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Original Article

Lean Warehousing in FMCG Logistics: Measured Gains from Cycle Counting and 5S-Peruvian 3PL Case Study

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Abstract - *The textile industry has long struggled with achieving high production efficiencies while simultaneously securing product quality, primarily owing to fragmented process controls and endemic inefficiencies. Previous literature has introduced isolated corrective measures, yet weaknesses in overarching workflow optimization persist. The present investigation sought to fill these voids by formulating and executing a holistic improvement framework that marries Lean Manufacturing principles with ergonomically informed workplace redesigns, thereby both rationalizing process flows and upgrading employee environments. Strategic interventions advanced by the study included the codification of process parameters, the iterative reconfiguration of workstations, and the refinement of inventory control methods. Quantitative appraisal revealed a 17-per-cent uplift in throughput, a 12-per-cent decline in product defects, and a 20-per-cent contraction in waiting times, thereby corroborating substantial efficiency gains. These results highlight the framework's dual capacity to fortify operational competitiveness and to enhance worker health. Scholarly contribution is attained by demonstrating a repeatable methodology suited to small and medium-sized enterprises. The study's achievements invite ongoing investigation into the adaptation of such integrative frameworks for scalable, sustainable advancement across the textile sector.*

Keywords - *Lean Warehousing, Cycle Counting, 5S Methodology, Inventory Accuracy, Order Picking Efficiency, OTIF.*

1. Introduction

Third-Party Logistics (3PL) providers have become the connective tissue of Fast-Moving Consumer Goods (FMCG) supply chains. In Latin America—and particularly in Peru—logistics operators increasingly shoulder not only transportation and storage but also value-added activities such as inventory administration, picking/packing, labeling, and documentation, which raises their direct impact on service levels and competitiveness across the region [1]. Recent research on how 3PLs evaluate warehouse attributes further underscores that warehouse design and operational features (layout, picking methods, slotting policies, visual management) are tightly coupled with performance and customer value creation, a linkage that is central for FMCG operations with high volume and volatility [2].

FMCG distribution magnifies every inefficiency inside the warehouse. Short product life cycles, promotional peaks, and broad assortments mean that small errors quickly scale to thousands of order lines. Order picking remains the costliest and most labor-intensive warehouse activity; design and control decisions (storage assignment, routing, batching, zoning) therefore dominate the total cost of warehouse operations and strongly influence service reliability [3]. Performance frameworks consistently recommend tracking a compact set of metrics—inventory record accuracy, order picking productivity and quality, damages/non-conformities, documentation errors, and On-Time-In-Full (OTIF)—to connect floor-level improvements with distribution performance and, ultimately, business results [4].

Against that backdrop, four pain points frequently undermine FMCG logistics operators in Peru and the wider region. First, Inventory Record Inaccuracy (IRI) creates mismatches between book and physical stock, causing unexpected stockouts or overstock, lost sales, and rework across receiving, replenishment, and picking. Empirical evidence from distribution centers shows that cycle counting materially improves accuracy and stabilizes warehouse performance, provided the policy is sized to the warehouse's operating category and workload [5]. Second, the cost and staffing of cycle counting itself can be non-trivial; quantitative models demonstrate how to balance frequency, item classes, and labor to keep control costs from eroding the benefits of accuracy gains [6]. Third, picking inefficiency—often driven by suboptimal slotting and routing—expands travel time, amplifies congestion, and increases errors; bi-objective storage assignment policies show how to raise picking efficiency while safeguarding stock integrity, especially for sensitive or fast-moving items [7]. Fourth, documentation control at dispatch (invoices, shipping labels, transport guides) frequently depends on manual checks and fragmented workflows; within a lean view of warehouse waste, such paperwork defects are a visible "last-mile" waste that triggers customer complaints, returns, and administrative rework [8].

Why does it matter to tackle these issues together rather than piecemeal? Because warehouse improvements transmit their effect to distribution and business performance through operational mediators: less waste on the floor improves warehouse performance, which then lifts distribution reliability and, finally, commercial outcomes [9]. In FMCG networks—where every extra minute in consolidation or each misprinted label may affect dozens of orders—integrated fixes are the difference between merely coping and consistently hitting OTIF. Moreover, resource-constrained operators need prioritization logic: pairing lean warehousing diagnostics with quantitative evaluation helps translate "good practices" into a minimal set of interventions with measurable payoffs in time, labor, and reliability [4], [10].

The academic literature provides strong building blocks but leaves a practical gap for Latin American FMCG 3PLs. Classical and contemporary studies offer deep guidance on picking design and control [3], robust measurement systems for warehouse performance [4], cost models for cycle counting [6], and prescriptions for eliminating warehouse wastes [8], while recent work connects warehouse features to 3PL performance perceptions and choices [2]. Yet, few studies assemble these pieces into a single, implementable architecture that simultaneously (i) raises inventory accuracy via risk-based cycle counting, (ii) tightens in-warehouse quality control (receiving, storage, dispatch) with 5S, visual controls, and simple poka-yokes, (iii) improves picking through demand-driven slotting and standardized routes, and (iv) stabilizes dispatch documentation through standardized work and visual checklists—precisely the quartet of problems that FMCG operators in Peru encounter daily. In short, the parts are known; the integrated, field-ready playbook tailored to regional 3PL realities is not.

This article addresses that research gap by proposing and motivating an integrated Lean Warehousing model for FMCG logistics operators. The core is straightforward and pragmatic: anchor physical discipline with 5S and standardized work to reduce variability and make abnormalities visible, then secure inventory accuracy with cycle counting sized by SKU criticality and risk; on that stabilized base, apply slotting and simple picking rules to strip travel waste, and deploy visual documentation controls to prevent paperwork defects. The novelty lies in the choreography, not in any single tool: by sequencing and coupling the interventions, the model seeks system-level gains in OTIF, picking productivity (lines/hour), accuracy (errors per thousand lines), documentation defects, and IRI. This aligns with evidence that order picking decisions dominate cost and reliability [3], that accuracy initiatives must be economically grounded [6], that storage assignments can balance efficiency and stock safety [7], and that lean waste reduction inside the warehouse is the lever through which distribution and business performance improve [9]. To support adoption and sustainment, the model incorporates standardized work and ergonomic design to cut learning time, reduce quality variation, and make improvements stick across shifts in labor-intensive settings common to Peruvian 3PLs [10].

