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Original Article

Enhancing Delivery Performance through Lean Logistics: Lessons from a Paint Manufacturing SME in Peru

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Abstract: *Like other emerging industries, the production of paint within emerging economies is plagued by unrelenting production, resource, and scheduling difficulties. Previous research has focused on undoing a small and medium-sized enterprise's (SME's) resource productivity waste through Lean Logistics; They, however, failed to demonstrate this empirically. My work closes these gaps through the application of a Lean Logistics framework in a Peruvian SME focused on process standardization coupled with a streamlined inventory system. Primary efforts centered on the development of standardized work instructions for order forecasting and employing the EOQ (Economic Order Quantity) model for inventory management. The model produced significant results by improving OTD (On Time Delivery) from 50.75% to 68.67%, increasing production capacity by 30.21%, and decreasing stockout-related downtime by 64%. These results confirm the model's claims on production flow optimization and supply chain reliability enhancement while underscoring the need to broaden Lean Logistics study focus to resource-scarce manufacturing settings.*

Keywords: *Lean Logistics, Production Optimization, Paint Manufacturing, SMEs, Inventory Management.*

I. INTRODUCTION

The small and medium sized enterprises (SMEs) in the manufacturing of paint products constitute an important segment of the industrial network on a global scale. As an industry, it forms an integral part of manufacturing with increasing paint production industry due to urbanization, heightened construction activities, and resurgence of house remodeling. As noted by the United Nations Environment Programmed, the global paint market is still largely dominated by SMEs with more than 55% of them being manufactures from emerging economies, thus strongly underpinning their social and their economic relevance [1]. In Latin America, the paint industry has demonstrated remarkable growth, particularly in Brazil, Mexico, Colombia, Chile, and Peru where SMEs are highly active in supplying to both the domestic and the regional markets [2]. Specifically in Peru, paint-related SMEs form a very important segment in the manufacturing subsectors that cater to the construction and hardware retailing, spurring local employment opportunities as well as the production of many locally designed specialized goods [3]. Yet this industry functions under a very harsh environment, characterized by low levels of automation, an absence of cutting-edge technologies, and poor operational efficiency of the automation tools that are available.

Although paint manufacturing SMEs emphasize working with leaner, more streamlined systems, they face certain constraining factors in the company's production processes. The structural challenges have the greatest impact toward the company's on-time delivery (OTD) performance. These companies also face non-value adding activities, lack of materials, insufficiently coordinated pre- and post-production scheduling, and unbalanced workflows in procurement and production. Recent research indicates that many of these firms do not have enough effective supply strategies, which leads to production stoppages due to unavailability of essential materials [4]. In addition, delays in mixing, packaging, and dispatching are because of absent standardized work processes combined with weak production sequencing techniques. Such inefficiencies diminish the effectiveness of the operational system and negatively impact service quality. In research conducted on Peruvian industrial SMEs, it was revealed that 62% of delivery date violations can be attributed to stockouts and waiting in highly utilized critical paths. [5] These factors reduce the firm's ability to effectively compete with companies that use more intelligent logistics and a demand responsive production planning.

As for this concern, watching over the operations of paint SMEs is best approached from the continuous improvement paradigm. The processes of small and medium enterprises (SMEs) are often streamlined and wastefully optimized using Lean Manufacturing and Lean Logistics methodologies which enhances key performance indicators (KPIs) such as efficiency or On-Time-In-Full (OTIF) delivering [6]. These methodologies assist in the material flow and inventory control system redesigning for SMEs, which greatly improves their processes, efficiency, and cost control without large technological capital expenditures. Research conducted on the lean approach in small industries reveals that work standardization, visual management systems, and economically driven inventory control enhance operational and logistics performance stability [7]. Cumulatively, adopting the organizational culture centered on continuous improvement enabled some of the firms to reduce total production lead times by 20% up to 40%, enhance the material availability, and customer satisfaction metrics [8]. This indicates the reasons towards the enhanced process efficiency is not solely company size, but rather a resource management methodology applied.

Nevertheless, the available research still indicates a striking absence regarding the systematic implementation of Lean Logistics tools in Small and Medium Enterprises (SMEs) within the paint industry, lean methodologies offered a myriad of benefits. Most studies focus on large-scale industries or those that undergo heavy technological penetration, such as automotive, metal-mechanical, or food processing [9]. Such absence of empirical evidence regarding manufacturing SMEs in the context of paints poses a knowledge gap that hinders the formulation of useful and adaptable management frameworks. Given this gap, the study aims to design and implement a production model centered on Lean Logistics tools tailored to the sector's specific features. The model proposed incorporates components like operational work standards (to ensure uniformity and consistency in the production execution), visual management systems (to track and monitor order and inventory levels in real-time), periodic inventory control on Q-model basis, ABC control, and Economic Order Quantity (EOQ) control. Unlike previous studies, production planning and inventory control are seamlessly integrated in this model to enhance operational flow, reduce stockouts, improve operational sequencing, and increase on-time delivery performance. In this regard, the model is anticipated to serve as a guide for continuous improvement in alignment with daily operations, waste, and performance targets [10].

