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Improving Quality, Productivity, and Lead Time through Toyota's 8-Step Problem-Solving Method in Indonesian Apparel Manufacturing

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Abstract

Apparel manufacturers face persistent challenges in maintaining product quality, improving production efficiency, and meeting increasingly demanding delivery schedules within volatile global supply chain networks. Recurring sewing defects and inconsistent shop-floor practices highlight the need for systematic continuous improvement (Kaizen) approaches that address root causes and sustain operations performance. Because Toyota's 8-Step Problem-Solving Method is based on the 4 step PDCA (Plan-Do-Check-Act) cycle, it provides an actionable framework to institutionalize lean routines and eliminate process waste. This study evaluates the implementation of this methodology and its implications for defect rates, sewing-line efficiency, manufacturing lead time, and standardized problem-solving routines. A longitudinal single-case study was conducted at an apparel manufacturing enterprise in West Java, Indonesia, focusing on six high-volume sewing lines over 12 months. Operations data from baseline and post-implementation phases were analyzed descriptively, while paired t-tests were used to assess performance changes. The results showed that the average defect rate decreased from 8.42% to 2.15%, sewing line efficiency increased from 58.30% to 81.60%, and manufacturing lead time declined from 24.50 to 14.20 days. Daily output per line also increased by 39.92%. All three primary performance indicators changed significantly ($p < 0.001$). The findings indicate that structured problem-solving, supported by root-cause analysis, targeted countermeasures, monitoring, and standardization, directly strengthens operational capability and downstream delivery reliability across the supply chain. However, further research is needed to establish the long-term sustainability and generalizability of these improvements across different industrial contexts.

Keywords

Kaizen, Lean Manufacturing, Supply Chain, Operations Management, PDCA, Toyota 8-Step Problem-Solving.

1. Introduction

In contemporary global supply chains, apparel manufacturing enterprises operate under increasingly demanding performance expectations, including shorter delivery windows, fluctuating order volumes, and stringent quality specifications. Indonesian apparel manufacturers contribute to industrial export revenues and employment generation (Banjarnahor et al., 2023). However, manufacturers in West Java and Central Java face persistent operational challenges, including rising labor costs, raw material price volatility, and intensifying competition from regional textile manufacturing hubs such as Vietnam and Bangladesh. These pressures require manufacturers to improve production efficiency, product quality, and responsiveness without compromising operational stability.

To remain competitive, apparel manufacturers must move beyond conventional batch production toward agile, lean-driven operations. Originating from the Toyota Production System, lean manufacturing emphasizes eliminating non-value-adding activities, reducing process variation, and minimizing overburden (Goshime et al., 2023). Tools such as Value Stream Mapping (VSM), 5S, and Single-Minute Exchange of Die (SMED) support waste reduction and process improvement. However, lean implementation does not automatically produce sustainable performance improvements. Research highlights that implementation difficulties often arise when organizations prioritize technical tools while neglecting employee involvement, management commitment, organizational culture, and continuous improvement (Kaizen) practices (Sahoo, 2020; Bhasin & Found, 2021). Consequently, establishing sustainable problem-solving routines remains a critical managerial challenge.

These challenges are particularly pronounced in apparel manufacturing because sewing operations are labor-intensive and sensitive to human variability. A typical woven shirt or denim trouser assembly involves approximately 25–45 distinct manual sewing operations. Variations in thread tension, machine gauge alignment, and operator handling can accumulate into quality defects, unbalanced production lines, and excessive work-in-process inventory (Alarcón et al., 2008). When disruptions occur, supervisors may prioritize immediate containment rather than systematically identifying and eliminating root causes. Such reactive responses can allow recurring defects, inefficient workflows, and prolonged manufacturing lead times to persist. Previous research shows that lean tools can improve apparel production performance by reducing inventory, processing time, and lead time (Hamja et al., 2019; Bizuneh & Omer, 2024). Nevertheless, operational improvements depend not only on tool selection but also on how problems are identified, analyzed, resolved, and prevented from recurring (Okes, 2019; Abdullah et al., 2022).

