SSRG International Journal of Economics and Management Studies
ISSN: 2393–9125 / https://doi.org/10.14445/23939125/IJEMS-V12I8P101

Volume 12 Issue 8, 1-11, August 2025

Original Article

Redesigning Order Preparation through Ergonomics and Method Engineering: Evidence from a Case Study in Retail Logistics

Angie Antuané Egúsquiza-Lozano[1], Fiorella Velarde-Jara[1], Elmer Luis Tupia-De-La-Cruz[1,*]

[1]*Carrera de Ingeniería Industrial, Universidad de Lima, Perú.*

[*]*Corresponding Author : etupiade@ulima.edu.pe*

Received: 05 June 2025 Revised: 13 July 2025 Accepted: 02 August 2025 Published: 18 August 2025

Abstract *- Storage layouts that do not align with workflows and poorly designed workstations often lead to poor performance in distribution centers in emerging markets. Earlier research has looked at picking accuracy, travel time, and related problems, yet it rarely brings those findings together with insights on what hurts workers over a shift. In response, the authors built a broad improvement blueprint that targets every step of order preparation while keeping people comfortable and alert. Their approach combines workload measurement, task simplification, clear work standards, and proven ergonomic rules, so throughput rises and fatigue drops at the same time. Field trials showed that labor output climbed 31 percent, orders left on schedule 20 percent more often, and overall handling costs fell by 14 percent. These gains demonstrate that coordinated changes can achieve productivity gains without compromising health. On the scholarly side, the work presents a step-by-step framework that low-budget firms elsewhere can copy, and on the economic side, it shows how better conditions can drive higher revenues. Follow-on studies are invited to test the model in receiving, returns, and other areas and to examine tools such as sensors and dashboards that could make the gains even more sustainable.*

Keywords *- Warehouse Operations, Ergonomic Redesign, Methods Engineering, Order Picking Efficiency, Retail Logistics.*

1. Introduction

Distribution Centres (DCs) sit at the heart of modern global retail, where they store, sort, pack, and ship goods to store shelves or directly to shoppers. When these facilities run smoothly, products reach markets on schedule, operating expenses shrink, and service quality climbs [1]. Yet in Latin America, soaring e-commerce sales and omnichannel expansion have pushed DCs to handle larger volumes with ever leaner turnaround times. In Peru and other emerging markets, progress in logistics has prompted developers to build new, well-situated centres that boost the backbone efficiency of the retail supply chain [2].

Even though distribution centers are a critical link in supply chains, they still grapple with persistent problems during order assembly. Common pitfalls include slow consolidation, picking mistakes, faulty labels, and orders missing items, all of which undermine delivery speed and accuracy [3]. Such shortcomings cause a cascade of issues, from pallets back in storage because loading was late, to returned shipments, fee penalties, and the slow erosion of consumer loyalty. The On Time In Full (OTIF) yardstick, which logistics managers lean on to gauge service quality, suffers badly when work is done by hand or in poorly lit, cramped areas [4]. Studies across several Latin American nations show that many e-commerce complaints trace back to incomplete packages or late arrivals born from these very order-prep blunders [5].

Tackling these issues is critical if companies want to make their supply chains faster and more competitive. Small gains in picking speed can yield large cost savings because this single task eats up almost 55 percent of a typical distribution center's payroll [6]. Streamlined labeling and quicker loading, in turn, boost customer confidence, especially when shoppers increasingly judge a retailer by how smoothly and promptly their orders arrive. More accurate picks cut the volume of returns and angry calls, lifting the bottom line almost immediately [7]. Good aisle design paired with written, enforceable standard work also curtails wasted steps and brief waits that rob people of productive minutes [8].

Despite this need, scholarly work rarely combines lean production with ergonomic science in the same order-picking redesign. The bulk of available studies chase time savings or budget cuts while ignoring how a given change might strain muscles or raise stress levels for the very workers asked to implement it [9]. That narrow view often creates jobs where fatigue spikes, errors multiply, and turnover climbs, forcing managers to hire and train all over again. Very few analytical tools, to date, offer a clear route for adjusting both workflows and workstations so that warehouses gain speed without harming people's health or morale [10].

The research presented here addresses this shortfall by developing an improvement framework grounded in Work Study and Ergonomics, then testing the framework in an actual retail distribution center in Peru. To guide the work, specific techniques, including detailed process mapping, time studies, postural assessments, and an optimized layout redesign, will be applied so productivity can rise, errors drop, and worker safety remains intact. By adopting this holistic stance, the study expects to show that greater operational efficiency and genuine labor well-being support each other rather than undermine one another. In addition to practical gains, the project aspires to offer the academic community a replicable model that other Latin American retail centers can adopt, thereby broadening the regional impact of the findings.

2. Literature Review

2.1. Application of Methods Engineering in Retail Distribution Centers

One of the best tools in industrial engineering for looking at and changing work processes to boost productivity, speed up execution times, and get rid of tasks that do not add value is methods engineering. This method has become an important part of retail distribution centers because the order preparation process uses a lot of operational resources. It helps make things run more smoothly. This method lets you break down each task into its most basic parts and look at things like the order of operations, how the operator moves around, and how they use logistics tools or equipment.

Meza-Ortiz et al. showed how methods engineering could be used in a spare parts distribution company. They redesigned the layout and operational sequence, which cut picking times by 29% and increased the rate of on-time order delivery by 7% [11]. This kind of intervention not only boosts productivity but also cuts down on operator fatigue by cutting out unnecessary movements. Montoya et al. used engineering methods in a manufacturing cell to reduce unproductive time by 41% by eliminating downtime between operations [12]. Even though the case is about manufacturing, the results can also be applied to distribution centers, where idle time is also a direct loss.

In the same way, Rajesh intervened in a warehouse for high-volume appliances. He suggested a new picking sequence method that rearranged internal routes, made operators 44% more productive, and cut lead time by 2.1 hours per day [13]. The PDCA cycle and analytical process diagrams were used to confirm that these changes worked. Korkmaz et al. did another study that looked at the loading and packaging processes at a logistics center. They were able to cut labor costs by 75% by changing the way work was done based on ergonomics, making tasks easier, and changing the flow [14].

