

Production Management Model based on Standardization and Autonomous Maintenance to improve Efficiency in an LPG filling plant

Naomi Abigail Del Castillo-Tapia, Angie Lizbeth Casablanca-Dominguez, Gino Viacava-Campos and Jorge Antonio Corzo-Chavez

Carrera de Ingeniería Industrial

Universidad de Lima

Lima, Peru

20202849@aloe.ulima.edu.pe, 20213056@aloe.ulima.edu.pe, geviacav@ulima.edu.pe,
jacorzo@ulima.edu.pe

Abstract

Improving operational efficiency remains a challenge in The Liquefied Petroleum Gas (LPG) bottling plants in Peru, where production systems seldom exceed the 85% efficiency benchmark, a level still considered low compared with international standards that typically surpass this value in stable and well-controlled operations. This demonstrates that efficiency continues to be a critical issue, especially in plants with high variability and limited preventive maintenance. The studied facility illustrates this problem clearly, operating at 72.85% efficiency and experiencing significant losses due to reprocessing and recurrent hose failures. To address this gap, the research proposes a production management model based on Standard Work (SW) and Autonomous Maintenance (AM), tools selected for their ability to reduce variability and prevent failures in critical tasks. The model adapts Lean Manufacturing principles to the hydrocarbon sector, where structured production systems remain limited despite strict safety and reliability requirements. The proposal standardizes filling, weighing, and sealing processes and enhances equipment availability through operator-led maintenance routines. Validation through pilot tests and simulation showed strong improvements, increasing efficiency from 72.85% to 94.75%, reducing rework from 31.4% to 13.7%, and lowering hose failures from 32 to 6 per 8-hour shift.

Keywords

Lean Manufacturing, Standard Work, Autonomous Maintenance, Efficiency, LPG

1. Introduction

The LPG bottling sector is essential to Peru's energy supply, yet many plants operate below the recommended performance levels. Zehra et al. (2025) report that the ideal production efficiency is 85%, whereas the plant analyzed operates at 72.85%, revealing a 12.15% technical gap that confirms the need for improvement. Current indicators such as a high rework rate and constant hose failures reflect typical weaknesses in LPG SMEs, where dependence on manual tasks, limited maintenance structure, and non-standardized routines increase variability and operational risk.

Although previous research has shown positive results, its applicability to this context is restricted, Flores et al. (2024) demonstrate improvements using Autonomous Maintenance, but their findings rely on structured environments with consistent routines and established verification practices. Likewise, Palomino et al. (2024) show that Standard Work can reduce variability and increase productivity, yet their results assume stable workflows and disciplined operator behavior. These conditions do not fully correspond to the operational fragility of LPG SMEs, where daily variability, lack of structured training, and informal maintenance habits limit the consistency of Lean techniques. These limitations

reveal a clear need to adapt Lean tools to fluid-handling processes and to SMEs requiring stronger operational discipline. Therefore, this study proposes a production management model based on Standard Work and Autonomous Maintenance. Standard Work stabilizes critical manual tasks such as filling, weighing, and sealing, while Autonomous Maintenance represents the most consistent pillar for this context since operators interact directly with hoses and equipment and can detect early deterioration. By integrating structured training, visual controls, and daily inspection routines, the model enhances consistency, strengthens process stability, reduces rework and leaks, and improves equipment availability in LPG bottling operations.

1.1 Objectives

This study aims to improve the operational performance of LPG bottling plants by addressing inefficiencies related to reprocessing and equipment failures. Specifically, the objectives are:

1. To improve production efficiency through the implementation of Standard Work and Autonomous Maintenance.
2. To reduce reprocessing in the bottling line by stabilizing weight-control procedures and standardizing sealing operations.
3. To decrease unexpected stoppages and operational instability by strengthening Autonomous Maintenance practices.

2. Literature Review

2.1. Improving efficiency in companies in the hydrocarbon sector through Lean Manufacturing

Improving efficiency in the hydrocarbons sector is essential due to high regulatory requirements, operational risks, and the need to maintain reliable and stable processes. In this context, Lean Manufacturing has established itself as a key methodology for optimizing flows, reducing waste, and standardizing critical activities. Gebeyehu et al. (2022) highlights that Lean enables agile and stable operations through tools such as VSM, 5S, and Kaizen, while Guzel and Asiabi (2022) and Silvestre et al. (2022) demonstrate significant reductions in downtime and defects when applying standardization and visual control techniques in high-risk sectors. Similarly, Pawlak (2024) and Dube and Gupta (2023) show substantial improvements in organization, safety, and efficiency through the implementation of 5S and standardized practices, elements aligned with the demands of LPG gas packaging. However, Minh and Quyen (2024) warn that the sustainability of Lean improvements depends on management commitment and continuous monitoring, factors that determine their permanence in organizations in the energy sector.