The Toyota 8-Step Problem-Solving methodology, also known as Practical Problem Solving, provides a structured approach to addressing operational problems, from problem clarification and root-cause analysis to corrective action and process standardization based on the 4 step PDCA (Plan-Do-Check-Act) cycle, (Bhattacharya et al., 2024). Unlike isolated lean tool applications, this methodology emphasizes disciplined analysis, evidence-based decision-making, and institutionalizing corrective actions. Although existing studies have examined lean implementation and performance improvement in apparel manufacturing, further empirical investigation is needed into applying a structured, multistep problem-solving methodology within the specific operational and organizational conditions of Indonesian apparel sewing operations. In particular, the relationship between systematic problem resolution, measurable production outcomes, and the development of sustainable shop-floor problem-solving practices warrants closer examination.

This study investigates the implementation of the Toyota 8-Step Problem-Solving methodology in an apparel manufacturing enterprise in West Java, Indonesia, focusing on its application to sewing operations and its implications for defect rates, sewing line efficiency, manufacturing lead time, and the sustainability of problem-solving routines. The study's novelty lies in examining a structured problem-solving methodology as an integrated approach to operational improvement in the Indonesian apparel manufacturing context, rather than treating Lean tools as isolated interventions. It provides context-specific empirical insights to help manufacturing managers combine measurable production improvements with more systematic, sustainable shop-floor problem-solving practices.

2. Literature Review

2.1. Lean Manufacturing and Operational Performance in Apparel Production

Lean manufacturing is a systematic production approach that integrates waste elimination, process standardization, and continuous improvement to enhance operational performance. Shah and Ward (2007) conceptualized lean production as a coherent system of interrelated practices rather than a collection of independent tools. However, successful implementation also depends on organizational conditions, including employee involvement, leadership, and a supportive improvement culture. Bortolotti et al. (2015) found that successful lean plants demonstrated stronger organizational culture characteristics and greater use of people-oriented lean practices. Similarly, Knol et al. (2018) showed that the critical factors supporting lean implementation vary by implementation maturity. These findings indicate that technical interventions must be accompanied by organizational capabilities that enable employees to identify problems, participate in improvement activities, and maintain standardized processes. Such integration is particularly relevant to apparel manufacturing, where labor-intensive sewing operations are sensitive to variations in task execution, workstation workloads, and production methods.

Operational improvement in apparel manufacturing can be assessed through defect reduction, sewing line efficiency, productivity, and manufacturing lead time. Bongomin et al. (2020) demonstrated the relevance of line-balancing techniques for improving garment assembly line efficiency. In an Indonesian garment manufacturing context, Oktyajati et al. (2024) examined one-piece flow as an approach to reducing production lead time. These studies show how production methods can address operational constraints, but individual interventions may not resolve recurring problems unless underlying causes are also investigated. Saurin et al. (2013) emphasized the systemic nature of lean practices, while Mothe et al. (2015) highlighted the complementary role of organizational and technical practices. Accordingly, sustainable improvement in apparel operations requires systematic performance measurement, employee participation, and process-level problem-solving rather than isolated technical adjustments.

2.2. Toyota 8-Step Problem-Solving Methodology in Apparel Operations

The Toyota 8-Step Problem-Solving methodology, commonly associated with Toyota Business Practices, provides a structured approach to defining operational problems, identifying root causes, implementing countermeasures, evaluating results, and standardizing successful improvements. Liker and Meier (2006) emphasized the importance of developing problem-solving capabilities and standardized processes within the Toyota Way. Shook (2008) further explained how the A3 management process structures problem analysis, countermeasure development, and organizational learning. More recently, Tapping et al. (2002) applied the eight-step Toyota Business Practice framework to a practical improvement project, demonstrating its applicability to systematic problem

identification and process redesign. The methodology is relevant to apparel manufacturing because recurring sewing defects, uneven workstation workloads, and production delays require evidence-based investigation rather than repeated temporary corrections. Its emphasis on understanding the actual workplace also helps identify operational conditions that production reports alone may not reveal.

In apparel assembly, the methodology begins by clarifying performance gaps and breaking them down by product style, sewing module, defect category, or workstation. Measurable targets are subsequently established, followed by root-cause analysis using direct workplace observation, the 5-Why technique, and fishbone diagrams. Based on the findings, teams develop and prioritize countermeasures by expected impact, feasibility, and implementation requirements. Teams implement selected actions through coordinated operational adjustments and trial runs, then compare performance with baseline measurements. Successful improvements are standardized through revised operating procedures, visual controls, and operator training. This sequence reflects systematic improvement and organizational capability development, while Six Sigma supports structured quality improvement (Ledbetter, 2018; Syamil et al., 2023). Integrating operational practices can also improve delivery performance, reinforcing the need to evaluate defect rates, sewing line efficiency, manufacturing lead time, and the sustainability of shop-floor problem-solving routines (Mostafa et al., 2020).

