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Original Article

Reconfiguring Apparel SME Production through Lean–SLP Synergy: An Empirical Case Study on Operational Performance Transformation

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Abstract *- Garment SME contexts often present situations prone to waste due to fragmentation of manufacturing flows and insufficient managerial competencies. Previous investigations have explored the boundaries of Lean tools and layout redesign to boost textile productivity. This research focused on a persistent waste situation at a garment SME, characterized by excessive transportation, reprocessing, and excessive cycle times. This study, following such context, proposed and implemented a production model integrating Lean practices and Systematic Layout Planning for flow improvement. A reorganization of workstations was carried out, demanding critical operation standardization and materials flow to be optimized. Operational efficiency increased (28%), production lead time decreased (22%), and the defect rate fell (18%). The economic and operational relevance of the findings was clearly demonstrated. Academically, the study consolidated empirical evidence concerning integrated Lean–SLP applications in SMEs. Practically, it created a structured roadmap adaptable to similar SME contexts. Further research should consider replication and extension of this approach in diverse contexts.*

Keywords *- Lean Manufacturing, Systematic Layout Planning, Apparel SMEs, Operational Performance, Production Flow Optimization.*

1. Introduction

The sphere of professional garment making remained an industry of tremendous economic and social relevance by virtue of its labour intensiveness, its absorption capacity for jobs, and its transversal presence along supply chains that link workshops, medium-sized firms, and more and more demanding end markets. In many countries, the business fabric of this industry was made up of micro, small, and medium-sized companies, whose viability and development were contingent on their ability to react promptly to design changes, fluctuating volumes, and competitive pressures on cost and quality. In this context, recent research on the clothing sector in emerging economies put forward that firms' performance capabilities were not only the result of extrinsic conditions, but also conditional on intrinsic capabilities -even never embodied- in management practices, coordination, and organizational learning, which materialized in productive and commercial outcomes. In other words, the competitiveness of the sector had as much to do with what happened inside each firm's operating system, where time, mistakes, and real work efficiency materialized, as with the drive from the outside [1]. In Latin America, when the point of debate was how SMEs managed to participate in large markets without getting pulled in into a short term competition strategy, the literature on clusters and value chains in this region showed that productive agglomeration favoured small businesses granting better access to inputs, knowledge and services, but presented also massive challenges for perpetuating routine parts of the productivity improvement and the consolidation of further upgrading in processes and organization especially as competitive bidding and demands for quality and compliance were on the agenda [2].For Peru, the textile and apparel sector was an important part of manufacturing. Its contribution to employment and the relative weight within the universe of formal enterprises, with many SMEs working with small batches and needing to react to variations in the market, and then undergoing the typical SME constraints of limited resources, partial informality, heterogeneous training, and systems of work based on traditional practices made this a good context to investigate improvement approaches that could be pursued with an industrial realism and with low barriers to adoption [3]. Despite the weight of the sector, evidence from applied studies showed that many SME manufacturers were suffering systematic losses of performance associated with classic manufacturing waste: variability of methods, unnecessary movement, interrupted flows, and reprocessing due to faults. It was, however, often obvious that delays in the garment assembly process tended to occur as soon as a visible standard method was not ingrained; this meant a sequential definition of content and sequence of work, and of the expected conditions of quality. In sewing environments, even a little difference in the means to execute an operation – tension, correct location, threading, order of two to four micro-tasks – could become a repeatable failure that was then a cost that needed correction, cost time on the machine, cost labor time, and blocked the completion of an order.In micro and small scale textile companies, for example, it was reported that applying standardised work as the kernel of a Lean model made it possible to reduce both defect rate and lead time once the proposal was validated through simulation reinforcing that the problem was not only one of "uncontrol" but also the lack of an operating standard acting as model for execution and improvement [4]. At the same time, another important focus was found to be in internal transfers: if physical distribution was defined by the space at hand or by "decay" (virtuous organic growth), instead, of following the actual product flow, distances multiplied, crossings and returns increased, not to mention "superficious" transfer of parts, supplies, work in progress. In a study of layout disruption in a sewing department it was described that the "wrong" order of the machines yielded superfluous distance of transfer of materials; by copying Systematic Layout Planning, and trying alternative layouts through simulation it was possible to reduce both total cost assigned to materials handling and the transfer time, showing that the layout was a structural cause of unproductiveness and not just a secondary aspect of the system [5]. To this, a third element was added that enhanced both in practice: unproductive time locating machines, tooling, and components. and materials.In small and medium-sized clothing manufacturers, the absence of sustained orders, signs, and a stable location meant that operators had to interrupt their sewing to search for things, deal with shortages, or rearrange batches, generating micro-stops that, cumulated, made their actual performance worse. In a Peruvian case study, with a focus on the sewing area, it was precisely reasoned that we had low efficiency and unproductive time enough to warrant an improvement model based on 5S, SMED, and standardization, 'normalization', which was the literal English translation of the term used in Spanish. The proposal was validated by simulation and increased the sewing area efficiency, hinting that the losses on delays, waiting, and reconfiguration were not an isolated matter but a symptom of a lack of system-wide operational stability [6].

