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Management Model to Improve the Service Level in a Chemical Products Trading Company

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Abstract

This study presents an innovative management model to increase the service level at Soquitex, a Peruvian company dedicated to the production and commercialization of chemical auxiliaries for the textile industry. The model integrates lean manufacturing tools such as process standardization, the implementation of a visual Poka Yoke system, and multi-stage quality control. The methodology combines root cause analysis, value stream mapping (VSM), key performance indicators (KPI), and operational simulations. Through this systemic approach, inefficiencies related to product deterioration, labeling errors, and storage were identified. With the implementation of the model, the service level is expected to improve from 85.36% to 87.5%, reduce non-conforming products by 15%, and decrease customer complaints by over 75%. This study not only provides practical value to the chemical-textile industry but also introduces a replicable and empirically validated model that aligns quality, operational efficiency, and customer satisfaction.

Keywords
Standardization, lean manufacturing, quality control, service level and textile industry quality standards.

1. Introduction

The Peruvian textile and chemical sectors face growing challenges, with textile exports declining by 14.5% in 2023 due to Asian competition and cost pressures. Soquitex, a chemical auxiliaries company, struggles to remain competitive, with a service level of 85.36%, below the 87.5% industry benchmark. This gap reflects operational inefficiencies that threaten customer retention and market position.

Key issues include inconsistent product quality, lack of standardized processes, and weak quality control. These factors contribute to high reprocessing costs and rejected batches, totaling S/. 21,035.30 monthly (7.44% of revenue). Additionally, incorrect specifications and poor storage communication have led to product deterioration and dissatisfaction.

Lean Manufacturing tools, such as process standardization and Poka Yoke, have proven effective in improving quality and efficiency. In a Peruvian chemical company, their implementation increased production efficiency by 84% and reduced defects by 20%. Poka Yoke has also minimized errors and improved operational accuracy, while work standardization has reduced inconsistencies and enhanced customer satisfaction across industries.

To enhance Soquitex's competitiveness, this paper proposes a management model integrating Lean tools to optimize efficiency, strengthen customer loyalty, and position the company as an industry leader. The following sections detail the methodology, results, and expected impact.

1.1. Objectives

This study aims to develop a management model based on Lean Manufacturing tools to improve the service level of Soquitex**,** a Peruvian company specializing in chemical auxiliaries for the textile industry. The research seeks to identify operational inefficiencies, design and implement standardized processes, and establish a robust quality control system to enhance production efficiency and customer satisfaction. Additionally, the study incorporates an informative Poka Yoke mechanism through labeling**,** ensuring proper storage conditions and minimizing product deterioration. The effectiveness of the proposed model will be evaluated through key performance indicators, including service level, defect rates, rework rates, and customer complaints, to measure its impact on operational performance and competitiveness in the chemical industry.

2. Literature Review

The chemical auxiliary industry, particularly in Latin America, has faced a marked decline in service level indicators due to persistent operational inefficiencies, including high rates of defective products, labeling errors, and weak quality assurance systems (Fortunato and Luceli 2023; Cordeir and Fellype 2020). These issues are often exacerbated by limited automation, non-standardized processes, and fragmented supply chain communication, ultimately impacting customer satisfaction and organizational reliability (Lira et al. 2021). In such environments, the implementation of Lean Manufacturing has proven instrumental in enhancing operational efficiency and product quality while reducing waste and variability (Shah and Ward 2019).

Process standardization plays a pivotal role in ensuring repeatability, reducing variability, and sustaining quality levels in chemical manufacturing environments. As outlined by Zhou et al. (2021) and Skrzypek (2016), establishing standardized workflows improves compliance with safety protocols and enhances productivity by minimizing inconsistencies in execution. In companies like Soquitex, standardization is a fundamental requirement for reducing product defects and improving internal coordination.

The use of Poka Yoke, specifically informative visual systems, has been recognized as a powerful technique to mitigate human error in labeling and storage procedures. Wolniak (2024) emphasizes that Poka Yoke systems, when adapted with digital visual elements, contribute to Industry 4.0 readiness by integrating human-centric error-proofing into dynamic operations. In chemical distribution chains, improper labeling can lead to serious compliance violations or customer misusage. Hence, visual Poka Yoke tools, as demonstrated by Fernández et al. (2023), help ensure correct product handling and improve traceability.