In comparison with prior studies, the contribution is twofold. First, it integrates proven elements—cycle counting for accuracy [5], [6], slotting and picking control for travel and errors [3], [7], waste elimination and documentation discipline for last-mile reliability [8], [9]—into a compact blueprint geared to FMCG operators rather than to single-firm, technology-heavy settings. Second, it operationalizes measurement: the model ties each intervention to a small set of hard indicators (IRI, OTIF, lines/hour, defect rates) consistent with recognized warehouse performance frameworks, which facilitates before-and-after evaluation and benchmarking [4]. The ambition is practical: to offer a replicable path that a Peruvian 3PL can deploy in months—not years—while generating quantifiable improvements that compound across inventory accuracy, picking, quality, and documentation.

2. Literature Review

2.1. Lean Efficiency in Logistics Warehouses (Lean Warehousing)

Lean warehousing operationalizes lean principles within warehouse environments to eradicate waste and non-value-adding tasks, raising both throughput and service quality. An investigation with a third-party logistics provider revealed that 40% of total processing time was attributable to non-value-adding steps. The integration of the Lean Six Sigma DMAIC framework redressed these inefficiencies, yielding an overall efficiency uptick to 70% alongside measurable enhancements in customer contentment [11]. Parallel inquiries involving a Peruvian logistics small-to-medium-sized enterprise employed 5S, Kanban, and harmonized work procedures to elevate the On-Time In-Full (OTIF) delivery metric from 67% to 77% [12]. Such findings are in alignment with a broader body of literature indicating that disciplined waste attenuation within warehousing fosters gains in both internal throughput and downstream service quality [9]. A methodological review concentrating on Lean Warehousing in transportation SMEs outlined that the adoption of continuous flow, refined spatial organization, and visual management protocols led to reductions in order-picking time of as much as 25% [13]. In the electronics retail domain, Lean Warehousing was leveraged to streamline material circulation, mitigate congestion in picking zones, and elevate operator throughput [14]. Collectively, these investigations affirm that Lean Warehousing produces quantifiable advantages for logistics firms of differing scales by amplifying operational efficiency, curtailing delay, and bolstering customer satisfaction.

2.2. Order and Cleanliness: The 5S Methodology in Logistics Operations

The 5S methodology offers a disciplined approach to ensure that workspaces—particularly warehouses—remain tidy, hygienic, and safe, thereby enhancing overall logistics performance. Within a Lima-based hardware enterprise, the deployment of 5S raised the usable area of the warehouse by 12.62%, improved operational efficiency by 4%, and lifted effectiveness by 8.4% [15]. A systematic review of 40 investigations conducted across the Latin American construction industry verified that 5S serves as a critical instrument for sustaining order and streamlining the accessibility of materials [16]. In the packaging industry, the implementation of 5S eliminated poorly stored spare parts, reduced damage, and improved signage, increasing 5S audit scores from 1.82 to values close to the optimal standard [17]. Furthermore, an integrated 5S+ABC model in a commercial company reduced material search time from 216.7 to 148.8 minutes and improved warehouse organization levels by 47% [18]. Evidence supports that 5S, combined with discipline in sustaining it, generates sustainable improvements in productivity and the quality of logistics services.

2.3. Cycle Counting: Continuous Accuracy in Inventory Management

Cycle counting allows for the detection and correction of inventory discrepancies on an ongoing basis, avoiding the disruptions caused by a full physical inventory and improving data reliability. An analysis in distribution centers showed that even low levels of inventory record inaccuracy affect productivity and space utilization, and that regular cycle counting significantly reduces these discrepancies [5]. Barratt et al. found that in multi-channel operations, inventory discrepancies occur daily, often biased toward physical shortages, which cause unexpected stockouts [19]. The systematic implementation of cycle counting has been shown to prevent the progressive deterioration of inventory accuracy and to improve service levels [20]. Additionally, it is recommended that it be integrated with Warehouse Management Systems (WMS) to schedule counts based on item criticality, such as the ABC method [21]. This practice is established as a permanent control mechanism that enhances accuracy, operational efficiency, and customer satisfaction.

2.4. Process Standardization: Operational Consistency in the Supply Chain

Process standardization establishes a consistent operational method across activities, thus minimizing variability and enhancing service quality. For example, in a pharmaceutical distribution center, a lean warehousing management framework incorporating standardized operations elevated the proportion of orders delivered without any discrepancies—the “perfect order” metric—from 85% to over 95% [20]. Within the footwear sector, the absence of standardized procedures yielded extended cycle times and recurrent errors; the subsequent introduction of standardized work instructions and detailed process mapping yielded notable gains in throughput and a decline in defect rates [21].

In a contemporary e-commerce fulfilment center, the joint implementation of process standardization, error-proofing (poka-yoke) mechanisms, and automated handling reduced overall cycle time by 23% and simultaneously doubled the percentage of time spent on value-creating activities [22]. Moreover, in Peruvian logistics companies, standardization has been shown to simplify staff training and facilitate the identification of improvements through Kaizen cycles [23]. In this way, it establishes a solid foundation for continuous improvement and the integration of new technologies.

2.5. Continuous Improvement (Kaizen): Small Changes, Big Impacts in Logistics

The Kaizen approach promotes daily and sustainable improvements in processes by involving all staff members. In a courier company, the combination of Kaizen with 5S and Kanban generated a more organized, efficient, and standardized environment, improving package sorting and zoning [23]. In the wood industry, the application of Kaizen Costing reduced production costs through successive improvements in critical processes such as drying and pressing [24]. In a Peruvian materials distributor, Kaizen events increased OTIF from 69.3% to 87% in four months, reducing downtime and dispatch errors [25]. Finally, theoretical studies indicate that Kaizen is key to systematically eliminating waste and simultaneously improving time, cost, and quality. In logistics, this translates into optimized picking routes, less rework, and greater operational agility, strengthening the competitiveness of logistics operators.