3. Methods

This study employed an empirical single-case study design with a longitudinal operational assessment. Case study research suits investigating complex operational phenomena in real-world industrial settings (Kharisma et al., 2023a). The research was conducted at an apparel manufacturing enterprise in West Java, Indonesia. The enterprise employs approximately 1,200 shop floor operators across 24 conveyor-assisted sewing lines and specializes in woven casual shirts and denim outerwear for global fashion brands.

The study focused on six designated high-volume sewing lines, L01 through L06, producing classic long-sleeve woven cotton shirts. The evaluation covered a 12-month observation period divided into three operational phases: (a) the baseline assessment phase (Months 1–3), during which historical pre-intervention data were compiled; (b) the implementation phase (Months 4–8), during which the Toyota 8-Step Problem-Solving methodology was implemented across all six lines; and (c) the post-implementation evaluation phase (Months 9–12), during which operational performance metrics were continuously monitored and statistically evaluated.

Key Performance Indicators (KPIs) were defined and measured using standardized operational formulas. The apparel Defect Rate (DR) represents the percentage of defective apparel identified during end-line quality assurance inspections, as expressed in Equation (1):

$$DR = \frac{\text{Total Defective Apparel}}{\text{Total Apparel Inspected}} \times 100\%$$

Sewing line efficiency (LE) measures the proportion of earned standard allowed minutes relative to the total available labor time on the sewing line, as defined in Equation (2):

$$LE = \frac{\sum_{i=1}^{n}(Q_i \times SAM_i)}{N_{\text{operators}} \times T_{\text{available}}} \times 100\%$$

where Qi represents the quantity of good apparel produced for operation style i, SAMi denotes the engineered standard allowed minutes per apparel item,

Noperators refers to the total number of operators assigned to the sewing line, and Tavailable represents the total available working minutes per shift.

Manufacturing lead time (Lt) is the total elapsed time, measured in days, from releasing fabric cutting to completing final carton packing for export shipment. It is calculated using Equation (3):

$$L_t = T_{\text{cutting}} + T_{\text{sewing}} + T_{\text{washing}} + T_{\text{finishing}} + T_{\text{packing}}$$

Table 1. Baseline Operational Performance Metrics Across Six Sewing Lines

Sewing Line	Daily Output (Pcs)	Defect Rate (%)	Line Efficiency (%)	Lead Time (Days)
Line L01	1,240	8.65%	57.40%	25.2
Line L02	1,280	8.12%	59.10%	24.0
Line L03	1,210	8.90%	56.80%	25.5
Line L04	1,310	7.95%	60.20%	23.8
Line L05	1,225	8.70%	57.50%	24.8
Line L06	1,265	8.20%	58.80%	23.7
Overall Mean	1,255	8.42%	58.30%	24.5

Table 1 shows that baseline performance varied across the six sewing lines. Daily output ranged from 1,210 to 1,310 pieces, while defect rates ranged from 7.95% to 8.90%. Line efficiency varied from 56.80% to 60.20%, while manufacturing lead time ranged from 23.7 to 25.5 days. Line L04 recorded the highest daily output and line efficiency, together with the lowest defect rate and a relatively short lead time. In contrast, Line L03 exhibited the lowest daily output and line efficiency, the highest defect rate, and the longest lead time. The baseline results indicate opportunities to improve product quality, production efficiency, and manufacturing lead time through systematic problem-solving.

4. Results

The Toyota 8-Step Problem-Solving methodology was implemented through cross-functional improvement teams comprising line supervisors, industrial engineers, quality inspectors, mechanics, and sewing operators. The intervention focused on six high-volume sewing lines (L01–L06) producing classic long-sleeve woven cotton shirts. Operational performance was evaluated by comparing baseline measurements with post-implementation results collected during Months 9–12. The analysis covered three KPIs: end-line defect rate, sewing line efficiency, and manufacturing lead time.