The effectiveness of Quality Management Systems (QMS) in reinforcing customer trust and process reliability has also been widely documented. A robust QMS enables manufacturers to align output specifications with regulatory standards and client expectations, reducing variability and reinforcing the brand's technical credibility (Rix 2018). In the context of the chemical sector, this translates into enhanced control over formulation integrity, packaging, labeling, and storage conditions—all key drivers of customer satisfaction.

Despite the maturity of Lean principles in some industries, there remains a limited body of empirical studies applying integrated Lean models specifically to the chemical auxiliary segment. While prior research has explored isolated improvements using quality control or logistics tools, few have proposed a holistic, structured framework as implemented in this study. For instance, He et al. (2021) explored reinforcement learning systems for textile optimization, yet such models lack the tangible, scalable structure needed for SMEs in chemical environments. This study addresses that gap by designing and validating a replicable management model tailored to operational realities and service-level constraints.

In addition, diagnostic tools such as Value Stream Mapping (VSM) and root cause analysis provide insight into production inefficiencies. When applied strategically, these tools enable organizations to identify non-value-added activities, resolve systemic bottlenecks, and improve process visibility (Bedoya and Hinostroza 2023; Morales et al. 2023). The results obtained in this research, particularly in reducing complaints and improving on-time delivery, reinforce the critical role of data-driven continuous improvement in chemical manufacturing settings.
Ultimately, this study demonstrates that while Lean Manufacturing, Quality Management Systems (QMS), and error-proofing tools like Poka Yoke have individually proven effective in industrial applications, there remains a significant opportunity for integrated, context-specific models. This research addresses that gap by proposing a practical, scalable, and validated management model tailored to the complexities of the chemical auxiliary

industry. The integration of these methodologies aligns with the principles of continuous improvement and operational excellence, as emphasized in the Toyota Production System (Ohno, 1988).

By incorporating QMS, work standardization, and an informative Poka Yoke system, Soquitex can enhance its service levels, minimize operational inefficiencies, and elevate customer satisfaction. These Lean Manufacturing tools offer a structured approach to process optimization, positioning the company as a leader in quality and reliability within the textile chemical industry. The adoption of such integrated systems is consistent with best practices in process safety and quality management, which advocate for the harmonization of safety and quality principles to achieve optimal performance (Mannan, 2014).

3. Methods

To accurately identify the root causes of the primary challenges affecting the service level at Soquitex, a structured methodology was implemented. This process involved data collection, problem analysis, and root cause identification through various analytical tools. These steps provided a comprehensive understanding of operational inefficiencies, serving as the foundation for designing targeted and effective solutions.

In the initial phase, data was collected on orders with defects over a three-month period within the company. This analysis provided valuable insights into the frequency and nature of recurring issues, which are summarized in the following Table 1:

Table 1. Types of Issues Identified in the Company

Type of Issue	Quantity	% Participation	% Cumulative
Incoming – Material defect rate	10	30.30%	30.30%
Storage compliance desviation (%)	10	30.30%	60.61%
Process Efficiency & Final-Product Defect Rate	8	24.24%	84.85%
Packaging automation utilization (%)	4	12.12%	96.97%
Preventive – Maintenance compliance (%)	1	3.03%	100.00%
Overall Non - Conformity Incidents	33	100.00%	100.00%

Subsequently, a key performance indicators (KPI) Table 2 was developed to systematically categorize the diverse types of issues affecting the company. These indicators not only facilitated the classification of identified problems but also provided a quantitative basis for measuring the impact of the proposed improvement strategies.

Table 2. Initial Key Performance Indicators

Indicator	Formula	Initial situation
Service level	$\frac{\text{orders delivered withouth claims}}{\text{Total orders}} x\ 100$	85.36%
Customer satisfaction	Calculated through a survey	80.00%
Quality – Related claim rate	$\frac{Quality\ defect\ claims}{Total\ claims} x100$	54.55%
Incorrect weight claim rate	$\frac{Weight\ error\ claims}{Total\ claims}\ x\ 100$	12.12 %
Company productivity (%)	$\frac{Kg\ Produced}{Effective\ labor\ hours} x100$	$83.63\ \frac{Kg}{H}$
Raw material quality claim rate	$\frac{Raw\ material\ quality\ claims}{Total\ claims}\ x\ 100$	30.30%
Storage issue claim rate	$\frac{Storage\ related\ claims}{Total\ claims}\ x\ 100$	30.30%
Standard batch lead time	Minutes from batch start to finished product	85.36 minutes
Total complaints (trim.)	Claims registered in the evaluation quarter	33 claims

Following this, after consolidating data from site visits and performance metrics, two critical diagnostic tools were applied: the Pareto Diagram and the Ishikawa (Fishbone) Diagram. These tools enabled a deeper analysis of the underlying causes of operational inefficiencies, allowing for the identification of high-impact problems and their root causes. Furthermore, they provided a structured approach to assessing the magnitude and effect of each identified issue within the company (Figure 1- Figure 7).

