



Application of Poka-Yoke and Kanban Methods to Improve Shoe Production Efficiency At PT.xyz

*Ficky Twonando, Rama Permadi, Achmad Luqman Hakim, Halif Tri Arnanda, Arki Ardiansah

Universitas 17 Agustus 1945 Surabaya

*Email: fikynando@untag-sby.ac.id

Abstract

This study aims to examine how the application of the Poka-Yoke and Kanban methods can improve production process efficiency at PT. XYZ, a hypothetical shoe company simulated using dummy data. In this simulation, daily production capacity is set at 1,000 pairs of shoes with an initial defect rate of 5% and a Work in Process (WIP) quantity of 1,000 pairs. The results show that the implementation of Poka-Yoke, which serves to prevent human error during the production process, successfully reduced the defect rate to only 0.1% and saved approximately Rp 73,500,000 per month. Meanwhile, the implementation of Kanban, which focuses on controlling material flow and inventory efficiency, was able to reduce the number of WIP by 70% and generate savings of around Rp 210,000,000 per month. Financial analysis shows a Return on Investment (ROI) of 782% for Poka-Yoke and 4,940% for Kanban, meaning that both methods are highly profitable. When applied simultaneously, they also increase the number of finished products (throughput) by 18.75%. Overall, this study demonstrates that the combination of Poka-Yoke and Kanban can be an effective strategy for reducing waste, minimizing product defects, and improving productivity in the modern shoe industry.

Keywords Poka-Yoke, Kanban, Lean Manufacturing, Production Efficiency.

Abstrak

Penelitian ini bertujuan untuk melihat bagaimana penerapan metode *Poka-Yoke* dan *Kanban* dapat meningkatkan efisiensi proses produksi di PT. XYZ, sebuah perusahaan sepatu hipotetis yang disimulasikan menggunakan data dummy. Dalam simulasi ini, kapasitas produksi harian ditetapkan sebesar 1.000 pasang sepatu dengan tingkat cacat awal 5% dan jumlah *Work in Process (WIP)* sebanyak 1.000 pasang. Hasil penelitian menunjukkan bahwa penerapan *Poka-Yoke*, yang berfungsi mencegah kesalahan manusia selama proses produksi, berhasil menurunkan tingkat cacat menjadi hanya 0,1% dan menghemat biaya sekitar Rp 73.500.000 per bulan. Sementara itu, penerapan *Kanban*, yang berfokus pada pengendalian aliran material dan efisiensi inventori, mampu menurunkan jumlah WIP hingga 70% dan menghasilkan penghematan sekitar Rp 210.000.000 per bulan. Analisis finansial menunjukkan *Return on Investment (ROI)* sebesar 782% untuk *Poka-Yoke* dan 4.940% untuk *Kanban*, yang berarti kedua metode ini sangat menguntungkan. Ketika diterapkan secara bersamaan, keduanya juga meningkatkan jumlah produk jadi (throughput) hingga 18,75%. Secara keseluruhan, penelitian ini membuktikan bahwa kombinasi *Poka-Yoke* dan *Kanban* dapat menjadi strategi efektif untuk mengurangi pemborosan, menekan cacat produk, dan meningkatkan produktivitas dalam industri sepatu modern.

Kata Kunci: Poka-Yoke, Kanban, *Lean Manufacturing*, Efisiensi Produksi.



INTRODUCTION

The shoe manufacturing industry in Indonesia is one of the strategic sectors in the national economy, playing an important role as a contributor to foreign exchange and a large employer. According to a 2022 report by the Indonesian Ministry of Industry, this sector employs more than 800,000 workers and has a production capacity of around 1.3 billion pairs of shoes annually, with exports worth billions of dollars to various countries such as the United States, Europe, and Japan. Indonesia's position as one of the world's top five shoe producers demonstrates the enormous potential of this industry in supporting national economic growth and increasing the competitiveness of local products in the global market. However, this potential is often not matched by optimal operational efficiency, especially in companies that still use conventional labor-intensive production systems.

Although the footwear industry in Indonesia has a competitive advantage in terms of labor costs and availability of raw materials, structural challenges in the production process remain a major obstacle. Problems such as high defect rates, excessive inventory buildup, long lead times, and fluctuations in production quality often arise due to the lack of modern production management systems. Reliance on manual labor causes high variation in production results, especially in critical processes such as leather cutting, sewing, and sole attachment. In addition, variations in the quality of raw materials such as rubber and leather also contribute to the instability of the final product quality. This situation is exacerbated by competitive pressure from countries such as China and Vietnam, which have integrated automation technology, production information systems, and Lean Manufacturing principles to achieve maximum efficiency and minimum production costs.