2.2. Reducing reprocessing through Standard Work

Reprocessing due to variability in weighing and filling activities is a recurrent cause of inefficiency in LPG bottling plants. Standard Work provides a structured method that stabilizes operations, reduces operator-dependent variability and ensures uniform execution. Recent studies confirm its impact on reducing defects and improving productivity. Calderon et al. (2024) demonstrate that integrating Standard Work with visual management significantly reduces operational errors, while Palomino et al. (2024) report productivity increases above 28% when standardization is applied in high-variability processes. Pawlak (2024) and Dube y Gupta (2023) highlight that Standard Work eliminates unnecessary motions and ensures consistency in manual tasks, which is critical in LPG processes where deviations in weighing directly generate reprocessing.

2.3 Preventing unplanned stoppages through Autonomous Maintenance

Unplanned stoppages due to hose failures and lack of preventive maintenance significantly reduce the efficiency of LPG bottling systems. Total Productive Maintenance (TPM) promotes autonomous inspection, cleaning and lubrication routines that allow early detection of faults and reduce machine downtime. Quiroz y Vega (2022) show that TPM increases machine availability and reduces stoppages through structured autonomous maintenance. Castañeda et al. (2024) confirm substantial improvements in Overall Equipment Effectiveness (OEE) when this pillar is implemented alongside preventive inspections. Vásquez et al. (2024) demonstrate reductions in unplanned stoppages when combining TPM with error-proofing systems. Gelaw et al. (2024) emphasize that TPM's effectiveness depends on consistent operator involvement and continuous monitoring, aspects critical in LPG filling operations.

3. Methods

3.1 Contribution and Proposed Solution Model

The proposed conceptual model (Figure 1) is presented as a structured Lean-based approach to address key inefficiencies in the LPG bottling process. Lean principles aim to reduce variability, stabilize operations, and improve equipment reliability (Dutta, 2024). In the evaluated plant, inefficiencies arise from reprocessing due to incorrect weighing and sealing, as well as unplanned stoppages caused by hose failures. The model integrates two complementary Lean tools: Standard Work, to stabilize critical weighing and sealing activities, and Autonomous Maintenance (TPM), to enhance equipment reliability through operator-based inspection, cleaning, and lubrication. Previous studies have shown that standardized methods significantly improve productivity (Islam & Ahmed, 2024). Both tools are aligned within a Plan–Do–Check–Act (PDCA) logic, where Standard Work reduces operational variability and TPM sustains machine performance by preventing degradation. The integration of PDCA with Lean tools such as Standard Work has been widely applied to structure process improvement and enhance efficiency. This interaction creates a robust, low-cost, and replicable solution that improves quality, safety, and productivity in LPG bottling operations.

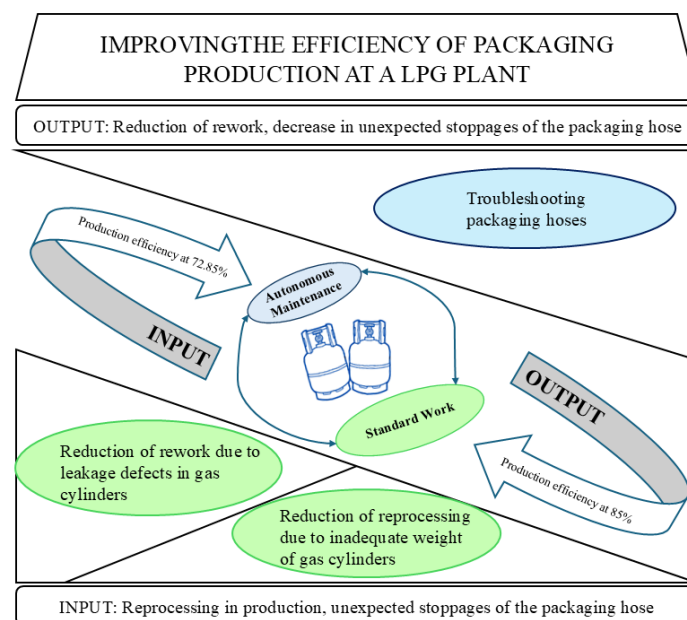


Figure 1. Proposed Solution Model

3.1.1 Component 1: Reduction of reprocessing due to inadequate weight of gas cylinders - Standard Work

This component focuses on one of the main sources of reprocessing in the LPG bottling line: deviations in the final cylinder weight. The as-is assessment showed that 31.4% of cylinders were outside the tolerance limits, verification required an average of 143.1 s, and no operators followed a standardized filling method. These conditions generated raw-material loss, extended cycle times, and high variability between operators.