II. LITERATURE REVIEW

A. Lean Logistics in SMEs of the Paints Sector

The implementation of Lean Logistics in manufacturing SMEs seeks to optimize material and information flows, eliminating waste and improving operational efficiency. Although the literature on SME-specific paints is limited, studies in similar industrial sectors offer valuable insights. For example, Muniyappa et al. highlight the effectiveness of Value Stream Mapping (VSM) as a tool to identify and eliminate non-value-adding activities in manufacturing processes [11]. Che Ani et al. applied VSM in a manufacturing operation, achieving significant improvements in cycle times and waste reduction [12]. Li and Fernández conducted a structured review of the application of VSM in the construction industry, highlighting its adaptability and benefits in different industrial contexts [13]. Korchagin et al. explored the integration of Lean and energy-efficient production in the aeronautics industry, demonstrating the versatility of Lean principles in various industries [14].

B. Standardized Work (Standardized Work) in SME Production Processes

Standardized work is central to the Lean philosophy, as it establishes consistent procedures for performing tasks, reducing variability and improving quality. Hirano emphasizes the importance of the five pillars of the visual workplace, which include standardization as a basis for continuous improvement [15]. Galsworth introduces visual systems which complement standardized work, facilitating the understanding and execution of tasks by operators [16]. Suzaki discusses the challenges of modern manufacturing and how standardization contributes to overcoming them [17]. Greif presents the concept of the visual factory, where standardization and visualization work together to optimize processes [18].

C. Visual Management in Lean Industrial Environments

Visual management is a key strategy in lean environments, allowing clear and fast communication of the state of processes. Galsworth describes the visual workplace as a self-explanatory, self-regulated environment where critical information is available at the point of use [16]. Hirano details how the implementation of visual tools improves efficiency and reduces errors [15]. Suzaki compares the responsiveness of a well-tuned production system with that of the human body, highlighting the importance of visualization in detecting and correcting problems quickly [17]. Greif emphasizes the role of visual applications in increasing worker participation in continuous improvement activities [18].

D. Model for Periodic Review (Model Q) in Industrial Processes

The periodic review model, known as Q Model, is an inventory management strategy where stock levels are reviewed at fixed intervals and orders are placed to replenish to a predetermined level. This model is particularly useful in environments where demand is variable, and ordering costs are significant. Cabrera-Gala et al. applied this model in a Mexican food company, managing to reduce both shortages and overstocking [19]. Islam et al. optimized inventory stock using the periodic review system in a seafood company, improving operational efficiency [20]. Dewa et al. integrated a stochastic periodic review system in an Indonesian SME, improving inventory management and reducing costs [21]. Kouki et al. discussed a regularly reviewed inventory control system for perishable goods, proposing policies that minimize shelf-life losses [22].

E. Economic Order Quantity (EOQ) Model Applied in Inventory Management in Industrial SMEs

The Economic Order Quantity (EOQ) model determines the optimal order quantity that minimizes total inventory costs, including ordering and maintenance costs. This model is widely used in SMEs to optimize inventory management. Wardana et al. applied the EOQ model in a cafeteria, achieving a significant reduction in inventory costs [23]. Ghiffari analysed raw material inventory control using the EOQ method in an Indonesian SME, achieving improvements in operational efficiency [24]. Hidayat et al. implemented the EOQ method in a tofu factory, optimizing inventory management and reducing costs [25]. Dania et al. used the probabilistic EOQ model to control flour inventory in a company, improving product availability and reducing costs [26].

III. CONTRIBUTION

A. Proposed Model

The production model designed for a small and medium-sized enterprise (SME) dealing with paint manufacturing is based on the principles of Lean Manufacturing and Logistics seeking to improve delivery performance. In Figure 1, the model is displayed together with its key elements and corresponding interactions. The model was structured based on the identification of key causes behind delayed deliveries, the absence of defined procedures, and inadequate raw material inventories; also known as inventory mismanagement. To overcome these challenges, two connected elements were proposed which were the operational activities standardization and effective management of a raw material warehouse. The first element contained the development of standard operating procedures for work as well as controlled production processes which minimized variability, improved employee training, and ensured process traceability. Also, the second element pertained to internal logistics, which included the planning of stock replenishment, raw material stocks control, and the calculation of economic order quantities for the input assurance. The integrated model allowed for the optimal interconnection between production activities and supply logistics, which streamlined material flow and improved delivery dependability while operational responsiveness was enhanced. From this developed model with the intention of addressing operational inefficiencies, a structural approach was formed to enhance supply chain agility and responsiveness focused on operations specific to an SME paint manufacturer.