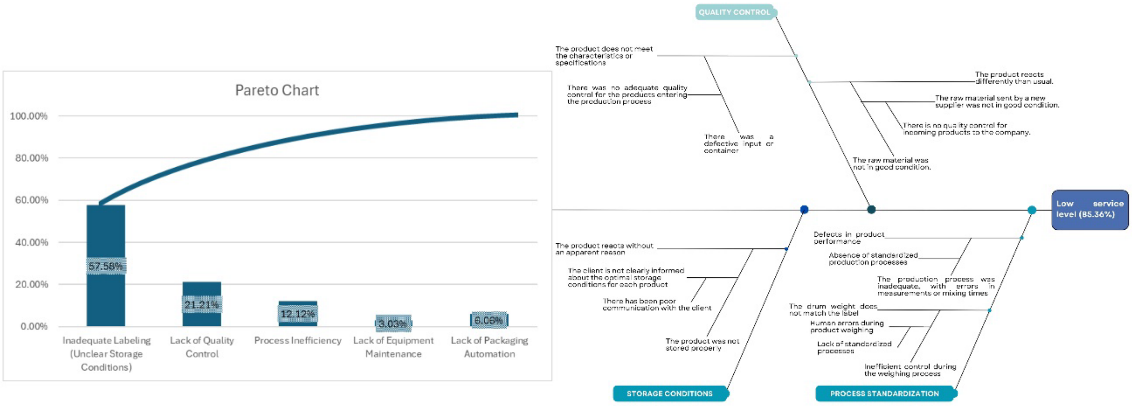


Figure 1. Ishikawa Diagram and Pareto Chart

To effectively address the challenges impacting operational efficiency and customer satisfaction, a problem tree analysis was conducted. This tool facilitated a structured identification of root causes, intermediate effects, and ultimate consequences of the issues affecting the service level. Key findings highlighted deficiencies in quality control, production standardization, and product labeling, which contributed to order defects and deterioration.
The application of problem tree analysis has been shown to significantly influence project performance. For instance, a study by Wanyonyi and Wanyonyi (2019) demonstrated that employing problem tree analysis in community-based projects in Kenya led to a statistically significant improvement in project outcomes, emphasizing its effectiveness in identifying and addressing root causes.

Moreover, integrating root cause analysis techniques, such as the 5 Whys method, can further enhance the identification of underlying issues. Ohno (1988) advocated for this approach within the Toyota Production System, highlighting its utility in uncovering fundamental problems that impede operational efficiency.
Based on this analysis, a structured solution model was developed to systematically mitigate these issues. The applied methodology ensures a rigorous, evidence-based approach, providing practical solutions aimed at optimizing operational efficiency and enhancing customer satisfaction. As a result of this analysis, a solution model was developed, and its diagram is presented below to detail its structure and rationale.

