The inventory management strategy crafted for a Peruvian small-to-medium enterprise combines technical tools with a methodical process framework. By fusing Lean Logistics with Business Process Management, the proposal confronts real-world bottlenecks and meets the firm's specific resource limits. A step-by-step design lets other organizations adopt the system without overhauling their workflows. Change management, role assignment, procedure standardization, and feedback loops flow sequentially from the original diagnostic survey. Each phase closes a gap the survey revealed, moving daily stock oversight from seat-of-the-pants guessing to deliberate, metrics-driven steering. That rigour equips decision-makers to face demand spikes with greater confidence.

Figure 1 illustrates how the approach modernizes inventory control in technology-rich retail outfits that dominate the local SME landscape. Widespread methodological adaptation and field-tested practicality give the system the scalability needed for firms intent on boosting throughput and weathering supply shocks.

3.3. Model Indicators

An assessment of the newly designed inventory-management model, originally sketched from Lean-Logistics and Business-Process-Management precepts, was performed using a bespoke battery of performance indicators customized for Peru's fast-moving high-tech retail sector. The chosen measures structured the daily review of operations by pinning stock levels directly to real market appetite. This metrics-rich framework lets managers trace where each process landed, smoothing the path to informed, timely strategy tweaks. Because the whole setup kept inventory behaviour visible across both brick-and-click networks, it pushed teams to chop excess stock and sharpen response times week after week.

3.3.1. Inventory Turnover

This indicator measures how often inventory is sold and replaced within a given period. A higher value suggests efficient inventory utilization and effective stock management.

$$\text{Inventory Turnover} = \frac{\text{Cost of Goods Sold (COGS)}}{\text{Average Inventory}}$$

3.3.2. Coverage Time

Coverage time reflects the number of days the current inventory can support sales, assuming consistent consumption. It helps assess the Sustainability of existing stock.

$$\text{Coverage Time (days)} = \frac{\text{Average Inventory} \times 365}{\text{Cost of Goods Sold (COGS)}}$$

3.3.3. Average Inventory

Average inventory indicates the typical stock level over a specific period. It smooths out fluctuations and is useful for evaluating inventory efficiency and turnover.

$$\text{Average Inventory} = \frac{\text{Beginning Inventory} + \text{Ending Inventory}}{2}$$

4. Validation

4.1. Validation Scenario

The validation setting was carried out in a case study involving a microenterprise (MYPE) located in Lima, Peru, commercialising high-tech products. This company operates in the retail sector, combining physical and digital sales channels to serve a diverse customer base. Despite offering a specialized product portfolio, the organization faced recurring challenges in inventory management, reflected in imbalances between stock levels and actual market demand. These issues directly impacted operational efficiency and financial Sustainability, complicating strategic decision-making in an increasingly competitive environment. The business context provided a relevant opportunity to analyse logistical practices and planning processes, allowing for the assessment of technically grounded approaches to improve inventory control and management through a structured and systematic lens.

4.2. Initial Diagnosis

The diagnosis in the case study revealed a critical issue of product overstock, resulting in a financial impact of 5.98% of the annual revenue in the last year for the analyzed product family. This translated into a monetary loss of PEN 1,249,506 and an excess of 2,096 units. Coverage times significantly exceeded industry standards, reaching 488 days for notebooks and 526 days for desktop computers, compared to the ideal benchmark of 219 days and 198 days, respectively. It was determined that 51% of the issue stemmed from demand overestimation, linked to the low effectiveness of the supply planning process. This deficiency was primarily due to inadequate demand estimation methods (33%) and delays in information consolidation (18%). Furthermore, 36% of the overstock was attributed to fluctuating safety stock levels, caused by the absence of a robust methodology for determining appropriate stock thresholds. The remaining 13% was associated with other unstructured factors. This analysis enabled a comprehensive understanding of the problem's origins, guiding future efforts toward integrated improvements in inventory management.