The first step was to clarify operational problems by comparing baseline performance with management targets. The company set three primary objectives: reduce the apparel defect rate to below 3.00%, increase sewing line efficiency to above 80.00%, and reduce manufacturing lead time to less than 15.00 days. Baseline measurements showed an average defect rate of 8.42%, a 5.42-percentage-point gap from the target threshold. Sewing line efficiency averaged 58.30%, a 21.70-percentage-point gap, while manufacturing lead time reached 24.50 days, exceeding the target by 9.50 days. These results established the need for systematic operational improvement.

The second step involved breaking down the quality problem to identify the most significant defect categories. Pareto analysis was conducted using 1,093 defective apparel pieces recorded during Month 3. As shown in Figure 1, Seam Pucker accounted for 412 defective pieces (37.69%), followed by Broken Stitch with 285 pieces (26.07%) and Skip Stitch with 194 pieces (17.75%). Together, these three categories represented 81.51% of all recorded defects. The remaining defects comprised Shade Variation (98 pieces, 8.97%), Oil Stain (54 pieces, 4.94%), Uncut

Thread (32 pieces, 2.93%), and miscellaneous defects (18 pieces, 1.65%). Accordingly, the improvement team prioritized Seam Pucker, Broken Stitch, and Skip Stitch as presented in Figure 1.

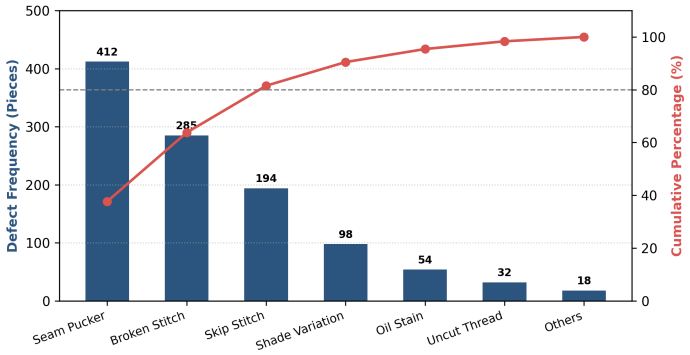


Figure 1. Pareto Analysis of Sewing Line Defect Categories

The third step established measurable improvement targets for the five-month implementation period. The team aimed to reduce the overall end-line defect rate from 8.42% to below 2.50%, increase average sewing line efficiency from 58.30% to above 80.00%, reduce manufacturing lead time from 24.50 to 14.50 days, and decrease Seam Pucker and Broken Stitch defects by at least 75.00%. These targets provided operational benchmarks for evaluating the subsequent intervention. The fourth step involved identifying the underlying causes of the priority defects. Following the Toyota principle of Genchi Genbutsu, industrial engineers and quality team members observed sewing stations directly. The team developed a fishbone cause-and-effect diagram to categorize potential causes across machine, method, material, and manpower factors.

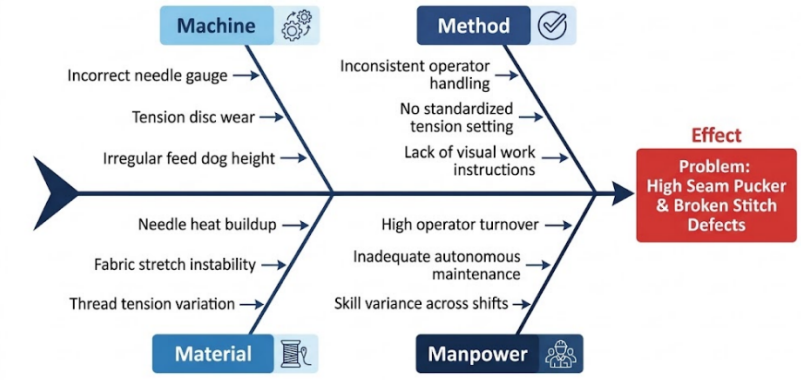


Figure 2. Fishbone Cause-and-Effect Diagram for Primary Sewing Line Defects

Figure 2 identifies four major root causes. First, the machine factor involved selecting the wrong needle gauge, specifically using size 14/90 needles instead of fine size 11/75 ball-point needles for delicate, lightweight cotton fabrics, which increased thread friction and caused fabric distortion. Second, the method factor involved inconsistent thread-tension settings across shifts, as operators adjusted tension discs without standardized parameters. Third, the material factor involved thread breakage from needle heat buildup during high-speed sewing, along with inadequate mitigation measures. Fourth, the manpower factor involved inconsistent fabric-handling techniques and the absence of standardized visual work instructions.