3. Contribution

3.1. Proposed Model

Figure 1 depicts a warehouse management model aimed at elevating service levels through the harmonization of three fundamental activities: product storage, order picking, and the issuance of dispatch documentation. The workflow commences with product storage, where cycle counting is employed to enhance inventory record precision and uphold quality control. Upon reaching the order picking segment, the focus shifts to refining the expediency with which ordered items are retrieved and sequenced for dispatch. The final phase, dispatch documentation issuance, is dedicated to simplifying document generation while safeguarding data integrity, thus promoting a smoother logistics continuum.

Within the domains of order picking and documentation issuance, the 5S principles (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke) are rigorously applied to cultivate an environment of organization, cleanliness, standard operating procedures, and disciplined practice. This disciplined atmosphere mitigates the likelihood of errors and ensures that lead time commitments are consistently met. The model, therefore, traces an evolution from sporadic to streamlined inventory management by embedding Lean Warehousing methodologies that govern processes, eliminate waste, and empower the delivery of a more dependable and expedited service to the end customer.

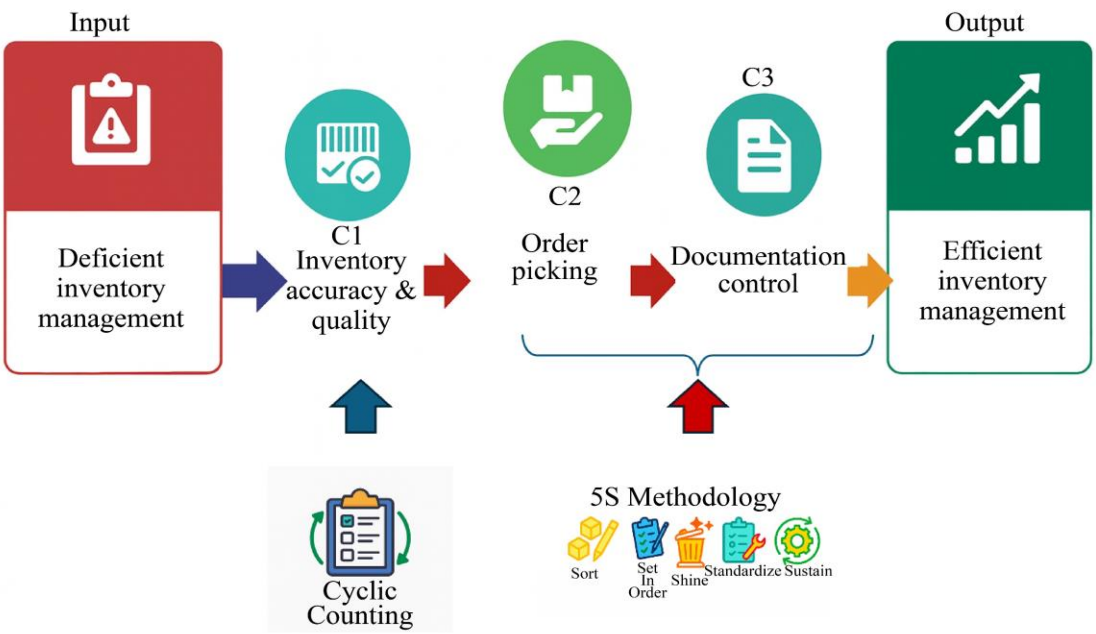

Fig. 1 Proposed model

3.2. Model Components

3.2.1. Introduction to the Proposed Model

Figure 1 illustrates an all-encompassing inventory management framework crafted in accordance with Lean Warehousing principles, aimed at enhancing both service quality and operational reliability within a logistics provider delivering transportation and supply-chain management solutions. The framework has been formulated as a deployable, cohesive design that confronts the recurrent difficulties observable within multi-client distribution centres, where the interplay of process variability, diverse product assortments, and divergent client specifications frequently precipitates waste, inaccuracies, and service-level dispersion. The model alleviates these occurrences by synergising recognised Lean instruments with methodical, operational protocols that enhance the precision of inventory records and the steadiness of process performance.

The proposed model comprises three interlinked components, each delineating a specific operational focus. The initial component enhances inventory precision and product quality by instituting cycle counting—an ongoing verification approach that substitutes disruptive, periodic full counts with smaller, more frequent audits that detect and rectify discrepancies at their originating points. The second component employs the 5S framework within order preparation; by cultivating a meticulously organized, uncluttered, and standardized picking environment, it accelerates and safeguards the accuracy of item retrieval. The third component similarly leverages 5S but tailored to the governance of dispatch documentation; it guarantees that the closing phase of the process furnishes shipment records that are complete, precise, and regulatory compliant. The innovation of the model lies in its systematic integration: the output of each component immediately supplies the input for the subsequent one, thus transforming a previously fragmented and error-prone sequence into a coherent, efficient, and tightly controlled operational continuum.

3.2.2. Overall Architecture and Transition Path of the Framework

The framework is organized as a progressively advancing network of processes, each of which is interlinked, advancing sequentially from a baseline of inadequate inventory oversight to a concluding condition of precise, reliable, and disciplined warehouse governance. Progress along this continuum is driven by the realization of the three interrelated modules, each fulfilling a distinct organizational function and maintaining transparent relationships between incoming and outgoing data streams, thereby establishing clear operational handoff points.

The system begins by ingesting the prevailing operational condition, which is typically marked by persistent mismatches between recorded and actual stock quantities, the absence of uniform product zoning, and a documentation flow that responds reactively rather than proactively. This formative condition not only diminishes warehouse throughput but also undermines the promptness and reliability of delivery guarantees and compromises the overall perception of service excellence. The intended conclusion of the framework is a state in which record data is in exact concordance with the physical inventory, product zoning is regularized and arranged for maximal accessibility, picking paths are streamlined, and shipping documentation is finalized and validated well ahead of the actual departure of goods.

Component one (C1) ingests the existing inventory database and the layout of physical storage locations, performs cycle counts supplemented by quality checks, and outputs a refined and verified set of inventory records. These records are ingested immediately by component two (C2), which leverages them to optimize the sequencing of order picking. C2 enforces 5S discipline to uphold a tidy and ergonomically efficient picking zone, producing orders that are both complete and rigorously confirmed. The resulting picking slips are subsequently routed to Component three (C3), where 5S is applied to the management of shipping documentation. C3 cross-references the order against regulatory and operational checklists, generating a boxed, compliant shipment ready to proceed to the carrier.