In this case, methods engineering is about making things work better and designing long-term sustainable work systems that lead to lower staff turnover, better order fulfilment, and happier customers. The studies that were looked at all agree that finding unnecessary tasks and using flowcharts and course diagrams together makes it possible to accurately map out areas where the order preparation process could be better.

2.2. Process Standardization for Operational Improvement in Retail Warehouses

Standardizing processes means writing down, organizing, and using the same steps to do things to ensure that tasks are done correctly, quickly, and consistently. In retail distribution centers, where there are multiple work shifts and a lot of staff turnover, this practice is essential for keeping operations consistent, preventing mistakes, and cutting down on training time. Mostafa & Essam showed that using the 5S method, which includes the standardization phase, cut down on activities that did not add value by 33% and total processing time by 25% in an electronic retail warehouse [15]. We were able to make these changes by using standard operating procedures (SOPs), visual labels, different record formats, and regular training for operators.

Lee and Chang also said that many warehouses have very different picking processes because there are no set rules for how to do it. This means that shifts and workers' productivity can be very different [16]. Meza-Ortiz et al. used a standardization strategy in a spare parts distribution warehouse in Peru. The redesign of the picking process, along with the creation of specific roles and a system of compliance indicators by product category, cut shipping mistakes by 43% and boosted productivity per operator by 19% [11]. This study shows how important it is to set up a logical and written order of steps for each task, from finding the item to entering it into the system and moving it to the shipping area.

On the other hand, standardization makes it easier to use automation technologies and makes it easier to keep an eye on things. Czerniachowska et al. did a study that showed that making operator routes and tasks the same made it easier to use a voice-picking system, which cut down on typing mistakes and made work more comfortable [17]. Lastly, standardization is necessary for ongoing improvement because it sets a standard that methods like Kaizen, Six Sigma, or SMED can be used on.

2.3. Time Study as a Tool for Logistics Planning and Control

Time study is a basic method for measuring how well logistics processes are working right now and setting production standards that can be used to plan resources. Using it in the order preparation process lets you find bottlenecks, figure out the best number of operators, and come up with ways to make things better based on real-world data. Many warehouses use this tool to save money on overtime, staff turnover, or late shipments. Korkmaz et al. did a study that showed that time analysis could be used to completely redesign the packaging and loading processes at a logistics center in Turkey. This cut the total process time by 47% [14]. Henríquez-Fuentes et al. also made a tool to measure time that found key factors that affect how quickly orders are delivered in a distribution system. This cut delays by 21% [18]. Rajesh's study of high-volume logistics centers shows that accurate timekeeping and making time distribution curves by task made it possible to find out that 32% of the operators' total time was spent on unproductive tasks like looking for products or doing manual checks [13]. Based on what was found, changes were made, like moving products around and making internal signs better. Czerniachowska et al. looked at three different work models using measures like "travel time," "picking time," and "validation time." The Solo-Picker model, which does not need an assistant, was 44% more efficient because it cut down on downtime [17]. This kind of research shows that time studies can be used for more than just controlling things; they can also help you make strategic decisions about how to allocate shifts, set up your layout, and adopt new technology.

2.4. Ergonomic Analysis for Risk Prevention and Productivity Improvement

Because musculoskeletal disorders are becoming more well-known as one of the main reasons for absenteeism and staff turnover in warehouses, ergonomic analysis in distribution centers has become a top priority. Operators are at risk of many things while preparing orders, such as lifting heavy loads, doing the same thing over and over, and being in uncomfortable positions. If these risks are not managed, they can hurt their health and lower their overall productivity. Nasir and Ion did a systematic review and found that picking tasks that are not ergonomically designed make workers more tired and less able to keep up a steady work pace all day [19]. They also found that bad route planning and shelves that are too low can lead to more muscle injuries. In an experimental study, Lavender et al. looked at how people stood when picking things up from different heights. The results showed that some arrangements caused a lot of strain on the lower back, and moving the heaviest items to different places made the work 34% easier [20]. Kajewska and Mateja also suggested a multi-objective optimization model that takes into account both execution time and ergonomic risk at the same time, finding a balance between productivity and worker health [6]. Finally, combining technologies like voice picking and radio frequency makes things run more smoothly and makes them more comfortable. Recent research shows that these tools use less paper, improve posture, and free up the operator's hands, making the operation more natural and less harmful [17]. These studies all show that ergonomic analysis is a part of workplace safety and a full plan for making the logistics system more sustainable.

3. Contribution

3.1. Proposed Model

Figure 1: The proposed operations management model, consisting of six linked steps that circle back on each other, all aimed at boosting productivity in a retail company's distribution centre. The design draws on Methods Engineering and Ergonomics, so continuous refinement of order-picking and shipping activities stays front and centre. The cycle kicks off with project selection, when a quick diagnostic pinpoints chokepoints and improvement opportunities. Next comes data collection and presentation, a phase where supervisors watch and log every task timing in real time. During data analysis, analysts dig deeper, using the recorded times to spot delays that recur and waste effort. With that map in hand, they craft an improved work method that pairs ergonomic principles with the required speed, cutting the strain employees face. A full work-analysis step then levels out workloads and matches people to tools, so no station is overloaded. The last stage sets a new time standard that planners can use to steer everyday operations, locking in a leaner, greener management approach. By following this structure, the team tackled the distribution-centre pain points in a way that respects the workers doing the job.

3.2. Model Components

Retail managers have long aimed to run their operations with maximum efficiency, and this drive has inspired models that blend lean improvement techniques with ergonomic design in logistics. Within that setting, the framework put forward here divides the order-picking and dispatch process in a warehouse into six step-by-step phases, so the intervention touches every critical area. As shown in Figure 1, the approach builds directly on Methods Engineering and Ergonomics by minimising wasted motion, establishing consistent work standards, and boosting the capabilities of the workforce. By spelling out these stages in a straightforward way, the model offers researchers and practitioners a flexible blueprint they can adapt to different warehouse layouts and volume patterns.

