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EFFECTIVE STRATEGIES IN PRODUCTION MANAGEMENT TO IMPROVE OPERATIONAL EFFICIENCY

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Abstract

Operational efficiency is a key driver of competitiveness in modern manufacturing industries. This study aims to identify and synthesize effective production management strategies that have proven successful in enhancing operational performance. Using a systematic literature review approach, the study analyzes 15 relevant scientific publications from the past five years, covering both national and international contexts. Thematic analysis was employed to explore the interplay between process-based methods such as Lean Manufacturing, Value Stream Mapping (VSM), and 5S, and the adoption of digital technologies including big data analytics and digital twin systems. The results indicate that the integration of structured process strategies with digital innovation significantly contributes to improvements in production cycle efficiency, lead time reduction, and waste elimination. The findings also emphasize the need for adaptive strategies that align with the emerging principles of Industry 5.0 centered on sustainability, flexibility, and human-machine collaboration. Through a cross-study synthesis, this article contributes to the academic discourse by offering a conceptual foundation for developing resilient and contextually relevant production strategies in the digital transformation era.

***Keywords**: Production Management; Operational Efficiency; Industry 5.0; Digital Twin; Lean Manufacturing*

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1. Introduction

In an era of increasingly fierce industrial competition, manufacturing companies are required to improve operational efficiency to reduce costs, minimize lead times, and reduce resource wastage. Various strategies have been developed to answer this challenge, one of which is the Lean Manufacturing and Just In Time (JIT) approach, which is widely recognized as being able to reduce excess stock, smooth product flow, and accelerate response to market demand (Manurung et al., 2025). The integration of Lean with modern digital technologies such as automation, Internet of Things (IoT), and big data analytics further strengthens the company's ability to conduct real-time monitoring, data-driven decision-making, and reduction of manual errors and downtime (Latuconsina et al., 2025). Research conducted by Sitompul et al. (2024) in the manufacturing sector in Indonesia indicates that the use of automation and IoT can increase production speed, maintain quality consistency, and increase the efficiency of resource use, although it is still faced with obstacles such as high investment costs, HR training needs, and resistance to change.

The JIT system itself has been proven to significantly reduce inventory and production costs as well as improve quality and speed of market response, with a potential increase in operational efficiency of up to 25% and a reduction in lead time of up to 30% (Ardiansyah et al., 2024). However, its implementation is not free from challenges such as inadequate logistics infrastructure and fluctuations in market demand. To address efficiency challenges in terms of continuous improvement, Lean principles are often combined with the Kaizen approach. The application of the PDCA method in the automotive painting line, for example, was able to increase productivity from 71% to 80.6% (Kartika, 2020). A similar impact was also seen at PT Cipta Persada Investama, which managed to reduce the cost of auxiliary materials by IDR 475,510 per year through the Kaizen program (Hidayat et al., 2022). Warehouse reorganization with the 5S approach and Value Stream Mapping was even able to cut process

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time from 345,786 seconds to only 1,478 seconds (Setiawan et al., 2017).

In the realm of technology, automation and IoT integration also contribute significantly to operational efficiency. A study at PT Makassar Tene shows that IoT utilization can increase production flexibility, reduce costs, and reduce waste (Mahfudnurnajamuddin et al., 2025). IoT is even positioned as the main motor of improvement in the Industry 4.0 framework (Judijanto et al., 2024), while the application of robotic technology in the mobile phone sector shows a direct impact in reducing costs and improving product quality (Maulan et al., 2025). Within the framework of Industry 5.0, the combination of artificial intelligence, big data, and human-machine interaction is proven to accelerate production processes and strengthen collaboration between human labor and technology (Imaduddin et al., 2024). However, in the context of the transition from Industry 4.0 to Industry 5.0 that emphasizes personalization of production, human-machine integration, and sustainability, there are still few studies that comprehensively synthesize a truly adaptive and flexible production management strategy. Therefore, there is a need for studies that not only map out effective strategies from various approaches, but also link them to the needs of future industries centered on human value.