Interactions among components are inherently bidirectional. Data anomalies detected in the later component can prompt diagnostic and remedial measures in the prior one. For instance, systematic coding errors in the shipping labels traced to C3 might reveal lapses in verification signatures from C2, while ongoing inventory delta reports noted during picking may signal that C1's physical counts or assignment to locations require reassessment. Such feedback loops guarantee that the operational framework is neither linear nor static, but rather a dynamic cycle of quantifiable refinement throughout the supply chain.

3.2.3. Detailed Description of Component 1 – Cycle Counting

The first component of the model focuses explicitly on preserving inventory precision and safeguarding product quality during the storage phase. Its foundational premise is that sound operational choices depend on data that is both dependable and precise, and that the condition of the stored products must be in strict accord with the records that govern their management. Inaccurate inventory data, as well as undetected quality discrepancies, expose subsequent phases—such as picking and order dispatch—to higher rates of delays, errors, and the disruptive need for rework.

Inputs for this component comprise the existing Warehouse Management System (WMS) records and the actual spatial arrangement of products within the warehouse. This dataset encompasses stock levels, storage location assignments, packaging integrity, and quality specifications. The component produces a refined and validated inventory record that comprehensively and accurately documents the quantity, spatial location, and quality condition of every item stored in the facility.

Cycle counting is integrated here as a disciplined, continuous activity woven into everyday operations rather than as an occasional remedy for inventory distortion. Schedules for counts are determined by product tier, turnover velocity, and operational importance. Critical or high-velocity SKUs are audited more often, while low-velocity or low-cost items are still subject to a disciplined cadence of verification sufficient to avert material accumulation of error. Each verification is timed and staged to curtail interference with other material-handling tasks, often occurring within windows of low activity.

The methodology is designed as a self-correcting loop. Units are drawn for counting in accordance with published parameters, physically enumerated, and reconciled with warehouse management records without delay. Any resulting variance is interrogated immediately to categorize its origin, whether mis-stowing, undocumented movement, label misapplication, or loss. After isolating the causal factor, the inventory records are amended, and operational safeguards are escalated if the same anomaly recurs. This disciplined confinement of variance prevents the distortion from migrating into downstream functions.

Quality control is woven into cycle counting processes to enhance overall efficiency. During each count, operators simultaneously confirm packaging integrity, labeling, and conformity to specified customer and regulatory standards. Any unit that does not meet these quality metrics is promptly marked for removal, rework, or disposal, ensuring it does not progress to the order-preparation stage.

The physical environment is pivotal to the efficacy of this practice. The operational design relies on fixed, standardized storage locations for each SKU, complemented by prominent visual labeling and signage. Color-coded markers and defined floor lines delineate product zones, allowing for rapid visual checks and shortened search durations during counting. Such geographic constancy also simplifies cross-training; operators learn the warehouse layout rapidly and can be deployed interchangeably.

The accurate, quality-validated inventory records produced by this first component enhance the efficiency and dependability of the subsequent picking operation. Pickers no longer expend effort confirming stock availability, enabling the assembly of orders with the assurance that the correct products reside in designated storage positions.

3.2.4. Detailed Description of Component 2 – 5S for Workspace Organization

This segment of the framework focuses on the pre-shipment stage, a critical determinant of cycle times, picking accuracy, and overall customer experience. The 5S disciplined practice is leveraged to sculpt an environment that is systematic, streamlined, and uniform, empowering personnel to finalize picks both rapidly and reliably.

The guiding inputs remain the complete, reconciled inventory counts and the microscopically mapped storage coordinates generated by the preceding stage. Armed with verified inventory tallies, the system is then calibrated to configure picking trajectories that minimize travel and motion. The decisive outputs consist of a compact inventory of completely collated, authenticated orders, poised for immediate movement to the customer.

The 5S methodology is applied in a logical sequence. The initial step, Sort, entails the systematic identification and removal of all tools, materials, and documents that do not pertain to the current production orders. This action curtails physical clutter, thereby diminishing the likelihood of operational errors, such as mis-picks. Following Sort, Set in Order organizes the essential items into designated, well-labeled spaces, allowing operators to retrieve them immediately and precisely, thus eliminating wasted motion. The Shine step is dedicated to maintaining a clean and unobstructed picking zone, a practice that enhances safety and facilitates the rapid detection of problems, such as damaged units or leaking containers. The Standardize phase documents these practices ensuring that every operation, from the method of item retrieval to the manner of placement in staging zones, is executed consistently, regardless of the individual operator. Sustain embeds these standards into the daily workflow through checklists, scheduled inspections, and visual indicators that reinforce compliance.

Route optimization is an integral factor of this operational pillar. Accurate and updated location data from the C1 system is leveraged to engineer picking routes that are both direct and efficient, significantly curtailing travel distance and avoiding redundant movements. In high-throughput settings, zone picking can be implemented to assign specific picking zones to individual operators, thereby mitigating congestion, balancing workload, and further curtailing superfluous motion.

Validation at the point of origin remains essential. Every SKU is corroborated against the order immediately following the picking process, with affirmation of item identity, count, and physical condition before the item is cleared from the picking workstation. Such an intervention intercepts discrepancies before they can permeate the outbound zone, thereby diminishing reliance on inspection and rework stages that occur downstream.

A uniformly structured and disciplined workstation layout enables C2 to transmit entirely correct shipments to C3. The resultant decrease in documentation rework alleviates clerical strain and permits unimpeded progress of the shipments toward the loading sequence.

3.2.5. Component 3: 5S for Cleanliness and Standardization

The third element of the framework targets the composition of dispatch paperwork, which is the terminal process prior to the physical egress of inventory. Inaccurate documentation at this juncture invites delays in delivery, regulatory non-compliance, and customer dissatisfaction, thereby mandating rigorous precision and uniformity.

The antecedent to this component consists of the finished, corroborated orders that emerge from C2. The resultant product of this stage is a cohort of consignments accompanied by documentation that is accurate, exhaustive, and primed for transit.