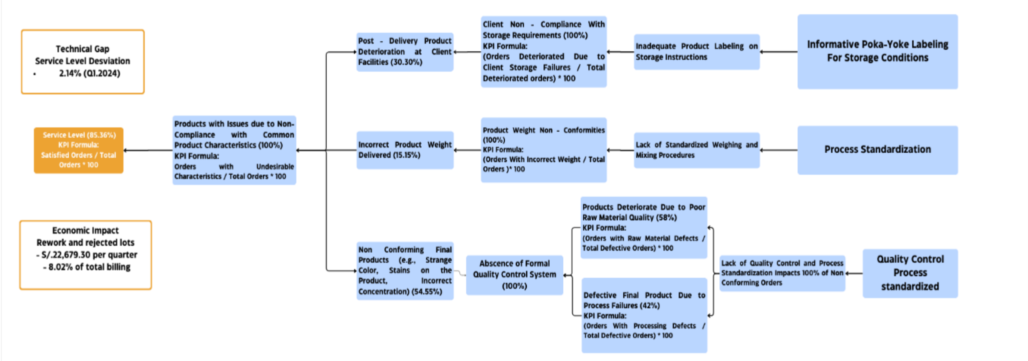


Figure 2. Problem Tree Analysis Diagram

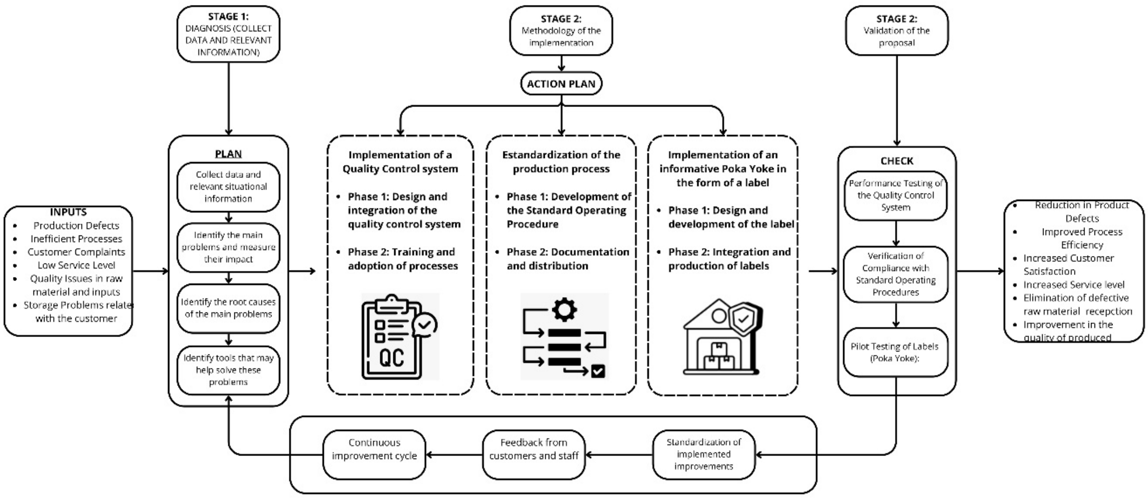


Figure 3. Design of the proposal of solution

4. Results and Discussion

4.1. Key aspects of the proposal

Active Participation and Commitment of Personnel. This aspect is one of the most important aspects of the implementation of all the proposal showed. Ensuring that all personnel involved in production processes receive adequate training on the new tools. This ensures they understand how to apply them and the long-term benefits.

Leadership and Management of Intervention. Leadership is vital in motivating the team and removing obstacles during the intervention. A key role of leaders is to maintain a positive attitude and provide continuous support, encouraging employees to embrace change.

Constant Evaluation and Monitoring. Ongoing evaluation and monitoring of progress through key performance indicators (KPIs) are essential for success. Continuous feedback from employees ensures that adjustments can be made, when necessary, keeping the intervention aligned with the desired outcomes.

4.2. Intervention

This chapter details the results obtained through the implementation of quality control measures, a standardized production procedure, and a Poka Yoke mechanism in the form of an informative label at Soquitex. These tools were introduced to address critical inefficiencies in production processes, improve customer satisfaction, and increase operational efficiency. The outcomes presented are based on key performance indicators (KPIs) to measure improvements in service level, production processes, and customer satisfaction. These findings serve as the foundation for evaluating the success of the solutions implemented.

Quality Control. The implementation of a quality control system was essential to ad- dress issues related to material defects and final product quality. Before the intervention, Soquitex lacked a formal inspection system for both incoming raw materials and finished products. By implementing standardized inspections at various stages of pro- duction, the company ensured compliance with technical specifications for inputs and outputs.

Specific steps in the implementation.

- Raw material inspection: A process for inspecting raw materials upon arrival was introduced to ensure they met quality standards before being processed.
- Final product inspection: After production, each batch of finished products under- went quality checks to verify weight, labeling, and appearance to ensure they met specifications.
- Assigning a quality control team: A dedicated team was assigned to conduct these inspections systematically.
- Employee training: All operators involved in the production and quality area were trained in the new quality control procedures to ensure they understood the importance of each inspection and how to conduct them properly.