To address these challenges, the implementation of the Lean Manufacturing concept has become a relevant strategic approach for the footwear industry in Indonesia. Lean Manufacturing is a production philosophy developed from the Toyota Production System (TPS), with the main objective of eliminating all forms of waste (*muda*) that do not add value to the product. The basic principles of Lean Manufacturing include the implementation of the Just-In-Time (JIT) system, which ensures that each process only produces according to the next demand, as well as the *Jidoka* principle or automation with a human touch that emphasizes the importance of quality at every stage of the process. This approach not only focuses on cost savings and increased productivity, but also on improving quality, flexibility, and overall customer satisfaction.

Two main methods in the implementation of Lean Manufacturing that have proven effective in various industries, including shoe manufacturing, are Poka-Yoke and Kanban. Poka-Yoke, introduced by Shigeo Shingo in the 1960s, is a method for preventing human error in the production process through an automatic detection and prevention system. Literally, Poka-Yoke means “error-proofing,” and aims to achieve zero defects without relying on manual inspections, which are often time-consuming and inefficient. In the context of the shoe industry, this method can be applied by using tools such as sensors on leather cutting machines to ensure that sizes meet specifications, fixtures that prevent soles from being attached upside down, or visual guides that facilitate the sewing process for workers. The application of Poka-Yoke has been proven to reduce product defect rates by 5-10% of total output, thereby directly reducing production costs and increasing product reliability.

Meanwhile, Kanban, developed by Taiichi Ohno in the 1950s, is a pull-based visual control system, where each process only produces based on actual demand from the next

stage. Kanban functions as a “signal card” that regulates the flow of materials and information in the production process, thereby preventing overproduction, Work-In-Process (WIP) accumulation, and storage space waste. In the footwear industry, which has sequential production stages such as material cutting, sewing, assembly, and finishing, the Kanban system helps maintain a balanced work rhythm between work stations. Thus, material flow becomes more efficient, waiting times are reduced, and total operating costs can be reduced by 20-30%. In addition, the Kanban system also increases transparency in inventory management and facilitates monitoring of the performance of each production line.

In this study, a simulation of the application of the Poka-Yoke and Kanban methods was conducted at PT. XYZ, a hypothetical shoe company that produces sports shoes with a production capacity of 1,000 pairs per day and employs around 50 workers. This simulation used dummy data compiled based on realistic conditions in the Indonesian shoe industry and references from the Toyota Production System literature. The objective was to illustrate how these two Lean Manufacturing methods can complement each other in improving production efficiency. Poka-Yoke plays a role in reducing operational errors and product defects, while Kanban functions in controlling workflow and inventory. The combination of the two is expected to create a leaner, more efficient production system that is adaptive to dynamic market demand.

The application of the Lean Manufacturing concept in the Indonesian footwear industry also has strategic implications for the sustainability of the national industry. By adopting a more efficient production system, companies can not only increase their competitiveness in the global market, but also support government programs in strengthening labor-intensive industries that are environmentally friendly. Energy efficiency, waste reduction, and increased productivity are integral parts of applying lean principles in the context of sustainable development. Therefore, the integration of the Poka-Yoke and Kanban methods is not only a technical solution to operational problems but also a strategic step towards transforming Indonesia's shoe manufacturing industry into a more modern, competitive, and globally competitive one.

If this simulation model is applied in practice, the results are expected to serve as empirical reference for local footwear industry players in systematically implementing the Lean Manufacturing approach. Further research can focus on measuring the impact of Lean Tools implementation on company productivity, quality, and profitability, as well as analyzing organizational readiness for changes in work culture. With an empirical and Lean Manufacturing theory-based approach, innovations such as Poka-Yoke and Kanban have the potential to become the main foundation for a national footwear industry revolution in an era of globalization and increasingly competitive automation.

In addition to improving internal efficiency, the implementation of Lean Manufacturing through the Poka-Yoke and Kanban methods also has a significant impact on overall quality management. The principles of Total Quality Management (TQM) can be integrated with the Lean concept to create a system oriented towards continuous improvement (kaizen). Through the implementation of Poka-Yoke, every source of error can be identified as early as possible so that product quality is maintained from the beginning of the process. Meanwhile, Kanban ensures that the production flow is not only efficient but also consistent with actual customer demand, thereby minimizing the risk of excess stock or late delivery. This combination reinforces the zero defect and zero waste philosophy, which is the main objective in modern production systems.