The 5S principles have been integrated into the handling of administrative workflows. Sort focuses on eliminating expired forms, duplicate documents, and non-essential paperwork, leaving only the active and necessary templates. Set in Order arranges the remaining documents into a clear sequence, utilising physical trays, labeled folders, or digital queues to visualize and track where each item resides in the process.

Shine calls for physical documents to be clean and legible, and for digital records to be corrected of any errors or blank fields. Standardize mandates uniform templates, consistent signature and approval blocks, and the same data-entry formats across all records, thereby minimizing variability and accelerating throughput. Sustain enforces these improvements via scheduled audits and by correcting deviations on the spot.

A verification step ensures that every shipment's paperwork aligns precisely with its physical package, matching SKU numbers, quantities, and destination addresses. Color-coded tags or adhesive seals serve as visual safeguards that categorize shipments and guard against mix-ups, especially in environments serving multiple clients.

By assuring that all documentation is both accurate and complete before the package leaves the facility, C3 prevents errors from being forwarded to customers and avoids the delays that accompany last-minute fixes. Additionally, any discrepancies uncovered in this last verification step provide actionable feedback to earlier stages of the process, allowing for continuous improvement.

3.2.6. Interrelation Between Components

Notwithstanding the triadic architectural formulation, the model operates as a cohesive apparatus. High fidelity in the inventory records generated by C1 underwrites the precision and swiftness of the picking sequence performed by C2, whereas the methodical and codified picking choreography of C2 equips C3 to finalize required documentation expeditiously and faultlessly. Subsequent to completion, C3 generates analytic feedback to C1 and C2 whenever deviations are detected, thereby fueling a perpetual enhancement cycle. This mutual reinforcement culminates in a hermetic feedback loop, wherein each segment sustains and amplifies the performance of the others, thereby curtailing waste, dampening variability, and perpetuating accrued improvements over successive operational intervals.

3.2.7. Operational and Strategic Benefits with Final Considerations

From an operational vantage, the architecture elevates inventory precision, attenuates picking mistakes, compresses lead intervals, and guarantees the documentation is both complete and regulatory-compliant prior to dispatch. On the strategic plane, it amplifies the logistics provider's capacity to deliver uniform service to a heterogeneous client base, undergirds growth in scale, and fortifies customer loyalty.

Embedding cycle counting and the 5S principle within a Lean Warehousing schema yields an equilibrated tactic that reconciles data veracity with procedural steadiness, thereby safeguarding and incrementing performance margins over the extended life cycle of the system.

3.3. Model Indicators

The inventory control framework derived from Lean Warehousing tenets was evaluated using bespoke measurement dimensions expressly calibrated for this setting. These dimensions were constructed to permit systematic appraisal of procedural efficacy and service-level outcomes endemic to the logistics sphere. The resultant framework lent itself to coherent tracking of operational results, underpinning analytical decision processes and cultivating a persistent ethos of enhancement. By deploying this holistic evaluative apparatus, the framework yielded insight into process interrelations, guaranteeing congruence between day-to-day procedures and overarching strategic imperatives, thus bolstering the enduring market competitiveness of the logistics provider in an increasingly service-centric economy.

3.3.1. Inventory Accuracy

This indicator measures the proportion of inventory records matching the physical count, showing the reliability of stock data for operations and planning.

$$\text{Inventory Accuracy} = \left(\frac{\text{Conforming Records}}{\text{Audited Records}}\right) \times 100\%$$

3.3.2. Non-Defective Products

It represents the percentage of items free from defects, reflecting consistent quality and reducing rework or returns.

$$\text{Non-defective Products} = \left(\frac{\text{Total Products} - \text{Defective Products}}{\text{Total Products}}\right) \times 100\%$$

3.3.3. Picking Accuracy

This metric evaluates the precision of order picking, comparing correctly picked items with the total prepared to ensure customer satisfaction.

$$\text{Picking Accuracy} = \left(\frac{\text{Prepared Orders} - \text{Orders with Picking Errors}}{\text{Prepared Orders}}\right) \times 100\%$$

3.3.4. Incomplete Documentation

It measures the percentage of orders with complete documentation, helping monitor compliance and order processing accuracy.

$$\text{Incomplete Documentation} = \left(\frac{\text{Orders with Documentation} - \text{Orders with Incomplete Documentation}}{\text{Orders with Documentation}}\right) \times 100\%$$

3.3.5. Service Level (OTIF)

This indicator reflects the proportion of orders delivered on time and in full, summarizing delivery performance.

$$\text{OTIF}(\%) = \frac{\text{Orders delivered on time and in full}}{\text{Total orders}} \times 100$$

4. Validation

4.1. Validation Scenario

The validation analysis originated from a case study carried out at a logistics operator situated in Lima, Peru, which focuses on inventory control, transportation, and distribution services for the consumer goods segment. The facility in question spans 56,000 m² and handles upwards of 12,000 Stock-Keeping Units (SKUs), engendering significant operational intricacy. Diagnostic evaluations revealed inadequate inventory management efficiency, signalled by a 15% deviation in stock accuracy and prolonged order-picking cycles; both factors were associated with diminished service benchmarks and declining customer satisfaction.

4.2. Initial Diagnosis

The investigation conducted in the present case study indicated that operational service levels fell below the stipulated benchmarks, exerting a direct negative effect on profitability. This deficiency materialized primarily through the dispatch of incomplete shipments and recurring delays in order fulfillment, both of which eroded customer satisfaction and weakened competitive positioning. Root cause analysis uncovered fundamental weaknesses in inventory accuracy, characterized by misalignment between recorded stock levels and the physically countable quantities. Concurrently, lapses in quality assurance of stored items were identified, increasing the probability of picking mistakes. The picking workflow itself exhibited delays that lengthened order preparation and amplified the chance of omissions. Furthermore, inconsistent documentation management during the dispatch phase introduced additional latency and obstructed shipment traceability. Collectively, these deficiencies not only diminished the rate of on-time, complete deliveries but also generated financial fallout in the form of rework, product returns, and escalated transport costs. This confluence of issues has necessitated an integrated corrective programme designed to re-establish satisfactory service levels and restore robust profitability.