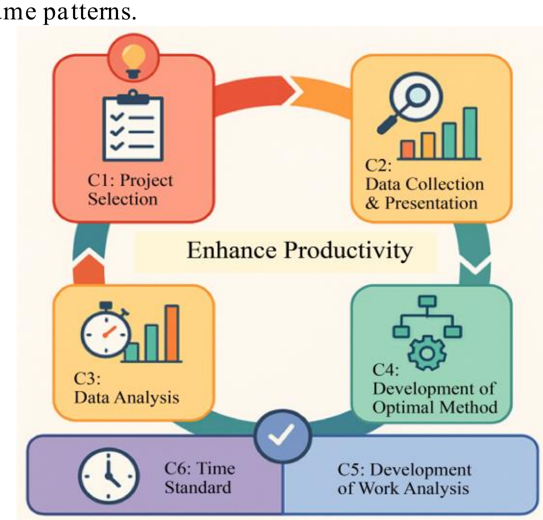

Fig. 1 Proposed model

3.2.1. Component 1: Strategic Project Selection as the Starting Point

The first step in the approach is to choose the logistics intervention, a choice that quickly narrows the project's scope and direction. A light diagnosis follows, mapping out the key steps in the material flow, with a focus on order picking and dispatch tasks. Projects are judged by three main filters: how much they will affect operations, how often the problem recurs, and whether Methods Engineering tools can be applied. This quick yet structured review sharpens the problem statement and shapes the data plan in the next phase, so that information is relevant and timely.

3.2.2. Component 2: Data Collection and Presentation as Analytical Foundation

After the target process is set, the model moves into hands-on data collection, which serves as the factual spine of all later analysis. Trained observers follow the core logistics steps-product extraction, order assembly, and dispatch-capturing each one's flow and delays. Time-study methods then translate these observations into precise task duration and variability figures.

Once scored, the numbers are displayed in charts and dashboards that immediately cut through detail and highlight comparisons. This clear, visual evidence becomes essential for spotting waste, pinning down bottlenecks, and isolating activities that add no value.

3.2.3. Component 3: Data Analysis for Identifying Inefficiencies

Once data has been structured, an in-depth analysis assesses the performance of each subprocess. Attention centres on spotting outsized time deviations, recurring bottlenecks, and tangled workflows. Idle periods, needless movement, and poor task sequencing are catalogued, while highly variable tasks are cross-referenced with workforce spread and equipment downtime. The outcome establishes a clear performance baseline and directs management to the most pressing improvement opportunities.

3.2.4. Component 4: Development and Presentation of the Optimal Method

Building on the analytical insights, the team designs a new work method that cuts waste, smooths flow, and lifts execution speed. Standardization sits at the core, creating reliable, repeatable task sequences. Ergonomic guidelines are woven in, reducing physical strain, awkward postures, and pointless effort. The redesigned method is recorded in flowcharts, visual aids, and short, user-friendly instructions, making it quick to grasp and implement on the shop floor.

3.2.5. Component 5: Work Analysis for Holistic Management

In this phase, researchers track task timing with the fresh framework to reveal how quickly staff adapt. Productivity scores hinge on the speed and accuracy of role changes and on how well operators are matched to their new duties. At the same time, the team calculates a headcount target that pairs each station with just enough workers to meet forecast output. The layout and tools for order picking are fine-tuned throughout to protect worker health and ease, since comfort and safety underpin long-run efficiency and stable quality.

3.2.6. Component 6: Time Standards as a Control and Planning Tool

In the sixth and final component, a distinct time benchmark is set for every dispatch task, providing both a practical yardstick for day-to-day control and a planning reference for longer time horizons. This standard weaves together the gains made in earlier steps, giving supervisors a clear, quantifiable way to track routine performance and quickly spot any unexpected drift.

Along with the time figures, a tailored list of required machines and tools is produced for each activity, so personnel and equipment are matched precisely to the workload. By implementing the time rules, managers at all levels gain sharper tactical insight and a stronger foundation for the centre's broader strategic goals. Thus, the procedure comes full circle, producing a robust, region-specific blueprint that can be copied across distribution networks and adapted to each retailer's unique pressures.

3.3. Model Indicators

Performance of the retail distribution centre was analysed within a Work Study–Ergonomics framework using a customised set of evaluation criteria. These measures, developed in a pilot phase, documented key behavioural and timing features of picking, packing, and dispatch activities, yielding a rounded picture of system efficiency.

By aligning data collection with ergonomic principles and ISO-standard work elements, the review generated credible evidence of process reliability and operator well-being. The resulting dataset now provides a firm resource for guiding productivity gains in future improvement cycles.

3.3.1. Productivity index (Order/man-hour)

This metric captured how many customer orders a worker fulfilled within one hour, revealing overall process agility and labour utilisation. Higher values indicated smoother task flows and fewer idle moments.

$$\text{Productivity Index} = \frac{\text{Total Orders Processed}}{\text{Total Man-Hours Worked}}$$

3.3.2. Percentage of On-Time Deliveries to the Carrier

It expressed the share of consignments transferred to the carrier before the committed cut-off, reflecting schedule discipline and coordination across picking, packing, and staging activities. A rising percentage confirmed tighter control over bottlenecks and unexpected delays.

$$\%\text{ On-time Deliveries} = \frac{\text{On-time Deliveries}}{\text{Total Deliveries}} \times 100$$

3.3.3. Percentage of Costs in Proportion to Sales

The ratio gauged how much the dispatch process consumed from each revenue dollar, integrating labour, overtime, and freight expenses. A lower figure signalled leaner operations and improved cost containment without compromising service reliability.

$$\%\text{ Costs to Sales} = \frac{\text{Dispatch Costs}}{\text{Sales Revenue}} \times 100$$