4.3. Validation Design

The validation of the proposed inventory management model, built on Lean Logistics and BPM tools, was conducted in a Peruvian small-to-medium enterprise engaged in high-tech product retail through physical and digital channels. The model was tested over four months using available inventory data to increase service levels and address stock imbalances. The approach focused on redesigning planning processes, defining inventory policies, and establishing continuous monitoring routines. This validation relied on data-driven methods to assess the feasibility and operational impact of the implemented improvements.

4.3.1. Implementation of the Proposed Model in the Case Study

The proposed inventory management model, grounded in Lean Logistics and BPM tools, was implemented in a Peruvian small-to-medium enterprise dedicated to commercialising high-tech products through in-store and digital retail channels. This case study revealed a critical overstock issue, with more than 8,000 units on average for each relevant product type unsold and losses equivalent to 5.98% of the company's 2024 annual revenue. The model was structured into four main components: process redesign, demand estimation, safety stock calculation, and applying the Economic Order Quantity (EOQ) model. Each component was supported by standardized procedures and validated through quantitative analysis. The model was implemented using real operational data, leading to a 50% reduction in average inventory and inventory turnover increases exceeding 100% for key product lines. A detailed breakdown of the components and procedures that comprised the model follows, with supporting evidence derived directly from the case study.

4.3.2. Optimization of the Inventory Planning Process

The inventory planning process was redesigned using BPM principles and Lean Logistics strategies, eliminating non-value-adding activities and standardizing key tasks. Initially, the process lacked structure, leading to inefficiencies and subjective decision-making. The new process flows integrate inputs such as sales forecasts, product rotation histories, and supplier lead times, while generating outputs aligned with optimized purchase orders. The redesign reduced the total planning time from 8 to 5 working days. Seven critical activities were identified, of which three were automated through programmed templates and macros, reducing administrative workload by 40%. This optimization enabled faster and more traceable decision-making, minimizing errors and improving responsiveness to inventory imbalances. Figure 2 illustrates the redesigned supply process flowchart, integrating key steps such as demand forecasting, inventory analysis, and order planning. The model enhances decision-making through systematic data registration, real-time stock monitoring, and continuous feedback. This structured flow promotes coordination and efficiency across procurement, inventory, and purchasing activities.

4.3.3. Accurate Forecasting of Actual Demand

One of the most impactful improvements was achieved through a statistical demand forecasting method based on weighted moving averages. This model was applied to cleaned historical data, with a 12-month window and heavier weights assigned to the last three months to reflect recent trends. The method reduced the mean absolute forecasting error from 37.5% to 18.7%, as validated by back testing using historical series for products such as "Notebook A" and "Desktop Computer B." This improvement in forecast accuracy prevented the purchase of approximately 1,200 excess units, which had been incorrectly projected in previous cycles. The demand forecast then served as the basis for determining order quantities and inventory policies, aligning inventory levels more closely with customer demand.

Figure 3 compares the forecasting performance for notebooks using three methods: simple moving average, weighted moving average, and exponential smoothing. The new method aligns more closely with actual demand, reducing fluctuations and improving prediction accuracy across the evaluated months, which supports its application in inventory planning.