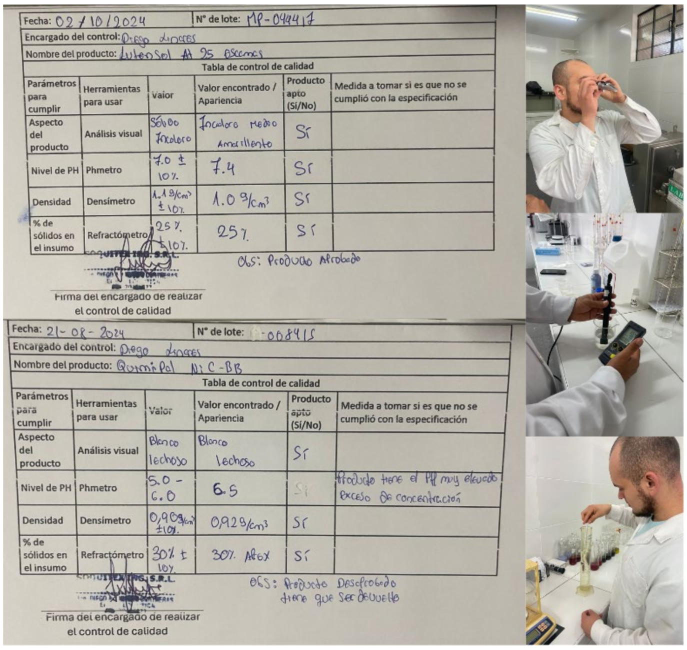


Figure 4. Quality control implementation

During the implementation of the quality control system, a total of forty-five quality checks were conducted, which allowed the identification of three batches of raw mate- rials and two batches of auxiliary chemicals produced within the company in poor condition. This intervention had a highly positive impact on the organization, as the defective raw material batches were about to be used in the production of more auxiliary chemicals, which would have had a significant negative effect on the company's economy. Thanks to the early identification of these defective batches, the distribution of faulty products to the final customer was avoided, thus preventing complaints and dis- satisfaction, which could have harmed the company's reputation.
Additionally, the timely detection of the defective batches allowed for the elimination of costs associated with transporting defective orders, as well as costs related to collecting the faulty orders, future reprocessing, and wasted time. This time, which would have otherwise been spent on non-value-adding activities, could be redirected to productive tasks that contribute to the company's growth and operational efficiency im- provident (Table 3).

Table 3. Quality controls realized.

Type	Quantity	Good Batches	Defect Batches
Raw material	20	18	2
Auxiliary chemical product	25	22	3

To evaluate the impact of implementing a quality control system in Soquitex, key performance indicators (KPIs) were analyzed both before and after the intervention. These indicators provide a quantitative perspective on the improvements achieved in production efficiency, defect reduction, and quality assurance processes.

The Table 4 below summarizes the formulas used to calculate each indicator, along with the initial situation and results observed post-implementation. These improvements highlight the effectiveness of the applied quality control measures in addressing production inefficiencies and enhancing customer satisfaction.

Table 4. Indicators after implementation of quality control measures

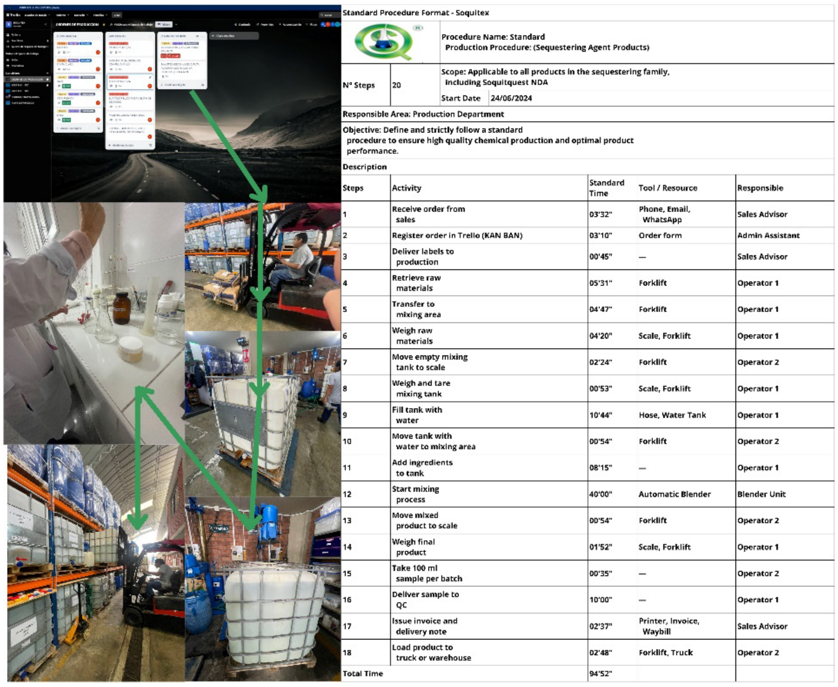
Indicator	Formula	Initial Situation	After Implementation	% Improve
Product Defect Rate (%)	$\frac{Number\ of\ defective\ products}{Total\ produced\ products}\ x\ 100$	11.87%	3.59%	69.76%
Quality related claim rate (%)	$\frac{Number\ of\ quality\ related\ claims}{Total\ Claims}\ x\ 100$	54.55%	21.21%	61.12%
Rework rate (%)	$\frac{Number\ of\ reprocessed\ products}{Total\ products\ produced}\ x\ 100$	5.40%	2.52%	53.33%
Inspection coverage (%)	$\frac{Number\ of\ inspected\ batches}{Total\ batches\ produced}\ x\ 100$	3.60%	16.18%	349.44%
Raw material quality claim rate (%)	$\frac{Number\ of\ claims\ related\ to\ raw\ material\ quality}{Total\ claims}\ x\ 100$	30.30%	9.09%	70.00%

