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Integrating 5S, Kanban, and Systematic Layout Planning to Improve Logistics Performance in a Peruvian Construction SME

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Abstract

Construction SMEs frequently faced schedule slippage and cost overruns due to fragmented purchasing, unreliable inventories, and improvised staging, while prior studies highlighted the promise of lean logistics and Systematic Layout Planning in comparable contexts. This work addressed those urgent deficits by examining a Peruvian SME dedicated to infrastructure and remodeling projects. The research proposed an integrated production-management model and piloted it for four months, combining 5S to stabilize order, Kanban cards and boards to pull replenishment, and SLP to reconfigure the temporary warehouse and staging flow. The pilot achieved tangible gains: efficiency rose from 78% to 92%, cycle time dropped from 68 to 52 days (−23.53%), downtime hours fell from 1,118 to 459 (−58.94%), and economic impact improved by more than 58%. The study advanced practice-grounded evidence for SMEs and suggested socioeconomic benefits through faster delivery and leaner inventories. It invited further replications and lightweight digital supports after processes stabilized.

Keywords
Lean Construction; Kanban; 5S Methodology; Systematic Layout Planning (SLP); Logistics Performance

1. Introduction
Small and medium-sized enterprises (SMEs) in infrastructure construction—remodeling and allied works included—create local jobs, activate regionally dispersed supply networks, and deliver value through short project execution cycles. In Latin America and Peru, the move from conventional management to sustained operational excellence has been patchy, with adoption among nations and market niches diverging. Lean uptake by Peruvian construction SMEs is hindered by cultural, training, and standardization issues, but it improves coordination, reliability, and project performance. This high relevance and partial acceptance illustrate the practical and scientific value of knowing how small firms may stabilize production and supply systems without huge contractor scale advantages.

Under these conditions, supply function frictions undermine SME performance. On small job sites, materials planning with incomplete or late information, reactive, fragmented, and weakly coordinated supplier management, and low inventory reliability that undermines work front synchronization are especially noticeable. Construction studies indicate that material-management practices, including planning, procurement, logistics, on-site handling, stock control, and waste mitigation, significantly impact project outcomes, including time, cost, efficiency, and quality (Yıldız et al., 2024). Complementary research that models the complexity of construction materials purchasing, focusing on micro, small, and medium enterprises, highlights demand variability, uncertain lead times, and information asymmetries as systemic obstacles that are amplified by limited formalization and information systems in SMEs (Donyavi et al., 2024). These deficiencies sometimes lead to stock-outs, "just-in-case" stockpiling, yard and temporary storage disarray, and late expediting that transfers waste from the supply chain to the work front.

SMEs can maintain diligent but lightweight initiatives to address such shortcomings. The physical structure of flow helps the system absorb unpredictability and deliver items on time when storage, staging, and movement patterns match the logic of work. Systematic Layout Planning (SLP) reduces travel distances and material handling, improving throughput in space-constrained and repetitive or semi-repetitive process sequences (Naqvi et al., 2016). In small firms with limited resources for sophisticated digital management, spatial redesigns are frequently the easiest approach to stabilize flow and set up dependable replenishment.

Related, labor-intensive SMEs demonstrate these advantages' practicality. SLP-guided redesigns of cutting, sewing, and staging areas in apparel and allied manufacturing can reduce total material-handling cost by a quarter, transfer time by a third, and ergonomics and line balance with modest capital and strong layout logic and workplace organization (Suhardi et al., 2019). Project-based, mobile construction differs from factory production, but small job sites have tight space, shared access routes, frequent crew interference, and high sensitivity to temporary storage and preparation areas. SLP creates a physical backbone that stabilizes flow and avoids needless motion, waiting, and rehandling when applied carefully.

Lean foundations complement information-flow structure. Visual management and standardization help prepare for technology-enabled control when digitalization expenditures are limited. When basic operational discipline (e.g., orderly work areas, visual stock control, standardized task sequences) is first established, digital planning and monitoring tools are more effective at aligning scheduling, supply, and execution and making deviations visible early enough to act (Eldeep et al., 2022). Practically, SMEs could sequence low-complexity Lean techniques before or alongside selected digital tools to get better results than extensive digital transformations on fragile physical processes.

The SME viewpoint helps explain adoption patterns. Fragmentation, short-term contracting, and unstandardized techniques hinder Lean diffusion in highways projects, which have many medium and small suppliers. Targeted training, supply-chain agreements that reward stability, and governance mechanisms that encourage longer-term relationships can help (Tezel et al., 2018). These levers create concrete practices for small contractors and specialty trades: agreeing on replenishment rules with key suppliers, stabilizing material call-offs, and standardizing kit preparation, which reduce work face variability and last-minute expediting.

This increasing data suggests Kanban is a good collaboration tool for SMEs. Kanban has moved from manufacturing to job-site and supply applications in construction, resulting in better crew and supplier synchronization, transparency of pending work, and reduced inventories and waiting through visual pull signals (Fuentes-del-Burgo et al., 2024). Small businesses like the mechanism because it is straightforward to learn and manage and expands with the operation, from physical cards to digital boards, while sacrificing demand-pulled replenishment.

This article addresses a research gap: while the literature recognizes the importance of materials management in construction performance and the promise of Lean and BIM for SMEs, few SME-oriented studies explicitly couple supply management with the physical redesign of material flow through SLP, and even fewer articulate a sequenced deployment that small firms can adopt without heavy upfront investment. We developed a production-management model for construction SMEs that integrates 5S (to stabilize order, visibility, and workplace standards), Kanban (to formalize simple pull-based replenishment rules with suppliers and crews), and SLP. The model aims to lower cognitive load, reduce implementation risk, and produce measurable gains in a timeframe compatible with SME constraints by consolidating order and visual control (5S), installing explicit, low-friction replenishment signals (Kanban), and aligning the physical path to the replenishment logic (SLP).