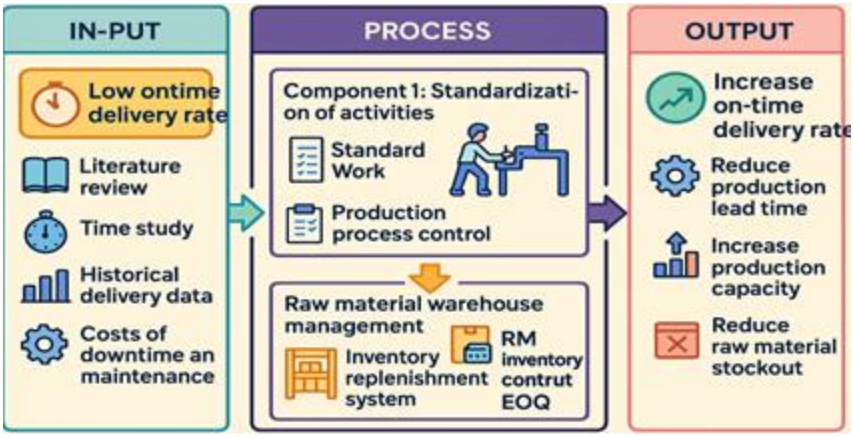

Figure 1 : Proposed Lean Production and Logistic Model

B. Model Components

In the case of small and medium-sized manufacturing enterprises, especially those operating in the sphere of paints production, the lack or inadequate management of certain operational and logistical functions tends to result in tardy deliveries, low productivity, and poor material usage. These operational inefficiencies not only influence the level of satisfaction of customers but also jeopardize the operational viability of such businesses. To address this issue, the model in Figure 1 is proposed with the intent to outline a solution that caters to the principles of Lean Logistics while attempting to internally synchronize operations with supply chain management by means of waste elimination and continuous value creation.

This model was developed with the intention to solve the repetitive issues within the production setting which include frustration due to unproductive time, the critical raw materials not being available at a set time, and monotonous work being done in a non-systematic manner. It accomplishes this purpose through two main components, which are the standardization of operational activities and the effective control of raw material inventory. The combination of these components ensures that crucial materials are available when needed and that production activities are executed with minimal interruption, which ultimately enhances the on-time delivery metric. Which distinguishes it from self-contained or ad hoc interventions, the importance of this model is in its systemic approach and modular design. Instead of silos, the model approaches problem-solving through integrative diagnostic analysis, time studies, historical demand, logistical cost analysis, and supplier lead time evaluations. This not only improves the agility of the production system but also enables informed strategic decisions for enduring competitive advantage in the primary structure of the production system.

In the following, I offer a detailed account of all the components of the model, beginning with the diagnostics step through implementation of standardized production processes, and optimizing inventory management of raw materials. I present each section with a practical and theoretical treatment that uniformly combines invasive interdisciplinary delivery method to enhance operational performance in actual delivery scenarios.

a) Operational Diagnosis and Design Principles

The creation of the model begins with an extensive diagnostic phase, which aims to uncover the reasons for unsatisfactory delivery performance. This assessment comprises internal process variables and supply-related external factors. The process starts with a scan of the technical literature to inform tool selection and proceeds with time and motion studies aimed at quantifying task delays. Alongside this, historical demand data, ordering and maintenance costs, and supplier lead times are evaluated to construct a balanced view of the issue.

The information obtained from these sources provides different perspectives regarding the problem, both quantitative and qualitative, in this case, the system. These insights depend on the diagnosis. For instance, some operations show extreme variability; there are no intermediate controls in the production line, critical raw materials frequently stock-out leading to production stoppages. These create bottlenecks which cumulatively cause loss of interdepartmental coordination.

With this context in mind, the design framework rests upon a systematic approach aimed at eliminating waste while creating unobstructed flows of materials and information. At this point, Lean Logistics serves me as an more than adequate conceptual framework that allows me to integrate production decisions with inventory management, thus adopting a broader perspective on the value chain.

b) Component 1: Standard Operating Activities Procedures

This model's first component addresses the standardization of operational production activities. This method seeks to streamline operational variability and enhance the replicability of proven practices—both of which are essential in contexts where quality and timeliness are critical. As illustrated in Figure 1, this component is portrayed as a foundational intervention which includes both standard work design and process control systems automation.

Standard work implementation entails setting the correct order of tasks, execution time, and quality for every step of the process. To ensure operational clarity, all information is structured into visual aids which are placed at workstations. Furthermore, formal policies stipulating roles and responsibilities for training, supervision, and ongoing performance assessment against set criteria to ensure standard compliance are established.

Process control mechanisms are now added to monitor activities as they are performed. This encompasses visual dashboards, control checklists, and standardized logs which together allow for early detection of variances, enabling prompt corrective measures. These controls build an environment of responsibility as well as self-assessment, in addition to helping stabilize production lead time variability.