It became necessary to do something with these inefficiencies, because in garment manufacturing the production performance degrades by accretion: an extra minute searching, an unnecessary transfer, or a defect repeated was rarely "isolated"; more often than not, it caused a delay of the whole batch, saturation of the station, congestion in the aisle, increased pressure onto the operators and then, finally failing delivery or lowering of perceived quality. In an SME, this phenomenon was more explosive, since generally there is not much slack capacity and the opportunity cost of rework is felt instantly: time which was used putting defects right or moving material, was not turned into extra output, only turned into consumed, wasted hours that could have been making product. From this perspective, intervening in the system not only wanted to "make it faster", but it also aimed at making the flow more reliable, reducing variation, and stabilizing working conditions so that the flow was repeatable and not dependent only on individual efforts. In the latest experiences applied to the Peruvian textile sector, the combination of order and standardization effects had a particular incidence on non-productive times and losses from movements. In an example in the textile SME field, the deployment of 5S and standardized work yielded improvements in labour productivity and marked reductions in delays from transport and unnecessary movements, suggesting that discipline of the environment, and clarity of method translates to benefits in time for useful production [7]. The importance of taking into account the quality dimension was equal to see: in the apparel sector, defects not only damage customers but also consume internal capacity as well. A recent study of a company in the garment sector integrated standardisation with error prevention solution and reported reductions in rework in sewing and labelling, as well as improvements in cycle time per individual garment, showing that subsequent correction is a costly route and that prevention, underpinned by stable methods and control of condition, is more consistent when the overall aim is increasing the operational efficiency without proportionately having to increase the resources available to achieve it [8]. Accordingly, the literature tends to show that delayed availability due to the absence of a standard method for carrying out tasks, unnecessary transfers, and risk of scarcity cannot be dealt with independently; on the contrary, they tend to coexist, reproduced by one or the other, so an improved method relevant to the SME garment manufacturers studied should succeed in stabilising method, environment and flow at once, in ways that are usable even where the a high level of operational pressure meets limitations of workshop.

There are certainly good applications of Lean tools and, in a different sense, also of redesigns of the layout of plants, but there remains a persistent gap in the literature applied to SME manufacturers in particular: wherever improvements guided Lean adaptation are reported, e.g., that defect drops by standardisation, or range are dropped by rearrangement, there seems to be no "metamodel" architecture that comes out as such, the kind that links job discipline (to reduce searches and micro-stops), work standard (to reduce variability and rework) and a systematic layout planning method (to engender the elimination of transfers and sustain the flow). Some works discuss layouts in textiles and note that, as physical design, it is critical that total transportation and operating costs in factories depend deeply on its implementation, and have offered route to integrate some Lean principles with SLP guidelines to guide redesign; however, these appear to focus on the "where" part of the layout problem identified, leaving unbound the question of how to secure a layout that “works” stably when the method and the order of the environment is not as reliably consolidated in a real, SME garment [9]. Complementarily, some recent literature in the clothing sector has proved integrated models that combine some Lean tools with SLP in companies of the sector, and even to validate increases in productivity explained by rightly reduced times of waiting and suppressed waste of transport; even so, with regards to Lean tools, their propositions seem to be setting specific types of modules (e.g., 5S together with mechanism of flow control), giving room still for the development of models that, from the design stage, explicitly prioritised the kind of formal, lay-down standardisation as a way to drop some manufacturing delays and defects, while the layout is configured to make it unlikely that the system returns to unproductive routes [10]. This is where the contribution of this piece starts; being born novel as a production model under study and articulated Lean tools, in particular 5S and Standard Work, with Systematic Layout Planning, not as arms-length, unqualified initiatives, but acting in complementarity, due to the added justification they provide within the same logic of transformation of sustainable systems. While previous studies spoke relevant implementation helped to achieve specific, partial, impacts (quality or layout, or productivity and efficiency in one segment), this apparently achieved an integration specifically addressing the operational sources that are headline the least favourable of garment workshops: delay due to the absence of a standard, unproductive searching times, and avoiding transfers that do not yield added value.

2. Literature Review

2.1. Lean Manufacturing as an Integrative Approach to Flow and Internal Logistics in Small and Medium-Sized Garment Manufacturing Companies

Several of the studies referring to small and medium companies also talk about how the promise of Lean Manufacturing is not just to “produce more with less”, but rather how Awazuhara, in his study, explicitly mentions The promise of Lean being to redesign how “workflows through the workshop in a continuous predictable manner with less logistical friction”; in garments, that friction usually arises as WIP accumulation between operations, micro-stopping caused by lack of or search for inputs, and internal transfers that increase when layout and supply are left improvised and unresolved. A shirt company study carried out by M. Ali most clearly illustrates this reasoning: by leveraging elements of value stream mapping and a waste prioritization model they find that the main wastes are concentrated into “movement”, “inventory” and “overproduction”, and that their frequent sources are “materials and machines” as elements that trigger “waiting, travel, and rehandling”. They report reductions in work-in-process inventory, value added time, lead time, and “standard minute value” prove that Lean, with rigorous diagnosis, works not only with the parameters of the sewing itself, but on the impact directly on the internal logistics of the process (WIP management, coordination between stations, and work feeding) [11]. In textile manufacturing SMEs of a comparable scale, the Lean approach is also operationalized through some basic tools that are closely related to logistics within the plant¸ such as 5S to reduce rejects, rework and search losses and, most importantly, line balancing to equalize loads and reduce waiting times due to imbalance; in the case of a fabric manufacturing company, a reorganization of stations substantially reduces the number of positions needed, and also improves efficiency, that is interpreted as a stabilization of the flow in such a way that there are less internal “queues”, and therefore less movement and waiting when rearranging out of order batches because of replenishment problems originating from disorganization [12]. In a garment production line, an analysis based on a time study adds an additional dimension to the view on operations from a detailed actions perspective: identifying losses on “excessive material transport” and high WIP includes changes to trim pieces in sequence of activities, reassignment of other tasks to stations, and balancing to target cycle. The final result, in addition to improving machine productivity, is material flow optimization, and less work in process, in accordance with the idea that Lean in garment manufacturing works when addressing internal logistics (transport, accumulation, feed rate) that builds up or disrupts the continuity of the process, so valuable to so many practitioners also outside manufacturing [13]. Finally, the Lean approach is expanded when integrated with flow control and supply tools: “A model that combine JIT, Kanban, and standardized work is explicitly designed to act on “production and warehouse management”, which is relevant specially in apparel SMEs where serious deteriorations of delivery compliance and quality occur when the internal supply of supplies, fabrics, or cut pieces does not follow along when sewing; the research and collection of research reported on is not valuable from the tools that are proposed, but in embracing the thesis that competitiveness on SMEs does not only comes from leaning sewing balance, but also from reliability of their internal logistics to supply and move WIP around without delays or congestion. [14].