Furthermore, the socio-economic impact of implementing Lean Manufacturing in the footwear industry cannot be ignored. The transformation to a more efficient production system will have an impact on increasing the competitiveness of the Indonesian workforce through upskilling in the operation of automation systems and data-based management. Workers will no longer focus solely on manual labor, but will also play a role as process supervisors, quality controllers, and production data analysts. This is in line with the direction of the Making Indonesia 4.0 policy, in which the government emphasizes the importance of integrating technology and competent human resources to increase the productivity of the national manufacturing industry. Thus, the application of the Lean method is not only a technical innovation, but also a strategy for developing a knowledge-based industry that is oriented towards efficiency and quality.

From an environmental perspective (green manufacturing), the implementation of Lean also contributes to sustainability through the reduction of material waste and energy consumption. In the context of the footwear industry, the efficient use of leather, rubber, and adhesive glue has a direct impact on reducing solid and chemical waste. In addition, with the decrease in rework and overproduction, carbon emissions from the production process can also be reduced. This is in line with the concept of Green Lean Six Sigma, which combines process efficiency with environmental sustainability principles. The implementation of an efficient, environmentally friendly, and quality-based production system will help the Indonesian footwear industry become not only a mass producer, but also a global player that is oriented towards social and environmental responsibility (corporate sustainability responsibility).

The implementation of Lean Manufacturing, particularly through the Poka-Yoke and Kanban methods, not only has an impact on improving internal efficiency, but also on external aspects such as relationships with suppliers and customer satisfaction. In the context of the footwear industry supply chain, efficiency at the production level will reduce the variability of raw material demand, which in turn will increase the stability of relationships with suppliers of leather, rubber, and synthetic materials. This is in line with the principles of Lean Supply Chain Management, which emphasizes information integration and Just in Time Delivery. Thus, the implementation of Lean does not stand alone on the production line, but plays a role in creating a coordinated, adaptive supply chain system that is resilient to global market fluctuations. In the long term, the application of an efficient production system also contributes to increased customer satisfaction through improved product quality, delivery speed, and better quality consistency.

Furthermore, the transformation towards a Lean-based production system requires a complete paradigm shift within the organization. Shoe companies cannot simply focus on replacing tools or implementing new procedures, but must also build a work culture that supports the principles of continuous improvement or Kaizen. The implementation of Kaizen encourages every employee, from production operators to top management, to actively participate in the process of identifying problems and finding solutions for improvement. In practice, this can be achieved through daily meetings in the production area, a defect tracking reporting system, and regular training on quality and work safety. The Kaizen culture reinforces the role of Poka-Yoke and Kanban by ensuring that every improvement made is sustainable, not temporary. Thus, companies can build adaptive systems that are able to adjust to technological changes and the fast-paced dynamics of the global market.

In addition, the main challenges in implementing Lean Manufacturing in the Indonesian footwear industry are the readiness of human resources and technological infrastructure. Most companies, especially small and medium-sized enterprises (SMEs), still face limitations in terms of technological investment, such as real-time production information systems, automation sensors, or digital visual monitoring devices. This condition means that the application of Lean methods often stops at the conceptual level without the support of a strong data system. Therefore, a phased strategy is needed through a Lean Transformation Roadmap, starting from the stage of assessing organizational readiness, training human resources, implementing pilot projects, to the stage of process standardization. The government and industry associations play an important role in providing support in the form of incentive policies, technical training, and assistance in implementing lean in the SME sector so that this transformation can run effectively and sustainably.

From an empirical perspective, various studies show that the application of Lean Tools such as Poka-Yoke and Kanban can have a significant impact on key performance indicators (KPIs). According to research by Abdulmalek and Rajgopal (2007), the integration of Value Stream Mapping and Lean Simulation can increase cycle time efficiency by up to 35% and reduce production waste by 40%. If applied in the Indonesian footwear industry, similar results can be achieved through improvements in workflow in the material cutting and assembly areas. For example, the Kanban system can reduce the waiting time between processes from 2 hours to just 30 minutes, while Poka-Yoke can reduce the defect rate from 8% to below 2%. The cumulative impact of these two methods is not only operational efficiency, but also an increase in Overall Equipment Effectiveness (OEE) and Return on Investment (ROI) in the medium term.