To correct this, a standardized work system was developed using the weight-control parameters established in Peruvian Technical Standard (NTP - Norma Técnica Peruana) 321.115:2012, defining a fixed sequence, mandatory checkpoints, and visual aids. Following implementation, the *to-be* results showed a reduction of non-conforming cylinders to 13.73%, a decreased verification time of 43.1 s, and a method-compliance rate of 69%. These improvements confirm that Standard Work effectively stabilizes the process and reduces rework caused by inadequate weighing. To support this improvement, the following process diagram summarizes the diagnostic steps, standardization activities, and evaluation checkpoints applied throughout Component 1 to reduce rework caused by inadequate cylinder weight (Figure 2).

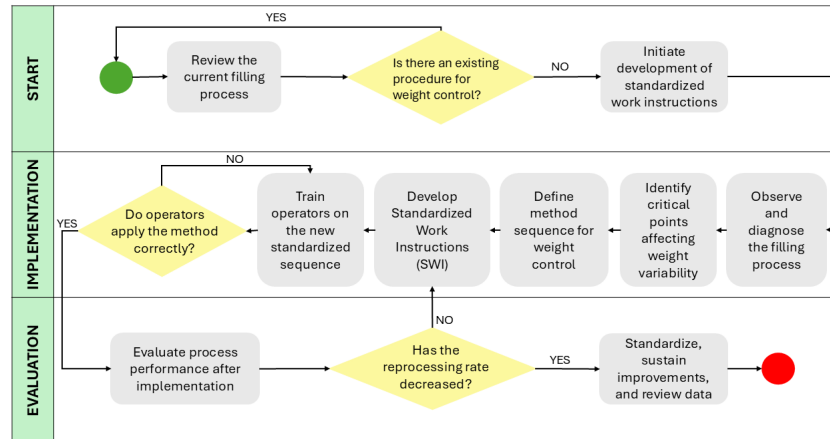


Figure 2. Flowchart of component 1

3.1.2 Component 2: Reduction of rework due to leakage defects in gas cylinders - Standard Work

This component addresses the variability and errors observed during the placement of plastic safety caps on LPG cylinder valves. The as-is evaluation showed that 29.8% of cylinders presented cap-related defects and 12.8% exhibited leak symptoms, reflecting a high occurrence of handling errors and insufficient control of the sealing process. These issues compromised product safety during storage and transportation, leading to reprocessing, quality-control failures, and potential customer claims.

To address this problem, a standardized and repeatable cap-placement method was established, incorporating critical variables such as step sequencing, tightening force, execution time, and historical failure patterns. After implementation, the to-be results indicated a reduction of cap-placement errors to 21.28%, leak occurrences decreased to 8.51%, and method-compliance improved to 76.6%, demonstrating a safer and more consistent sealing process. The following flowchart summarizes the main stages of Component 2 and the standardized sequence applied to reduce leakage-related rework in LPG cylinders (Figure 3).

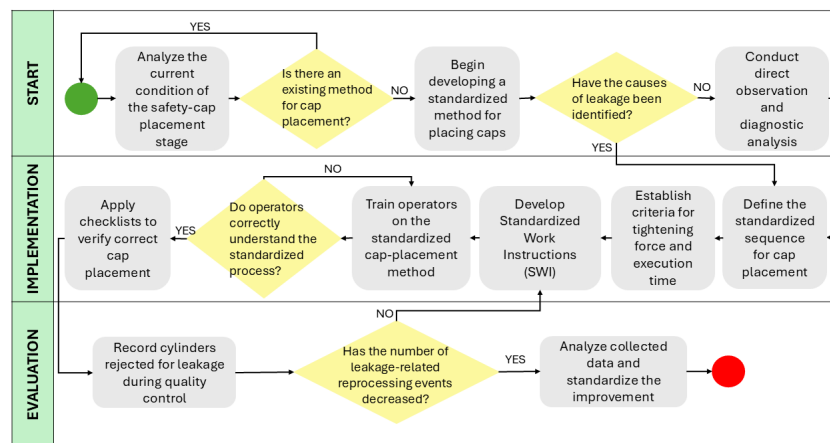


Figure 3. Flowchart of component 2

3.1.3 Component 3: Troubleshooting Packaging Hose Failures - Autonomous Maintenance

This component focuses on the high frequency of hose failures observed in the LPG filling line, which caused unexpected stoppages, reduced system availability, and increased corrective maintenance costs. The as-is simulation results confirmed the magnitude of the problem: hose failures occurred at an average of 32 ± 1.8 times per cycle, contributing significantly to downtime and operational instability.

To address this issue, the Autonomous Maintenance (AM) tool assigned operators responsibility for performing basic hose-care routines, including cleaning, protective-cover installation, anomaly tagging, and visual inspection using structured checklists. After implementation, the *to-be* results showed a substantial decrease in hose failures to 6 ± 0.9 events (an 81% reduction), supporting more stable cycle times and overall process continuity. The flowchart below provides a visual overview of Component 3, mapping the autonomous maintenance activities implemented to prevent hose-related interruptions in LPG filling operations (Figure 4).