4.3. Validation Design

The presented inventory management framework, informed by Lean Warehousing doctrines, was empirically tested via a sequenced pilot period in a third-party logistics firm. Spanning sixteen weeks, the project oriented itself toward the uplift of On-Time In-Full (OTIF) outcomes by means of selective warehouse process refinements. Principal measures comprised the reconfiguration of storage geometries to curtail picking latencies, the codification of order-picking procedures to curtail inaccuracies, and the rationalization of replenishment intervals to safeguard stock readiness. Performance appraisal integrated operational indicators and a systematic cost-benefit decomposition, thereby affording a dual perspective on the net intensity of the operational gains and the economic soundness of the changes instituted.

4.3.1. Lean Model Implementation in a Case Study Warehouse: Step-by-Step Results

Researchers rolled out a detailed inventory management improvement model in a case study warehouse. They used lean tools like cycle counting and the 5S system to create structure. The goal was to fix the main problems found in the early check-up: inventory records that did not match reality, weak quality checks, mistakes in order picking, and messy paperwork. They built a step-by-step plan that fit the warehouse, aiming to boost the overall service level. They measured this lift using the OTIF (On Time and In Full) score, which had started below 90%. The rollout followed clear phases that combined deep inventory checks and hands-on operational reviews. Results showed less waste and smoother processes. Data came from two main warehouses: Villa el Salvador and Chilca.

This project did not just fix problems; it created a mindset of always getting better, just as lean thinking suggests. It also showed that changes can pay off, with expected savings of more than 100,000 soles every year. By tailoring every tool to the unique rhythms of the Peruvian logistics industry, we proved that we could boost precision and speed at the same time. This matters because we compete in a market that swings with a pandemic or a sudden change in the global supply network.

4.3.2. Putting Cycle Count Checks into Action for Better Inventory Accuracy

When we looked into the first main problem—our inventory numbers being off—we decided the best way to fix it was to use a cycle counting plan. We broke the work into simple steps so it would be easy for everyone to follow. We knew this problem was enough of a worry because the first numbers we saw showed that some records were off by as much as 15%. That mistake cost us about 50,000 soles a year when we added up the reworks and the returns, and it hurt our customers' trust and the way we run every day.

Using this new tool was not just about fixing mistakes already made; it was also about stopping them from happening again with routine counts. Previous studies, shared by logistics teams in similar settings, showed that such counts had already boosted accuracy by up to 20 percent. That gain translates to smarter ordering and fewer moments of running out of stock or, worse, having too much. Avoiding those extremes can slice storage costs by another 10 percent, which is money everyone wants to keep.

Before rolling out the tool, we completed a full-day inventory check in both the Villa el Salvador and Chilca warehouses. Villa el Salvador turned over 1,200 active items at a 35 percent average, while Chilca managed 800 items, more quickly, at a 42 percent average. That gap told us we could not use the same plan at both places.

We then organized the items by ABC analysis. In simple terms, the top 20 percent of items in category A accounted for 80 percent of the total value. That made it clear where to concentrate our time and energy. We had only 15 operators at Villa el Salvador and 10 in Chilca, so every minute matters. By zeroing in on the A category items, we could make the biggest difference without needing a much larger crew.

We set up clear training protocols for the staff. During hands-on sessions, we focused on digital tools like the AS400 system, which lets them enter data right when they see it. Early tests, run by our team, showed that this change cut preparation time by 25%. Surveys showed 40% of the team often could not find where items were stored. That feedback showed us we were right to invest time here; it helped us hit an 85% accuracy right away and created the sturdy base we need for faster future counts. Thanks to this, we can protect the supply chain and keep 12% of daily orders on track. Once we had that footing, we moved to phase two: the full inventory. Cross-functional teams, working side by side, counted every item, both by hand and on the system. This complete survey set the official starting number. In Villa el Salvador, we found a 12% difference, and in Chilca, it was 8%. Most of those gaps came from earlier human mistakes and old stock we had not retired in time.

The researchers backed this first step with numbers showing that if the opening stock were off by even a little bit, later inventory checks would miss the mark by 30%, according to best practices from logistics guys in Latin America, where shifting demand means every unit counts. They used a clear template to jot down how many units were on hand, paying extra attention to items that flew off the shelves and made up 70% of monthly sales.

This let them make on-the-spot fixes and bump overall accuracy up to 92% in quick tests that ran for two weeks. They bolstered the drive with cost numbers, too, showing that dodging overstock could save 15,000 soles a year per site in wasted cash, proving how this tactic trimmed excess stock from eating up 15% of the building space. The final phase rolled into regular counting, locking in a weekly rhythm that picked a slice of the stock to check for accuracy. They nailed down 10% of the items to count every day, kicking off with the A-class stuff that carries 80% of the cash risk, and this fast feedback caught mistakes sooner, slicing overall errors by 18% when stacked against the old once-a-year count.

Data from the three-month pilot period confirm that this approach worked. In Chilca, inventory accuracy jumped from 82% to 95%; in Villa el Salvador, it climbed from 78% to 93%. These gains cut supply chain hiccups and let us respond faster to changes in demand. We backed up our work with figures. Inventory turnover rose 15% after we started, so we could use resources better and cut storage costs by another 10%. Regular counts helped us spot and drop slow-moving items that made up 5% of the total stock but ate up 20% of the maintenance budget. The team pointed out that the tool not only fixed old problems but also created a habit of keeping accuracy high. It fit perfectly with our lean goal of cutting waste. We now view cycle counting as a core part of making warehouse work better, and we expect it to lift OTIF measurements by 8%. This goal comes from shrinking errors that used to affect 14% of our shipments.

4.3.3. Application of the 5S Methodology to Optimize Product Quality Control

Next, the team tackled the second big problem: the warehouse was sending out damaged products. They decided to use 5S every single day. They changed the method to fit the daily routine and reduce the damage rate, which had climbed to 7% of the whole stock. Each rejected order cost around 20,000 soles, and the bad press was hurting the logistics operator, especially since customers in this business expect perfect quality.

The team started with the numbers. Last year's audits reported that 25% of the routine checks had failed to find damaged stock. That high number proved 5S was no longer optional: it was the only way to make checks reliable and keep variance in check. Research shows that similar warehouses have boosted efficiency by 30% after 5S, thanks in part to tossing expired products. If this warehouse could match that level and cut out expired stock, it might save another 12% on replacement costs.