Standardization also lays the groundwork for better integration with the logistical systems. Well defined and structured processes make it possible to predict material requirements, schedule activities, and allocate resources optimally. Such systemic clarity improves interdepartmental decision making and coordination with minimal delays, thereby improving resource efficiency.

Furthermore, standardized procedures shorten the training period for new personnel, enhancing operational resilience to unexpected disruptions. This allows the firm to be less reliant on specific personnel by providing a systematic approach that ensures the retention of relevant knowledge which can then be easily transferred across shifts or production lines.

c) Component 2: Efficient Management of Raw Material Inventory

The raw material warehouse, which is instrumental in integrating material resources into the production process, conveys the second key element of the model. Inventory management or stockpiling presents some problems for a great many SMEs, mainly because of inadequate foresight, weak controls, and a stock management system that reacts to situations instead of planning for them. This component, illustrated in Figure 1, is composed of three synergistic elements: a raw material replenishment system, stock level information system, and economic order quantity (EOQ) calculations.

The main purpose of the replenishment system is to enable continuous stock renewal based on preset rules for defining the minimum reorder levels. Another vital replenishment inventory management component is the dynamic reorder point which, in addition to projected demand and supplier lead time, relies on predefined safety stock levels. This business method provides considerable protection against stockout contingencies while improving logistical dependability.

Inventory control is performed based on inputs, outputs, real consumption rates, and tracking efficiency. Automated registers enable alert trigger mechanisms when critical thresholds are hit for various levels. Enhanced level of transparency helps heuristic planning, which improves accuracy and reduces artifacts and deterioration resulting from poorly managed storage

As an ordering cost and holding cost balancing mechanism, the model uses EOQ. The calculation considers how frequently materials are used, the storage dimensions of each item, and the available space. By optimizing order sizes for each cycle, the company avoids overstocking, shortages, and reduces expending responsive inventory management.

These three tools were integrated to create a more responsive supply system that works on 'real' production needs. The interplay of production scheduling and material supply logistics is more streamlined, thus ensuring materials are supplied in the proper number and time without additional costs. This strategy enhances the delivery performance while enabling better control over resource allocation.

d) Expected Outcomes and Other Implications in Relation to Lean Logistics Principles

The timely delivery rates an organization achieves is one of the foremost indicators of lean logistics integration accuracy. On the timely delivery within an organization, the lean logistics integration is expected to be influenced by the refinement to the production cycles. The operational capacity relies on the organizational structure in terms of the workload and resources, while on the other hand, raw material services directly depend on effective procurement processes. These aspects describe the achievement of lean logistics aims.

Elements of waste minimization, functional visual control processes, maintenance on a constant scheduled demand, and overall organizational improvement on determining the need directly characterize the division aligning with lean logistics principles through planning for the demand. The specialized construct of the model permits installment to be phased, which can be made stepwise to fit the resources and feasibility of micro enterprises. Along these lines, the model's dependence on the data makes it useful for tracking and measuring different variables and for making changing over extensive periods.

Serving as a technical model is noting the extension these operations have on a small-scale paint manufacturing company. Notably, from the model the paint manufacturing SME operates within, the bottle neck effects that arise from the marketing and production increase on vein responsive and agile replying mechanisms to serve undertaken and advance to use processes examine and evolve while sustaining extensive responsive marketing is incorporated.

Conclusively, the framework depicted in Figure 1 addresses a fundamental operational problem in a coherent, adaptable, and applicable manner. The integration of standard processes with anticipatory inventory control manifests Lean Logistics and illustrates its application within the context of a small manufacturing enterprise. The company, because of this approach, can respond to fluctuations in demand while ensuring uninterrupted production, thereby improving its market competitiveness.

C. Model Indicators

The performance of paint manufacturing SMEs implementing a production model grounded in Lean Manufacturing and Lean Logistics was assessed through tailored evaluation criteria designed to reflect the operational priorities of this sector. The indicators were systematically selected to enable consistent analysis of the model's effectiveness in enhancing on-time delivery performance. This structured evaluation framework allowed for rigorous monitoring and facilitated continuous improvement by capturing key dimensions of production efficiency, material availability, and process stability. Overall, the model's indicator system provided a coherent basis for validating the practical impact of the proposed methodology within the SME manufacturing context.

a) Indicator: On Time Delivery

This indicator reflects the ability of the production system to meet scheduled delivery dates. It measures service reliability and customer satisfaction by calculating the percentage of orders delivered within the agreed timeframe.

$$\text{On Time Delivery (\%)} = \left(\frac{\text{Orders delivered on time}}{\text{Total orders}}\right) \times 100 \quad (1)$$

b) Indicator: Production Capacity per Shift

This metric estimates the number of units that can be produced during a single work shift, based on the available production time and the average cycle time. It indicates operational efficiency and throughput.