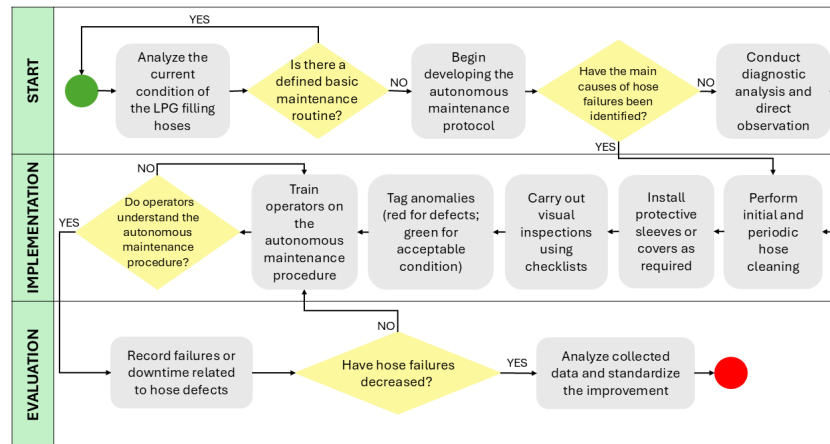


Figure 4. Flowchart of component 3

4. Data Collection

Data collection was conducted to establish an accurate baseline of the LPG filling process and to validate the proposed improvement methods. A mixed approach was used—historical plant records, instrumental measurements, direct observation, and pilot testing—ensuring reliable, traceable, and representative field data.

For Component 1, data were gathered at the filling station, recording final cylinder weight, deviation from regulatory tolerance, and verification times. A sample of 51 cylinders was selected using systematic sampling (1 out of every 16 cylinders), based on a 95% confidence level and historical defect proportion of 10%. The pre-implementation results showed high dispersion (weights ranging from -0.8 kg to $+1.6$ kg relative to the nominal value), with a verification-time standard deviation of 239.04 s, confirming that the process was not standardized.

For Component 2, 47 cylinders were evaluated for cap placement and leak detection, also under a 95% confidence level and a historical defect proportion of 3.3%. The data revealed significant variability: 30% incorrectly placed caps and 13% leak occurrence, with inconsistent tightening force and sequence execution, demonstrating lack of uniformity among operators.

For Component 3, data were obtained from historical hose-failure records and a pilot of autonomous maintenance. A sample of 20 observations was used to parameterize the simulation model, applying goodness-of-fit tests ($p > 0.05$) to confirm data consistency. Field observations revealed recurrent wear, leaks, and cracks that operators initially detected inconsistently, evidencing variability in inspection criteria before standardization.

Overall, data collection remained consistent through the use of calibrated instruments, systematic sampling, and immediate field recording. The variability observed across weight, time, sealing quality, and hose-failure detection provided clear quantitative evidence of non-standardized conditions prior to the improvement implementation. Table 1 summarizes the baseline indicators for each component, including current production results and their corresponding variability. For Components 1 and 2, variability was obtained directly from the pilot samples, as these defects occur frequently and can be measured reliably within a short observation window. In contrast, the variability of Component 3 was calculated using historical monthly failure records, since hose leaks are low-frequency, wear-driven events that cannot be adequately captured during a brief pilot test.

Table 1. Baseline indicators and statistical variability before improvement implementation

Component	Indicator	Current production results	IC
C1	% of cylinders with incorrect weight	31.4	95%
C2	% Incorrect cap placement	30	95%
C3	Hose-failure rate (failures/hour)	4	95%

5. Results and Discussion

5.1 Proposed Improvements

Table 2 summarizes the projected and obtained results for the three key operational indicators evaluated after implementing the proposed improvements. The model achieved the expected performance in two of them; however, one limitation observed is that the rework rate, although improved significantly from 31.4% to 15.79%, did not fully reach the projected target of 15.2%. This slight deviation suggests that certain sources of variability in the sealing and verification stages were not completely stabilized during the evaluation period. Factors such as operator learning curves, residual manual adjustments, and limited time for method consolidation could explain this gap. Incorporating additional Lean tools such as Poka-Yoke to error-proof sealing tasks could further reduce operator-dependent variation. Strengthening method audits and extending practical training would help close this remaining variability and reinforce long-term process stability.

Table 2. Proposed Improvements

Indicator	To Be Projected	To Be Obtained	Impact
Efficiency	85%	94.5%	Noticeable improvement toward sector benchmark
Rework	15.2%	15.79%	Significant reduction in variability and reprocessing
Hose failures (failures/hour)	2	0.75	Major decrease in equipment-related interruptions

5.2 Numerical Results

The proposed production management model generated significant improvements in the main indicators of the LPG bottling process. As shown in Table 3, Standard Work reduced variability in the weighing operation, resulting in fewer cylinders outside tolerance, shorter verification times, and improved method compliance. These changes reflect a more stable and controlled process.