This addition complements and expands previous research. First, it applies established SLP effects from labor-intensive SMEs to small project sites, where storage, staging, and access routes are generally under-engineered despite their influence on safety and productivity. Second, it requires fundamental operational discipline to adopt digital planning, mirroring Lean–BIM studies that advise against adding technology to unstable processes (Eldeep et al., 2022). Third, it prioritizes supplier coordination using Kanban and calibrates replenishment rules for SMEs without planning departments using recent construction-specific syntheses (Fuentes-del-Burgo et al., 2024). These options reconcile information flow with physical flow and incorporate the outcome in simple routines that crews can own to solve the main failure drivers in construction SMEs—late or incorrect materials planning, fragmented supplier relationship, unreliable stocks.

The proposed model aims to help small contractors move away from firefighting toward predictable, cleaner, and safer operations with fewer stock-outs and "fear stock," shorter internal lead times between storage and use, and clearer visibility from scheduled tasks to staged materials. Stable, observable processes provide better data for planning and control, enabling gradual digitization and quick efficiency advantages. It addresses Latin American and Peruvian SMEs' resource restrictions, unpredictable demand, and multi-trade coordination while proposing a reproducible route that can be tested within months and grown as organizational confidence and capabilities improve. The essay then describes the background and diagnostic baseline, model design and components, the four-month validation pilot, and operational and economic findings.

2. Literature Review

This section synthesizes the scholarly evidence on logistics improvement in small and medium-sized enterprises (SMEs) dedicated to infrastructure construction, including remodeling and related works. The review draws on peer-reviewed and open-access sources (e.g., Scopus, Web of Science, Scielo, LACCEI, IEOM, ACM, and Google Scholar), privileging empirical studies and systematic reviews from the last decade. Inclusion criteria were: (i) SME settings or clearly transferable conditions to small contractors; (ii) explicit logistics outcomes (lead time, inventory levels, handling time, service level, or cost); and (iii) the application of Lean-based methods. The discussion is structured around four recurrent interventions—Lean Logistics, Kanban, 5S, and Systematic Layout Planning—followed by a comparative synthesis that surfaces points of consensus, boundary conditions, and research gaps to inform the model validated in this study.

2.1 Lean Logistics to Optimize Logistics Processes

In the logistics of construction SMEs, adopting Lean principles makes it possible to eliminate waste and align the flow of materials and information with real demand. For example, a case reported by Llanos-Solórzano et al. showed that distribution productivity increased from 61% to 87% after a Lean Logistics deployment that cut idle time and excess inventory (Llanos-Solórzano et al., 2025). In a similar vein, a Peruvian study documented how a Lean Logistics–based warehouse model—combining 5S, ABC classification, and layout redesign—reduced non-conforming orders from 62% to 12% and improved space utilization from 42% to 82%, signaling a clear operational gain (Díaz-Estela et al., 2025). These initiatives indicate that supply-chain-focused Lean tools (e.g., value stream mapping and process Kaizen) can accelerate deliveries and curb inventory build-up, while also making warehouses cleaner and safer—conditions that translate into higher efficiency for small contractors handling remodeling and related works (Díaz-Estela et al., 2025; Llanos-Solórzano et al., 2025).

2.2 Kanban to Visualize and Control Inventories

Kanban is a pivotal visual device for managing material flow in SMEs. Implementing cards or digital boards helps small firms make stock levels visible and synchronize replenishment with actual consumption, reducing both stock-outs and overstock. In practice, an integrated Lean model for construction SMEs achieved a 58% reduction in inventories and a 22% improvement in handling times when Kanban was combined with complementary techniques (Pineda-Pomachagua & Núñez-Romero, 2024). Sectoral evidence in industrial service settings similarly shows that Kanban mechanisms—such as two-bin systems or e-cards—cut critical-part shortages and secure the availability of spares (Pineda-Pomachagua & Núñez-Romero, 2024). Beyond inventory effects, Kanban strengthens internal communication: by making flow visible in real time, teams respond faster to changes, bottlenecks ease, and the supply chain becomes more predictable for small construction projects (Pineda-Pomachagua & Núñez-Romero, 2024).

2.3 5S as a Foundation for Order and Discipline

The 5S methodology (sort, set in order, shine, standardize, sustain) is essential for organizing the logistics environment in SMEs. Systematic application reduces time lost searching for tools or materials and fosters safer working conditions. In a warehouse setting, a 5S program reduced retrieval time for frequently used items by 37%, reflecting faster access driven by waste elimination and intelligent labeling (Lesiba & Gupta, 2025). Within logistics processes, 5S yields “cleaner, safer, and more organized” spaces, with safety gains that lower absenteeism and lift overall operational efficiency (Díaz-Estela et al., 2025). Likewise, when 5S was embedded within a Lean model, disciplined housekeeping and visual standards helped sustain benefits over time; after rearranging spaces and equipment (Sort and Shine), standardized procedures ensured the improvements would stick (Pineda-Pomachagua & Núñez-Romero, 2024). In sum, across comparable SMEs, 5S consistently minimizes disorder and builds worker ownership, converging in faster and safer logistics (Díaz-Estela et al., 2025; Lesiba & Gupta, 2025; Pineda-Pomachagua & Núñez-Romero, 2024).