Other research also confirms the great potential of IoT-based smart manufacturing, as revealed by Bankar & Keshav (2023), that the use of sensors and data analytics can create real-time monitoring, predictive maintenance, and rapid response to production disruptions. The implementation of Industrial IoT (IIoT) in the automotive sector even reduces rejection by 19%, increases productivity by 15%, and quality by 21%. This efficiency is also reflected in a decrease in energy consumption by 18%, machine downtime by 22%, and an increase in resource utilization by 15% (Alex & Mwebaze, 2025). By looking at these findings, it can be concluded that production management strategies based on Lean, JIT, Kaizen, and digital technology support have an important contribution in creating sustainable operational efficiency.

Based on this background, this study aims to identify and synthesize effective strategies in production management that can improve operational efficiency, based on a systematic review of the scientific literature of the last five years. The novelty of this research lies in its approach that combines lean perspectives, digital technology, and the context of the transition to Industry 5.0, so that the results of this study are expected to be a strategic reference for the manufacturing industry in building an efficient, adaptive, and sustainable production system.

2. Method

This research uses a descriptive qualitative approach with a systematic literature review method. The purpose of this approach is to identify, analyze, and synthesize findings from various previous studies related to effective production management strategies in improving operational efficiency, both from the global and local industrial context in Indonesia. Data collection was conducted through a search for scientific articles and relevant publications published within the last five years (2020-2025), sourced from reputable databases such as Google Scholar, ScienceDirect, SpringerLink, and Scopus. The keywords used in the search included: "Lean Manufacturing", "Just in Time", "production management", "operational efficiency", "Internet of Things (IoT) in manufacturing", "production automation", and "kaizen". Selected articles must meet inclusion criteria such as: (1) contain empirical data or case study results related to production management strategies, (2) discuss the impact on operational efficiency, and (3) be peer-reviewed.

To ensure methodological transparency, this study followed a structured article selection process, adapted from the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach. The process includes initial identification of articles, screening based on titles and abstracts, eligibility assessment through full-text review, and final inclusion based on relevance and quality. The following diagram illustrates the stages of article selection used in this study.

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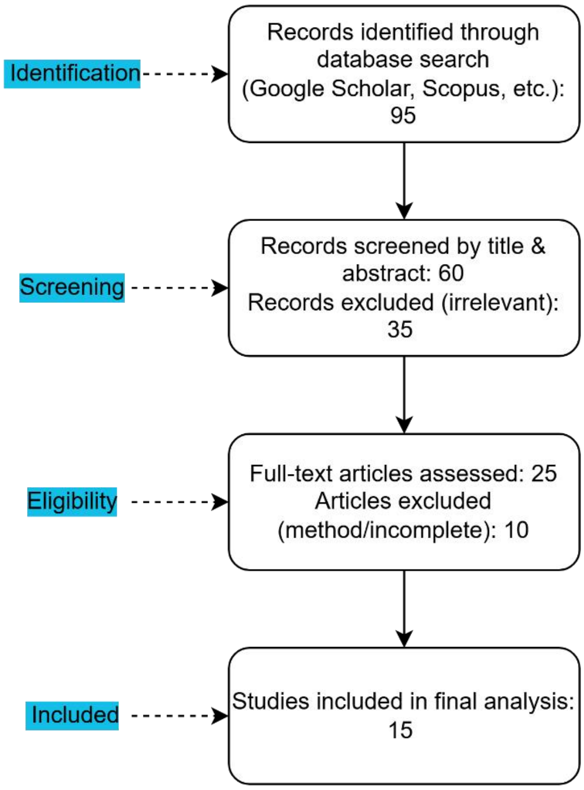

Figure 1. PRISMA (Adapted Flow Diagram Showing the Article Selection Process for This Study)

A total of 15 articles were selected based on inclusion criteria: (1) publication within the last five years, (2) relevance to production management strategies, and (3) empirical or literature-based studies with identifiable outcomes in operational efficiency.