Table 3. Comparison of scenarios before and after Standard Work – Weight control

Indicator	Original Scenario	Improved Scenario	Δ Improvement
% Inadequate-weight	31.4	13.7	-56 pp
Verification time (seg)	143.1	43.1	-70 pp
Weight SD (kg)	0.5	0.4	-20 pp
Method compliance	0%	69%	+ 69 pp

As shown in Table 4, Standard Work also improved sealing performance. The introduction of a standardized method and visual guides increased operator compliance and reduced both incorrect cap placement and detected leaks. These changes indicate a more consistent and controlled sealing process, with a slight increase in sealing time due to greater attention to the procedure.

Table 4. Comparison of scenarios before and after Standard Work – Leak reduction

Indicator	Original Scenario	Improved Scenario	Δ Improvement
Method compliance	0%	76.6%	+76.6 pp
Caps incorrectly placed	29.8%	21.3%	-29 pp
Leaks Detected	12.8%	8.51%	-33 pp
Sealing time (seg)	1.4	1.64	+17%

As presented in Table 5, Autonomous Maintenance significantly improved hose reliability. Daily inspection, cleaning, looseness detection, and red-tagging routines reduced the hose-failure rate, leading to a more stable and reliable operation.

Table 5. Comparison of scenarios before and after Autonomous Maintenance – Hose failure

Indicator	Original Scenario	Improved Scenario	Δ Improvement
Hose-failure rate (failures/hour)	4	0.75	-81%

The combined implementation of Standard Work and Autonomous Maintenance generated significant improvements in the overall performance of the LPG bottling process, the results are shown in Table 6.

Table 6. Overall results of the improvement model

Indicator	Original Scenario	Improved Scenario	Δ Improvement
Production Efficiency	72.85%	94.75%	22 pp
Rework Rate	31.4%	15.79%	-15.61 pp

5.3 Graphical Results

As evidenced in Figure 5 a significant reduction in the percentage of cylinders with inadequate weight after the implementation of Standard Work was reduced. Improvements are also observed in weight variability and operator compliance with the standardized method, confirming the stabilization of the weighing process. Also in Figure 6 it can be easily observed that the verification time decreased notably in the improved scenario, demonstrating the increased efficiency achieved through the simplification and standardization of the weighing routine.

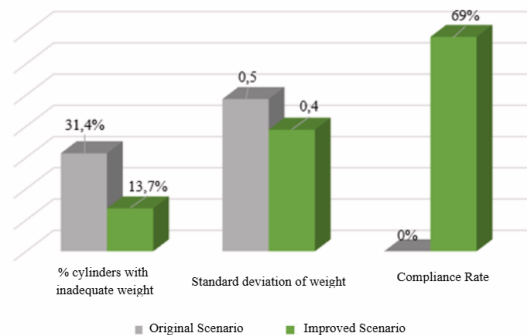


Figure 5. Standard Work – Reduction of inadequate-weight cylinders

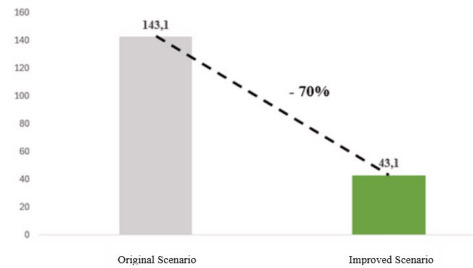


Figure 6. Standard Work – Improvement in verification time

The reduction in incorrectly placed caps and detected gas leaks after standardizing the sealing procedure is illustrated in Figure 7. The increase in method compliance demonstrates greater operator control and consistency during the sealing task. Additionally, the sealing time is slightly longer, which is expected due to the incorporation of a structured and more deliberate standardized sequence.

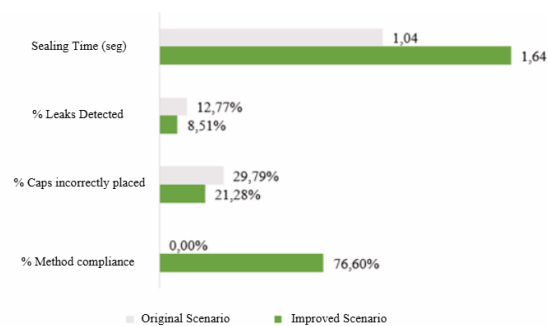


Figure 7. Standard Work – Reduction of leak-related defects

The visual comparison that is shown in Figure 8 highlights a substantial reduction in hose failures after the simulation Autonomous Maintenance. Daily inspections, cleaning routines, and defect tagging contributed to improved equipment reliability and fewer interruptions.

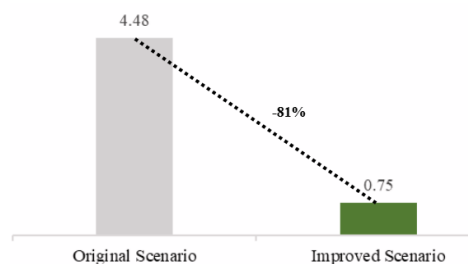


Figure 8. Autonomous Maintenance – Reduction of hose failures

The overall production results show an increase in operational efficiency and a reduction in rework when comparing the original and improved scenarios as can be observed in the Figure 9. These improvements reflect the combined impact of Standard Work and Autonomous Maintenance on the LPG bottling process.