The updated indicator analysis shows significant improvements post implementation. The Defect Rate decreased by 69.76%, from 11.87% to 3.59%, indicating a major reduction in defective products. Claims due to quality issues dropped by 61.12%, from 54.55% to 21.21%, reflecting a substantial improvement in customer satisfaction and fewer quality-related complaints. The Rework Rate saw a 53.33% reduction, from 5.40% to 2.52%, suggesting enhanced process efficiency and fewer products requiring reprocessing. Inspection Coverage increased by 349.44%, from 3.60% to 16.18%, demonstrating a significant expansion in the scope of quality control measures. Finally, Claims due to quality of raw materials improved by 70.00%, from 30.30% to 9.09%, highlighting better supplier quality management and raw material inspection. These improvements indicate that the quality control system was effective in enhancing production processes and product quality.

Standardized Production Procedure. The lack of a documented and uniform production process led to variations in output quality and delays. The creation of technical manuals and training programs provided operators with clear guidelines, ensuring consistency across all production batches.

Specific stages in the implementation

- Identify Critical Processes: This includes evaluating all stages of production, from raw material procurement to final product output.
- Document Best Practices: This includes defining step-by-step procedures, quality control measures, and key performance indicators (KPIs) that ensure consistency and efficiency.
- Develop Standard Operating Procedures (SOPs): These should clearly outline the tasks, responsibilities, and expected outcomes at each stage, along with safety protocols and quality standards to be adhered to.
- Train Employees: This ensures that everyone is familiar with the new standardized procedures and understands the importance of following them to maintain consistency.
- Implement Monitoring and Evaluation Systems: Set up systems to regularly monitor adherence to the standardized processes.
- Continuous Improvement: Encourage a culture of continuous improvement by regularly revisiting and refining the standard processes based on feedback, performance data, and evolving industry standards.



Standard Procedure Format - Soquitex

Procedure Name: Standard Production Procedure: (Sequestering Agent Products)

N° Steps	20	Scope: Applicable to all products in the sequestering family, including Soquitquest NDA		
		Start Date	24/06/2024	
Responsible Area: Production Department				
Objective: Define and strictly follow a standard procedure to ensure high quality chemical production and optimal product performance.				
Description				
Steps	Activity	Standard Time	Tool / Resource	Responsible
1	Receive order from sales	03'32"	Phone, Email, WhatsApp	Sales Advisor
2	Register order in Trello (KAN BAN)	03'10"	Order form	Admin Assistant
3	Deliver labels to production	00'45"	—	Sales Advisor
4	Retrieve raw materials	05'31"	Forklift	Operator 1
5	Transfer to mixing area	04'47"	Forklift	Operator 1
6	Weigh raw materials	04'20"	Scale, Forklift	Operator 1
7	Move empty mixing tank to scale	02'24"	Forklift	Operator 2
8	Weigh and tare mixing tank	00'53"	Scale, Forklift	Operator 1
9	Fill tank with water	10'44"	Hose, Water Tank	Operator 1
10	Move tank with water to mixing area	00'54"	Forklift	Operator 2
11	Add ingredients to tank	08'15"	—	Operator 1
12	Start mixing process	40'00"	Automatic Blender	Blender Unit
13	Move mixed product to scale	00'54"	Forklift	Operator 2
14	Weigh final product	01'52"	Scale, Forklift	Operator 1
15	Take 100 ml sample per batch	00'35"	—	Operator 2
16	Deliver sample to QC	10'00"	—	Operator 1
17	Issue invoice and delivery note	02'37"	Printer, Invoice, Waybill	Sales Advisor
18	Load product to truck or warehouse	02'48"	Forklift, Truck	Operator 2
Total Time		94'52"		