In the fifth step, the cross-functional team developed and evaluated countermeasures using a multi-criteria selection matrix incorporating technical

feasibility, implementation cost, operator acceptance, and impact velocity (Kharisma et al., 2023b). The selected measures addressed the identified root causes through engineering adjustments, standardized procedures, material improvements, and operator development as presented in Table 2.

Table 2. Selected Countermeasures and Implementation Responsibilities

Root Cause Category	Identified Root Cause	Selected Engineering and Operational Countermeasure	Responsibility
Machine	Incorrect needle size causing fabric distortion and seam pucker	Standardize needle gauge to size 11/75 ball-point needles for woven shirts and conduct daily needle inspections.	Maintenance Supervisor
Method	Arbitrary operator thread tension adjustments	Develop calibrated thread tension charts for each fabric weight and install digital tension gauges on sewing machines.	Industrial Engineer
Material	Thread breakage associated with high-speed needle heat buildup	Apply thread lubricant oilers and upgrade to high-tenacity core-spun polyester sewing threads.	Quality Assurance Lead
Manpower	Variation in operator handling and line imbalance	Provide visual Standard Operating Procedure cards at each machine station and conduct skill-matrix cross-training.	Production Line Manager

The sixth step involved implementing the selected countermeasures across Lines L01–L06 over an eight-week execution period. Maintenance technicians replaced worn sewing machine tension discs and recalibrated feed dog heights. Industrial engineers installed laminated visual Standard Operating Procedure cards at eye level at sewing stations, specifying fabric-handling angles, seam allowance widths, and thread tension settings. Line supervisors also conducted daily 10-minute morning meetings to review quality targets and address operator feedback.

During the seventh step, operational performance was monitored through hourly visual tracking boards installed at the head of each sewing line. Quality auditors conducted statistical process control checks every two hours, while department managers held weekly performance reviews to assess metric stabilization and address emerging operational problems. These monitoring activities supported evaluating countermeasure implementation and identifying deviations that required corrective action.

The eighth step focused on standardizing successful practices to prevent identified problems from recurring. The plant's Quality Management System incorporated engineering modifications and operational routines. The plant institutionalized standardized thread tension charts and needle inspection logs across all 24 sewing lines, extending the improvements beyond the six lines directly assessed. Operator cross-training matrix programs were also incorporated into monthly human resource development plans (Prahendratno et al., 2023). These measures established formal procedures to sustain improvements and support continuous improvement.

Post-implementation measurements showed improvements across all three primary KPIs. The average end-line defect rate declined from 8.42% to 2.15%, equivalent to a 6.27-percentage-point decrease or a 74.47% relative reduction. Sewing line efficiency increased from 58.30% to 81.60%, representing an improvement of 23.30 percentage points and a 39.97% relative gain. Manufacturing lead time decreased from 24.50 to 14.20 days, saving 10.30 days and achieving a 42.04% reduction. The post-implementation averages therefore exceeded the original targets for defect rate and line efficiency, while manufacturing lead time fell below the 15-day threshold.

Table 3. Comparison of Key Operational Metrics Before and After Implementation

Key Operational Metric	Baseline (Pre-Implementation)	Post-Implementation (Mean)	Absolute Change	Relative Gain
Defect Rate (%)	8.42%	2.15%	−6.27 percentage points	74.47% reduction
Seam Pucker Rejects (pieces)	412	78	−334 pieces	81.07% reduction
Broken Stitch Rejects (pieces)	285	54	−231 pieces	81.05% reduction
Skip Stitch Rejects (pieces)	194	41	−153 pieces	78.87% reduction
Line Efficiency (%)	58.30%	81.60%	+23.30 percentage points	39.97% improvement
Daily Output per Line (pieces)	1,255	1,756	+501 pieces/day	39.92% improvement
Manufacturing Lead Time (days)	24.50	14.20	−10.30 days	42.04% reduction

Based on Table 3, the three priority defect categories also recorded substantial reductions. Seam Pucker rejects declined from 412 to 78 pieces (81.07%), Broken Stitch rejects decreased from 285 to 54 pieces (81.05%), and Skip Stitch rejects fell from 194 to 41 pieces (78.87%). Daily output per line increased from an average of 1,255 to 1,756 pieces, representing an additional 501 pieces per day and a 39.92% improvement. Collectively, these findings indicate that the intervention coincided with improvements in product quality, production efficiency, and manufacturing flow.