$$\text{Production Capacity} = \frac{\text{Available production time}}{\text{Cycle time}} \quad (2)$$

c) Indicator: Downtime Due to Stockout Rate

This indicator quantifies the percentage of productive time lost due to raw material shortages. It is essential for identifying weaknesses in inventory management and ensuring continuous flow in production.

$$\text{Downtime Due to Stockout (\%)} = \left(\frac{\text{Downtime hours}}{\text{Total working hours}}\right) \times 100 \qquad (3)$$

IV. VALIDATION

A. Validation Scenario

The validation setting was done in a case study of a micro and small enterprise (MSE) engaged in manufacturing and selling paints in Lima, Peru. This MSE operates within the manufacturing sector and has a wide range of products, which includes paints for vehicles, decorative paints, industrial paints, and paints for traffic signs. Even though the case study firm had broad product range, it encountered severe operational problems which adversely impacted its delivery performance. One of the most challenging problems was recognizing unproductive time in the production cycles and stock-outs which delayed the customer delivery timelines. A lack of process uniformity and poor control of buffer stocks compounded these inefficiencies. In this regard, the firm possessed typical characteristics of small enterprises, such as limited resources and underdeveloped technological systems. These attributes made the firm a suitable case study to assess the effectiveness and practicality of a production model anchored on Lean principles. Addressing these operational delays was the focus of the research.

B. Initial Diagnosis

The evaluation performed as part of the case study noted that one of the key operational shortcomings is low on-time delivery rate, which in this case was 50.75% in 2021, remarkably below the industry benchmark of 74.60%. This technical gap incurred a significant economic cost estimated at PEN 78,769.14, which is 2.52 % of the organization's annual revenue. Among the most important issues unproductive times which is 68.52% of the total problem. Unproductive times are broken down into non-standardized production activities (59.70%), excessive distances of material handling (4.00%), disorder and uncleanliness in the work areas (4.83%). Additionally, stockouts represents 31.48% of the problem, which is due to a lack of raw materials (17.97 %) and insufficient control of stock (13.51%). With these analytics, one was able to extract substantial evidence concerning the structural problems undermining delivery dependability, which was also used as rationale to take measures focus on improving the synchronization of processes.

C. Validation Design

The validation of the proposed production model, grounded in Lean Manufacturing and Lean Logistics principles, was carried out over a four-month period within a paint manufacturing SME. The approach focused on addressing delivery delays by implementing standardized work procedures and improving raw material inventory management. These strategies aimed to reduce production variability and prevent stock shortages, both of which had previously contributed to missed delivery deadlines. The pilot intervention followed a structured plan and was monitored using a data-driven approach, enabling a precise evaluation of the model's impact on operational performance and its feasibility in a resource-constrained context.

The solution's design was based on developing a remedy for the primary reason pertaining to the production challenge of a small-sized paint manufacturing company, which was the low on-time delivery rate and huge financial losses suffered due to inefficiencies within the company. The solution was devised aided by available scientific literature and was carried out using a model formulated with two key parts: operational activities standardization and the effective control of raw material inventory. These parts were chosen because they have the potential of directly alleviating the root causes within the diagnostic phase such as unproductive time due to a lack of standardized processes, and poor inventory control leading to recurrent stockout scenarios. The overall aim of the proposed modification was to improve the responsiveness of the company, lower fluctuations in operations with more predictability, and ensure critical inputs are supplied for production as scheduled.

a) Component 1: Process Activity Standardization

i) Establishing Activity Order

The intervention started with creating a constituent task list for the paint production process. A project member went line by line recording the time spent with direct operations, materiel transport, delays, and control activities for every operator along the production line with the help of a "Time measurement sheet." This documentation assisted in comprehending the differences in work sequences for each operator, which caused inefficiencies and disrupted process control.

ii) Categorization of Standard Activities

After the activities were recorded, and in coordination with the most efficient operator, the team set out to classify them based on contribution to value. This classification was made using the VA (Value-Added), NNVA (Necessary but Non-Value-Added), and NVA (Non-Value-Added) structure. This was important to separate operational actions that actively supported product manufacturing and quality control from those that were wasteful or redundant in the operational workflow.

Figure 2 shows the classification of value-adding activities in the gloss paint manufacturing process. Through the VA–NNVA–NVA methodology, 15 operations were analyzed to identify which activities generate value, are necessary but non-value-adding, or are wasteful. This analysis supported the standardization of tasks to optimize process efficiency.