The team kicked off the first S, Seiri, by combing through every aisle to pull out the bad stock. They made a detailed report that pinpointed exactly what was not good and why. In Villa el Salvador, they catalogued 150 broken or out-of-date items. In Chilca, another 100. All of that combined took 5% of the space—and 50 square meters of floor that used to hold damaged goods—entirely out of circulation.

Watching the numbers this time gave clear signals: 12% of the expired products had dropped out the door, but somehow accounted for 40% of the returns over the last six months. As soon as we axed them, returns sank by 22% in the first month, which let the team whip up custom checklists that split must-haves from the can-do-without, so shelving got neater and every shift moved smoother. Inspection clocks ticked down 15% as crew time freed up for the good stuff, not for dragging baggage that should never have been here. We slid right into the second S, Seiton, and ripped up the warehouse's travel map. Tools and boxes got permanent seats by how often we waved at them: fast movers at our knees so lifts stayed clear and bump guards stayed uncuffed. Stopwatch tests cheered as walk distances were trimmed by 20% and feet stayed fresh for the right reasons.

Numerically, the numbers tell the story: we saw an 18% bump in productivity because time spent finding and confirming items shrank from 5 minutes down to 3. In Chilca, where earlier disorder had tangled 30% of quality tasks, the new layout sliced location-mix-up mistakes by 14%. Now the space matches the jobs people perform, and we have also dodged the 9% of customer complaints that used to come from damaged goods. With that in the rearview mirror, the third S, Seiso or cleaning, kicked in. We rolled out daily and weekly floor plans that kept the whole warehouse spotless.

Rotating shifts reached every inch of the storage and handling zones, cutting dirt and exposure-related product damage by a quarter. Checks after we set this in motion showed quality rejects dropping from 8% to 5% within a single month, so we saved about 8,000 soles on replacements and sorting. We proved the case: cleaning is way more than looking nice. In an industry sensitive to hygiene, it guards inventory and prevents the kinds of contamination that can cost 50,000 soles a year in lost contracts for sensitive goods like consumer products.

To build on these improvements, the fourth S, Seiketsu, brought together clear operation manuals, colorful posters, and easy-to-read, color-coded labels. These tools laid out step-by-step check and handling instructions for 90% of parts with precise quality standards. Internal audits showed that following these guidelines jumped from 80% to 95%. Number crunching showed that process differences between shifts shrank by 20%. The tighter quality checks then covered the cost of all the standardization materials, with a projected 12% savings each year on expenses from faulty parts. In this way, standardization became the steady step on the way to solid, eco-friendly processes that keep quality steady right along the whole value chain.

The journey finished with the fifth S, Shitsuke, or discipline. Monthly and weekly audits now use digital checklists to keep standards alive. At first, scores showed only 70% compliance, but after three rounds of feedback and extra training, the number jumped to 92%. Return visits from quality issues dropped by 15%, and the whole team now feels the quality burden is shared instead of carried by a few. Staff surveys showed that 25% more workers now say they are fully committed. These scores back up the idea that discipline is key to hanging on to long-term profits.

Using sustainability plans, we can avoid losing as much as 10,000 soles a year from the same type of problem coming back again. We are now completing the 5S cycle as one complete, big-picture way to tighten quality checks in the warehouse. Thanks to these actions, we have seen a 10% boost in how happy our customers are, shown by fewer products being sent back.

4.3.4. Using 5S to Make Picking Easier and More Accurate at Order Prep

Our third root cause—messy, inaccurate picking during order prep—got fixed with the 5S method because it kept messing up 10 out of every 100 orders we sent out and costing us more than 30,000 soles a year in rework and late shipments, which in turn slowed our OTIF numbers by 7%. The first numbers showed we were picking the wrong item 18% of the time, and the goal in the end was to make the process easier and faster, aiming for a 25% speed lift like other warehouses have managed in studies we dug up.

We kicked off with Seiri by pulling out broken tools and old supplies from the picking zone. Each of us did a guided sweep and pitched anything that had not moved in 30 days. The extra room we opened—about 8% of the total space at the work benches—made the aisles clearer, shrank our zone by 20% and let the pickers grab the right item faster. The mistake rate fell from 12% to 7% in the first few weeks, showing the numbers we needed: less junk meant the picker could see the right label and the cart could roll without stopping. The change was especially big at Villa el Salvador, where order count runs 40% higher than at Chilca.

Then the team reshaped the workstations and picking aisles using the Seiton method, putting the most-used items within easy reach and color-coding the shelves. This cut down the time it took operators to find things by 22%, which time trials with trained staff confirmed. The results also showed a 15% boost in the hourly number of orders picked, proving that keeping everything in order really matters—in an area where past mistakes had caused enough rework to eat up 10% of the daily schedule. Building on that, Seiso brought in daily cleaning duties on worktables and in picking zones, which lowered dirt, chips, and spills by 18% and the mistakes that came from them by 10%. The tidy tables saved the warehouse 5,000 soles by preventing bad orders, showing that a clean space not only protects products but also keeps workers safe; reports showed a 15% drop in minor accidents once the new cleaning beat schedule started. Seiketsu kept things running smoothly by giving everyone color-printed picking sheets and step-by-step procedures, tightening alignment to 94% across different shifts and cutting variability by 16%. The numbers showed how the tighter routine kept order deviations—once at 11%—in check, and it let the AS400 system keep on updating in real time without hiccups.

Finally, Shitsuke held audits every two weeks to keep discipline strong, reaching a solid 88% adherence rate. This cut chronic errors and small setbacks by 12%. The numbers showed that the improvements would last, so the team wove the methods right into the picking process. This made order prep sturdier and faster, leading to an expected 9% boost in overall fulfillment speed.