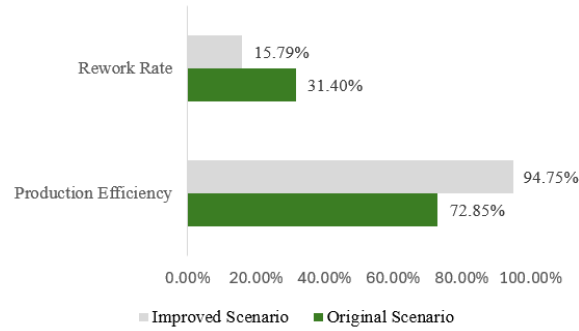


Figure 9. Overall Results

5.4 Validation

To validate the effect of Standard Work on the weighing operation, a pilot study was conducted using a systematic sample of 51 cylinders, determined through the finite-population proportion formula ($N = 800$, 95% confidence, $p=0.1$, $E = 8\%$). Table 7 displays the variables considered in the analysis and their confidence intervals.

Table 7. Confidence Intervals for SW - Weight Control

Indicator	IC 95%
Percentage of cylinders with inadequate weight (%)	[4.3 ; 23.2]
Average weighing verification time (s)	[7.8 , 78.4]
Weight standard deviation (kg)	[0.33 ; 0.50]
Checklist compliance rate (%)	[56.3 ; 81.7]

The 51 observations were organized into analytical weeks to assess temporal behavior. As observed in Figure 10, the weekly data stabilize after week 3, confirming the effect of Standard Work on improving consistency in the weighing task.

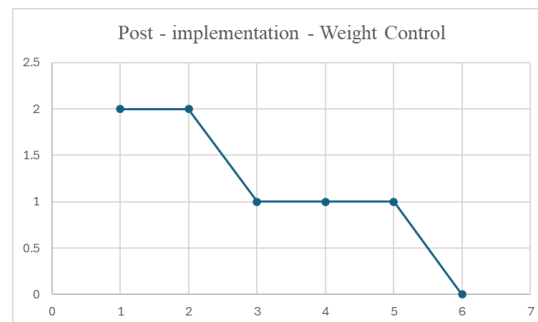


Figure 10. Post - Implementation Weight Control

To validate the effect of Standard Work on reducing reprocessing due to leakage from improper sealing, a pilot study was conducted using a systematic sample of 47 cylinders. The sample size was determined with the finite-population proportion formula ($N = 800$, $p = 0.033$, 95% confidence, $E= 5\%$). This sample provides sufficient precision to detect changes in sealing defects. Table 8 displays the variables considered in the analysis and their confidence intervals.

Table 8. Confidence Intervals for SW - Cylinder Leaks

Indicator	IC 95%
Method Compliance (%)	[64.5 ; 88.7]
Incorrectly placed caps (%)	[9.6 ; 33]
Detected leaks (%)	[0.5 ; 16.5]
Sealing time (s)	[1.58 ; 1.70]

The 47 observations were organized into analytical weeks to assess temporal behavior. As observed in Figure 11, the weekly data stabilize after week 4, confirming the effect of Standard Work on improving consistency in the cylinder leaks.

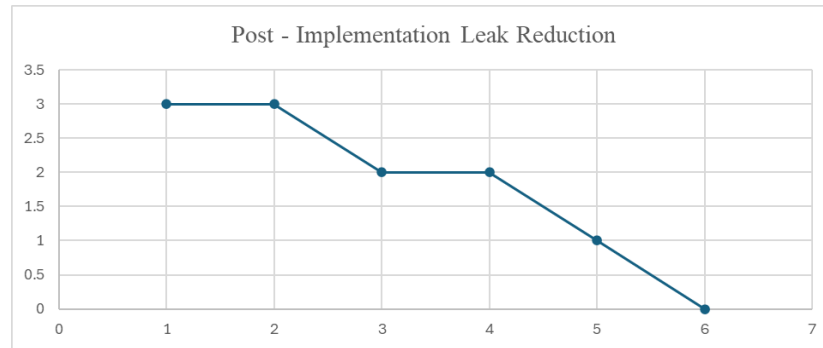


Figure 11. Post - Implementation Leak Reduction

To validate the effect of Autonomous Maintenance on hose reliability, the sample size was calculated using the same finite-population formula applied in the Standard Work analysis ($p = 0.01$, 95% confidence, $E = 5\%$), based on a pilot sample of 30 cylinders. Hose failures and related stoppages were then recorded under normal operating conditions. Additionally, a discrete-event simulation model was developed in Arena to evaluate system performance under two scenarios: current conditions and Autonomous Maintenance implementation. Figure 12 presents the process flow diagram of the constructed model.