VALUE-ADDED ANALYSIS									
Gloss paint manufacturing process									
Section: Production	Product: Gloss Paint Number of operators: 3	Cycle Time: 185.62 Number of operations: 15			Observed by: Operator 1	Value-added analysis		
Element	Description of operations	Operation time (A)	[illegible] time (B)	Waiting time (C)	Control time (D)	VA	NNVA	NVA
1	Identify pigments and liquid inputs from the preparation manual	1.87				✓		
2	The operator moves to the warehouse area		1.85				O	
3	Search for pigments and solvents to be used in the raw material and inputs warehouse			4.37				✕
4	Transfer pigments and solvents to be used from the warehouse (raw material and inputs) to the weighing area		1.44				O	
5	Weigh inputs and raw materials	2.72				✓		
6	Transfer pigments and solvents (heavy) to the grinding area		1.42					✕
7	Wait for the machine to finish grinding	26.42				✓		
8	Find a measuring tool			2.82			O	
9	Measure the grain size				2.76	✓		
10	Transfer the grinding to the filtering area		1.06			✓		
11	The operator moves to the storage area		0.76				O	
12	Find solvents to be used in the raw material and input warehouse			3.76		✓		
13	Transfer solvents from the warehouse (raw material and input) to the filtering area		1.13			✓		
14	Wait for the machine to finish filtering	24.08				✓		
15	Transfer the grinding to the mixing area		1.09					✕

Figure 2 : Classification of Value-Adding Activities

iii) Development of the Standard Operating Procedure

Following the classification, a Standard Operating Procedure (SOP) was drafted which comprised activities, description, and control point. This procedure included 30 activities and acted as a delineating document for operational personnel. To facilitate the comprehension and execution of tasks, drawings were utilized such as naming conventions for containers designated for raw material weighing. This approach enhanced material accuracy and diminished clutter. Furthermore, every input was assigned a SKU which made the procedure easier to read and simplified materials dispatch from the warehouse.

Figure 3 presents a Standard Operating Procedure (SOP) specifically developed for the paint manufacturing SME under study, as part of the proposed solution based on Lean tools. This document formalizes the sequence of activities in grinding, mixing, filtering, and packaging stages, clearly defining responsibilities, equipment, and control criteria. It details the weighing of raw materials—a critical task that was previously performed empirically and without standardization. The implementation of this SOP helped reduce operational variability, improve raw material traceability, and facilitate staff training in a context characterized by high workforce turnover.

Standard Operating Procedure			
Procedure: Paint Manufacturing Product Name: GL001-245 GL			[illegible]
Areas: Grinding, Filtering, Mixing, Filling, Packaging			
Process Owner: Production Manager Process Responsible: Chemical Operator			
Equipment - Grinding Tower - Packaging Machine - Filtering Tower - Mixing Tower			
Tools - Affinity Ruler - [illegible]			
No	Activity	Description	Control
[illegible]	[illegible]	[illegible] in the warehouse and weighs them: SSL-1850: 18.5 kg SSL-0540: 5.40 kg SSL-0770: 7.70 kg SSL-2450: 24.5 kg	Validate weight

Figure 3 : Standard Operating Procedure - SOP

iv) Implementation of Visual Quality Control

While the SOP was being drafted, visual control methods were introduced concentrating on two important areas of operational concern related to the product quality: the size of the grains and the viscosity of the mixture. These were also controlled using a Visual Aid which contained suggested values based on industry norms. Guides for these verifications were designed as step-by-step checks for operators to incorporate into their routine as self-regulating mechanisms. With the adoption of these controls, the team improved their ability to identify and spontaneously deal with problems without having to be instructed.

Figure 4 presents the Visual Aid for grain fineness control, implemented to ensure product quality in paint production. It provides step-by-step instructions for preparing, applying, and visually evaluating samples using a grindometer, facilitating standardization and enabling operators to detect deviations quickly during the manufacturing process.

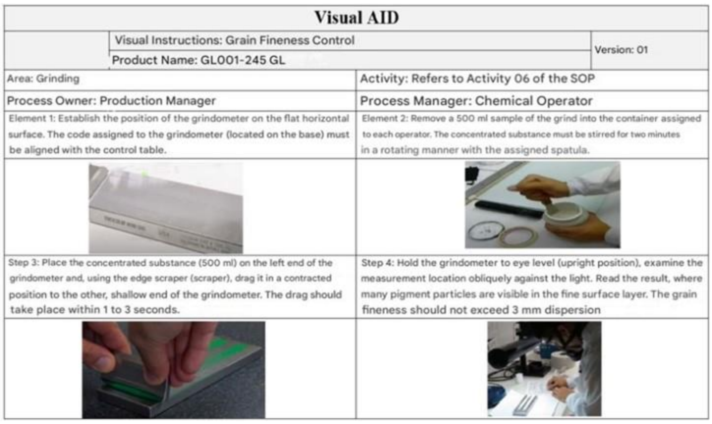

Figure 4 : Visual Control

b) Component 2: Management of the Raw Material Inventory

i) Setting of Reorder Level

About the second identified root cause as stockouts, a continuous review inventory system policy was designed. The first stage in this process is finding out what the reorder point is, in this case, with an average monthly demand of 180 sacks and a lead time of three days. Along with this value, a safety stock of 168 sacks was added, which was calculated based on a standard deviation of 36 sacks at a 95% service level. Thus, a reorder point of 708 sacks was set which instructed the company to take action to refill the stock so that stock replenishment can be done in time and production do not stop due to lack of materials.