2.4 Systematic Layout Planning to Optimize Space

Systematic Layout Planning (SLP) provides a structured way to design or reconfigure the logistics footprint of SMEs. Through activity charts and relationship matrices, SLP identifies the best placement of areas (e.g., receiving, storage, staging) to minimize travel and avoid crossings. In construction-adjacent SMEs, proper layout planning "minimizes material-handling distances and reduces waste," with substantial efficiency gains (Herwanto, 2024). In an industrial maintenance shop, reconfiguring the flow with SLP eliminated 58% of unproductive walking between diagnostic and repair stations (Álvarez-Bustinza & Meza-Ortiz, 2025). When SLP is integrated with Lean (for instance, positioning high-turnover items near points of use), firms shorten internal transport times and improve on-time delivery. In one application that combined SLP with inventory practices, optimized warehouse zoning cut material-handling time by 22% and freed roughly 200 m² of usable space (Pineda-Pomachagua & Núñez-Romero, 2024). Taken together, these findings indicate that SLP offers relevant productivity and quality gains for construction SMEs by ensuring that physical space and information flow work in tandem (Álvarez-Bustinza & Meza-Ortiz, 2025; Herwanto, 2024; Pineda-Pomachagua & Núñez-Romero, 2024).

2.5 Synergy of Lean Methods in Construction SMEs

Multiple studies converge on the idea that combining Lean methods generates compounding effects in SME logistics. A highlighted case integrated Kanban, SLP, and 5S in a remodeling firm, achieving a 58% reduction in inventory levels, 22% lower handling times, and about a 20% operating cost saving—outcomes that would be hard to reach with isolated tools (Pineda-Pomachagua & Núñez-Romero, 2024). Similarly, pairing Lean Logistics with SLP lifted service-shop productivity from 61% to 87%, illustrating how visual management, flow-oriented layout, and disciplined standards reinforce one another (Álvarez-Bustinza & Meza-Ortiz, 2025). For construction SMEs, the coordinated use of these methods creates a robust material-flow system: Kanban clarifies demand and triggers replenishment, SLP engineers the shortest and safest paths, and 5S maintains order on the ground—together driving operational efficiency, cost reduction, and shorter lead times (Álvarez-Bustinza & Meza-Ortiz, 2025; Pineda-Pomachagua & Núñez-Romero, 2024).

3. Methods

This section outlines the methodological framework adopted for the development and validation of the proposed production management model. It describes the conceptual foundations, the design of the model and its components, as well as the indicators used to evaluate its performance. The approach was structured to ensure both scientific rigor and practical applicability in the context of a small and medium-sized enterprise dedicated to infrastructure construction and remodeling.

3.1. Proposed Model

Figure 1 presents the proposed conceptual production model, grounded in Lean Manufacturing philosophy and the Systematic Layout Planning (SLP) methodology. The scheme integrated three main components—Kanban, 5S, and Layout—represented as interconnected gears that enabled the transition from an initial state marked by low purchasing efficiency to an improved scenario with high performance in procurement management. Kanban facilitated the organization of material flows through a visual replenishment system that minimized excesses and ensured timely availability, while the implementation of 5S promoted workplace standardization by fostering order, cleanliness, and operational discipline. Complementarily, the redesign of the layout based on SLP principles allowed a more effective distribution of areas, reducing unnecessary movements and promoting a continuous flow of activities. The model was applied in the context of a small and medium-sized enterprise dedicated to infrastructure construction, including remodeling and related services, where efficient purchasing and temporary storage management were critical to meeting deadlines and ensuring service quality. Overall, the methodological proposal aimed not only to enhance operational efficiency but also to encourage the adoption of an organizational culture oriented toward continuous improvement and aligned with Lean principles.