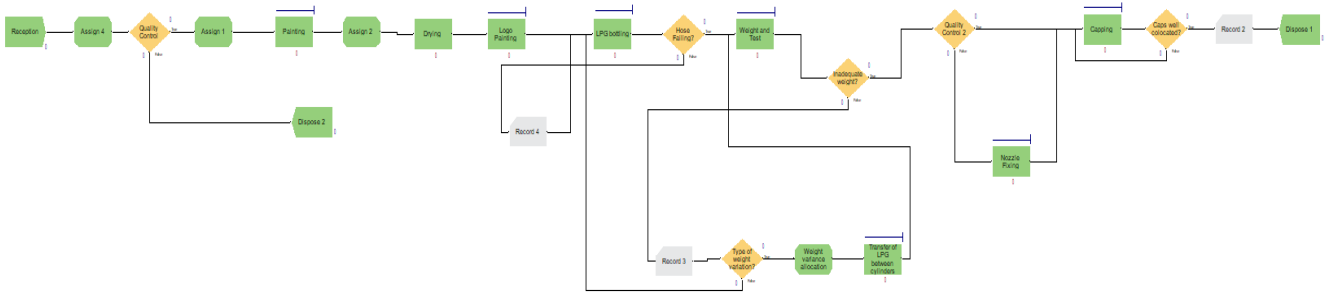


Figure 12. Arena Diagram

After defining and simulating the current operating condition of the LPG bottling process, a second scenario was developed to represent the expected effects of the improvement proposal, both were executed by 30 replications. In this improved scenario, the structure and sequence of operations remain unchanged; only the operational performance parameters are modified. The cycle times of the filling, weighing, and sealing stages are adjusted according to the standardized values obtained from the implementation of Standard Work, while the hose failure rate is reduced to reflect the effect of the daily inspection, cleaning, tightening, and tagging routines established under Autonomous Maintenance. Table 9 summarizes the simulation results for an 8-hour shift.

Table 9. Simulation results

Indicator	Original Scenario	Improved Scenario	IC 95 %
Production	756	758	[704 ; 812]
Hose failures	32	6	[1 ; 11]
Poorly weighed cylinders	364	167	[145 ; 189]
Cycle Time (hours)	0.091	0.067	[0.0639 ; 0.0711]

6. Conclusion

To improve the operational performance of the LPG bottling process, a production management model based on Standard Work and Autonomous Maintenance was implemented to address reprocessing, operational variability, and hose failures. The application of standardized procedures in the weighing and sealing stages reduced reprocessing from 31.4% to 13.7%, while inadequate-weight defects decreased by 56% and sealing defects by 33%, demonstrating greater process consistency and reduced human variability. Autonomous Maintenance routines strengthened daily inspection and early detection of abnormalities, decreasing hose failures by 81% and improving equipment reliability. As a result of the coordinated implementation of both tools, the overall efficiency of the bottling line increased from 72.85% to 94.75%, reflecting substantial improvements in availability, performance, and quality. These outcomes confirm the technical feasibility of the proposed model and its potential replicability in similar LPG bottling facilities.