To assess whether the observed changes were statistically significant, two-tailed paired t-tests were conducted using daily shop-floor tracking metrics across the six sewing lines. The reported t-values were 14.82 for defect rate reduction, 18.45 for line efficiency improvement, and 12.36 for manufacturing lead time reduction, with all three results reported at $p < 0.001$. These findings indicate statistically significant pre- and post-implementation differences in the evaluated performance indicators. However, the strength of this conclusion depends on the paired observations, sample size, and test assumptions being appropriately documented.

5. Discussion

The findings demonstrate the practical value of the Toyota 8-Step Problem-Solving methodology for addressing recurring quality problems and improving operational performance in apparel manufacturing. The simultaneous improvements in defect reduction, sewing line efficiency, and manufacturing lead time suggest that structured problem-solving can connect technical corrective actions with broader production objectives. This finding supports Shah and Ward (2007), who conceptualized lean production as a system of interrelated practices rather than isolated improvement tools. In this case, the team integrated defect prioritization, root cause analysis, countermeasure implementation, performance monitoring, and standardization into a continuous improvement process.

The substantial reductions in the three priority defect categories also highlight the importance of identifying and addressing underlying causes rather than relying on repeated inspection or product rework. This approach aligns with Hodge et al. (2011), who examined adapting lean manufacturing principles to the textile industry, and Bizuneh and Omer (2024), who emphasized systematic waste prioritization and reduction in apparel production. By using Pareto analysis to prioritize dominant defects and a fishbone diagram to investigate their causes, the improvement team directed resources toward recurring problems with substantial operational consequences. The findings therefore illustrate how structured problem-solving can translate defect analysis into targeted engineering and operational interventions in labor-intensive sewing environments.

The improvement in sewing line efficiency is also relevant to previous research on garment production. Bongomin et al. (2020) demonstrated the relevance of line balancing for improving garment assembly line efficiency, while Oktyajati et al. (2024) examined one-piece flow as an approach to reducing lead time in the garment industry. Although these studies focus on different operational techniques, their findings offer complementary perspectives on the importance of coordinating production activities and reducing process inefficiencies. The present study extends this perspective by examining how a structured problem-solving methodology can address quality, efficiency, and lead time within one integrated intervention. Nevertheless, because multiple countermeasures were implemented simultaneously, the observed improvements cannot be attributed exclusively to any single action or to the eight-step methodology independently of its supporting practices.

Beyond technical interventions, the findings emphasize the organizational conditions required to sustain lean improvements. Bortolotti et al. (2015) highlighted the importance of organizational culture and supportive lean practices, while Fadnavis et al. (2020) examined cultural traits that influence problem-solving during lean transformation. Similarly, Albliwi et al. (2014) identified critical failure factors associated with Lean Six Sigma implementation. In the present case, operator involvement, visual work instructions, daily meetings, cross-training, and formalized inspection routines helped embed corrective actions into everyday production activities. These practices suggest that operational improvement depends not only on identifying technical causes but also on establishing routines that enable employees to apply and maintain standardized solutions. This interpretation is consistent with Bhasin and Found (2021), who emphasized the challenge of sustaining lean ideology beyond initial implementation.

The study also offers a practical implication for manufacturing managers. Extending standardized procedures and inspection routines to all 24 sewing lines illustrates an attempt to institutionalize improvements beyond the six lines directly evaluated. However, these improvements require continued monitoring because successful implementation does not automatically guarantee long-term sustainability. Netland (2016) emphasized that lean implementation outcomes depend on contextual contingencies, while Netland et al. (2020) discussed the role of

leadership in supporting lean practices. Accordingly, management should maintain operator participation, review performance deviations, and periodically reassess standardized procedures.

This study contributes case-based evidence on applying Toyota 8-Step Problem-Solving in an export-oriented apparel manufacturing setting by examining quality, efficiency, and lead time together. Its main contribution is demonstrating how a structured sequence of problem identification, root cause analysis, countermeasure implementation, monitoring, and standardization can be operationalized for shop-floor improvement. However, the single-company design and simultaneous implementation of several countermeasures limit causal attribution and generalizability. Future studies could examine multiple factories and longer observation periods to determine whether the improvements persist and whether the methodology produces comparable outcomes under different production conditions.