Figure 5. Implementation of standardization

In the initial situation, the production process was characterized by inefficiencies, redundant activities, and idle times. Tasks such as manually registering orders, searching for raw materials, and waiting during the mixing process caused delays and inconsistencies. Operators often remained inactive during mixing, leading to distractions and errors in the production. As a result, the total production time reached 85.44 minutes.

In contrast, the improved procedure streamlined workflows by integrating tasks and eliminating redundancies. Searching and transporting raw materials were combined with other activities, while operators utilized the mixing time to perform subsequent steps, such as adding raw materials and secondary ingredients. These adjustments reduced the total production time to 72.53 minutes, achieving a 26.8% improvement. Additionally, the implementation of clear, standardized procedures ensured a continuous workflow, minimized errors, and enhanced process efficiency. Finally, before the product is delivered to the final client, the product must be passed to quality control, where a specialist approved the product (Table 5).

Table 5. Indicators related to standardized procedures.

KPI	Formula	Before	After	% Improve
Production Time Reduction	Standard Time Achieved	107’22”	94’52”	11.85%
Incorrect Production procedure Claims Rate	$\frac{\text{Claims due to improper procedures}}{\text{Total Claims}} x\ 100$	24.24%	15.15%	37.50%
Incorrect Weight Claims Rate	$\frac{\text{Weight related claims}}{\text{Total claims}} x\ 100$	12.12%	3.03%	75.00%
Overall Quality Claims Rate	$\frac{\text{Quality related claims}}{\text{Total Claims}}$	54.55%	21.21%	61.12%

Implementation of a Poka Yoke in the Form of an Informative Label The implementation of informative Poka Yoke mechanisms through enhanced labeling significantly reduced storage-related errors in the handling of chemical products. Previously, the company lacked clear communication of storage requirements, leading to improper storage by clients and resulting in product degradation and customer complaints.

These storage conditions were defined based on the Safety Data Sheets (SDS) pro- vided for each product, which outline the specific handling and storage requirements as supplied by the company. Additionally, the implementation of the labeling system considered two critical regulatory frameworks: the Occupational Health and Safety Regulations for Workplaces (MTPE) and the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

The GHS provides standardized criteria for classifying chemical products and ensuring their labels communicate hazards effectively, using globally recognized symbols, signal words, and precautionary statements (United Nations, 2021). This dual alignment with the SDS and the GHS ensures compliance with both national and international safety standards, fostering improved risk management and operational consistency. Moreover, these guidelines enable the accurate identification of potential hazards during storage, contributing to the prevention of accidents and product deterioration.

This intervention involved these key steps:

- Defining storage conditions: Critical parameters, such as temperature and isolation, were established following guidelines from [insert regulatory entity, e.g., GHS].
- Designing standardized labels: Labels were developed to include clear visual and textual instructions, hazard warnings, and handling guidelines.
- Training and implementation: Staff and clients were trained to interpret and apply the labels effectively.

Figure 6. Implementation of Poka Yoke

As a result, storage errors were reduced by 70%, minimizing product defects, improving customer satisfaction, and lowering costs associated with rework and complaints. This initiative underscores the effectiveness of Poka Yoke in preventing errors and ensuring operational consistency in the chemical industry (Table 6- Table 7).

Table 6. Indicator related to storage conditions

Indicator	Formula	Initial Situation	After Implementation	% Improve
Storage Related Claims Rate	$\frac{Claims\ due\ to\ storage\ issues}{Total\ Claims}\ x\ 100$	30.30%	3.03%	90.00%

Finally, the overall indicators that were obtained upon completing the implementation are presented below.