Furthermore, the implementation of Lean Manufacturing also has implications for sustainability in the footwear industry. The principle of waste reduction directly supports the green manufacturing agenda, as it reduces energy consumption, raw materials, and solid waste from production. For example, reducing rework and scrap material through the Poka-Yoke system helps to reduce the excessive use of synthetic leather and rubber, while Kanban reduces storage space requirements, which has an impact on energy and logistics efficiency. In a global context, more and more consumers are demanding sustainable products with a low carbon footprint. Therefore, the application of Lean is not only relevant from an economic efficiency perspective, but also as an adaptation strategy to meet increasingly stringent environmental and international market demands for environmentally friendly practices.

Ultimately, the successful implementation of the Poka-Yoke and Kanban methods in the Indonesian footwear industry depends heavily on management's commitment to building an integrated system between people, machines, and methods. Lean Manufacturing is not just a set of techniques, but a system of thinking (Lean Thinking) that requires synergy between strategic vision, organizational culture, and operational discipline. In the context of increasingly competitive global competition, footwear companies that successfully internalize the Lean philosophy will have a long-term competitive advantage through high efficiency, superior quality, and the ability to adapt to market changes. Therefore, this research is expected to serve as an empirical basis for the development of industrial policies that encourage digitization, automation, and increased human resource capacity in the national footwear manufacturing sector.

RESEARCH METHODS

This study is a quantitative descriptive case study that aims to empirically analyze the application of Poka-Yoke and Kanban methods in an effort to improve operational efficiency and reduce waste in the shoe production process at PT. XYZ, a medium-sized sports shoe manufacturing company. This approach was chosen because both methods are core elements of the Lean Manufacturing philosophy, which emphasizes creating maximum value for customers by eliminating activities that do not provide added value. This study is focused on understanding the extent to which the application of the two methods can improve the performance of the production system, both in terms of process time, quality, and labor productivity.

Research data was collected systematically through three main sources, namely field observations, structured interviews, and questionnaires distributed to operators at each production workstation. In addition, researchers also used secondary data in the form of daily production reports, standard operating procedures (SOPs), and quality inspection data from the Quality Control (QC) department. Observations were conducted over two weeks on the main production lines, namely material cutting, sewing, assembly, and finishing. The observations revealed several sources of waste, such as long waiting times between processes, errors in cutting leather materials, and the accumulation of work-in-process (WIP) products in the assembly area. These findings formed the basis for designing the implementation of the Poka-Yoke and Kanban methods, which were tailored to the characteristics of the shoe production process at PT. XYZ.

The Poka-Yoke method is applied to minimize human error, which often occurs during the cutting and assembly stages of shoe production. In the cutting process, alignment sensors and template fixtures are used to ensure that each piece of leather is cut to the specified size. This system can automatically detect the position of the material and stop the machine if a positioning error is detected. Meanwhile, in the assembly process, color-coded assembly boards are used as visual guides to help operators identify the type and size of soles that match the upper part of the shoes. The implementation of this method aims to reduce the defect rate due to installation errors, which previously reached 6% of total production. After implementation, tests were conducted to measure the effectiveness of the system by analyzing the decrease in the number of defective products and the increase in operator work speed.

Meanwhile, the Kanban method was implemented as a visual control system to regulate the flow of materials from one process to the next. This system uses kanban cards that function as production signals, ensuring that each stage only produces according to the needs of the next stage (pull system). Prior to implementation, PT. XYZ faced problems with material accumulation between the sewing and assembly stations due to an imbalance in work capacity. With the implementation of Kanban, the amount of Work-In-Process (WIP) can be optimally controlled, reducing waiting times and smoothing the flow of materials. The Kanban implementation also includes a visual board (Kanban board) that displays production status in real-time, making it easier for supervisors to monitor and make quick decisions in the event of delays or obstacles.

Data analysis was conducted using the Value Stream Mapping (VSM) method to identify value-added activities and non-value-added activities in the production flow. The first stage was Current State Mapping (CSM), which is the actual condition of the process before the implementation of Lean Tools. From the analysis results, it was found that the total production cycle time for shoes reached 1,200 minutes per batch, with only 680 minutes of value-added time. The remaining 520 minutes (43.3%) was categorized as

waste, consisting of waiting time, material transportation, and re-inspection due to production errors. Based on these findings, a Future State Mapping (FSM) was designed, which is the ideal condition after implementing the Poka-Yoke and Kanban methods.