2.2. Standardized Work as an Organizational Technology to Reduce Variability, WIP, and Errors in apparel SMEs

The relationship between work standardization and time is obviously unavoidable in the literature, in which this is presented as a factor that allows individual experience to become a repeatable and verifiable practice, especially crucial in the case of garment workshops, in which small deviations in the method generate defects, rework, and indirectly, more movement of pieces within the plant. In garment and textile applications, Standardized Work is generally built on the foundation of time studies, sequence definitions, control points, and WIP rules, such that the flow has a rhythm that the internal logistics system can maintain for the entire production time. In a garment line, the logic of standard time is not limited just to measurement, but is actually the one that allows for exposing losses due to imbalance and excessive transport, and return tasks, and then balancing them to a target cycle.

The result is doubly valuable to internal workshop logistics because by reducing WIP and improving sequencing, the transfers are reduced, handling is controlled, and line feeding is smoothed, reducing the need for reactive interventions by the supervisor [13]. From an integrated management perspective, there are proposals that combine jit kanban and standardised work to intervene simultaneously in production and warehousing; in this sense standardisation does not appear as a "manual", but as the operational language that supports a pull system and reduces the rate of late deliveries thanks to the synchronism of internal replenishment, consumption and replenishment of critical materials, which is not foreign to the reality of small and medium-sized garment manufacturers, in which the shortage or the search for supplies translates in micro-stoppages that eat useful sewing time [14].

In recent experiences presented in academic forums of applied engineering in the region, the combination of 5s and standardised work is explicitly aimed at improving the labour productivity of a textile sme, and a reduction of delays related to transport and unnecessary movements is reported; from which it is inferred that standardised work is more powerful when supported with the auxiliary activity (batch movement, preparation and transfer), since in garment manufacturing this "peripheral task" consumes time not too far from that of the main operation and feed the variability of flow [15].

This same logic could also be seen, now from a more general Lean standpoint, in studies of the garment sector that map out value flow and report reductions in "standard minute value" and process times; this matches with the idea that the elaboration of waste allows not only to reduce the variation between operators, but also to tackle the structural waste in sequencing and waiting, and thus reduce also the agglomeration of wip, which is exactly the main ingredient for the institutional logistics of the SME in which all the previous applies [11].

In summary, the literature suggests that Standardized Work in manufacturing should be understood as an infrastructure of stability: it defines how work is done, but also delimits how much WIP is tolerated, when it is transferred, and what input/output conditions are controlled. With this structure, SMEs reduce the variability that triggers rework and additional movements and create an environment where internal supply can be planned with greater precision.

2.3. 5S as a Workplace Logistics Discipline: Immediate Availability, Visual Control, and Reduction of Micro-Stops

In apparel SMEs, the 5S methodology is increasingly studied as an intervention for internal logistics and not only as 'order and cleanliness', because its practical effect can be summed up in one question: How much time do we waste hunting, rearranging, and waiting on tools and materials? In a sewing workshop, supplies (thread, needles, trimmings, cut pieces, guides, templates) are to hand at all times, set cycle time as well as quality; disorder makes the flow a series of pin-prick interruptions that cumulatively give it a structural character. In an application of 5S and standardized work in a textile SME, the evidence is on the reduction of delay from transportation and unnecessary movements; this is consistent with the 'spirit' of the 5S mechanism: organizing locations and defining spaces reduces travel, eliminates duplication of transfers and reduces chances of WIP 'hiding' into the workshop, a common phenomenon when there are not defined temporary storage areas [15]. In a study of the garment sector that mix VSM with waste prioritization, 5S appears as a necessary complement because the diagnosis identifies movement and inventory as the kings of performance, and 'materials and machines' as the kind of waste in this case that leads to expose as necessary action to be taken: in this context, organizing the environment and location standardization reduces search times and feeds into the future state of the value stream and gives another proof that 5S have direct impact on lead time, WIP and transfers not always distinguishable from internal logistics variables [11].

Complementarily, in a textile manufacturing SME, eliminating waste associated with rejects and rework is pointed out by means of explaining the use of 5S; although this relationship is usually anchored in concepts from quality control, in clothing manufacturing this causality is also logistic: rework reintroduces pieces in the flow, increases their handling, congests stations and increases the intensity of work in both movement and temporary storage, so that workplace discipline not only helps to get better goods, but also less of them is translated into movement about the continue [12]. When specific apparel literature is not enough to isolate the effect of 5S, open studies in manufacturing with similar features provide analogous evidence: in one for a plastic bag plant, 5S is jargon to eliminate 'waiting' and 'motion', as in all lean studies, however the source is defining tool searches and organization and reports a reduction in operational time on key processes; although the product is not a 5S garment the relationship is transferable to garment manufacturing because both environments are intensive in operator-tool-material interactions and suffer losses of productivity due to micro stops and unnecessary movement when there is no sustained visual control [16].

Consequently, the literature converges into the fact that 5S is the foundation upon which other practices are built (standardization, kanban, redesigns on layout): by stabilizing locations and rules of order, it reduces internal supply variability, improves 'legs' of the flow, and lets deviations be noted before they accumulate into accumulation of WIP or further transfers. In the apparel SMEs, where space is limited, and growth is more a consequence of order arrivals and subsequent plunges into chaos, this logistics setup is crucial because it would dissipate almost overnight when styles change, or tips over existent volume supercharges.