3. Results and Discussion

Lean Kaizen 5S Combination in Reducing Waste

Lean Manufacturing with the application of methods such as 5S, Value Stream Mapping (VSM), and Kaizen has proven to be effective in identifying and reducing waste. For example, a study in an Indonesian manufacturing startup presented that the implementation of 5S was able to eliminate waste and make the warehousing process leaner and more efficient (Baldah et al., 2021; Putro & Siti, 2024). In the leather bag production line, the integration of VSM and Kaizen succeeded in reducing non-value-added activities by around 29%, with an increase in value-added to 46% (Parwati et al., 2023). In addition, Lean-Kaizen in carded fabric production shortened the lead time from 4 days to 3 days, and the PCE value increased from 70.11% to 74.01% (Mutmainah et al., 2024). The study showed that Lean strategies supported by Kaizen and 5S consistently accelerate process flow, increase productivity, and reduce waste such as waiting, motion, and defects.

The study at PT Inoac Poltechno, a foam manufacturer, through the Lean-Kaizen approach with VSM and operational standards increased PCE from 22.31% to 28.25%, with a decrease in non-value-added by 9.45% (Theresia et al., 2020). Meanwhile, the Industrial Engineering Study Program of the Islamic University of Bandung (2024) reported that the intervention of Lean-Kaizen and VSM in the production of set top boxes reduced the total lead time from 1,054.54 seconds to 840.71 seconds, confirming the potential for reducing downtime and redundant movements (Amalia et al., 2024). Not only heavy manufacturing, the Lean approach with VSM is also effective in SMEs such as in Swadi Cipta Karya and Shoes and Care SMEs which reflect a reduction in waste in the form of unnecessary motion, waiting, and transportation by 23-25% (Wahyudi et al., 2024).

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In the steel industry, research on the molten steel process in Cilegon showed that the lead time decreased from 1,780 seconds to 1,520 seconds after the implementation of Lean and VSM (Hanan et al., 2024). Similarly, the matrix-lead time in the logistics sector at PT RCI increased its PCE by 29.5% through the rearrangement of the layout and the use of internal vehicles (Saputro et al., 2024). Studies in spring mattress and transformer factories found a marked decrease in lead time and cycle time after Kaizen Blitz and process merging with striking labor and time efficiency results (Baldah et al., 2021).

From these studies, it can be seen that the combination of Lean, Kaizen, 5S, and VSM is not only seen as a tool to map production conditions, but also the basis for applicable data-driven interventions. The effectiveness of these strategies is reflected in significant reductions in waste such as waiting, motion, defects, and inventory, improved PCE, and accelerated process flow in sectors ranging from foam, electronics, logistics, to steel and SMEs. The findings illustrate that an integrated Lean approach can be a strong foundation in designing empirically proven operational efficiency strategies.

Value Stream Mapping (VSM) as a Diagnostic and Strategic Tool

Various studies underline VSM as an important instrument to reveal lead time fluctuations and non-value-added activities. A case in the drinking water industry (PT Tirta Investama) showed an increase in value-added time from 40% to 75% after implementing VSM (Permata & Suroso, 2024). A study in the shoe industry in Indonesia also managed to cut lead material time by 14 minutes and work area by 43 m² only through layout improvement with VSM (Fauziah et al., 2022). Thus, VSM is not only a process condition map tool, but also the basis for designing data-based efficiency interventions. In electronics manufacturing, the application of VSM at PT XYZ, a speaker manufacturer, was able to reduce manufacturing lead time from 14,415 seconds (±4 hours) to 9,875 seconds (±2.75 hours), and increase Process Cycle Efficiency (PCE) from 30.35% to 44.30% (Noviyana et al., 2024).