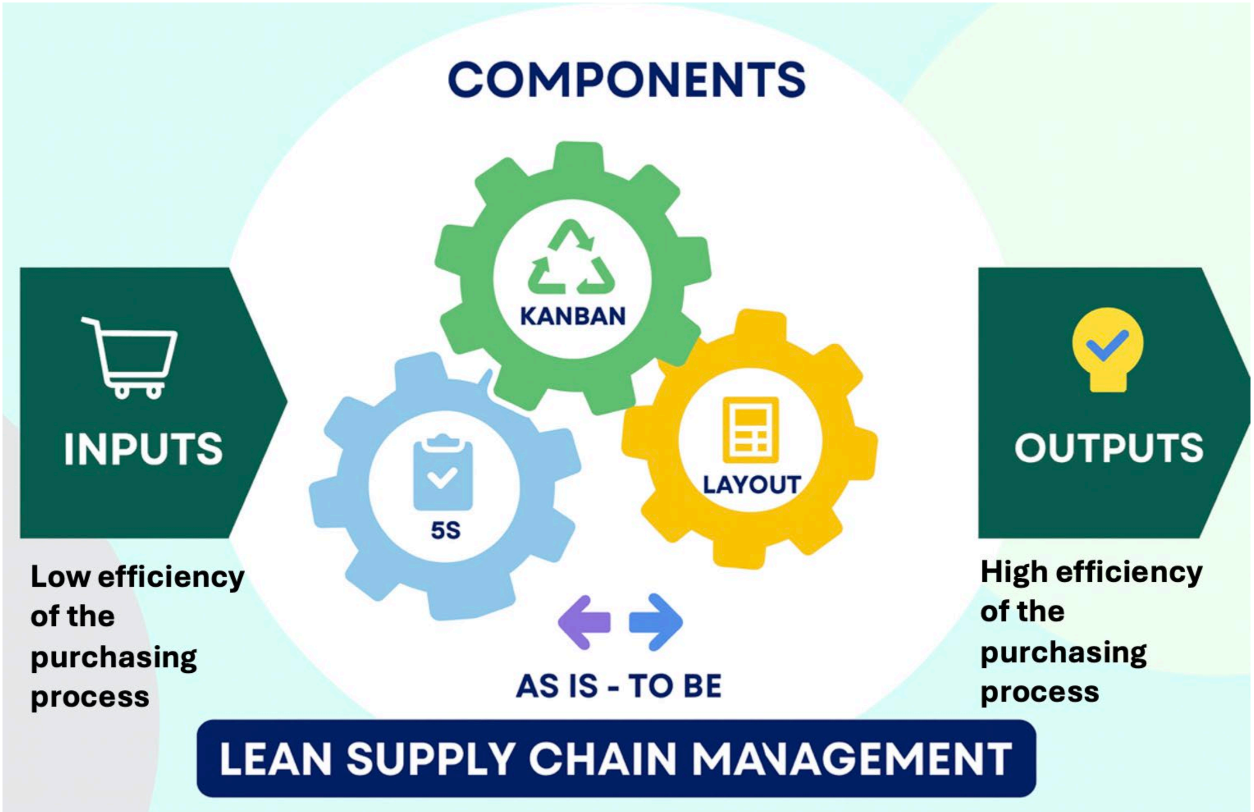

Figure 1. Proposed Model

3.2. Model Components

Figure 1 illustrates the proposed production model, designed under the principles of Lean Manufacturing and the Systematic Layout Planning (SLP) methodology. The model is conceived as a comprehensive framework that seeks to transform the purchasing and material flow processes in small and medium-sized enterprises dedicated to infrastructure construction, including remodeling and related services. In such organizations, inefficiencies in procurement and temporary storage management often generate delays, additional costs, and quality inconsistencies. The proposed model responds to these challenges by integrating three fundamental components—Kanban, 5S, and Layout—conceived not as isolated tools but as complementary mechanisms that interact continuously to ensure both operational improvements and cultural change.

The contribution of this model lies in its ability to connect practical applications of Lean principles with the structured logic of SLP. By doing so, it does not only aim to optimize the use of physical resources but also to enhance coordination between procurement, storage, and distribution processes, areas that are often overlooked in construction-related SMEs. Furthermore, the model provides a methodological pathway that bridges the "as-is" situation with the "to-be" scenario, demonstrating how structured interventions can progressively transform organizational performance.

Kanban as a Visual and Flow-Regulating Mechanism

The first component of the model is Kanban, which plays a central role in regulating the flow of materials and information. Within the context of infrastructure construction SMEs, the application of Kanban serves as a mechanism to synchronize purchasing requirements with actual consumption at worksites or warehouses. By employing a system of visual signals, the process avoids overstocking and minimizes the risk of shortages, enabling materials to be replenished only when necessary.

This visual management system introduces transparency into the supply chain, as all participants can monitor the status of material flows without depending solely on digital records or complex procedures. The cyclical nature of Kanban cards—or equivalent visual markers—ensures that the pull principle becomes embedded into daily operations, reducing variability in material availability. Through this system, procurement decisions are no longer speculative but are instead grounded in actual demand signals, which contributes to a more reliable planning process.

Moreover, the adoption of Kanban fosters accountability and discipline among employees, as they become actively engaged in monitoring inventory levels and signaling replenishment needs. This collaborative aspect aligns with the broader Lean philosophy, where value creation depends on the participation of all organizational members. In this sense, Kanban is not limited to an inventory management technique but becomes an essential element of cultural transformation.

5S as a Foundation for Order and Discipline

The second component of the model corresponds to the 5S methodology, which provides the foundation for workplace order and discipline. In construction-related SMEs, temporary warehouses and storage facilities often face challenges related to disorganization, accumulation of unnecessary materials, and inefficient use of space. These conditions not only reduce operational performance but also increase the likelihood of accidents and material losses.

The implementation of 5S—sorting, setting in order, shining, standardizing, and sustaining—addresses these challenges by establishing a systematic approach to workplace organization. The first stages focus on identifying and removing items that are not required, thereby ensuring that only useful tools and materials are available. Subsequent steps emphasize arranging items logically, maintaining cleanliness, and creating standardized practices that prevent the reemergence of disorganization.

In practice, 5S also serves as a visible indicator of operational discipline, since a well-organized warehouse reflects the company's commitment to efficiency and safety. By embedding these practices into the daily routines of employees, the organization develops a shared sense of responsibility toward maintaining optimal working conditions. Over time, this not only improves productivity but also enhances employee morale, as workers operate in environments that support efficiency rather than hinder it.

Within the proposed model, 5S is strategically positioned to complement the Kanban system, since the effectiveness of visual management depends on an orderly and disciplined workplace. Together, these components ensure that material flows are not obstructed by clutter, delays, or inconsistencies, thus enabling smoother transitions between operational stages.

Layout Redesign through Systematic Layout Planning

The third component of the model is the redesign of the physical layout, guided by the principles of Systematic Layout Planning (SLP). Unlike manufacturing plants, SMEs in the construction sector often deal with temporary or semi-permanent storage facilities where material flows are not always optimized. Poorly planned layouts can lead to excessive movement, inefficient utilization of space, and longer lead times, all of which directly impact the cost and quality of projects.