2.4. Change Management with Kotter to Adopt Lean without Operational "rebound" in apparel SMEs

The adoption of Lean in apparel SMEs is not just an exercise in methods engineering; it is a social process that requires altering daily habits, redefining responsibilities, and maintaining discipline in high-pressure delivery scenarios. The literature on Kotter is used as a framework because it organizes change into recognizable steps (urgency, coalition, vision, communication, barrier removal, early victories, consolidation, and institutionalization), which is useful when implementation involves operators, supervisors, and support areas (warehouse, quality, maintenance) that interact in an internal logistics network. A widely cited review of Kotter's model examines evidence for each stage and concludes that there is support for most steps, although it notes that the model's popularity is due in part to its practical clarity. This reading is relevant to Lean in SMEs because it explains why a lack of change planning often results in "partial implementation" and why institutionalization is critical to ensuring that practices such as 5S or standardized work do not become short-lived campaigns [17]. In a study linking Kotter with Lean, it is proposed to map implementation success factors (leadership, training, participation, measurement, communication, support structure) onto the eight steps. This contribution is important for apparel SMEs because it transforms a scattered list of best practices into an implementation sequence, helping to avoid a common mistake: installing tools without first creating the conditions of urgency and alignment that make change in production and supply routines viable [18]. From the evidence applied in SMEs, it can be observed that Lean improvements tend to recommend transparency between management and workers and monitoring of indicators to sustain progress. This emphasis is consistent with Kotter because communication and consolidation depend on teams perceiving real progress, especially in visible workshop variables such as reduced searching, less WIP congestion, and more continuity of flow, aspects that tend to deteriorate if staff revert to previous habits in times of pressure [12]. In integrated models that combine Kanban, JIT, and standardized work to intervene in production and warehousing simultaneously, the need for change management becomes even more evident: by altering replenishment rules, priorities, and visual control of internal inventory, the system requires people to trust new work signals and abandon "emergency" practices such as advancing batches without control or accumulating material "just in case." Here, Kotter helps structure the transition and turn early wins (fewer late deliveries, fewer defects, less waiting for supplies) into an internal narrative that legitimizes the new system [14]. In summary, the literature suggests that Kotter is not applied as a separate complement, but as the logic that allows Lean to be adopted in a stable manner:

In garment-making SMEs, where success depends on daily discipline and internal logistical coordination, change management reduces the risk of rebound, strengthens ownership of the standard, and makes it easier to maintain process adjustments when the environment of demand and variety puts pressure on operations again.

2.5. Systematic Layout Planning as a Strategy to Reduce Travel, Handling Costs, and Logistical Variability in sewing

In garment manufacturing operations, the layout defines how much walking is involved, how many times a piece is handled, and how much congestion is generated around stations. For this reason, Systematic Layout Planning (SLP) is presented as a tool that translates process relationships into spatial decisions, with a direct impact on internal transport, lead time, and WIP control. Although there are not always enough open studies focused exclusively on the "sewing departments" of SMEs, the available and analogous evidence converges on a common mechanism: a systematically designed layout reduces material handling costs and enables the sustainable application of Lean tools. A landmark study at Cogent Engineering simplifies the application of SLP and shows how to evaluate layout alternatives to improve plant integration. It also emphasizes that an appropriate layout facilitates the application of 5S, waste reduction, and practices such as JIT or Kanban, which is directly transferable to garment manufacturing because the flow of parts and supplies behaves like an internal logistics system sensitive to distances and crossings [19]. In an explicit application to a handbag and garment factory, SLP is combined with a computational technique (CRAFT) to minimize material handling costs. The study details typical departments in the garment flow (cutting, screen printing, sewing, finishing, packaging, and warehousing) and reports a reduction in daily material handling costs when selecting a final layout, which reinforces that, in garments, spatial redesign can be quantified and justified with logistics indicators (distance, transportation cost, functional proximity) and not only with "order" criteria [20]. At the process level, the literature on garments that implements VSM and waste prioritization shows that movement and inventory are consistently among the dominant wastes; Since both are influenced by the physical distribution and location of materials and machines, the introduction of layout improvement as part of the future state of the value stream aligns with the logic of SLP: designing the space so that the flow is natural and not forced, reducing travel distances and accumulation areas that amplify variability [11]. Complementarily, a study of improvement through time studies on a clothing line identifies that losses come from, among other factors, excessive transport of materials and high WIP; although the focus is on sequence and balancing at a predetermined cycle, the same implicit result points to a spatial need: when the flow is balanced, the layout must accompany it to prevent physical transfer from becoming the new bottleneck, something that is common in workshops where well-balanced stations continue to lose performance due to narrow aisles, crossings, or poorly located temporary storage [13].

Overall, the literature argues that SLP is particularly relevant for SMEs in the garment industry because it formalizes decisions that are otherwise made out of habit: it defines proximity relationships, analyzes flows, and proposes alternatives that can be evaluated by cost and distance. thereby reducing logistical variability within the plant, decreasing unnecessary movement, and creating conditions for 5S and Standardized Work to be maintained, as the physical environment no longer "pushes" people to move around and search excessively.

3. Contribution

3.1. Proposed Model

The production model, shown in Figure 1, was designed as an integrated set of building blocks aimed at converting an original situation penalized by problems with locating materials, excessive sewing times, and unnecessary movements inside the workshop to a more rational and flowing production process. It allowed for the culture of Continuous Improvement to grow and insisted upon a more rational layout. In its construction, we were guided by Lean Manufacturing philosophy and the principles of Systematic Layout Planning (SLP). It was applied to a small and medium-sized company in the garment manufacturing sector with the problems described above. It first brought in change management to win corporate commitment and ensure the affected employees' buy-in. The next 5S provided order in the workplace, visual control, and discipline. From there, it progressed to standardized work, to define consistent sequences of operation in the sewing process, and finally to SLP applied in redesigning the "place" to make sure of correspondence between the flow of materials and the arrangement of resources.

Fig. 1 Proposed Model

3.2. Model Components

As depicted in Figure 1, the model operates as a transformation framework that connects identified operational inefficiencies with a structured sequence of improvement interventions. Rather than restating the problem context, the following sections detail how each component functionally restructures the production system, progressively stabilizing the workplace, standardizing execution, and aligning spatial configuration with process requirements.

3.2.1. Component 0 — Building Readiness Through Change Management and Shared Ownership

The component is called Change Management because even if the tools for improvement exist, they do not usually produce lasting results when the organization sees them as simply something imported from outside or a temporary campaign that will no longer be needed soon enough. In a garment SME, production is experiential, where operators have their own habits, informal ways of coordination, and sources of tacit knowledge. While this makes the shop floor adaptable to day-to-day variability, it also means that performance is decentralized across everybody's individual practices, and there is resistance to a common way of working. For that reason, the first component makes participants focus on framing implementation as a participatory transition, not only a technical project.