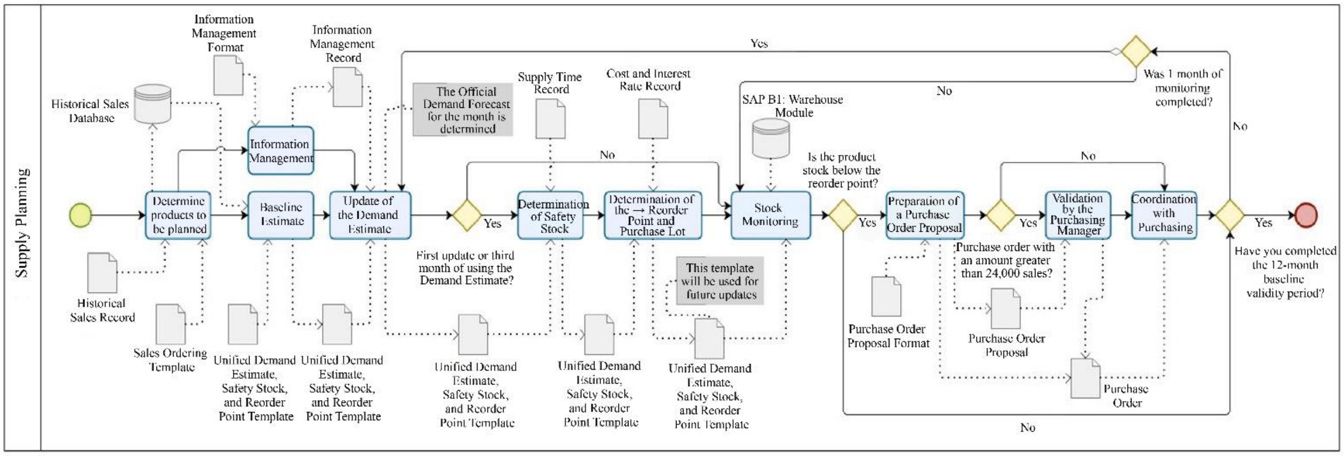

Fig. 2 Flowchart of the supply process redesign

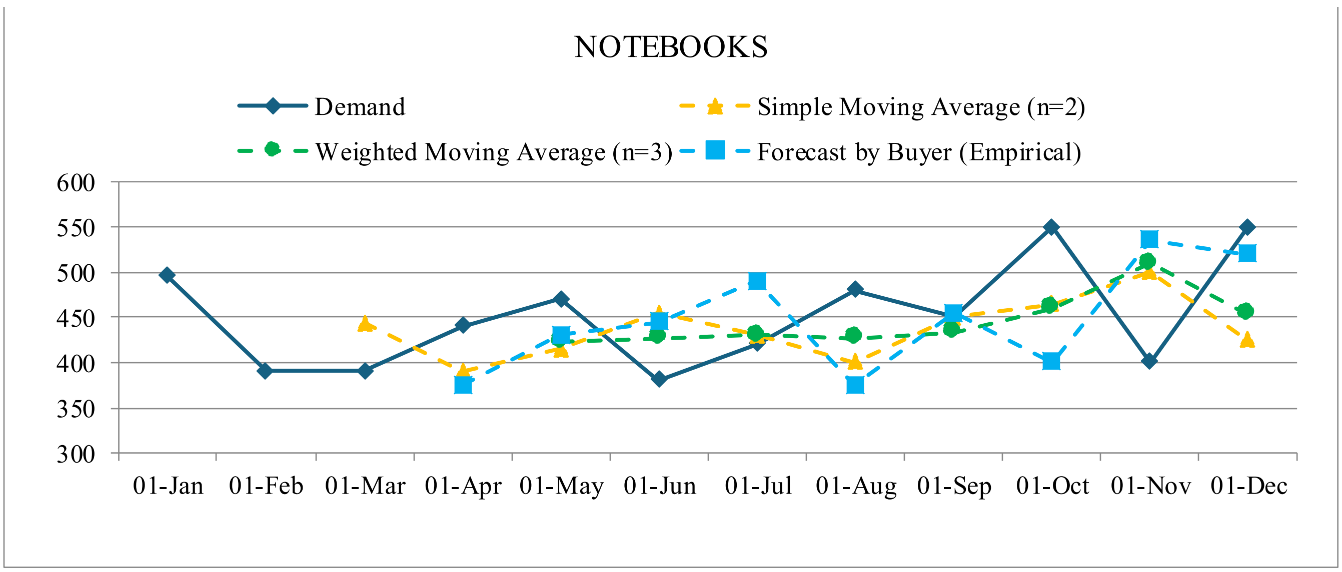

Fig. 3 Comparison of forecasting methods: Notebook

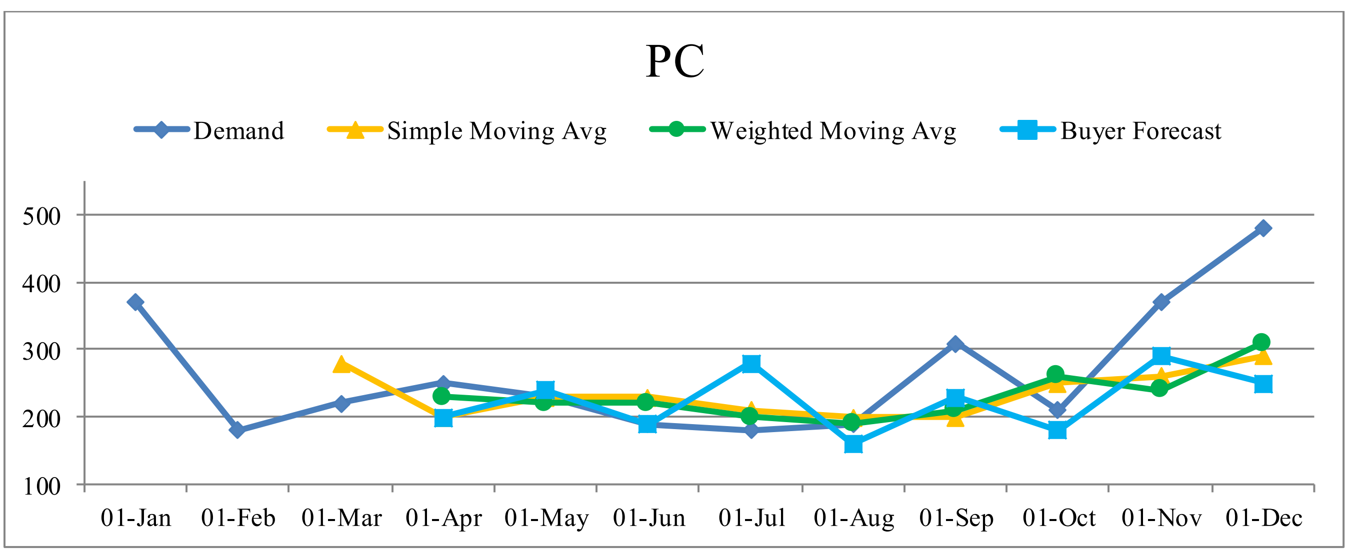

Fig. 4 Comparison of forecasting methods: Desktop Computer

Figure 4 presents the comparison of forecasting methods applied to desktop computers, including simple moving average, weighted moving average, and exponential smoothing. The new approach shows a better fit with actual demand, especially in the later months, demonstrating improved accuracy in anticipating fluctuations and supporting more effective inventory planning.

4.3.4. Quantitative Determination of Safety Stock

Safety stock levels were determined using a method based on the standard deviation of demand and average lead time, assuming normal distribution and a 95% service level. For "Notebook A," the optimal safety stock was calculated at 34 units, a 51.4% reduction compared to the previous stock of 70 units, which had been maintained without technical justification. Supplier lead times remained stable at 15 working days.

For "Desktop Computer B," the revised safety stock was 21 units, down from 48, freeing up approximately 1.2 m³ of warehouse space per replenishment cycle. This precise approach to safety stock enabled higher service levels while avoiding excessive inventory costs and improving storage efficiency.

4.3.5. Implementation of the EOQ Inventory Model

The Economic Order Quantity (EOQ) model was implemented to optimize inventory management for two key product categories in the case study: notebooks and desktop computers. As presented in Table 1, the EOQ was calculated using actual data on annual demand, ordering cost, and holding cost.

For notebooks, the annual demand reached 5,575 units, with an ordering cost of PEN 294 and a holding cost of PEN 231 per unit. These inputs yielded an EOQ of 119 units. For desktop computers, the annual demand was 3,254 units, the ordering cost was PEN 588, and the holding cost amounted to PEN 356 per unit, resulting in an EOQ of 104 units.