Table 7. Key Indicators of the implementation

Indicator	Initial situation	After Implementation	% Improve
Service level	85.36%	96.41%	12.95%
Customer satisfaction	80.00%	90.00%	12.50%
% of claims due to quality issues	54.55%	21.21%	61.10%
% of claims due to incorrect weight	12.12%	3.03%	75.00%
% Company productivity	83.63%	89%	6.42%
% of claims due to quality of raw mate- rials	30.30%	9.09%	70.00%
% of storage-related problems	30.30%	3.03%	90.00%
Production Time	85.44minutes	72.53 minutes	15%
Number of complaints	33	10	69.70%

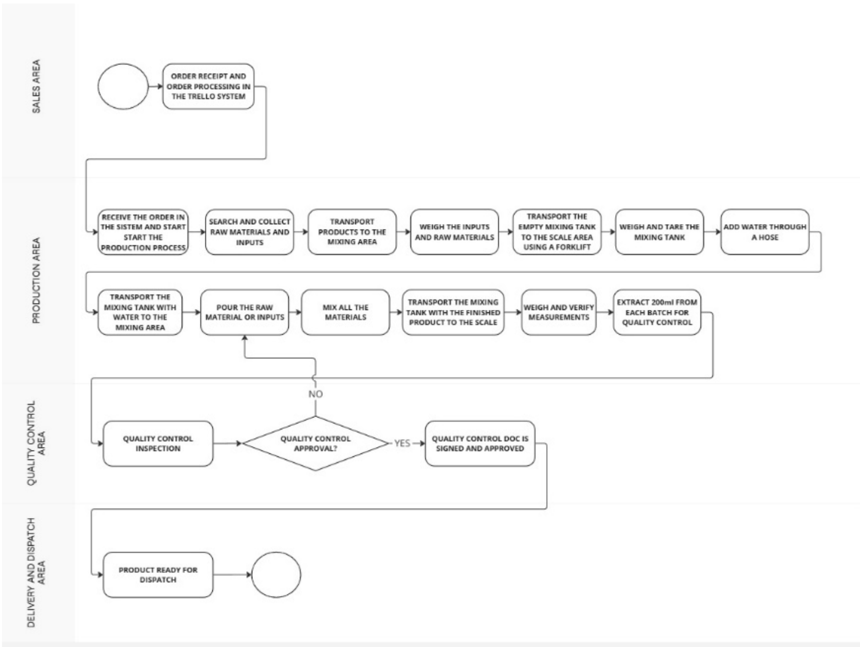


Figure 7. Final Flow Diagram

5. Discussion

The implementation of tools in the chemical company led to significant improvements. Customer service increased by 90%, ensuring reliable deliveries and optimal product conditions. Defective inputs dropped to 4%, confirming effective quality control in rejecting non-conforming materials before production. Standardized processes reduced production issues by 19.8%, improving efficiency and minimizing errors. Additionally, product deterioration from poor storage decreased by 5%, as the new labeling system helped customers handle products correctly.

These results align with previous studies. The cases studied showed that work standardization improved service levels in SMEs, reducing order issues and non-value-adding activities from 19.35% to 6.45%. The defect rate also declined from 12% to 4.38%. Another study involving a chemical company found that implementing a Quality Management System increased operational efficiency by 85% and reduced non-conformities. Complaints dropped by 40%, and resource management improved through better teamwork.

6. Conclusions

The management model proposed for Soquitex effectively addressed key operational inefficiencies and achieved significant improvements in service level, product quality and customer satisfaction. Key results include:

- Defect reduction: Before implementing the quality control and Poka Yoke tools, the percentage of defective inputs reached 7.5%. With the new measures, this value decreased to 4%. In addition, the percentage of defective auxiliary products was reduced from 10% to 5%, which minimized returns and waste.
- Process optimization: The standardization of production processes achieved a significant reduction in variability. Before implementation, production problems accounted for 38.06%, while subsequently this percentage was reduced to 19.8%. Additionally, quality complaints were reduced by up to 20.4%, significantly decreasing, reinforcing the effectiveness of the proposed model.
- Improved customer communication: Informative labels and measures implemented to ensure correct labeling allowed storage problems to be reduced from 10% to 5%. This, in turn, contributed to an improvement in customer satisfaction, which rose from 80% to 90%. These actions ensured that products were stored correctly, decreasing spoilage, and improving the overall customer experience.

While these interventions demonstrated measurable success, increased automation and ongoing employee training are critical to maintaining progress. This study provides a valuable framework for other companies in the chemical sector seeking to improve their service levels and operational efficiency.

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