The use of SLP introduces a structured methodology to reconfigure these spaces based on material flow requirements, adjacency needs, and safety considerations. The process begins with an analysis of current layouts and flow patterns, followed by the identification of alternative arrangements that reduce unnecessary movements and ensure logical sequences of operations. Factors such as access to frequently used materials, proximity to loading and unloading zones, and separation of hazardous items are carefully evaluated to design an optimal configuration.

In the proposed model, the layout redesign does not operate in isolation but reinforces the gains achieved through Kanban and 5S. For instance, once inventories are regulated through Kanban and workspaces are organized via 5S, the redesigned layout provides the physical environment that sustains these improvements. The combination of these interventions creates a coherent system where materials move seamlessly, employees perform tasks with less effort, and operational bottlenecks are systematically reduced.

Integration of Components: From "As-Is" to "To-Be"

The strength of the proposed model resides in the integration of its three components. Kanban, 5S, and Layout redesign are represented as interconnected gears in Figure 1, symbolizing the interdependence that ensures the model's effectiveness. Rather than functioning as isolated initiatives, each component enhances the others, generating a cumulative effect that transforms the organization.

The transition from the "as-is" situation, characterized by inefficiencies in purchasing and material management, to the "to-be" state, marked by improved operational performance, becomes possible through this integration. Kanban ensures demand-driven replenishment, 5S guarantees organizational discipline, and the layout redesign provides the physical foundation for efficient workflows. Together, they establish a system where material flows are streamlined, resources are used more effectively, and employees operate within a structured yet flexible framework.

Application Context: SMEs in Infrastructure Construction
The model is particularly relevant in SMEs dedicated to infrastructure construction and remodeling, where the interplay between procurement, storage, and site delivery significantly influences project outcomes. These organizations frequently operate under resource constraints, with limited capacity for extensive technological investments. The proposed model provides a cost-effective and pragmatic approach that leverages Lean and SLP principles to achieve tangible improvements without requiring complex infrastructure.

By applying the model in this context, SMEs can address persistent inefficiencies that undermine competitiveness, such as material shortages, delays caused by poor coordination, and space limitations in temporary warehouses. Moreover, the adoption of Lean practices contributes to building a culture of continuous improvement, which strengthens the organization's ability to adapt to future challenges.

Conclusion: Toward a Lean-Oriented Organizational Culture
In summary, the proposed production model represents a structured yet adaptable approach to enhancing procurement and material flow processes in construction-related SMEs. By integrating Kanban, 5S, and Layout redesign under the guiding principles of Lean Manufacturing and Systematic Layout Planning, the model establishes a pathway for organizations to evolve from inefficient practices to a culture of operational excellence.

The contribution of this model extends beyond operational outcomes, as it provides a conceptual framework that emphasizes the importance of discipline, transparency, and structured planning in small-scale environments. In doing so, it not only addresses immediate inefficiencies but also lays the foundation for sustainable improvement and competitiveness in an industry characterized by variability and high demands.

3.3. Model Indicators
The evaluation of the proposed production model for a small and medium-sized enterprise in the infrastructure sector was carried out through a set of carefully designed performance measures. These measures were adapted to capture the dynamics of construction and remodeling processes, allowing a consistent assessment of operational improvements. By applying a systematic approach, the analysis enabled the identification of relevant patterns in efficiency gains and resource utilization. This comprehensive perspective ensured a reliable monitoring framework that not only reflected the actual performance of the system but also supported continuous enhancement of practices aligned with Lean and SLP principles. The following section presents the indicators employed for the validation of the proposed model.

Efficiency
Efficiency reflects the proportion of productive time compared to the total available time, showing how well resources are used to achieve planned performance.

$$\text{Efficiency (\%)} = \left(\frac{\text{Actual Output}}{\text{Planned Output}}\right) \times 100$$

Cycle Time
Cycle time measures the average duration required to complete a process from start to finish, indicating responsiveness and operational speed within production.

$$\text{Cycle Time} = \frac{\text{Total Processing Time}}{\text{Number of Units}}$$

Downtime Hours

Downtime hours represent the total time when operations are interrupted due to failures, maintenance, or inefficiencies, directly impacting system availability and productivity.

$$\text{Downtime Hours} = \sum_{i=1}^{n} \text{Time Stopped}_i$$

Economic Impact

Economic impact assesses the monetary effect of operational improvements, comparing initial costs with post-implementation values to highlight financial benefits and cost reductions.

$$\text{Economic Impact (\%)} = \left(\frac{\text{Baseline Cost} - \text{Improved Cost}}{\text{Baseline Cost}}\right) \times 100$$

4. Validation

This section presents the validation process of the proposed production management model, detailing the context of application, the initial diagnosis of the problem, the design of the pilot implementation, and the main results obtained. The analysis emphasizes both operational and economic impacts, providing evidence of the model's effectiveness in improving efficiency and ensuring practical feasibility.

4.1. Validation Scenario

The validation scenario was carried out in a case study of a small and medium-sized enterprise (SME) in the construction sector, located in Lima, Peru, and dedicated to infrastructure projects within the industrial and retail segments. The company executed both remodeling and building works, covering a wide range of technical specialties. Its operations were structured around bidding processes, and once awarded, the organization deployed specialized staff to start activities according to the project schedule. The case study had a multidisciplinary team composed of architects, site managers, safety officers, and technical operators, supported by back-office areas such as logistics, administration, and finance. In addition, it was responsible for the supply and installation of materials, ensuring compliance with technical requirements and economic proposals. During project execution, the company frequently faced challenges arising from client-driven modifications, schedule adjustments, and additional activities, which created complexities in maintaining orderly operations and meeting established deadlines.