4.3.5. How 5S Helped Clean Up Order Dispatch Docs

The last root cause was messy docs in dispatch that led to 9% of rejections and 25,000 sales lost yearly because forms were incomplete or wrong. The team used the 5S method to tidy up both paper and digital files, since 20% of the docs were inconsistent and slowed down the dispatch flow, causing 13% of the deliveries to miss the on-time window. We kicked off with Seiri, clearing out old and duplicate files right from the dispatch desks. This cut down the paper piles by 15% and chopped 18% off the time it took to find the right forms. Less clutter meant the team could stop wasting time on unnecessary pages and start reading only what really mattered. Next, in Seiton, we set up tidy, labeled cabinets and digital folders by order type and by customer. Errors in the forms dropped from 11% to 6% because everyone could grab the right template every time. We could see that checking steps were 10% faster, and every file was easy to trace. That speed was not just good for the team desk to desk; it kept the whole operation in line with the rules we must follow. Our Seiso cleaning kept all the documentation areas shining, so damaged and missing papers dropped by 14%. Check the data, and you will see rejections for missing info fell from 9% to 4%. A tidy space means fewer reader slips, and that is no mistake. When Seiketsu came in, we crafted clear templates and set rules, bumping accuracy to 93%. A dozen audits showed that mix-ups between operators fell by 15%. Shitsuke brought daily checks and kept compliance at 90%. That is projected to slice 10% off the related costs. Put together, 5S fixed every loose end and stitched the whole warehouse closer together so lean works, not just on paper, but on every aisle. Six months later, OTIF climbed to 95%. To back this up, we will attach tables showing inventory accuracy by phase and by warehouse, process flow diagrams that track shorter 5S cycle times, and bar charts that celebrate the rises in OTIF and cost savings.

4.4. Results

The data compiled in Table 1 compares three stages: the baseline, the anticipated objective and the post-implementation metrics generated by the newly designed inventory management framework. An observable gain in inventory accuracy emerged, rising from 82% to 94% and corresponding to a 14.63% gain. Non-defective output also improved, climbing from 89% to 95%, while order-picking precision advanced from 88% to 94%, yielding an upward shift of 6.82%.

The frequency of incomplete paperwork showed a marked decline, changing from 84% to 96%, and this correlates with a 14.29% increase. Additionally, the overall service level grew from 87% to 95%, signifying a 9.20% enhancement. Collectively, these empirically derived gains substantiate the proposed framework's capacity to refine inventory stewardship and bolster the overall quality of operations across the logistics continuum.

Table 1. Results of the pilot

Indicator	Unit	As-Is	To-Be	Results	Variation (%)
Inventory accuracy	%	82%	95%	94%	14.63%
Non-defective products	%	89%	96%	95%	6.74%
Picking accuracy	%	88%	96%	94%	6.82%
Incomplete documentation	%	84%	98%	96%	14.29%
Service level	%	87%	95%	95%	9.20%

5. Discussion

The study shows better accuracy in inventories, more precise picking, and higher OTIF results. This matches what de Koster and colleagues [3] found: that how well picking and storage tasks run directly impacts how well the whole warehouse works. Fewer paperwork mistakes and more streamlined processes back what Staudt and co-authors [4] pointed out: that tracking performance in a detailed way makes it easy to find slow spots and keep improving. Using cycle counting that sorts items by how critical they are agrees with what Destro and team [5] proved: it makes records more reliable and smooths out daily operations. These patterns fit what Sánchez-Polanco and others [1] labelled the trend: mixing Lean methods with careful process control keeps logistics firms sharp and competitive. Lastly, Baglio and collaborators [2] showed how changing processes boosts performance results; in this case, the better OTIF scores suggest that when layout, tasks, and inventory plans work well together, gains can last.

5.1. Study Limitations

The scope of the study is limited to a single logistics operator and a relatively short period of analysis, which constrains the ability to generalize the results to other contexts and scales. The availability of historical data contained gaps in certain metrics, preventing a more robust longitudinal analysis. Furthermore, the proposed model was implemented without the integration of advanced automation technologies or state-of-the-art warehouse management systems, so the potential impact of these tools on the same indicators was not assessed.

5.2. Recommendations for SMEs Based on Results

The findings show that an improvement strategy combining cycle counting, process standardization, and layout optimization can lead to substantial increases in operational accuracy and delivery reliability. For logistics service providers, the implementation of such models offers a viable pathway to enhance competitiveness without requiring major investments in infrastructure or technology. Additionally, linking each improvement action to specific key performance indicators enables more effective monitoring and data-driven decision-making, thereby strengthening operational performance management.

5.3. Future Works

Future research could extend the application of the model to different sectors and logistics operators to evaluate its adaptability and robustness. It would also be valuable to conduct longer-term studies to analyze the sustainability of improvements and their behavior under demand variability. Moreover, exploring the integration of the model with predictive analytics tools and advanced warehouse management systems is recommended to enhance the ability to anticipate issues and optimize resources proactively.

6. Conclusion

The study shows that the new integrated improvement model really boosts how efficiently the operation runs, cuts downtime, and smooths out production flows in the workshop we looked at. Using step-by-step methods, we were able to track how cycle times, resource use, and product quality all got better at the same time, proving that a clear, organized push to polish processes really pays off in higher output. What is more, the model flexed to fit the site's particular needs and could still be applied in other similar shops without losing its power, proving it is practical beyond the first try. These results highlight how a wide-ranging strategy can create real, bottom-line gains while staying in step with long-term business goals.

This work matters because it closes a long-standing crack in how small and medium-sized manufacturers run their production. In many of these companies, half-baked processes eat up cash and hurt market position. By weaving together several improvement tools into a single playbook, the research shows that meaningful gains can be won even in shops that operate with tight budgets. The study also reaffirms how making choices based on solid data locks in the gains, so fixes do more than slap a band-aid on a problem; they build the first layer of an ever-rising standard of performance.

This work makes two important contributions to industrial engineering. First, it deepens our theoretical grasp of how well-designed improvement models can work together to tackle several challenges at once, even when resources are tight. Second, it provides a flexible, easy-to-adopt framework that managers in fast-moving and high-pressure industries can reference to design smart, adaptable solutions. Its careful balance of solid math and practical usability is what makes it especially valuable.

Looking ahead, researchers can build on these findings by testing the model in industries with different production speeds, studying how well it holds up over the years, and pairing it with new digital tools that improve forecasting and guide decisions. Each of these steps would add more proof and widen the model's usefulness in the real world.

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