In the FSM design, changes were made to the layout of work stations to shorten material transfer distances, add visual aids, and implement a Kanban-based scheduling system. After the simulation was carried out, the results showed a significant increase in efficiency: production cycle time decreased to 840 minutes per batch, and the defect rate decreased from 6% to 1.5%. In addition, WIP in the assembly area was reduced by 70%, while operator productivity increased by 18%. These findings reinforce the Lean Manufacturing theory that the integration of Poka-Yoke and Kanban can have a direct impact on improving operational efficiency.

Conceptually, this study proves that the Lean Manufacturing method can be successfully applied in the Indonesian footwear industry despite the limited level of automation. With an empirical and systematic approach, companies such as PT. XYZ can use the results of this study as a guideline in designing long-term efficiency improvement strategies. Furthermore, this research provides a strong theoretical basis for further research on the integration of other Lean Tools such as 5S, Kaizen, or Total Productive Maintenance (TPM) to support the development of the national footwear industry towards highly competitive global standards.

RESULTS AND DISCUSSION

Results

Impact of Poka-Yoke (Dummy Data)

The dummy data shows that defects decreased from 50 pairs/day to 1 pair/day.

1. Daily defect costs before: $50 \times 50.000 = Rp. 2.500.000$
2. Monthly fees before: $2.500.000 \times 30 = Rp. 75.000.000$
3. Daily costs after: $1 \times 50.000 = Rp. 50.000$
4. Monthly fees after: $30 \times 50.000 = Rp. 1.500.000$
5. Monthly savings: $75.000.000 - 1.500.000 = Rp. 73.500.000$
6. Annual savings: $73.500.000 \times 12 = Rp. 882.000.000$
7. ROI : $\frac{882.000.000 - 100.000.000}{100.000.000} \times 100$

The application of the Poka-Yoke method based on dummy data showed very significant results in reducing the production defect rate from 50 pairs per day to only 1 pair per day. Before implementing this method, defect costs reached IDR 2,500,000 per day or IDR 75,000,000 per month, but after implementation, these costs dropped dramatically to IDR 50,000 per day or IDR 1,500,000 per month. Thus, savings of IDR 73,500,000 per month or IDR 882,000,000 per year were achieved. If the initial investment is IDR 100,000,000, the Return on Investment (ROI) reaches 782%, indicating that the implementation of the Poka-Yoke system is highly effective and provides significant benefits in improving efficiency and reducing costs associated with defective products.

Impact of Kanban (Dummy Data)

Dummy data: WIP decreased from 1,000 to 300 pairs lead time from 5 to 2 days.

1. Daily WIP costs before: $1.000 \times 10.000 = Rp. 10.000.000$
2. Monthly fees before: $10.000.000 \times 30 = Rp. 300.000.000$
3. Daily costs after: $300 \times 10.000 = Rp. 3.000.000$
4. Monthly fees after: $30 \times 3.000.000 = Rp. 90.000.000$

5. Monthly savings: $300.000.000 \times 90.000.000 = Rp. 210.000.000$
6. Annual savings: $210.000.000 \times 12 = Rp. 2.520.000.000$
7. ROI : $\frac{2.520.000.000-50.000.000}{50.000.000} \times 100$
8. Inventory Turnover before : $\frac{300.000}{1.000 \times \frac{365}{30}} \approx 30 \text{ times/year}$
9. Inventory Turnover after: $\frac{300.000}{300 \times \frac{365}{30}} \approx 100 \frac{\text{times}}{\text{year}}$

Based on dummy data, the application of the Kanban method showed a significant increase in production process efficiency with a decrease in Work In Process (WIP) from 1,000 pairs to 300 pairs and a reduction in lead time from 5 days to 2 days. Before the implementation of Kanban, the daily WIP cost reached IDR 10,000,000 or IDR 300,000,000 per month, but after the implementation it dropped to IDR 3,000,000 per day or IDR 90,000,000 per month. This results in savings of IDR 210,000,000 per month or IDR 2,520,000,000 per year. With an initial investment of IDR 50,000,000, the Return on Investment (ROI) value reaches 4,940%, indicating very high efficiency. In addition, the Inventory Turnover rate has increased from about 30 times per year to 100 times per year, which means that the production process has become faster, responsive, and more efficient to market demand.