3.3.4. Optimal Number of Operators per Area

This indicator estimated the headcount needed to meet demand at standard pacing, balancing ergonomic constraints and workload distribution. Aligning labour supply with takt time prevented overstaffing while preserving operator well-being and throughput stability.

$$\text{Optimal Operators} = \frac{\text{Total Standard Labour Time}}{\text{Available Time per Operator}}$$

4. Validation

4.1. Validation Scenario

The validation study was anchored in a real-world scenario involving a well-established retail firm based in Lima, Peru. After almost thirty years of continuous operation, this enterprise now oversees thirty-one outlets scattered throughout the capital and outlying areas, with the movement of stock managed by two dedicated distribution centres-one tailored for small items and the other for heavier merchandise. The site chosen for examination specialized in what industry jargon often labels the big-ticket category, moving costly, weighty articles such as refrigerators, sofas, and sizable electronics. Handling that product mix demands a logistics choreography where every step, from receiving pallets to loading delivery trucks, happens in lockstep. Yet in the year leading up to the case study, order-prep and dispatch routines began to fray, pick routes tangled, packing benches overflowed, and truck turn times drifted upward. As a result, overtime climbed, transport invoices swelled, and on-time delivery promised in marketing materials slipped, warning signs for any firm vying for shoppers' loyalty in a crowded retail field.

4.2. Initial Diagnosis

The case study's analysis reveals that the order-preparation stream is not meeting company standards: only 92% of shipments arrived at the transport dock on time, which is less than the required minimum of 95%. In the most recent reporting period, this performance gap resulted in an estimated PEN 1.9 million in annual losses. Late order loading accounted for 44 percent of the time miss, followed by incomplete packs (28 percent) and mislabeled boxes (12 percent). The remaining 15 percent was attributed to a combination of other factors. According to root-cause mapping, preparations beginning too late account for 48.1 percent of all delays, the lack of documented work standards accounts for 22.3 percent, and an excessive manual workload on staff members accounts for 13.6%. Operator errors accounted for 33.6 percent of incomplete orders, understaffing for 28.6 percent, and undocumented steps for 37.8 percent. Lastly, labeling errors were associated with incorrect delivery addresses 43.3 percent of the time, with new hires still not receiving follow-up training 36 percent of the time, and with incorrect items picked up 21 percent of the time. When taken as a whole, these results suggest a systematic set of issues that management needs to address to restore productivity to an acceptable level.

4.3. Validation Design

The new operations-management framework, built on principles of work study and ergonomic design, was trialed over four months at the distribution centre featured in this case study. During the validation stage, the picking zone was scrutinized: time-motion recordings directed changes in task structure, and ergonomic scans shaped adjustments to each workstation. These elements refined methods, spread work evenly, and cut biomechanical risk. Performance data taken before and after rollout, including pick rate, travel time, and signs of operator fatigue, made it possible to judge both productivity gains and cost-effectiveness for the retailer's logistics network.

The following sections detail how the proposed model was put to work in a retail firm that wanted to speed up its order-prep area. Using Methods Engineering as a guide, the team moved step-by-step from choosing the project to setting time standards, looking closely at six parts of the operation that pinpointed bottlenecks, rewriting workflows, brought in ergonomic aids, and setting clear, measurable targets. The effort was driven by chronic low efficiency, which drained money through costly overtime, late deliveries, and repeated returns. Work design drew on hard numbers from motion studies, ergonomic checks, and productivity scores broken down by subprocess and product line. Findings proved that rearranging the operation was both doable and overdue if the firm hoped to hit world-class delivery rates. Each model step moved the team forward, taking them from diagnosis straight through to testing and signing off on the new best practice, thereby creating a solid base for a smoother logistics chain.

4.3.1. Component 1: Strategic Focus and Project Selection

The first step was to pinpoint with precision the issue undercutting operations. Analysts zeroed in on low productivity in the dispatch phase, especially during picking and truck loading, at a busy high-volume distribution centre. That bottleneck was driving steep cost overruns, including S/. 190,000 in overtime pay and penalties exceeding S/. 1,978,000 for late deliveries. Furthermore, on-time transport compliance averaged only 92 percent overall, with critical months such as January slumping to 88 percent. These economic and operational metrics elevated the project to the firm's highest improvement priority.

4.3.2. Component 2: Comprehensive Data Collection and Clear Presentation

With the problem framed, teams turned to gathering performance data from the affected processes. The Extended Warehouse Management system provided granular information about each subprocess. Analysts reviewed over fifty field orders and found that average picking time stood at 24.19 minutes, well above the 14.95 minutes set as the target by the Analytical Process Diagram. That 9.24-minute disparity pointed to multiple root causes, including suboptimal product siting, frequent staff rotation, and underused picking equipment.

4.3.3. Component 3: In-Depth Data Analysis

Quantitative analysis divided throughput data by product category and operator. Televisions moved at a sustained 36 units per hour, while flat-pack, assemblable articles averaged only 13 units, mainly because of handling irregularities and differing storage configurations. Retrieval time also proved sensitive to location; items kept on the sales floor were typically fetched 3.5 minutes faster than those stored on overhead racks. During dispatch, the process delivered 24 completed orders per hour, yet operator output fluctuated dramatically, suggesting that systematic executive variances drive a sizeable portion of the observed productivity gap. Each order consumed 0.73 minutes on average, but truck loading repeatedly surfaced as a choke point, destabilising on-time departure windows.

4.3.4. Component 4: Development and Presentation of the Ideal Method

In response to those findings, a revised operating method was drafted to match actual demand patterns. Analysts concentrated on the two most consequential subprocesses-picking and dispatch-evaluating product dimensions, mass, turnover frequency, storage tier, and individual operator histories. High-complexity lines, such as televisions, still achieved 36 units per hour, yet larger flat-pack assemblies seldom surpassed 13 because their bulk and awkward edges slow isolation and packing. Location further shaped efficiency: articles stored in rack cells yielded 152 picks per hour, whereas those on the main sales floor dropped to just 31, a disparity that reinforced the case for dedicated high-rise pick zones.