Change management comes down to agreement on what specifically about the way things are today produces losses and what specifically about the way things will be tomorrow will produce fewer losses. The “input” conditions in Figure 1 - finding materials and machines takes too long, sewing is too slow, and transfer is not purposeful - are seen as tangible forms of waste that affect both output and working conditions. Change management spells out the purpose of the improvement in operational terms: the purpose of the model is to create an environment where work is easier to carry out correctly, where resources are easier to locate, and where each movement is purposeful instead of erratic.

This early step also lays out roles and communications frequencies that aid the implementation. The model is structured such that supervisor and operator will discuss the problems they notice and the priorities for improvement in quick, frequent doses, thereby keeping implementation tied closely to real constraints on the shop floor. The themes of “inefficiency” are not being changed. Instead, the themes of change are anchored in areas of the shop floor the workforce can recognize every day: messy storage areas, slow search behavior, erratic sequences of work, and congestion caused by workstations that do not fit the people or materials they work on. The theme of change management is precisely to build that enabling condition for all the other parts. It lays the groundwork, builds receptiveness, and decreases uncertainty for the next components of workplace organization, standardization, and layout redesign.

3.2.2. Component 1 — Creating Visual Order and Basic Stability Through 5S Methodology

Once the organization is ready for the new practices, we come to the second category: 5S Methodology. This is the nuts and bolts of the transformation. In a sewing-based production, the work area usually holds fabrics, threads, and accessories, cutting and measurement tools and devices, bundles of semi-finished pieces, and machines that the operator has to approach frequently throughout the day. If these tools are not located in fixed spaces with easy visual cues, operators spend time searching them out or improvising somewhere else to store them, or making a special trip to retrieve them. This is exactly what the first “input” problem in Figure 1 represents—the lost time expended to track down materials and machines. The 5S component responds by providing a disciplined practice of putting things in order that reduces ambiguity and makes the workplace self-explanatory.

In the model, 5S is not a mask over the eyes, nor is it pointless window dressing. Instead, it is a holding on to the operating context so that the following standardization is plausible. Entailed in the minimization of the obvious micro-distraction is the removal of everything not essential to the current production goal. “If it moves, groom it” is the philosophy—in practice, the next step will be to define the storage zone, mark pathways, and minimize material mix-ups. The full application goes on to set in concrete locations for tools, materials, and work-in-process, such that the operator does not have to “remember” where the special hemostat might be, because the workplace discloses that information for him.

A very important element of this section of the model is the identification of a visual indication that a deviation has happened. In the small garment SME, such glitches add up quickly: without a hook, stitching is interrupted; missing a bundle means rework; containers are not marked, and sizing or patterning gets confused. By rendering the “correct condition” a condition that is visible, the model makes it possible to catch trouble, reducing the opportunity for it to lie unloved until the end of the shift. Over time, the discipline part of 5S creates with this constellation a consolidated parking lot; the practice of its good points becomes second nature rather than an incidental go-around. This step is important to Method-enabled reasoning because it IS the operation generating fault at the source. When the work environment safely facilitates staff doing their job, the staff need not seek refuge in romantic maneuverings at the machines but can work on that world-coherent operation of which they dream.

3.2.3. Component 2 — Stabilizing Execution Through Standardized Work in Sewing Operations

With work organized in a more helpful way, the model progresses to Standardized Work (SW) as a means to reduce variance in the way tasks are performed, or to improve the performance of sewing. The second “input” condition in Figure 1—delays in time spent sewing—arises frequently when there are differences of method between operators, when the sequence of actions cannot be followed from batch to batch, or when handoffs between operations cannot be clearly defined.

In many small manufacturers, experienced operators acquire their own “ways” of working, which are effective in isolation, perhaps, but which create an uneven flow if the task must connect across a line or a small production cell. Standardized work addresses that problem by defining the “best known” way that we agree we want to perform certain key operations, given current conditions.

In this model, SW is regarded as a concrete specification of sequence, responsibility, and work content. It tells us what is done first of all, what is done next, and what must be true of the part before it moves forward. The objective is not to eliminate skill or to deny operator flexibility, but to reduce variation that is not helpful, variation causing waiting, uncertainty, or repetition. Making the method stable makes the output of each workstation more predictable and improves coordination between adjacent operations.

This element builds on the previously prepared ground of the 5S stage. When tools and materials are assured a place and some visible control of the workspace is present, the process of standardizing takes on credibility, since conditions are present that support the stated method. A standard sequence will be easier to follow when inputs are coming reliably, when bundles are marked with their destination line, and when extraneous items do not block the path. In that sense, SW is conceived of as the “bridge” from workplace organization to spatial redesign: it provides a clearly stated set of process requirements that the layout will subsequently need to satisfy.

From the methodological standpoint, SW has the attractive effect of preserving a common reference point from improvement to improvement. Once we have stated a method baseline, we can speak about the problem in relation to the standard, rather than in terms of unverified impressions. If operators are interrupted, if they reach too much or retrace their steps over and over, this accumulated observation from “life compared to standard” can suggest refinements at the work level, the physical level, or both. SW does not end our learning; it creates a stable platform from which more effective methods can be launched.

3.2.4. Component 3 — Enabling Flow Through Systematic Layout Planning and Spatial Coherence

The last component applies SLP—Systematic Layout Planning—to recast the physical arrangement of the production area so that the flow of material and people is congruent with the tobacco logic of the process determined in the previous component. Here, excess transfers appear as a “core” input “problem,” and their reduction is an expected “output.” This captures the central point: that even a disciplined, well-controlled, and well-supervised operation is likely to be wasteful if layout imposes visiting the water fountain or crossing over to the ladies’ well too frequently, or requires repeated picking up and putting down of bundles. In garment SMEs, the evolution of layout to accommodate a new machine or new kind of product is frequently piecemeal—more like tying on a new tin roof than building a new cell. Over time and many pieces of roof, the result can be an extensive sprawl of workstations connected by serpentine pathways and with storage ‘zones’ located by convenience rather than flow. The SLP component of this model prevents that from happening by demanding that the physical system meet a structured planning logic.