References

- Calderón, D., Chavez, M. and Quiroz, J., Proposal for improving product delivery times through the Standard Work tools, TQM and the Sweep Method in a company in the logistics sector, *Proceedings of the International Conference on Innovation and Trends in Engineering*, 2024. <https://doi.org/10.1109/CONITI64189.2024.10854856>
- Castañeda, S., Rodriguez, S., Orkun, Y., Aranda, D. and Alvarez, J., Increase of the availability of machinery in a food company applying the TPM, SMED and RCM methodologies, *International Journal of Engineering Trends and Technology*, vol. 72, no. 8, pp. 128–138, 2024. <https://doi.org/10.14445/22315381/IJETT-V72I8P114>
- Dube, L. and Gupta, K., Lean manufacturing-based space utilization and motion waste reduction for efficiency enhancement in a machining shop: a case study, *Applied Engineering Letters*, vol. 8, no. 3, pp. 121–130, 2023. <https://doi.org/10.18485/aeletters.2023.8.3.4>
- Dutta, S.(2024). Lean manufacturing and process optimization: Enhancing efficiency in modern production. *International Journal of Scientific Research in Computer Science, Engineering and Information Technology*, 10(5), 265–273. <https://doi.org/10.32628/CSEIT241051024>
- Flores, R., Huamán, C. and Quiroz, J., Improving productivity in the metalworking sector through lean manufacturing and tpm tools: A case study in Peru. *South African Journal of Industrial Engineering*, vol. 35, no. 2, pp. 91–109, 2024. <https://doi.org/10.7166/35-2-3013>
- Gebeyehu, G., Abebe, M., & Gochel, A. Production lead time improvement through lean manufacturing, *Cogent Engineering*, vol. 9, no. 1, article 2034255, 2022. <https://doi.org/10.1080/23311916.2022.2034255>
- Gelaw, M., Azene, D. and Berhan, E., Assessment of critical success factors, barriers and initiatives of total productive maintenance (TPM) in selected Ethiopian manufacturing industries, *Journal of Quality in Maintenance Engineering*, vol. 30, no. 1, pp. 51–80, 2024. <https://doi.org/10.1108/JQME-11-2022-0073>
- Guzel, D. and Asiabi, A., Increasing productivity of furniture factory with lean manufacturing techniques (case study), *Technical Journal*, vol. 16, no. 1, pp. 82–92, 2022. <https://doi.org/10.31803/tg-20211010121240>
- Islam, M., & Ahmed, S. (2024). Work standardization in lean manufacturing for improvement of production line performance in SME. *Malaysian Journal on Composites Science and Manufacturing*, 13(1), 68–81. <https://doi.org/10.37934/mjcs.13.1.6881>
- Minh, N. and Quyen, N., Comparative study on the reasons for failure factors of sustaining operational improvement methodologies in manufacturing enterprises, *The TQM Journal*, vol. 36, no. 7, pp. 1961–1975, 2024. <https://doi.org/10.1108/TQM-11-2022-0330>
- Palomino, F., Verde, L. and Ruiz, M., Mejora de la productividad en una empresa maderera a través de herramientas de estandarización y SMED con enfoque Lean, *Proceedings of the LACCEI International Multi-Conference for Engineering, Education, and Technology*, Costa Rica, pp. 17–19, 2024. <https://doi.org/10.18687/LACCEI2024.1.1.251>
- Pawlak, S., The impact of selected lean manufacturing tools on the level of delays in the production process: a case study, *Management Systems in Production Engineering*, vol. 32, no. 1, pp. 103–107, 2024. <https://doi.org/10.2478/mspe-2024-0011>
- Quiroz, J. and Vega, M., Review lean manufacturing model of production management under the preventive maintenance approach to improve efficiency in plastics industry SMEs: A case study, *South African Journal of Industrial Engineering*, vol. 33, no. 2, pp. 143–156, 2022. <https://doi.org/10.7166/33-2-2711>
- Silvestre, M., Chaicha, V., Merino, J. and Nallusamy, S., Implementation of a Lean Manufacturing and SLP-based system for a footwear company, *Production*, vol. 32, 2022. <https://doi.org/10.1590/0103-6513.20210072>

Vásquez, Y., Morales, S. and Corzo, J., Production management model for waste reduction using 5S, TPM and Poka Yoke tools in a peanut snack manufacturing company, *Proceedings of the 10th World Congress on Mechanical, Chemical, and Material Engineering*, pp. 22–32, 2024. <https://doi.org/10.11159/icmic24.109>

Zehra, K., Mirjat, N. H., Shaki, S. A., Harijan, K., Kumar, L., & El Haj Assad, M. Optimizing Auto Manufacturing: A Holistic Approach Integrating Overall Equipment Effectiveness for Enhanced Efficiency and Sustainability. *Sustainability*, 16(7), 2024. <https://doi.org/10.3390/su16072973>

Biographies

Angie Lizbeth Casablanca-Dominguez is currently a bachelor's degree holder in Industrial Engineering from the University of Lima. Her research interests include process optimization, project management, and innovation.

Naomi Abigail Del Castillo-Tapia is currently a bachelor's degree holder in Industrial Engineering from the University of Lima. Her research interests include process optimization, marketing, and innovation.

Gino Viacava-Campos is currently a professor in industrial engineering career at Universidad de Lima. He holds a Master in Operations and Logistics from Universidad Peruana de Ciencias Aplicadas (UPC) (Perú) and is Industrial Engineer from the Universidad de Lima (Perú). He has experience in industrial and service companies to improve productivity, development of business models and structure compensation systems. He has worked in the human resources area, operations and logistics areas of a transnational company, locally and overseas. As consultant he has experience with construction, manufacturing, services, mining, commercial, finance and education sectors. His main research interests are lean manufacturing, master production schedules, logistics, compensation systems for small and medium-sized enterprises

Jorge Antonio Corzo-Chavez is currently a professor in industrial engineering career at Universidad de Lima, chief executive officer at Conquista Lab, and associate consultant at Manpower Group for multinational companies. He holds a Master in Business Administration from Universidad ESAN (Perú), a Master in Marketing Science from ESIC Business & Marketing School (Spain) and is Industrial Engineer from the Universidad de Lima (Perú). He has experience in advising industrial and service companies to improve productivity and development of business models. He has worked in areas of entrepreneurship and innovation, marketing and commercial for the construction, metalworking, mining, services, and education sectors. His main research interests are lean manufacturing, master production schedules, logistics, machine learning, and innovation for small and medium-sized enterprises