For the redesign, a twenty-day time study captured the activities of ten picking and six dispatch operators. On average, each picked line item consumed 6.41 minutes, with 3.49 minutes lost to travel between high racks. In dispatch, the crew processed an average of twenty-four orders per hour; top performers consistently reached thirty-two to thirty-three orders. Observed variations formed the basis for a best-practice checklist now used in operator training.

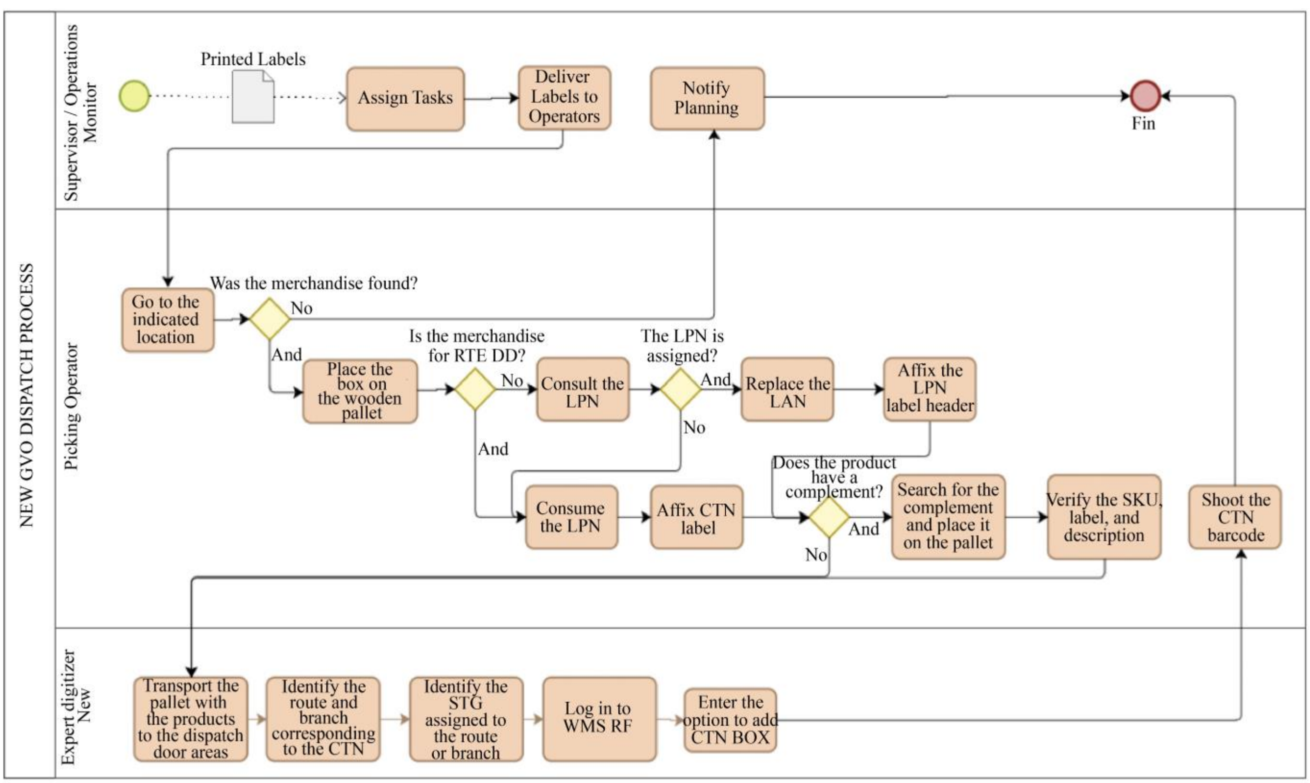

Fig. 2 Diagram of the improvement in the picking process

Routine administrative tasks, principally system entry, were shifted to a dedicated data-entry clerk, cutting the picking operators' workload from fifteen to ten tasks and the dispatch workload from eight to seven. This realignment lets floor personnel concentrate on value-added actions. Automation of key warehouse-management-system steps further trimmed loading time for outbound trucks. Job-Strain-Index analysis guided a workflow redesign and a suite of ergonomic measures. Tasks involving loads over thirty kilograms produced strain scores above the critical threshold of 7.5. Remedial steps included adding two electric pallet jacks, mandating five-minute recoveries each hour, and instituting weekly supervisor-led ergonomics training.

Consequently, standard preparation time contracted from 14.95 to 11.13 minutes, translating to a 25.5 percent gain. The revised process harmonizes productivity, safety, and sustainability and has received conditional approval from the logistics committee for staged rollout across all shifts.

Figure 2 illustrates the redesigned picking process, incorporating validation checkpoints, optimized task sequences, and the separation of administrative and operational roles.

The flow emphasizes continuous movement, systematic verification, and efficient order preparation through a lean structure that eliminates redundancies and improves coordination between data entry and physical execution.

Figure 3 shows the improved dispatch-to-transport process, highlighting the integration of WMS programming, load assignment, and verification activities. Tasks are redistributed to separate administrative and operational responsibilities, ensuring fluid coordination, faster execution, and error reduction. The streamlined flow facilitates efficient truck loading and accurate documentation for outbound logistics.