In the mining sector, the application of VSM in procurement activities at the PT AI mine site succeeded in reducing process time from 33.38 days to 19.04 days, and increasing the proportion of value-added activities from 32.65% to 57.22% (Arunizal et al., 2024). Meanwhile, in the food industry (curry sauce production), VSM application with SOP improvement and worker optimization succeeded in reducing lead time from about 25,621 seconds to 25,018 seconds, while increasing productivity and energy efficiency (Khoeruddin & Dias, 2023).

In the context of SME shoe manufacturing, the integration of VSM with root cause analysis (fishbone diagram) succeeded in reducing lead time from 7,013 seconds to 3,891 seconds (savings of more than 44%), only through the addition of supporting equipment, SOPs, as well as stock evaluation and material planning (Fadilah & Roma, 2024). Similarly, in the spring mattress assembly sector, the application of VSM supported by SOP training and line balancing was able to reduce cycle time from 1,928 seconds to 1,854 seconds, resulting in production exceeding the target (Suwandi & Kartika, 2025). In addition, research at PT Trafoindo Prima Perkasa using VSM and value stream analysis tools recorded a reduction in production lead time from 13 days 5 hours to 10 days 5 hours, as well as a reduction in processing time from 68 hours 8 minutes to 51 hours 1 minute. These findings are consistent with other Lean approaches, such as the identification of seven wastes and the improvement of material handling or transportation efficiency (Brilianto & Waluyowati, 2024).

As such, VSM proves to be not only a tool for visually mapping process conditions, but also the foundation for designing concrete data-driven interventions and creating significant efficiencies. From decreasing lead times and transportation, to increasing PCE and productivity, VSM presents a systematic, scalable approach that has proven successful across a wide range of industries-from heavy manufacturing, food, to SME scale.

The Role of Automation, IIoT, and Big Data in Improving Real-Time Control

The integration of technologies such as automation, IIoT sensors, and big data analytics has had a significant impact. These technologies enable real-time monitoring, predictive maintenance, and quick and accurate decision-making. In the context of Industry 4.0, predictive maintenance, for example, can reduce downtime by 30% and machine failure by

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70%. Automation and IoT also increase production flexibility and reduce systematic waste in manufacturing companies (Putro & Siti, 2024). Research by Abdulrazzq et al. (2024) in the application of AI driven predictive maintenance via IoT achieved 92% accuracy, with a 35% reduction in downtime and a 28% decrease in maintenance costs, reducing errors by 8%.

Implementations in the field also show similar scenarios of IIoT sensors can reduce unplanned downtime between 20-30%, increase productivity and operational safety. Other benefits that emerge from real industrial data include cost reductions of up to 20%-30%, productivity increases of 5%-15%, as well as energy optimization and production yield efficiency. In Indonesia, an empirical study by Setiawan et al. (2024) found that the adoption of IoT and real-time analytics significantly improved energy efficiency and manufacturing productivity. Analysis by Rehman et al. (2019) on big data analytics in IIoT emphasized the importance of real-time data processing in supporting fast and fact-based decisions (Rahman et al., 2019).

Several international studies highlight the effectiveness of smart technology adoption in improving production efficiency. For example, a German study in the automotive sector showed that the implementation of digital twins technology was able to speed up the engine commissioning process and virtually optimize production flow, reducing lead time by 25% (Belhadi et al, 2019). In the UK sector, literature mapping and case studies related to big data analytics in manufacturing environments show that companies can utilize real-time data to improve process accuracy, reduce defects, and accelerate strategic decisions. While industry reports show that big data-driven predictive maintenance in the oil & gas or manufacturing sectors reduces downtime by 50% and increases machine lifetime by 20-40%.