4.2. Initial Diagnosis

The diagnosis carried out in the case study revealed that the low efficiency in purchasing management generated an economic impact of PEN 265,055.32, equivalent to 2.31% of the annual revenue. This problem was evidenced by a purchasing management efficiency of 84.55%, below the company's internal policy that required at least 90%. Among the main factors, deficient planning of material requirements accounted for 60.50% of the issue, leading to overstocking at 12.63%, product returns and changes at 29.29%, and production stoppages due to lack of materials at 58.08%. Likewise, poor supplier management represented 17.23% of the problem, with delivery delays contributing 69.03% and incorrect fulfillment of requirements accounting for 30.97%. Finally, low inventory reliability explained 22.28% of the situation, stemming from material deterioration at 62.50% and material losses at 37.50%. These findings reflected a structural weakness in the procurement processes, where insufficient control and coordination led to economic losses and disrupted operational continuity.

4.3. Validation Design

The validation of the proposed production management model, which combined Lean practices with Systematic Layout Planning (SLP), was carried out through a pilot implementation lasting four months in a small construction company dedicated to infrastructure and remodeling projects. This pilot aimed to mitigate inefficiencies affecting workflow and resource allocation. The process involved reorganizing work areas to improve material flow, applying Lean tools to eliminate waste, and standardizing activities to enhance process consistency. Results were measured through operational indicators, confirming efficiency gains and demonstrating the model's practical and economic viability within the production context.

The Diagnostic Foundation: A Deep Dive into Operational Inefficiencies

Before the formulation of any improvement strategy, an exhaustive diagnosis of the existing supply process was carried out to identify and quantify the sources of waste that undermined the productivity and efficiency of the logistics cycle. This initial analysis revealed a system plagued by delays, disorganization, and a lack of visibility, which translated into a total cycle time of 68 days for the procurement and supply process. The investigation focused on collecting empirical data from previous projects, specifically from three works executed in university entities, to build a solid foundation upon which to build the improvement proposal.

The first analytical tool employed was the ABC analysis, an inventory categorization technique based on the Pareto principle, which posits that a small percentage of items (category A) accounts for the largest portion of consumption value. Upon analyzing the materials used in the Villa, Monterrico, and San Isidro projects, a consistent pattern emerged: materials for drywall, flooring and pavements, and electrical conduits (EMT) were recurrently classified in category A. This revelation was crucial, as it allowed optimization efforts to be focused on the products with the greatest impact and frequency, ensuring that any improvement in their management would have a multiplier effect on the overall project efficiency.

Additionally, Process Operation Diagrams (DOP) were created for the most relevant items identified in the ABC analysis. These diagrams made it possible to break down each process into its constituent activities, quantifying the associated times. The drywall installation process, for example, had a total time of 37 days, composed of 10 operations and 4 inspections. Similarly, floor installation required 21 days, with 6 operations and one inspection, while the electrical conduit installation process was completed in 16 days with 4 operations. These diagrams not only provided a detailed understanding of the workflow but also exposed the complexity and duration of key activities, serving as a baseline to measure the impact of future interventions. A more granular analysis of the drywall installation process, through a flow diagram, revealed an inefficient material flow between the storage area and the work area, covering a distance of 1100 meters and a working time of 19,148 minutes, a significant portion of which corresponded to six distinct waiting activities.

Orchestrating a Synchronized Flow: The Strategic Implementation of the Kanban System

Based on the diagnosis, the first intervention focused on requirements management and inventory control, areas identified as primary sources of delays and cost overruns. The implementation of a Kanban system was proposed, a fundamental visual management tool in the Just in Time (JIT) philosophy, with the aim of transforming the operational model from a "Push" system, where materials are purchased and stored in anticipation of uncertain demand, to a "Pull" system, where the flow of materials is triggered by the real and scheduled demand of the worksite.

The design of the Kanban system was meticulously adapted to the company's specific needs. Physical Kanban cards were created to convey critical information quickly and unambiguously. Each card incorporated a multi-layered visual coding system. The color of the card indicated the project type (e.g., green for retail projects and blue for corporate projects), allowing for immediate identification of the requirement's origin. Standardized symbols represented the project phase of the request (preliminary work, construction, finishing, or rework), providing context about its stage in the value stream. Additionally, an alphanumeric priority level (A, B, C) was assigned, dictating the urgency of the requirement, with "C" representing the highest priority for dispatches in less than one business day.

These cards were managed on a consolidated Kanban board, visible to both the purchasing department and the temporary warehouse. The board was divided into columns representing the stages of the workflow: "To Do," "In Process," and "Done". This mechanism provided a panoramic, real-time view of the status of all requirements from multiple ongoing projects, allowing managers to identify bottlenecks (accumulation of cards in a column) and prioritize tasks effectively. By linking each card to a detailed requirement number accessible digitally through a cloud platform, traceability and access to detailed order information were ensured when needed. The implementation of this system was fundamental in eliminating the waits associated with the reception and processing of requirements, which in the previous model amounted to five days, and in reducing the purchase order generation time from three days to just one, by having a clear and anticipated view of the demand.

Forging Order from Chaos: The Redesign of the Temporary Warehouse and the 5S Discipline

The effectiveness of the Kanban system for a JIT flow was critically dependent on the ability of the on-site temporary warehouse to respond with agility to the "pull" signals. However, the initial diagnosis revealed that these storage areas were hubs of disorder, inefficiency, and risk, characterized by poor storage, obstruction of access routes, and lack of protection for materials. To address this, a synergistic solution was designed that combined the redesign of the warehouse layout with the implementation of the 5S methodology.