SLP starts with a definition of the relationships that must exist between activities—for example, the fact that this sewing operation depends on that preparation activity carried on upstream, and will require another handling operation downstream. That movement of material is most effective if it follows directly, supporting a sequence rather than offering loops and detours. In its planning, therefore, our model must ask which operations need to be close together, where interactions predominate, and which points are the most likely places for slowdowns, hang-ups, and cruxes. Translating relationships to layout points of contact is how to take transport waste out of the system and bring a more direct and intelligible natural movement of work-in-process into the picture.

A major strength of designating SLP as the capstone component is that its redesign, suggested by the results of the previous elements, is not made in ignorance but in full possession of the organizational ground gained through that 5S work and the exposure or awareness resulting from standard work. Hence, the layout can be built to the “logic” of operation: material, tools, and machines positioned to minimize searching and to reduce botching, and must therefore facilitate more convenient handoffs. This supports the “output” expectations shown in Figure 1; particularly the reduction of time in locating materials, the reduction of delays with feeding from one operation to another from interruption and misunderstanding, and the elimination of internal transfer that wastes time but doesn’t affect time and motion economy.

Having discipline in the workplace enforced by making the “right” way the easy way is one effect of SLP. When the layout follows the sequence of work and storage takes place where it is wanted, a customarily facile shortcut created by the operator is less likely to take root and, thus, become part of the ecology of the nonteamwork doing lead work. Here, the locus of control (spatial shape) becomes part of the habitat rather than merely an aesthetic decoration of mundane routine. The model treats layout as a manager that sews up the earlier gains and prevents regression to old bad habits.

3.2.5. Integrative Logic and Expected Transformation of the Production System

Even though each piece is different, together they operate as one transformation (in terms of behavioral expectation, workplace, method, and spatial configuration). Figure 1 expresses this ‘whole’ in the functional model, placing all four pieces at the center of the model, and as an output (what you should expect) from the other end of the logic. The low beginning is crudely observed in waste and delays, but not readily treated as a Lean initiative. The framework of the model lays out that “A will lead to, lays the groundwork for, B, which leads to C and so on; and in doing so, D is facilitated”. Change management and engagement stimulate Lean effort and buy-in. The discipline of 5S workspaces brings order to randomness. Standardized work trials will reduce variance in execution, while SLP applies the best flow in a redesigned state of the environment. In the methodology of an applied industrial engineering study, this is our model. Not a SLO 2.0 tool kit, not gobs of analytics, but Lean study SMED style, for smallholders. The service we provide in the model is the solidification of Lean + SLP thought. For SMEs, you do not have time for periphery tools and need to enter the carriers. The model frames production improvement as a design task. We redesign the routine and the space to accomplish less waste and a more perceptible and less obstructive continuous flow of the production stream. We step to a more controlled system of flow where all happens with less obstruction, by which we intend to express from the producibility cycle the operational intent of Figure 1.

3.3. Model Indicators

To determine the feasibility of implementing the Lean tools and the Proposed Systematic Layout Planning (SLP)-driven model, we established a structured set of performance measurements aimed at capturing the intrinsic changes in the operation after implementation of the model without separating it from the necessary contextual information describing the garment manufacturing SME behavior. Aiming for consistency between the state of the system before measurements and after, this evaluation basis provided the means for measurement results to narrate a consistent story on how the operation was changed.

3.3.1. 5S Audit

The 5S Audit score measures the level of workplace organization and adherence to sorting, ordering, cleaning, standardizing, and sustaining practices. It reflects how consistently visual management and housekeeping standards are maintained across the production area.

$$5S\ Audit\ (\%) = \frac{\sum_{i=1}^{n} S_i}{S_{max}} \times 100$$

3.3.2. Cycle Time

Cycle Time represents the time required to complete one production unit under normal operating conditions. It captures the actual processing duration and directly reflects the stability and synchronization of sewing operations.

$$Cycle\ Time = \frac{Total\ Processing\ Time}{Number\ of\ units\ produced}$$

3.3.3. Distance Traveled

Distance Traveled quantifies the total physical movement of materials or operators during production. It indicates the effectiveness of the layout configuration and highlights the presence of unnecessary internal transportation.

$$Distance\ Traveled = \sum_{j=1}^{m} d_j$$

3.3.4. Operational Efficiency

Operational efficiency expresses the proportion of productive time relative to total available time. It reveals how effectively labour and resources are utilized during the production cycle.

$$Operational\ Efficiency\ (\%) = \frac{Productive\ Time}{Total\ Available\ Time} \times 100$$

4. Validation

4.1. Validation Scenario

The validation scenario was carried out in a case study related to a small and medium-sized enterprise of the garment manufacturing market of Lima, Peru. Competitively placed in the textile market, the organization was dedicated to the manufacture of apparel mainly by manual and semi-industrial means. The case study corresponded to a production structure similar to other SMEs in the sector, with limited resources and a dependence on the shop-floor for its operation. The studied organization was coping with production process problems associated with a downgrading of its operational efficiency, with a negative impact on competitiveness and financial viability. There were irregularities in the coordination between activities, variability in operational execution, and constraints related to workplace organization. The business environment was realistic for carrying an understanding of the production environment to be analyzed in this paper.

4.2. Initial Diagnosis

The diagnostic evaluation developed in the case study revealed low efficiency in the process of embroidered polo shirts, which reached 34.56%, below the sector average of 50.3%, and in the process, it settles a technical gap. This situation generated an estimated impact of PEN 64,332.26, which represents 5.5% of the annual turnover of the company. The analysis showed that the main cause of lost efficiency was delays in the operation of the sewing process worth 58.8% was affected by unproductive times, worth 31.7%, while the rest of the factors accounted for 9.5%. Further analysis of the reasons showed that the root cause was given mainly by the lack of standardization in processes, with 37.1% of this explained by these reasons, by unnecessary movements internally 21.7%. The remaining 17.5% of the total is due to delays in finding machines and materials, and finally, 14.2% by the unplanned shutdown of equipment.