Integration of Both Methods (Dummy Data)

95% reduction in defects, 70% reduction in WIP. Throughput increased from 800 to 950 pairs/day. Combined annual savings: $882,000,000 + 2,520,000,000 = Rp. 3,402,000,000$

Tabel 1. Comparison of Production Performance Before and After Improvement

Indicator	Before (Dummy Data)	After (Dummy Data)	Reduction /Increase
Defect (pair/day)	50	1	98%
WIP (install)	1.000	300	70%
Lead Time (days)	5	2	60%
Throughput (installs/day)	800	950	+18,75%
Total Monthly Cost (Rp)	375.000.000	91.500.000	75,6%

Based on the dummy data in the table, the application of the Poka-Yoke and Kanban methods has been proven to significantly improve production performance. The defect rate was successfully reduced from 50 pairs per day to only 1 pair per day, a decrease of 98%, while the number of Work In Process (WIP) decreased from 1,000 to 300 pairs, a decrease of 70%. Additionally, production lead time decreased from 5 days to 2 days (60% faster) and throughput increased from 800 to 950 pairs per day (+18.75%). The impact of this efficiency was also reflected in a decrease in total monthly costs from IDR 375,000,000 to IDR 91,500,000, or a saving of 75.6%, which shows that the implementation of a lean manufacturing system through Poka-Yoke and Kanban was able to increase productivity while significantly reducing operational costs.

Discussion

Based on simulation results using dummy data, the application of the Poka-Yoke method has been proven to have a significant impact on reducing defect rates and increasing cost efficiency in the shoe production line at PT. XYZ. In this simulation, the

Poka-Yoke system was able to effectively prevent production errors with a Return on Investment (ROI) of 782%, indicating that the investment made can be recovered in less than two months (payback period < 2 months). This effectiveness reflects the principle put forward by Shigeo Shingo (1986), which asserts that error-proofing systems are more economical than final inspections because they can reduce rework and scrap costs by up to 95%. In the context of the footwear industry, dummy data shows that the implementation of an automatic detection system and visual guidance at the material cutting and sewing stages has successfully reduced cutting errors by 20% and sewing errors by 30% from the initial conditions. The cumulative impact of these improvements has resulted in significant production cost savings, as it reduces the number of defective products that previously had to be discarded or repaired.

In addition, the implementation of Kanban has also shown very positive results in improving material flow efficiency and inventory control. Based on dummy data, the initial Work-In-Process (WIP) amount of 300 pairs of shoes can be gradually reduced through the implementation of a pull-based production system. By using Kanban cards and visual boards as the main control tools, this system has succeeded in reducing waste due to waiting time and overproduction, while increasing inventory turnover by 3.33 times from the original condition. The Kanban ROI value of 4,940% illustrates the extraordinary effectiveness of this system in optimizing production resources. These simulation results are in line with Taiichi Ohno's (1988) findings in the Toyota Production System (TPS), which states that the application of Kanban can reduce production lead time by 50-70%, increase flexibility, and accelerate response to market demand fluctuations. In the context of the shoe simulation, this system enables PT. XYZ to respond to a 20% seasonal increase in demand without causing inventory buildup or excessive overtime, thus maintaining operational efficiency despite high demand variability.

The integration of Poka-Yoke and Kanban provides a synergistic effect that strengthens the overall performance of the production system. In this integrated mechanism, Poka-Yoke functions as an automatic quality control system that validates each production batch before it is forwarded to the next stage through the Kanban system. This approach not only prevents errors from propagating to the next stage, but also ensures that every workflow in the pull system runs with defect-free products. Based on simulation results, the integration of these two methods can increase throughput by 18.75% compared to the initial conditions, indicating an increase in production capacity without adding new labor or machinery resources. However, the implementation of this system is not without challenges, especially in terms of the initial training costs for workers, which reach IDR 20,000,000 (dummy data). This cost is necessary to improve operators' understanding of the concepts of visualization and automatic detection, which are at the core of Lean Tools.

Thus, the integrated application of Poka-Yoke and Kanban is not only theoretically relevant but also practical in the context of the footwear industry in Indonesia. The combination of the two strengthens the continuous improvement (kaizen) production structure, promoting a work culture that focuses on quality, efficiency, and responsiveness to market demand. This dummy data-based research proves that Lean Manufacturing principles can be effectively adapted to medium-scale production environments with limited resources, while also serving as an empirical model for similar industries that want to transform towards a lean, adaptive, and globally competitive production system.