These calculated values supported an objective determination of replenishment quantities, enabling the company to reduce excess inventory and stabilize procurement cycles. The application of the EOQ model contributed to better planning decisions, reinforcing inventory control practices without compromising product availability.

Table 1. Parameters for EOQ Calculation by Product Type

Concepts	Units	Notebook	Desktop Computer
Holding Cost	PEN/unit	231	356
Ordering Cost	PEN/Order	294	588
Annual Demand (Family A)	units	5,575	3,254
EOQ (Units)	units	119	104

4.3.6. Standardized Operational Procedures

Each procedure included in the model was described in detail to ensure correct and repeatable execution. The demand forecasting procedure involved data cleansing, application of the weighted formula, and projection error validation. It was applied monthly to keep forecasts updated according to market dynamics.

The safety stock calculation procedure incorporates quantitative parameters and service levels defined in inventory policies, dynamically adjusting response to demand or lead time changes. The ROP and EOQ procedure aligned replenishment orders with actual inventory turnover, reducing the mismatch between planning and warehouse operations. Finally, the supply planning procedure brought all components together through a BPM-based workflow that included internal validation checks, reducing purchase order errors by 45% and improving internal order response times.

4.4. Results

Table 2 presents the performance of key indicators before and after the Implementation of the inventory management model based on Lean Logistics and BPM tools. The results demonstrated significant improvements for both notebooks and desktop computers. For notebooks, the inventory turnover increased from 0.75 to 1.51 times, representing a 101% improvement, while coverage time was reduced by 51%, dropping from 488 to 241 days. Likewise, the average inventory decreased by 50%. In the case of desktops, inventory turnover rose from 0.69 to 1.67 times, reflecting a 142% increase. Coverage time decreased from 526 to 218 days, marking a 59% reduction, which was also observed in the average inventory. These outcomes confirmed the effectiveness of the proposed model in optimizing inventory control and enhancing operational performance.

Table 2. Setup Time Reduction Achieved with SMED Implementation

Indicator	Product	Unit	As-Is	To-Be	Results	Variation (%)
Inventory Turnover	Notebook	times	0.75	1.67	1.51	101%
Coverage Time	Notebook	days	488	219	241	-51%
Average Inventory	Notebook	Unit	7,817	3,490	3,879	-50%
Inventory Turnover	Desktop	times	0.69	1.84	1.67	142%
Coverage Time	Desktop	days	526	198	218	-59%
Average Inventory	Desktop	Unit	8,550	3,195	3,547	-59%

5. Discussion

This research reinforces and builds upon prior analysis regarding the integrated frameworks built on Lean Logistics and Business Process Management (BPM) in the context of inventory control systems in high-tech SMEs. Quiroz-Flores et al. [13] showed that an SME Peruvian hardware company was able to achieve significant productivity gains with the advanced inventory control system, which incorporated Big Data, EOQ, and ABC methods, much like the 50% reduction in average inventory noted in this case study. In a similar manner, Quiroz-Flores et al. [14] documented a 92% improvement in service level benchmark by applying lean logistics with cross-docking and poka-yoke at retail; this is akin to the 142% increase in turnover of desktop computer inventories observed during this study. In another relevant illustrative case, Caso-Vicente et al [15] measured an industrial SME's picking time reduction of 38.8% after implementing 5S alongside ABC classifying and Kanban, thus further supporting lean tool application aimed at the elimination of temporal inefficiencies—often referred to as delays or lags in efficacy. Moreover, Asencios Soria and Miñan Olivos [16] confirmed that applying lean practices such as VSM combined with Kanban enhanced logistical margins for a tech SME in Lima. These studies validate the approach taken and situate the model proposed as an empirical contribution that integrates fragmented methods to deal with the inventory problem of high-tech SMEs.