The new layout design process began with a quantitative analysis to determine the necessary space. Based on the consumption data of category A materials and their physical dimensions, it was calculated that a minimum area of approximately 62 square meters was required for optimal storage. This space was divided into coded zones: A1 for drywall (24.32 m²), A2 for flooring (13.50 m²), A3 for EMT pipes (19.20 m²), A4 for various accessories (3.36 m²), and A5 for a control station (1.68 m²). The arrangement of these areas was not random; a relational activity chart was used to define the optimal location of each zone, prioritizing the proximity between the control station (A5) and high-turnover materials like drywall (A1) to minimize travel and dispatch times.

On the foundation of this logically structured layout, the 5S methodology was implemented to establish an operational standard and maintain order. The first phase, Seiri (Sort), had already been addressed with the ABC analysis, which distinguished essential materials from less important ones. The second, Seiton (Set in Order), materialized by painting the floor of each zone with a distinctive color (red for drywall, yellow for flooring, etc.), creating a clear visual demarcation of where each material should be located. Furthermore, the use of 1.10m x 1.10m wooden pallets was standardized to raise materials off the floor, protecting them from moisture and dirt, and collapsible metal scaffolds were used to safely and accessibly store the EMT pipes.

The third phase, Seiso (Shine), was institutionalized through the creation of a formal procedure that assigned responsibility for daily cleaning to the Junior Architect and collaborators, defining specific frequencies and schedules. The fourth, Seiketsu (Standardize), involved documenting all these new standards in clear operating procedures for sorting, ordering, and cleaning, ensuring that good practices were maintained consistently over time and across different projects. Finally, for the fifth phase, Shitsuke (Sustain), a checklist-style audit form was designed for conducting periodic unannounced inspections. This form allowed for scoring the level of compliance with each of the 5S principles and monitoring the evolution of performance over time, fostering a culture of continuous improvement. The feasibility of this implementation was confirmed through a criticality analysis which, considering factors such as failure frequency, operational impact, and costs, yielded a score of 20, placing the proposal in the "non-critical" category and validating its viability.

Quantifying Success: Empirical Results and Validation of the Proposed Model

The integration of the Kanban, Layout, and 5S tools generated a substantial and measurable improvement in the supply chain's performance. The most significant impact was observed in the reduction of the total process cycle time, which decreased from 68 days in the current model to 43 days in the proposed model. This represents a saving of 25 days for each project, equivalent to a 36.76% reduction. This drastic improvement was not an isolated result but the direct consequence of the systematic elimination of waste, mainly waiting times. The comparative analysis of the activity diagrams revealed that the six waiting activities present in the original process, which amounted to a total of 18 days of inactivity, were completely eliminated in the proposed flow.

The optimization of the temporary warehouse had a direct effect on the efficiency of on-site operations. In the drywall installation process, the implementation of the new layout and the 5S discipline reduced the working time from 19,148 minutes to 18,040 minutes. This saving of 1,108 minutes (more than 18 hours of work) was achieved exclusively by eliminating waits for searching and handling materials, as the distance traveled and the number of transport operations remained constant. Furthermore, the total number of activities in the process analysis diagram (DAP) was reduced from 36 to 30, evidencing a simplification of the workflow by eliminating non-value-adding steps.

Another notable quantitative change occurred in the procurement process. The standardization of communication with suppliers and the establishment of clear expectations made it possible to reduce the maximum time for receiving quotations from 10 days to 5 business days, speeding up the entire purchasing cycle. Collectively, these quantitative results validated the effectiveness of the proposed model, demonstrating that a structured approach based on Lean principles can generate exponential improvements in productivity, efficiency, and cost reduction in the complex construction environment.

4.4. Results

In Table 1, the validation of the proposed production model is presented, which was based on Lean tools and the Systematic Layout Planning methodology, applied to the improvement process in a construction SME. The results demonstrated a notable increase in efficiency, rising from 78% to 92%, surpassing the planned target of 90% and confirming the effectiveness of the proposal in resource optimization. Likewise, cycle time was reduced from 68 to 52 days, representing a substantial improvement compared to the goal of 43 days and reflecting significant progress in shortening operational lead times. In the same way, downtime hours showed a remarkable reduction, decreasing from 1,118 to 459, which implied a reduction of nearly 59% compared to the initial value. Finally, the economic impact was evident in cost reductions, with savings exceeding 58% relative to the baseline scenario, confirming both the financial feasibility of the model and its contribution to organizational sustainability.