ii) Economical Order Quantity (EOQ) OC Calculation

Then, using the standard system with annual consumption at 2160 sacks, an ordering cost of 150 soles and annual holding cost of 30 soles per every inventory item, the Economic Order Quantity (EOQ) was calculated. The result indicates an EOQ of 809 sacks, alongside a favorable total inventory cost composed of ordering and holding expenses, the company was able to streamline spending. This policy avoided last minute purchases and enabled accurate planning of when to purchase inputs.

iii) Drafting Control Strategies for Inventory

Along with the logistical calculations, uniform templates were created to track and manage the raw material's movement. These templates complied with the ergonomic framework of Peruvian Law 28305, which regulates the use of controlled chemical substances. Inspection fields designed to guarantee the traceability of those inputs within the system that require surveillance or inspection were included. These policies also adopted a 95% service level as the operational norm for preventing stockout situations, barring exceptional or unmanageable circumstances.

Figure 5 shows the Raw Material Inventory Entry Control, a tool implemented to register all incoming materials in the warehouse. It records invoice numbers, product names, quantities, and responsible personnel, ensuring traceability and accurate stock management, thus reinforcing the inventory control component of the proposed Lean Logistics model.

iv) Training of Warehouse Operators

The deployment of these policies was supported by an educational campaign directed towards the warehouse personnel. Training sessions occurred weekly for four weeks. Each Training focused on aspects like format utilization, basic inventory computations, and the organization's compliance with the law. This initiative was designed to foster a positive attitude towards the fresh policies among employees, fueling their responsibility and assuring that the new system would be used correctly, as intended.

Raw Material Inventory Entry Control				
Version: 01	Objective: Keep a record of everything that enters the raw material warehouse			Date: 06/25/2024
Prepared: Operator		Position: Chemist		Signature:
Approved: Boss		Position: Production		Signature:
No.	Invoice No.	Product Name	Quantity	Observations
1	E001-000487	Pigment GL-023	185	-
2	E001 000487	Pigment Ci, ()()	167	
3	E001-000487	Pigment GL-015	131	-
4	E001 000487	Pigment GL 001	10	
5	E001-000487	Pigment GL-007	79	-
6	E001-000487	Pigment GL-004	63	-
7	E001 000487	Pigment Ci1, (02.1	18	
Responsible	Name: Chief	Position: Administration		Signature:

Figure 5 : Control of Incoming Raw Material Inventories

v) Training of Warehouse Operators

The deployment of these policies was supported by an educational campaign directed towards the warehouse personnel. Training sessions occurred weekly for four weeks. Each Training focused on aspects like format utilization, basic inventory computations, and the organization's compliance with the law. This initiative was designed to foster a positive attitude towards the fresh policies among employees, fueling their responsibility and assuring that the new system would be used correctly, as intended.

Figure 6 presents the Training Program implemented to reinforce inventory management practices. It focused on the importance of inventory levels and the correct use of input and return control formats. Operators from different production areas participated in the sessions, ensuring proper understanding and standard application of procedures throughout the warehouse.

Training Program			
Version: 02	Training: Inventory Level Record		Date: 09/15/24
Prepared: First and last name		Position: Administrator	Signature:
Approved: First and last name		Position: Manager	Signature:
Objective: Maintain shoe inventory levels in order to be able to carry out tasks, orders, and sales when necessary. Agenda: 1. Importance of inventory levels 2. Formato – Control de Entrada de Inventarios 3. Raw Material Return Control Format			
No.	Operator	Área	Signature
1	Anonymous 1	Mixed	
2	Anonymous 2	Ground	
3	Anonymous 3	Filtered	
Evidence: Image			

Figure 6 : Training Program

D. Results

Table 1 presents the impact of implementing the production model based on Lean Manufacturing and Lean Logistics tools in a paint manufacturing SME. The results showed a significant improvement in the on-time delivery rate, which increased from 50.75% to 68.67%, representing a 35.31% improvement. Likewise, the production capacity per shift rose from 1380 to 1796.83 gallons per shift, reflecting a 30.21% increase over the baseline. Additionally, the downtime due to stockouts decreased from 6% to 2%, achieving a 64% reduction, which indicated greater control over raw material availability. These results confirmed the effectiveness of the proposed model in enhancing operational efficiency and delivery reliability, aligning with the strategic objectives established in the research.