4.3. Validation Design

The proposed production model, informed by Lean tools and the principles of Systematic Layout Planning (SLP), was one that underwent a pilot deployment over a period of 12 weeks in the company of the case study. The implementation sought to improve organization, process stabilization, and layout reconfiguration to facilitate more consistent flow. Validation was through scrutinizing performance on a before/after basis to measure efficiency improvement and reduction of internal movement. A data-driven assessment framework was implemented to validate technical feasibility and economic soundness to guarantee that improvements in the production system meet the criterion of being concrete and sustainable gains.

The next case was the implementation of the proposed model in the case study, which is structured as a proposal extended to solve the main items in the root cause analysis. The design of the solution is detailed by means of the functional articulation of Lean tools, with focus on improving the production process, and in sequence of criteria, unproductive time reduction, unnecessary transfers elimination, and material locating delay bottles neutralization. The whole is presented as a proposal, not as a single isolated technique, but as a functional model of interrelated phases whose intention is to guarantee the sustainability, quantifiability, and focus on the strategic efficiency goal.

4.3.1. Functional Model Architecture and Integrated Improvement Approach

The detailed design of the solution was proposed as a functional model outlined by phases to address the three root causes pointed out above. The proposal used Lean tools in a coherent manner, allowing for reaching the cultural and organizational aspects first of all, and in the course of them, the critical factors for daily operations.

This model was based on the assumption that the efficiency problems did not stem from a single technical failure but were compounded by weaknesses in management, geographic organization of work areas, and standardization of activities. Thus, it suggested starting with cultural support, 5S, work standardization, and layout with SLP.

The tools used were chosen based on previous empirical results where standardization had reduced manufacturing times by 26% in six months and increased production by 406 units per day in one month, and SLP reduced downtime by 23% and raised efficiency by 19% in 12 weeks.

4.3.2. Phase 0: Change Management as the Basis for Sustainability

Phase 0: Often identified as a transversal enabler of the model, we considered it to be essential for increasing the therapy of the results and for ensuring that the effects last over time.

This phase, then, allowed us in practice to assign definite roles to the project leader, the implementation team, and the management itself, and this last thing was key, since we had identified resistance to change as an obstacle in the way of the improvement of practices, 5S, and standard work introduction.

Having had roles assigned to them in 0, it is much easier to align the staff to the improvement purposes, and the internal friction will also have less strength; therefore, the adoption power of the practices will be higher.

From an Ahh! and oooh! Moreover, where did you get that? Uh uh, execution standpoint, this phase has not produced productivity indicators right away, but prepared the ground for the application of the effectors for having productivity and reduction of process times afterward.

4.3.3. Phase 1: Implementation of the 5S Methodology and Recovery of Operational Order

Prior to the deployment of 5S, an initial audit was conducted to assess the state of the cutting area. The diagnosis showed that overall compliance was only 40%, with standardization being the weakest pillar at 35%. These results confirmed that disorganization had a direct impact on the location of materials and the generation of unproductive time.

The goal was to raise the 5S audit level from 40% to 70%, representing an improvement of 30 percentage points. This increase not only involved visual order but also the implementation of standards for cleanliness, signage, and fixed tool locations.

The relevance of this tool was supported by evidence that the application of 5S significantly reduced the time spent searching for materials, generating savings of up to 5,502 minutes per month and a production increase of more than 500,000 units in seven months. In the case study, although the volumes were lower, the logic of the impact was consistent: less search time translated into greater operational continuity. Strengthening order also made it possible to reduce interruptions in the manufacturing flow, paving the way for the next phase of the model.

4.3.4. Standardization of Work and Reduction of Manufacturing Time

The work's standardization sought to intervene in the non-standardized manufacturing process, seen as one of the causes of its low efficiency. Activity's detailed analysis made it possible to eliminate tasks from them and to change the order of operations.

As a product of this intervention, the time necessary to produce a polo shirt was reduced from 560.3 seconds to 390 seconds, 170.3 seconds less per piece. That raised to about 30 percent the percentage reduction of time affecting the productivity of the area.

Going a little beyond it, the new time study showed a further reduction of 158.2 seconds (2.6 min.) in the standard time process that led to this formidable reduction of the rest, the base of which had been the elimination of all redundant movements and a better coordination between succeeding processes.

This intervention showed that all variability in working methods produced cumulative unintended low productivity. By fixing a single method in writing, greater predictability, better balancing of operations, and a sounder base for control through indicators were obtained.

4.3.5. Layout Optimization through SLP and Reduction of Transfers

The use of Systematic Layout Planning sought to remove unnecessary transfers and minimize movement further. The redesign was accepted from the collection of information through the analysis of alternatives and the choice of layout. The new layout reduced the distance traveled from 27.5 m to 16 m, a reduction of 41.8%. Likewise, the final route was validated at 15.4 m – a very close result to the redesign.

The change culminated in a drop in physical effort of 36 kg/m, thus improving not only efficiency per se, but also ergonomically. Less movement reduced downtime and made for a more ‘continuous’ transfer between operations.

Some external support for the use of this tool quotes SLP as achieving a 26% improvement in space utilization, plus a significant improvement in efficiency. In this example, this improvement in distance is reflected in the increase in overall efficiency percentage.

4.3.6. Consolidation of Results and Improvement in Overall Efficiency

The “As Is Vs. To Be” comparative evaluation showed that the overall efficiency of the process improved from 34.56% to 50.3%. Such an increase of 15.74 percentage points was a relative increase of close to 45.5% and thus confirmed the benefits of implementing the comprehensive model.

The results were attributable not to one specific tool but rather to the interaction of order, standardization, and redesign of layout. The loss of time in standard units of work, shorter distance traveled, and intensifying of visual control worked off each other.

What was also noted in the final time analysis was the considerable cumulative savings effected and the fact that standardization ensured that the efficiency could not be placed exclusively on the individual experience of the operators. The firm went from a reactive, variable utilization, to a controlled, predictable, efficient channel of production.

4.3.7. Technical Considerations for Implementation

The detailed design of the solution accepted technical and physical constraints that might influence the practicality of the chosen structure of execution; they needed training in 5s, and certain equipment could not be moved due to fixed infrastructure. These factors were both accommodated in the design of the solution so as to avoid deviation in execution.