6. Conclusion

The findings demonstrate that implementing the Toyota 8-Step Problem-Solving methodology was associated with substantial improvements in quality, sewing line efficiency, and manufacturing lead time in the investigated apparel manufacturing enterprise. The average defect rate decreased from 8.42% to 2.15%, representing a 74.47% reduction, while sewing line efficiency increased from 58.30% to 81.60%. Manufacturing lead time declined by 42.04%, from 24.50 to 14.20 days, and daily output per line increased by 39.92%. Paired t-test results indicated statistically significant changes across all three primary performance indicators ($p < 0.001$). These improvements followed systematic defect identification, direct workplace observation, root-cause analysis, targeted countermeasures, performance monitoring, and process standardization. The findings suggest that manufacturers can use structured problem-solving to integrate quality improvement with production efficiency and delivery performance. For managerial practice, the results highlight the importance of involving operators, establishing visual work instructions, monitoring performance deviations, and incorporating successful countermeasures into quality management systems. Extending standardized procedures across production lines may further support organizational learning and consistent operational practices.

Nevertheless, interpret the findings with several limitations in mind. The study examined a single manufacturing enterprise and six sewing lines, limiting the generalizability of the results to other factories, products, and production systems. Furthermore, the study implemented multiple countermeasures simultaneously, preventing the independent effects of individual interventions from being determined. Although performance changes were statistically significant, the results do not establish that the methodology alone caused the observed improvements. The 12-month observation period also provides limited evidence regarding long-term sustainability. Future research should employ multi-case or comparative designs across apparel manufacturers, extend observation periods, and examine whether performance gains persist after implementation. Researchers could also evaluate individual countermeasures, investigate organizational factors influencing sustained improvement, and assess the transferability of the Toyota 8-Step Problem-Solving methodology across different manufacturing contexts.

References

Abdullah, M. I., Masdar, R., Karim, F., Din, M., Zahra, F., Furqan, A. C., … Megawati, N. (2022). Improving the management of school operational assistance (SOA) grants through expenditure governance. *Economic and Business Horizon, 1*(3), 1–12.

Alarcón, L. F., Diethelm, S., Rojo, O., & Calderón, R. (2008). Assessing the impacts of implementing lean construction Evaluando los impactos de la implementación de lean construction. *Revista Ingenieria de Construcion, 23*(1), 26-33.

Albliwi, S., Antony, J., Abdul Halim Lim, S., & van der Wiele, T. (2014). Critical failure factors of Lean Six Sigma: a systematic literature review. *International Journal of Quality & Reliability Management, 31*(9), 1012-1030.

Banjarnahor, A. R., Taruna, M. S., Faried, A. I., Suryani, W., Hutama, N. A., Sondakh, D. E., ... & Simarmata, J. (2023). *Ekonomi digital: Transformasi bisnis di era digital.* Medan: Yayasan Kita Menulis.

Bhasin, S., & Found, P. (2021). Sustaining the lean ideology. *Management Decision, 59*(3), 568–585.

Bhattacharya, A., Good, J., & Sarder, M. D. (2024). Assessing the role of Toyota 8-Step problem-solving in digitalizing shop floor operations. *IEEE Transactions on Engineering Management, 71*(34), 3412–3425.

Bizuneh, B., & Omer, R. (2024). Lean waste prioritisation and reduction in the apparel industry: Application of waste assessment model and value stream mapping. *Cogent Engineering, 11*(1), 23-41.

Bongomin, O., Mwasiagi, J. I., Nganyi, E. O., & Nibikora, I. (2020). Improvement of garment assembly line efficiency using line balancing technique. *Engineering Reports, 2*(4), 1215-1226.

Bortolotti, T., Boscari, S., & Danese, P. (2015). Successful lean implementation: organizational culture and soft lean practices. *International Journal of Production Economics, 160*(1), 182-201.

Fadnavis, S., Najarzadeh, A., & Badurdeen, F. (2020). An assessment of organizational culture traits impacting problem solving for lean transformation. *Procedia Manufacturing, 48*(1), 31–42.

Goshime, Y., Kitaw, D., Ebinger, F., & Jilcha, K. (2023). Developing an improved reverse engineering adoption model towards the improvement of performance in metal engineering industries. *African Journal of Science, Technology, Innovation and Development, 15*(1), 89-106.