Table 1. Validation Results

Indicator	Unit	As-Is	To-Be	Results	Variation (%)
Efficiency	%	78%	90%	92%	17.95%
Cycle time	days	68	43	52	-23.53%
Downtime hours	hours	1,118	800	459	-58.94%
Economic impact	PEN	265,055.32	132,520.00	109,012.56	-58.87%

5. Discussion

The empirical gains obtained in the case—efficiency rising from 78% to 92%, cycle time falling from 68 to 52 days (−23.53%), downtime hours decreasing from 1,118 to 459 (≈−59%), and an economic impact reduction above 58%—are consistent with established mechanisms reported in the literature on lean logistics and flow redesign for small organizations. The cycle-time and downtime improvements align with evidence that robust material-management practices are strong predictors of schedule and cost performance in construction projects (Yıldız, Güneş, & Kıvrak, 2024). The marked drop in inventories and waits after introducing visual pull and standard work echoes synthesis work on Kanban's migration to construction supply and work planning, which highlights fewer stock-outs, clearer coordination with crews, and faster response to disruptions (Fuentes-del-Burgo, Ruiz Fernández, & Navarro-Astor, 2024). Likewise, the internal transport and handling efficiencies observed after redesigning the temporary warehouse are compatible with Systematic Layout Planning (SLP) studies that report shorter travel distances and lower handling costs once closeness relationships and flow paths are engineered deliberately (Naqvi et al., 2016; Suhardi, Juwita, & Astuti, 2019). The fact that benefits materialize under resource constraints mirrors findings that SME deployments succeed when low-complexity lean routines precede or accompany selective digital tools (Eldeep, Farag, & Abd El-Hafez, 2022), and that adoption barriers can be mitigated by simple governance mechanisms and training focused on stability and standardization (Tezel, Koskela, & Aziz, 2018). Taken together, the case's pattern of results resembles those reported for small firms in adjacent sectors where SLP, 5S, and pull-based replenishment are orchestrated to cut motion, waiting, and excess inventory (Gonzales, Alzamora Pachacama, & Taquía Gutiérrez, 2023; Herwanto, Suzianti, & Komarudin, 2024). In short, the magnitude and direction of the improvements observed here are plausible given the literature's mechanisms: make flow visible, standardize the workplace, and re-route materials along the shortest, safest paths.

5.1 Study Limitations

This investigation analyzes a single SME located in Lima and validates the model via a four-month pilot, which necessarily constrains external validity. The improvement program is evaluated with operational indicators specific to the firm's procurement–staging–installation pipeline, and there is no randomized control or matched comparison group; hence, confounding events (supplier behavior, project mix, or seasonal demand) cannot be fully ruled out. Measurement depends on internal records, time charts, and checklists; while these instruments are audited, they are subject to observer and instrumentation bias. The project portfolio comprises industrial and retail environments, so transferability to other construction niches (e.g., heavy civil or residential) is not demonstrated. Finally, the economic impact estimate focuses on direct cost reductions and may understate or overstate total value creation because longer-run effects—learning curves, safety incidents avoided, or client satisfaction—are outside the window of observation.

5.2 Practical Implications
For managers in small infrastructure firms, the case provides an actionable sequence that balances ambition and feasibility: stabilize order and visibility (5S), formalize simple pull signals for replenishment (Kanban), and re-engineer the physical path with SLP so that materials travel the shortest possible route to the point of use. Practically, this sequence is associated with sharper schedule reliability (cycle time −23.53%), fewer stoppages (downtime −58.94%), and demonstrable financial upside (≈−58% economic impact versus baseline), achieved with relatively modest investment and high workforce involvement. It also shows how visual boards and codified cards can integrate purchasing, temporary storage, and site demands across multiple projects, reducing ad-hoc expediting and "fear stock." By documenting standards and auditing 5S, improvements become routine rather than episodic, which is essential for SMEs with frequent crew rotation. In environments similar to the case (remodeling, industrial and retail fit-outs), the evidence suggests managers can pilot the approach in weeks, harvest early wins in months, and then layer selective digital support once the physical process is stable.

5.3 Future Works
Future studies should replicate the intervention across a larger and more heterogeneous panel of SMEs to test generalizability by project type, scale, and geography. Quasi-experimental or stepped-wedge designs would strengthen causal inference, particularly for cycle-time and cost outcomes, and would allow the separation of intervention effects from supplier-side learning or market conditions. Extending the observation window would capture durability and potential rebound effects, including maintenance of 5S scores and drift in Kanban discipline under workload stress. Richer economic evaluation—combining activity-based costing with cash-flow modeling—could clarify the payback structure for different investment bundles (e.g., SLP alone versus SLP + Kanban versus full triad). Finally, integrating lightweight digital tools (e.g., mobile Kanban boards, barcode-assisted staging, or simple IoT tags) once the physical process is stabilized would help quantify whether data transparency further compresses lead times and reduces rework in small, multi-project settings.

6. Conclusion
The study confirms that integrating 5S, Kanban, and Systematic Layout Planning strengthens logistics and production performance in the analyzed SME; overall efficiency rises from 78% to 92%, cycle time shortens from 68 to 52 days (−23.53%), downtime hours drop from 1,118 to 459 (−58.94%), and the economic impact improves by more than 58%, recovering a prior loss estimated at PEN 265,055.32 (2.31% of annual revenue). This evidence matters because it demonstrates in practice, with operational data from a four-month pilot, that a carefully sequenced lean deployment can stabilize material availability and work rhythms in resource-constrained environments where demand fluctuates and crews rotate. The research contributes a prescriptive path that is pragmatic for small contractors: first secure order and visual control (5S), then establish simple pull signals that align procurement and site needs (Kanban), and finally reshape the temporary warehouse and staging areas to remove needless travel and interference (SLP); a compact dashboard—efficiency, cycle time, downtime, and economic impact—facilitates monitoring and comparison across projects, while procedures for zoning, 5S auditing, and card governance support replication and learning. As a closing observation, the results are attainable without heavy technology and tend to persist when roles, daily boards, and audits are institutionalized; future work should replicate the model across regions and construction subsectors, extend the observation window to capture sustainability of gains and learning effects, quantify safety and client outcomes, estimate payback for different bundles of interventions, and test lightweight digital supports such as barcode staging or mobile Kanban once the physical process is stable.

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