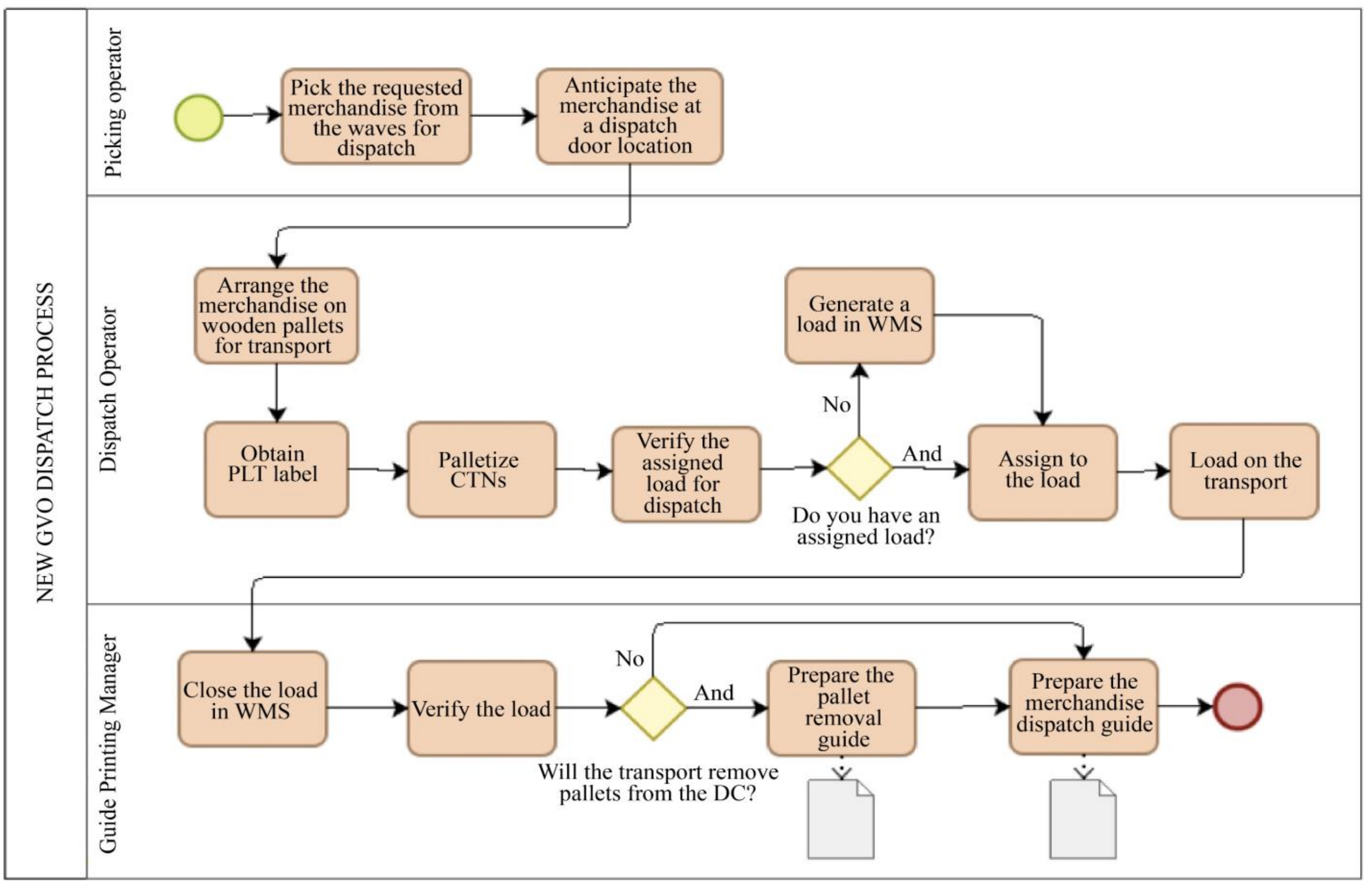

Fig. 3 Improved diagram of the dispatch to transport process

Table 1 summarizes the ergonomic risk assessment for six product categories based on the Job Strain Index (JSI). Items like washing machines and refrigerators exceed the danger threshold, reflecting high physical demand. In contrast, televisions and cabinets show safe levels, highlighting variability in manual handling risks across different merchandise types.

Table 1. Ergonomic risk assessment table by category

Category	Weight (Kg)	Picking Type	Transport Type	Units Dispatched Daily	IE	DE	EM	HWP	SW	DD	JSI (Risk Factor)	JSI Rating
Front-loading Washing Machine	60	Manual	Manual cart	150	9	2	1.2	2	1.5	1	10.8	Dangerous
Gas Kitchen Stove	30	Manual	Manual cart	110	5	3	1	2	1.5	1	7.5	Dangerous
Double-door Refrigerator	40	Manual	Manual cart	120	5	4	1.5	2	1.5	1	15	Dangerous
LED Television (32–50")	30	Manual	Manual cart	250	3	0.5	1	1	2	1	0.5	Safe
Recliner Armchair	28	Manual	Manual cart	45	5	3	1	2	1.5	1	7.5	Dangerous
Wooden TV Stand Cabinet	28	Manual	Manual cart	95	3	0.5	1	1	2	1	0.5	Safe

4.3.5. Component 5: Work Analysis and Optimal Staffing

This component examined the optimal staffing level needed to handle the volume of orders and used the standard term optimal roll. After reviewing attendance records, the average effective hours per operator per week were determined to be 43. On this basis, a three-crew rotating schedule was designed to maintain 24-hour coverage without overtime, linking duty handovers to natural workflow peaks. Operator assignments within each shift were then ranked according to historical productivity by time block. The availability of pallet jacks and stackers was mapped to each work phase, so every worker had equipment nearby. When 24 pickers and 12 dispatch clerks staffed each rotation, model results showed that orders could be fulfilled at 94-percent efficiency, thus eliminating the previous surplus of personnel.

Description of Machines	Electric pallet trucks	Electric stackers	Manual pallet trucks
MQ-2022	2	8	20
MQ-2023	4	8	20
Image			

Fig. 4 Internal logistics vehicles at the Distribution Centre

Figure 4 presents the internal logistics vehicles used at the Distribution Centre, comparing equipment availability between 2022 and 2023. The number of electric pallet trucks doubled, enhancing operational efficiency, while electric stackers and manual pallet trucks remained constant, maintaining a balanced logistics infrastructure for material handling and load transportation.