Table 1 : Indicators After Model Implementation

Indicator	Unit	As Is	To Be	Results	Variation (%)
On Time Delivery	%	50.75%	74.60%	68.67%	35.31%
Production Capacity per Shift	gl/Shift	1380	1920	1796.83	0.30205072
Downtime Due to Stockout Rate	%	6%	1%	2%	-64%

V. DISCUSSION

The outcome of this study indicates an improvement in the On-Time Delivery (OTD) rate performance from 50.75% to 68.67%, a total improvement of 35.31%. This study aligns with Lean manufacturing SME research focused on the utilization of Lean tools and their impact on production optimization [11], [12]. Specifically, Value Stream Mapping (VSM) is fundamental to minimizing non-value-adding activities, leading to better cycle time and operational efficiency [13], [14]. Furthermore, the process standardization and visual management system in this model corroborates Hirano [15] and Galsworth's [16] claims that these approaches enhance process variability and provide better control over the process. It is important to note that the reduction of downtime due to stockouts decreasing from 6% to 2% (-64%) supports Cabrera-Gala et al. [19] findings that periodic review models improve inventory levels and reduce production halts. Overall, the model has illustrated considerable positive change to the identified key performance indicators, signifying effectiveness in a manufacturing setting constrained by technology and heavily reliant on materials management.

Even with the advancements made, the study has certain limitations that need to be highlighted. To begin with, the validation of the model was done for one SME only and it belongs to the paint industry. This significantly restricts the applicability of the findings to other industries with diverse operational attributes. In addition, the assessment period for the study was four months, which constrains evaluating the long-term sustainability of the improvements. Another critical limitation is the reliance on historical data for planning, which may evolve based on predictive demand shifts that were not considered in the current model. Finally, the lack of automation for tracking and controlling inventory processes may present limitations for larger companies wishing to scale the model.

The study's findings bear significant direct consequences for manufacturing SMEs, particularly within the paint sector. Adopting a Lean Logistics model with process standardization increases operational efficiency and improves flexibility in addressing demand changes. This improves reliability in meeting delivery schedules and reduces stockout-related downtime costs. Moreover, the use of visual aids integrates the monitoring of operations and improves real-time decisions. In addition, these practices help SMEs reduce the technological constraints, a major feature of their environment, and highly competitive nature of the market by enhancing their competitiveness through waste reduction and efficient resource use.

Proposed further research could include extending the application of the discussed model to other manufacturing sectors to assess its versatility and effectiveness across different operational scenarios. It is also proposed to study the incorporation of new technologies for better process automation, cyber-physical systems, and more precise control of inventory, production in real-time. A longitudinal study could assess the sustainability of improvements made to SMEs competitiveness and growth over time in the long run. Moreover, incorporating simulation methods for demand variation forecasting would enhance the resource planning optimization and operational efficiency of the model.

VI. CONCLUSION

The application of Lean Logistics on the SME under analysis revealed marked enhancements within the operational performance of the SME. The calculated improvement in On-Time Delivery (OTD) was by 35.31% of the total OTD tweaked from 50.75% to 68.67%. Along with that, the production capacity per shift rose from 1380 to 1796.83 gallons, which is a growth of 30.21%. This was accompanied by a 64% reduction to the downtime due to stockouts, improving the availability of raw materials and continuity of processes. The results justify the rationality of applying process standardization along with proficient raw material control on logistical operations to sharpen the operational and delivery performance of the SME within the paint manufacturing industry.

This research is particularly relevant because it deals with very important issues facing manufacturing SMEs that operate in resource-scarce settings. The model could not only streamline the production flows but also addresses the critical problems of material shortages and unbalanced workloads. In the context of a highly competitive environment, achieving the delivery benchmarks with minimal disruptions greatly enhances the operational reliability and sustainability of the firm. Moreover, this model shows that applying Lean internal logistics can bolster the dependability of supply chain operations without massive technological expenditures.

This research aids the Industrial Engineering domain by applying Lean Logistics principles to the paint manufacturing industry, which remains largely undocumented. This model, unlike traditional ones which concentrate on mass industries, is tailored to the operating dynamics of small and medium-sized enterprises (SMEs). The systematization of standard operating procedures and inventory control systems fosters an orderly setting that aids in the elimination of waste, stabilization of processes, and optimal utilization of resources. Additionally, this study enhances the literature by improving logistical efficiency systems in SMEs and providing them with a structured approach, thus balancing the literary imbalance.

Further analysis should confirm the model's strength and adaptability to other manufacturing settings to test its robustness and scalability. The model's responsiveness could also be enhanced by the addition of new technologies like real-time inventory monitoring and automated process control. These modifications could be assessed by longitudinal studies to determine the lasting effects of these changes on the SMEs' competitiveness and growth over time. Furthermore, enhanced simulation techniques could refine the model's predictive capabilities, improving resource allocation and minimizing material supply disruptions.

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