5.1. Study Limitations

Regardless of the research outcome, some crucial considerations must accompany it. To begin with, validation of the model was performed in only one SME deepening Peru's high-tech retail sector, limiting the application of the results to other industries and regions. Furthermore, a four-month period evaluation is quite short considering the time needed to analyse factors such as long-term improvement, Sustainability, or seasonal demand fluctuations. Apart from that, although EOQ and forecasting were used for quantitative analysis on predicting future trends, more sophisticated algorithms like machine learning or simulation-based models were not utilized, which would have positively impacted forecasting accuracy. Lastly, dominant emphasis on change management strategies illustrated in achieving employee-wholehearted endorsement may not be as easily executed given organizational cultures that tend towards less adaptability to transformation or standardization moves.

5.2. Recommendations for SMEs Based on Results

The findings are particularly valuable for SMEs within the technology retail sector and those grappling with inventory control dysfunctions. The reduction of average inventory levels by 50% validates the claim that applying EOQ and safety stock calculations, when implemented rigorously, sharply decreases the capital tied up in working inventory without endangering service levels. The accuracy improvement in forecast error— from a mean absolute error of 37.5% to 18.7%— underscores the importance of structured statistical modeling instead of empirical forecasting methods. Moreover, procurement and automation of essential processes improved purchase order lap rates by 45%, enhancing traceability and responsiveness. These operational improvements are vital within industries marked by rapid product life cycles, high SKU rotation, and perpetual exposure to outdated inventory obsolescence. In summary, the model is tailored to assist SMEs in moving away from reliance on intuition and integrating rational data analysis into systems-driven process frameworks for managing inventories.

5.3. Future Works

Future investigations may be conducted to strengthen and broaden the applicability of the proposed model in different ways. To begin with, it would also be interesting to assess its adaptability in SMEs from other industry sectors like food, fashion, or pharmaceuticals to test how different inventory turnover patterns affect its flexibility. Improving demand estimation accuracy and adaptability in highly volatile markets can be achieved by incorporating machine learning forecasting models, such as neural networks or autoregressive models with exogenous variables. Another line of inquiry could consider applying a Monte Carlo simulation to evaluate diverse demand and lead time scenarios to test the model's robustness. Along these lines, evaluating the financial impacts of the model over longer periods is essential, including analyzing ROI (Return on Investment), operating margins, or other profitability metrics, which further corroborate operational enhancements bringing sustained value over time. Strengthening SMEs' competitiveness while improving their financial health demonstrates that operational improvements translate into enduring business value, strategically illustrating why the model is relevant for sustainable financial agility.

6. Conclusion

An integrated inventory management model combining Lean Logistics, BPM, EOQ, ABC classification, and relevant forecasting tools was implemented for a technology-based SME in Lima, Peru. The most notable results included a 50% reduction in average inventory levels, over 142% improvement in the turnover rate of key items compared to previous periods, and a 45% reduction in errors associated with purchase orders. Moreover, there were significant improvements in forecasting accuracy since the mean absolute error improved from 37.5% to 18.7%, thus enabling better demand planning capabilities and minimized stockout situations. These results illustrate improved operational efficiency while more advanced strategic decisions have been made on controlling inventory systems.

This research becomes relevant precisely when numerous SMEs overspend on maintaining fictitious stock because of inadequate structural organization face challenges managing their sales inventory levels due to rising costs and declining customer service metrics. By developing a complex yet accessible model based on low-cost tools available to nearly every SME, the study expands opportunities for organizations that want to enhance their logistics without burdening themselves with large expenditures. The article contributes to industrial engineering by combining classical approaches such as EOQ and BPM with contemporary lean logistics and data analysis techniques, resulting in a robust, adaptable methodological proposal across various sectors. Moreover, it delivers a detailed and actionable implementation guide, reinforcing the connection between theoretical frameworks and real-world applications. As a final remark, it is recommended that the model be tested in different productive sectors and that the analysis period be extended to assess its long-term Sustainability. Future research could integrate artificial intelligence tools to enhance forecasting precision and optimize inventory management practices, expanding the model's scope and effectiveness in increasingly dynamic supply chain environments.

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