Figure 5 displays the improved Analytical Process Diagram (APD), highlighting a streamlined workflow composed entirely of value-added activities. With zero non-value-added time, the process achieves a total duration of 667 seconds across 20 operations, reflecting efficiency gains through task simplification, activity sequencing, and the elimination of unnecessary steps.

Item	Activity	○	⇨	□	D	▽	Total
	Quantity	2	4	0	0	0	20
Total Time (seconds)	591	20	56	0	0	0	667
VA Time (seconds)	591	20	56	0	0	0	667
NVA Time (seconds)	0	0	0	0	0	0	0
Note:	**VA Time**: Value-Added Time **NVA Time**: Non-Value-Added Time						

Fig. 5 Improved Analytical Process Diagram (APD)

4.3.6. Component 6: Time Standard Definition

The final step specified a revised time standard for preparing each order. Using observations taken after the flow improvements were implemented, the average pick-and-pack cycle now averages 11.13 minutes, down from the old benchmark of 14.95 minutes. The new timing is the reference for day-to-day performance tracking, supporting monitoring and corrective action. It permits sales managers to set attainable, quantifiable targets at the individual level, offers personnel timely feedback, and issues alerts within two deviations. The standard is also embedded within the logistics KPI dashboard, guiding resource allocation, goal assignment by shift, and financial diagnostics. Early projections indicate that achieving the new target could free enough labour hours to yield annual savings exceeding PEN 400,000.

4.4. Results

Table 2 collects the principal performance measures recorded after the re-engineered operations management framework, influenced by Method Engineering and Ergonomics, was put to empirical test. The productivity index improved from 2.8 to 4 orders produced per man-hour, representing a 42.9 percent increase that indicates operator time is now allocated more efficiently. On-time deliveries climbed to 96.5%, a 4.9% rise that confirms standardizing tasks has eased the worst bottlenecks. The share of costs relative to sales fell from 1.44% to 1.20%, translating to a 16.7% drop in expenses caused by late processes. Finally, the optimal number of workers per area was lowered from 50 to 36, a 28% cut that illustrates how balancing workloads with ergonomic design can streamline resource use.

Table 2. Setup Time Reduction Achieved with SMED Implementation

Indicator	Unit	As-Is	To-Be	Results	Variation (%)
Productivity index	Order/man-hour	2.8	5	4	42.86%
% On-time deliveries to the carrier	%	92%	98%	96.50%	4.89%
% of costs in proportion to sales	%	1.44%	1%	1.20%	-16.67%
Optimal number of operators per area	person	50	34	36	-28.00%

Displayed equations are centered and set on a separate line. Please avoid rasterized images for equations, tables, flow charts, algorithms, datasets, line-art diagrams and schemas. Whenever possible, use vector graphics instead.

5. Discussion

The present study's findings indicate a 17.8 percent drop in order-picking cycle time and a 60.6 percent cut in non-productive minutes, suggesting marked process improvement. These results echo the conclusions of Briones-Chávez et al. [2], who linked Lean Warehouse practices to better on-time-in-full (OTIF) scores in owner-operated logistics firms. Duque Jaramillo et al. [1] also argue that intelligent slotting, such as the criticality matrix used here, drives faster picking, a point supported by the observed gains. As noted by Abushaikha et al. [4], waste elimination and task standardisation are indispensable for lasting warehouse progress and guided the formulation of the procedures tested here.

Ergonomic upgrades parallel Battini et al.s [7] warnings about musculoskeletal risk from rigid postures and confirm that workstation redesign can ease physical demands. The notion, advanced by Moya Navarro [3], that clearer aisles and shorter paths lift productivity, is validated in this study by the reduced travel times recorded during trials.

Taken together, the quantitative and qualitative data lend solid support to the improvement approach put forward in this research, and their consistency with well-established theories on logistics and warehouse efficiency is documented.

5.1. Study Limitations

While these promising results are encouraging, several limitations merit careful consideration. First, the case study was confined to a single retail firm, so the insights may not transfer smoothly to other industries or alternative business models. In addition, the investigation home was only on the picking stage and, therefore, ignored related steps- such as put-away, receiving, and dispatch- that might also shape overall throughput and cost. The proposal also stopped short of integrating any digital tools or advanced analytics- a gap that, if filled, probably would have lifted performance even higher. Lastly, the paper offers only a preliminary, high-level look at implementation expenses and expected payback, thus leaving readers without the full economic picture needed to judge practical viability.

5.2. Recommendations for SMEs Based on Results

The findings of this study provide actionable guidance for managers of small and medium retail warehouses seeking to streamline their operations. By applying tools like the criticality matrix, process flow charts, and careful workstation redesign, these firms achieved noticeable gains in order-picking speed without heavy hardware expenses.

Such results reinforce the notion that a culture of continuous improvement can flourish even in resource-constrained settings when changes are made step by step. Moreover, the methods documented here constitute a user-friendly reference for logistics supervisors and industrial engineers confronting comparable issues, offering a clear, replicable path to performance gains. Emphasizing ergonomic standards further shows that any drive for efficiency must honour worker safety and comfort as foundational, not optional, elements of warehouse success.

5.3. Future Works

Several follow-up studies could deepen and widen the effects already seen, so researchers are encouraged to pursue them. One clear opportunity lies in linking the framework to digital tools, such as voice-picking systems or business-intelligence dashboards, to yield ongoing visibility and faster, data-driven decisions. It would also prove useful to assess additional warehouse activities—Inbound receipt, stock replenishment, or returns processing—to measure how the same concepts affect the value chain as a whole. Long-term observation studies are needed to show whether the gains persist and whether they produce sustained cost or service benefits. Finally, parallel experiments in different sectors can test the model's flexibility and yield tailored, industry-specific guidelines for adoption.

6. Conclusion

The project shows that a process-improvement model built on methods engineering and ergonomics can noticeably streamline order picking in retail distribution centres. Stepwise task reconfiguration, clear standard work, and ergonomic fixes together drove measurable lifts in labour output, on-time shipments, and overall cost. These gains appear in the formal metrics but also in lower reports of fatigue and injury, underscoring the value of balancing system speed with worker comfort.