Hamja, A., Maalouf, M., & Hasle, P. (2019). The effect of lean on occupational health and safety and productivity in the garment industry – A literature review. *Production & Manufacturing Research, 7*(1), 316–334.

Hodge, G. L., Ross, G. K., Joines, J. A., & Thoney, J. (2011). Adapting lean manufacturing principles to the textile industry. *Production Planning & Control, 22*(3), 237–247.

Kharisma, L. P. I., Miftachurohmah, N., Jannah, U. M., Wahyudi, F., Datya, A. I., & Syamil, A. (2023a). *Analisis & perancangan sistem berbasis studi kasus.* Jambi: PT Sonpedia Publishing Indonesia.

Kharisma, L. P. I., Yahya, S. R., Handayanto, R. T., Gunawan, I. M. A. O., Handika, I. P. S., Hatta, H. R., & Syamil, A. (2023b). *Metode SPK favorit di masa depan: Teori dan contoh.* Jambi: PT Sonpedia Publishing Indonesia.

Knol, W. H., Slomp, J., Schouteten, R. L., & Lauche, K. (2018). Implementing lean practices in manufacturing SMEs: Testing 'critical success factors' using Necessary Condition Analysis. *International Journal of Production Research, 56*(11), 3955-3973.

Ledbetter, P. (2018). *The Toyota template: The plan for just-in-time and culture change beyond lean tools.* Boca Raton: CRC Press.

Liker, J. K., & Meier, D. (2006). *The Toyota way fieldbook: A practical guide for implementing Toyota's 4Ps.* New York: McGraw-Hill.

Mostafa, S., Tam, V. W., Dumrak, J., & Mohamed, S. (2020). Leagile strategies for optimizing the delivery of prefabricated house building projects. *International Journal of Construction Management, 20*(8), 867-881.

Mothe, C., Nguyen-Thi, U. T., & Nguyen-Van, P. (2015). Assessing complementarity in organizational innovations for technological innovation: The role of knowledge management practices. *Applied Economics, 47*(29), 3040–3058.

Netland, T. H. (2016). Critical success factors for implementing lean production: The effect of contingencies. *International Journal of Production Research*, *54*(8), 2433–2448.
Netland, T. H., Powell, D. J., & Hines, P. (2020). Demystifying lean leadership: What do lean leaders actually do? *International Journal of Operations & Production Management*, *40*(6), 721–743.
Okes, D. (2019). *Root cause analysis: The core of problem solving and corrective action.* Milwaukee: Quality Press.
Oktyajati, N., Mayasari, S., & Purwati, S. (2024). Implementation of a one piece flow system to reduce production lead time in the garment industry. *Tekinfo: Jurnal Ilmiah Teknik Industri dan Informasi*, *12*(1), 1-12.
Prahendratno, A., Pangarso, A., Siswanto, A., Setiawan, Z., Sepriano, S., Munizu, M., Purwoko, P., Simarmata, N., Pramuditha, P., & Syamil, A. (2023). *Manajemen sumber daya manusia: Kumpulan teori & contoh penerapannya.* Jambi: PT Sonpedia Publishing Indonesia.
Sahoo, S. (2020). Assessing lean implementation and benefits within Indian automotive component manufacturing SMEs. *Benchmarking: An International Journal*, *27*(3), 1042–1084.
Saurin, T. A., Rooke, J., & Koskela, L. (2013). A complex systems theory perspective of lean production. *International Journal of Production Research*, *51*(19), 5824–5838.
Shah, R., & Ward, P. T. (2007). Defining and developing measures of lean production. *Journal of Operations Management*, *25*(4), 785–805.
Shook, J. (2008). *Managing to learn: using the A3 management process to solve problems, gain agreement, mentor and lead.* Boston: Lean Enterprise Institute.
Syamil, A., Ichsan, M., Syahrazly, M., Fadjar, M. P., & Revidia, I. R. (2023). Enhancing quality across industries: A systematic literature review on the impact of Six Sigma. *Global Business & Finance Review*, *28*(7), 59–74.
Tapping, D., Luyster, T., & Shuker, T. (2002). *Value stream management: Eight steps to planning, mapping, and sustaining lean improvements.* Boca Raton: CRC Press.

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