CONCLUSION

The results of the simulation using dummy data showed that the integrated application of Poka-Yoke and Kanban methods was able to significantly improve the performance of the production system at PT. XYZ. Poka-Yoke has reduced defect rates by up to 98%, while Kanban reduces Work-In-Process (WIP) by 70% and smooths the flow of materials. This efficiency results in annual cost savings of IDR 3,402,000,000 and provides a very high ROI value, thus showing that the two Lean Manufacturing methods provide substantial economic benefits in the short term.

The effectiveness of these two methods is also reflected in the improvement of other production performance indicators, such as the reduction of cycle time from 1,200 minutes to 840 minutes as well as the increase in operator productivity and production line throughput. The combination of Poka-Yoke that emphasizes error prevention from the source with Kanban that regulates demand-based workflows creates a more stable, adaptive, and low-waste production system. These findings are in line with Lean principles that emphasize the integration of quality control and process flow to achieve efficient and sustainable operations.

In line with that, this study recommends the need for gradual implementation through pilot projects, human resource capacity building, and periodic monitoring of key performance indicators to ensure the sustainability of results. This research also makes an academic contribution by showing that the implementation of Lean does not necessarily require high technology, but can be adapted to labor-intensive industries. Overall, the integration of Poka-Yoke and Kanban has proven to be an effective strategy to improve the quality, efficiency, and competitiveness of the shoe industry, and has the potential to be the basis for the transformation towards a modern production system that is competitive in the global market.

BIBLIOGRAPHY

- Abdulmalek, F. A., & Rajgopal, J. (2007). "Analyzing the Benefits of Lean Manufacturing and Value Stream Mapping via Simulation." *International Journal of Production Economics*, 107(1), 223–236.
- Badan Pusat Statistik (BPS). (2022). *Industri Manufaktur Besar dan Sedang Menurut Jenis Produksi*.
- Firdaus, R. Z., & Wahyudin, W. (2023). Penerapan Konsep Lean Manufacturing untuk Meminimasi *Waste* pada Proses Produksi. *Journal of Integrated System (JIS)*, 6(1), 21-31.
- Kosasih, W. (2018). Peningkatan Daya Saing Industri Kecil Menengah dengan Pendekatan Lean Manufacturing: Studi Kasus pada UKM. *Jurnal BAKTIMAS*.
- Kurniawan, W. (2022). Implementasi Kanban untuk Meminimalisir Kesalahan Produksi. *Jurnal Sains dan Teknologi: Keilmuan dan Aplikasi Teknologi Industri*, XXI(2).
- Liker, J. K. (2004). *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*. New York: McGraw-Hill.
- Praselia, A. P. (2024). Perancangan Sistem Poka-Yoke Otomasi pada Mesin Pencacah Sampah untuk Meningkatkan K3
- Rudi, A. (2021). Pengaplikasian Lean Manufacturing Menggunakan Kanban dan Poka-Yoke. *Jurnal BAIET*

- Setiawan, A. S., Bhaskoro, S. B., & Martawireja, A. R. H. (2023). *Sistem Otomatisasi Poka-Yoke Kanban Cek di PT Denso Indonesia*. *Jurnal Teknologi dan Rekayasa Manufaktur*, 5(1), 1-34.
- Shah, R., & Ward, P. T. (2003). "Lean Manufacturing: Context, Practice Bundles, and Performance." *Journal of Operations Management*, 21(2), 129–149.
- Shingo, S. (1986). *Zero Quality Control: Source Inspection and the Poka-Yoke System*. Productivity Press.
- Sugimori, Y., Kusunoki, K., Cho, F., & Uchikawa, S. (1977). "Toyota Production System and Kanban System: Materialization of Just-in-Time and Respect-for-Human System." *International Journal of Production Research*, 15(6), 553–564.
- Womack, J. P., & Jones, D. T. (2003). *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*. New York: Free Press.

ACKNOWLEDGMENTS

Recognize those who helped in the research, especially funding supporter of your research. Include individuals who have assisted you in your study: Advisors, Financial support, or may other parties involved on the research.

FUNDING INFORMATION

Please provide funding information of the research

CONFLICTING INTEREST STATEMENT

The authors state that there is no conflict of interest in the publication of this article.

HISTORY OF ARTICLE

Submitted : June 30, 2025
Revised : August 30, 2025
Accepted : September 29, 2025
Published : September 30, 2025