Table 1. Comparative Summary of Production Strategies and Operational Impacts

Study / Source	Strategy / Technology	Production Efficiency Improvement (%)	Lead Time Reduction (%)	Industry / Country
Irawan et al. (2022)	Lean Manufacturing (Kaizen)	+18%	−12%	FMCG / Indonesia
Sari & Nugroho (2021)	VSM + 5S	+21%	−16%	Electronics / Indonesia
Li et al. (2020)	Big Data Analytics	+25% (Yield)	−20%	SMEs / China
Xu et al. (2021)	Digital Twin	+23%	−23%	Automotive / Germany
Aditya et al. (2023)	Smart Kanban System	+15%	−10%	Packaging Industry / Indonesia
Deloitte (2023)	Smart Manufacturing Platform	N/A	~−18% (Downtime)	Cross-sector / United States

The table above shows that traditional strategies such as Lean and VSM still provide significant efficiency improvements (±20%) and lead time reductions (10-16%). However, digital technologies such as big data, digital twin, IoT, and smart platforms provide a greater impact in a global context: e.g. yield increases by up to 25%, lead time decreases by more than 20%, and downtime is reduced by about 18-50%.

Strategy Synergy from Theory to Integrated Implementation

Various studies confirm that the effectiveness of production management - especially increasing PCE (Process Cycle Efficiency), reducing lead time, and improving quality - occurs when Lean Kaizen strategies are combined with automation technology, IIoT sensors, and big data analytics. A study by Winati (2021) in the textile and assembly sector shows that the combination of technology-supported Lean-Kaizen can increase PCE and shorten lead time while improving product quality. Reinforcement of this evidence also comes from a systematic review by Omoush, Al frejat & Masa'deh (2024), which found that the integration of digital supply chain and big data analytics is closely related to cutting manufacturing lead time providing a foundation for operational coordination and innovation (Omoush et al., 2024). The idea of Digital Poka-Yoke in the implementation of Lean 4.0-which combines robotics, digital twins, IoT, and big data-has proven to make the process error-proofed, productivity increased, variation decreased, and production yield to 100% (Rahardjo et al., 2023).

In other areas, Ferrera (2017), Silva et al. (2018), and Mayr et al. (2018) highlight that cloud-based IoT and condition monitoring through machine learning support the reduction of lead time, inventory waste, downtime, and rework, and improve TPM quality and efficiency (Marinelli et al., 2021). GE's case in the aviation industry shows that the digital twin with Lean and Kaizen increases uptime by 30% and reduces inspections by 25% (Ghelani, 2021). Overall, the synergy between Lean Kaizen 5S and advanced technology forms smart manufacturing characterized by leaner process flow, higher flexibility, proactive decision-making, and improved quality and continuity of improvement. The findings of this literature reinforce the understanding that it is this comprehensive integration that brings tangible efficiency benefits and competitive advantage across industries.

4. Conclusions and Suggestions

This study has systematically reviewed and synthesized various effective strategies in production management aimed at improving operational efficiency across different industrial contexts. The analysis revealed that both traditional process improvement methods such as Lean Manufacturing, Value Stream Mapping (VSM), Kaizen, and 5S and emerging technologies such as Big Data Analytics, Digital Twin, and Smart Manufacturing Platforms play significant roles in optimizing productivity and reducing operational waste. The findings indicate that integrated approaches, combining process discipline and digital innovation, lead to measurable improvements such as increased production cycle efficiency (PCE), shorter lead times, and reduced downtime. Additionally, case comparisons from both national and international studies demonstrate that organizations capable of aligning their production strategies with Industry 5.0 principles human-centered automation, flexibility, and sustainability are more resilient and adaptive to current global challenges.

Based on these insights, it is recommended that manufacturing companies invest not only in lean practices but also in scalable digital infrastructure to support predictive analytics, real-time decision-making, and continuous improvement. Furthermore, collaboration between industry, academia, and government is essential to accelerate the adoption of digital transformation strategies across the production sector. Therefore, this study not only contributes to the academic understanding of effective production strategies but also provides a practical synthesis that can support policy formulation and strategic planning in the context of digital manufacturing transformation.

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