The finding is timely, given mounting marketplace pressure for faster, error-free deliveries across many emerging economies. By tackling inventory flow alongside the physical demands on employees, the work counters legacy logistics philosophies that trade workforce health for short-run speed or reduced expense. Its main contribution is proof that durable improvement follows when workflow respects human capability rather than forcing personnel to bend to unrealistic process goals.

This study advances logistics scholarship and practice in Latin America by testing a low-cost, adaptable toolkit that operators can implement with little new infrastructure. More than a technical novelty, the toolkit lays out step-by-step diagnostic and procedural stages that managers of bottlenecked distribution centres can follow, thereby codifying practical lessons for the wider region.

For future work, researchers should extend the framework to receiving, put-away, and storage functions while examining how it intersects with sensors, cloud tools, and artificial intelligence. Longitudinal assessments would clarify whether the framework remains robust over time and whether it delivers enduring competitive gains for retailers.

References

[1] Juan Camilo Duque Jaramillo, Manuela Cuellar Molina, and Juan Miguel Cogollo Flórez, "Slotting and Picking: A Review of Methodologies and Trends," *Ingeniare. Revista Chilena de Ingeniería*, vol. 28, no. 3, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[2] Adriana Briones-Chávez, Nicolas Sandoval-Soldevilla, and Juan Carlos Quiroz-Flores, "Applying Lean Warehousing Tools to Improve OTIF: A Case Study in a Logistics SME in the Freight Transportation Sector in Peru," *SSRG International Journal of Mechanical Engineering*, vol. 12, no. 1, pp. 113–126, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[3] Marcos Moya Navarro, "Simulation of a Manual Order Picking System in a Distribution Center of a Convenience Store Chain," *18th LACCEI International Multi-Conference for Engineering, Education, and Technology*, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[4] Ismail Abushaikha, Loay Salhieh, and Neil Towers, "Improving Distribution and Business Performance Through Lean Warehousing," *International Journal of Retail & Distribution Management*, vol. 46, no. 8, pp. 780–800, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[5] Marcos Moya Navarro, "Identificación de Factores que Influyen En el Faltante de Productos en las Góndolas de los Supermercados Por Medio del Análisis Factorial Por Componentes Principales," *19th LACCEI International Multi-Conference for Engineering, Education, and Technology*, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[6] Brigita Gajšek et al., "Towards Productive and Ergonomic Order Picking: Multi-Objective Modeling Approach," *Applied Sciences*, vol. 11, no. 9, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[7] Daria Battini et al., "Additional Effort Estimation Due to Ergonomic Conditions in Order picking Systems," *International Journal of Production Research*, vol. 55, no. 10, pp. 2764–2774, 2017. [CrossRef] [Google Scholar] [Publisher Link]

[8] Sandy E. Castillo et al., "Impact of Slotting on the Supply Chain for Warehouse Management: A Systematic Review," *22nd LACCEI International Multi-Conference for Engineering, Education, and Technology*, 2024. [CrossRef] [Google Scholar]

[9] Dominic Loske et al., "Logistics Work, Ergonomics and Social Sustainability: Empirical Musculoskeletal System Strain Assessment in Retail Intralogistics," *Logistics*, vol. 5, no. 4, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[10] Édson Mauro Carvalho Dutra, Guilherme Linhares Laureano, and Ana Regina de Aguiar Dutra, "Ergonomic Study of the Dispatch of a Pharmaceutical Distribution Company," *Interações*, vol. 18, no. 3, pp. 159–168, 2017. [Google Scholar] [Publisher Link]

[11] Gian Piero Palomino-Paucar, Álvaro Eduardo Vidal-Ugarte, and Richard Nicholas Meza-Ortiz, "Warehouse Management and Order Picking Optimization in Spare Parts Distribution: An Empirical Study from Peru on Continuous Improvement Strategies," *SSRG International Journal of Economics and Management Studies*, vol. 12, no. 2, pp. 11–20, 2025. [CrossRef] [Publisher Link]

[12] Mildrend Montoya-Reyes et al., "Method Engineering to Increase Labor Productivity and Eliminate Downtime," *Journal of Industrial Engineering and Management*, vol. 13, no. 2, pp. 321-331, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[13] Adithya Narayanan Rajesh, “Labor-Saving in Order Picking- A Real Time Study Advancing Lean Operations,” *American Journal of Supply Chain Management*, vol. 9, no. 3, pp. 16–25, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[14] İbrahim Halil Korkmaz et al., “Job Analysis and Time Study in Logistic Activities: A Case Study in Packing and Loading Processes,” *Central European Journal of Operations Research*, vol. 28, pp. 733–760, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[15] Noha A. Mostafa, and Youssef Essam, “Using Lean Tools in Warehouse Improvement: A Case Study from Electronics Retail Sector,” *7th European Conference on Industrial Engineering and Operations Management*, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[16] Joo Ae Lee et al., “A Study on the Picking Process Time,” *Procedia Manufacturing*, vol. 3, pp. 731–738, 2015. [CrossRef] [Google Scholar] [Publisher Link]

[17] Kateryna Czerniachowska, Radoslaw Wichniarek, and Krzysztof Żywicki, “A Model for an Order-Picking Problem with a One-Directional Conveyor and Buffer,” *Sustainability*, vol. 15, no. 18, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[18] Gustavo R. Henríquez Fuentes et al., “Time Measurement in a Distribution System under a Methods and Time Study,” *Información Tecnológica*, vol. 29, no. 6, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[19] Danish Nasir, Rakesh Venkitasubramony, and Suresh Kumar Jakhar, “Ergonomics in Warehouse Design and Operations: A Systematic Literature Review,” *Operations Research*, vol. 25, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[20] Steven A. Lavender et al., “Ergonomic Considerations when Slotting Piece-pick Operations in Distribution Centers,” *Applied Ergonomics*, vol. 97, 2021. [CrossRef] [Google Scholar] [Publisher Link]