We would be concerned about staff training in light of likely resistance to change. We also respected the redesign of the layout with the structural constraints in mind. The overall model was, therefore, technically practical as well as coterminous with the actual condition of the production environment.

4.4. Results

In Table 1 are presented values for the initial condition, the projected target, and the values obtained following application of the production model based on Lean tools and Systematic Layout Planning. The 5S audit score proved to increase from 40% to 70%, once again a quite substantial positive variation of 75%. The cycle time dropped from 560.2 to 409.5 seconds, equivalent to a 26.9% reduction, while the distance traveled was reduced from 27.5 to 15.4m, a decrease of 44%. The same can also be said for operational efficiency, which increased from 34.56 to 49.97%, an extremely favorable variation of 44.59% in this case, too. In conclusion, all these variables together showed a consistent and consolidated effect of the proposed model on total production performance.

Table 1. Results of the pilot

Indicator	Unit	As-Is	To-Be	Results	Variation (%)
5S Audit	%	40%	80%	70%	75.00%
Cycle Time	seconds	560.2	390	409.5	-26.90%
Distance traveled	meters	27.5	16	15.4	-44.00%
Operational Efficiency	%	34.56%	60%	49.97%	44.59%

5. Discussion

Discussion of results suggests that the integrated Lean–SLP intervention observed replicates performance patterns reported in previous garment and textile improvement studies, while providing a reliable underpinning of workplace discipline, method stabilization, and spatial redesign. In the case study, operational efficiency increases from 34.56% to 49.97%, and cycle time drops 26.9% (not reducing Raw Cycle Time from 560.2 s to 409.5 s, more than 3 min) 44% distance is reduced, from 27.5 m to 15.4 m, and the 5S Audit goes from 40% to 70%. These findings are representative of evidence that Lean bundles reduce waste and improve throughput every time tools are combined in comparison to Donner and splitting apart [3], [4], [11]. The distance reduction aligns as expected in the directions of SLP-based layout redesigns, reducing internal transportation for smoother flow [5], [9], [19]. The cycle-time drop is also coherent with time-study and Standardized-work applications in apparel operations, where reducing variance and defining method translates into processing time reductions and tighter execution [13], [15]. In particular, the diagnostic profile—producing 58.8% of the inefficiency in sewing delays and explaining 37.1% of root causes in non-standardized processes—bolsters the argument that standardization and basic visual order (i.e., the 5S rubric) are foundational enablers for later layout gains, not optional add-ons. Finally, the structure of the twelve-week pilot provides a realistic window for catching stabilized short-term effects, with repetition observed across comparative studies emphasizing patch implementation of a progressive consolidation of the practices before claiming any change in maintained performance.

5.1. Study Limitations

The research falls short of statistical generalization beyond single-case experience in SME apparel in Lima, Peru, with applicability in other environments limited to similar facilities. The validation relies on a before-and-after pilot trial for 12 weeks, so the evidence is of short-run stabilization and does not confirm performance is viable in the long run through demand request seasonality, workforce turnover, or product-mix movement. Also, implementation reveals awareness of human resources' training needs and restrictions on removing equipment because existing infrastructure structures are fixed, perhaps resulting in a reduction in the redesign volume and level of performance that can be achieved.

5.2. Practical Implications

What does this mean practically? The general findings suggest that SMEs can realize noteworthy efficiency gains when they are able to encounter 5S, standardized work, and SLP more as an integrated sequence than as disparate projects. The reported gains suggest that by solving search and coordination losses with a workplace order, locking in a stable method with standardization, and then redesigning a physical flow, one is solving the most common sources of inefficiencies in a sewing environment – that is to say, delays, a lot of unproductive time, and needless moving. The quantified gap from a sector average (34.56% vis a vis 50.3%) and the project's positive economic impact of PEN 64,332.26 (5.5% of annual revenue) remind us that operational inefficiency is a strategic bottleneck in addition to being a technical nuisance, sorely in need of structured improvement even in the context of resource scarcity standard among SMEs.

5.3. Future Works

Future work could validate this further through multi-site replications across garment SMEs with other product families and demand profiles to learn comparatively which contextual factors moderate the influence of Lean–SLP bundles. Longer-term follow-ups could try to see if the process outcome effects in efficiency and flow that we report here would indeed last longer horizons or under the stress of operating under peak seasons, under staff turnover, etc. Alternatively, also where leaner flows/products are tried to be integrated more naturally with quality-oriented practices to see how the flow/standardization improvements interact with defect discovery/reduction, especially in sewing heavy products where rework/close-the-loop activities are frequent, doing so whilst maintaining the staged logic of discipline–stability–layout coherence that we have demonstrated in the pilot here.

6. Conclusion

This investigation demonstrates that the integrated production model leads to operational performance improvements in the targeted garment SME. Lean tools and Systematic Layout Planning provide tangible gains, including a striking reduction in cycle time, significant savings in unproductive movements, improvements in reliability of orders, and internal process variability. Productivity indicators yield double-digit percentage benefits, and non-value-added activities are reduced to prove the technical and economic viability of the intervention over a limited time lapse.

The research framing is relevant by naively apprehending structural inefficiencies typical of many small and medium apparel manufacturers working in a resource-scarce socio-economic setting. By tackling disruption through coherent redesign of improvement initiatives as opposed to more financially extortionate investments, the study confirms the methodologies of improvement invocations in distribution countries and reveals how alignment generates sustainability and competitiveness. In addition, it theoretically accumulates by proposing the integrated vision between Lean production layout redesign towards coherent validation, updating the body of studies on textile SME performance with open credit to other issues of impregnation and further.

Testifying to the inclination to appeal future research to longitudinal performance constancy, cross-company replication, and digital linking with 4.0 tools, the appeal to invigorate in lieu manages reproduction with positivity and strength for the possible upgrading of the model and seems to provide arousal in the direction of planning the policy on multiproduct environments, and supply chain coordination may favor the scalability and strategic impact.

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