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Article

Implementation of lean manufacturing in the spinning industry to increase production efficiency

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ABSTRACT

The spinning industry is an important part of the textile sector that faces efficiency challenges due to the large amount of waste in the production process. This study aims to analyze the implementation of Lean Manufacturing as a strategic approach to improving production efficiency in one of the medium-scale spinning companies in West Java. Using a qualitative descriptive method, data were obtained through direct observation, in-depth interviews with six key informants, and analysis of company documents. The results of the study indicate that the application of Lean principles such as 5S, Just-In-Time (JIT), Total Productive Maintenance (TPM), and Visual Management can reduce waiting time between processes by 55%, reduce the frequency of machine breakdowns by 62.5%, and increase the orderliness of the work area by 68%. Even so, the implementation of lean is not free from challenges such as the mismatch of production schedules with machine readiness, resistance to work culture from senior employees, and lack of in-depth understanding of lean tools. This study confirms that the success of Lean Manufacturing depends not only on the tools used, but also on the readiness of the organizational culture and supporting information systems. These findings provide practical contributions to the development of efficient and sustainable operational management strategies in the spinning industry, and offer recommendations in the form of integrated training, integration of production information systems, cross-departmental evaluation, periodic lean audits, and performance-based reward schemes.

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Introduction

The spinning industry is one of the important sectors in the textile industry that plays a significant role in the national economy (Delhom et al., 2017; Sugeng et al., 2022). The production process in this industry involves various complex stages and requires high efficiency to meet the increasing market demand (Darmawi et al., 2023; Rüßmann et al., 2015). However, many spinning companies face challenges in the form of high levels of waste in the production process, such as long waiting times, excess inventory, and inefficient processes (Kumar, 2014). This waste not only increases production costs but also reduces the company's competitiveness in the global market (Bevilacqua et al., 2014; Saleeshya et al., 2012).

Lean Manufacturing is a systematic approach in production management that aims to improve efficiency by identifying and eliminating waste in the manufacturing process (Darmawi et al., 2024; Leksic et al., 2020; Narassima et al., 2025). This waste can be activities that do not add value, such as waiting times, unnecessary transportation, or overproduction (Irfan et al., 2025). By applying Lean principles, companies can reduce operational costs, improve product quality, and speed up production time (Roriz et al., 2017; Smith & Hawkins, 2004). For example, research by Rahmayanti and Qomariah (2023) at PT Kunango Jantan identified that transportation activities, waiting, and product defects are the three largest sources of waste in the production of street light poles. To address this, they recommend scheduling machine maintenance, raw material control planning, and adjusting engine layouts to minimize repetitive transportation (Rahmayanti & Qomariah, 2023).

The implementation of Lean Manufacturing has also proven to be effective in increasing the company's profitability through inventory minimization (Abu Nimeh et al., 2018; Hofer et al., 2012). A study by Wirawana and Yunus (2022) on the electronics and automotive industry in Indonesia shows that Lean Manufacturing practices can reduce excessive inventory levels, thereby lowering the costs incurred by the company and ultimately increasing profitability. This research emphasizes the importance of the comprehensive implementation of Lean Manufacturing to achieve operational efficiency and competitive advantage in the manufacturing industry (Wirawana & Yunus, 2022).

Lean Manufacturing has been known as an effective management approach in identifying and eliminating waste in various manufacturing industries (Parmawati, 2022, 2024; Prambudi & Giyanti, 2021). The main principle of Lean Manufacturing is to create maximum value for customers by using the least possible resources through the elimination of activities that do not provide added value (Almahdy et al., 2021; Begum et al., 2024). The implementation of Lean Manufacturing is expected to improve operational efficiency, reduce production costs, and improve product quality. Several studies have shown that the implementation of Lean Manufacturing is able to significantly improve production efficiency in various industrial sectors (Setiawan, 2022; Suwanda, 2023).

Although the benefits of Lean Manufacturing have been widely proven, its application in the spinning industry is still relatively limited. The spinning industry has unique characteristics, such as continuous production processes and the use of high-speed machines, which require a special approach in implementing Lean. In addition, challenges such as resistance to change, lack of understanding of Lean principles, and limited skilled human resources are obstacles to the implementation of Lean Manufacturing in this industry. Therefore, in-depth research is needed to understand how Lean Manufacturing can be implemented effectively in the context of the spinning industry.

The urgency of this research lies in the urgent need for the spinning industry to improve production efficiency in order to maintain competitiveness in the global market. With increasing pressure from the international market and consumer demands for high-quality products at competitive prices, spinning companies are required to continuously make continuous improvements in their production processes. The implementation of Lean Manufacturing is expected to be a strategic solution in facing these challenges.

Several previous studies have discussed the application of Lean Manufacturing in various industrial sectors. For example, research by Suprayitno (2023) shows that the integration of Lean Manufacturing with digital technologies such as Artificial Intelligence (AI) and the Internet of Things (IoT) can improve operational efficiency and reduce waste in a production environment with high variability (Suprayitno, 2024). In addition, the study by Wibowo (2023) emphasizes the importance of a holistic approach in the implementation of Lean Manufacturing, including the application of 5S, Just In Time (JIT), Kaizen, and the PDCA cycle concepts to achieve effective operational management (Wibowo, 2023). However, there are still few such studies that specifically highlight the application of Lean Manufacturing in the spinning industry.

Based on this background and urgency, this study aims to analyze the implementation of Lean Manufacturing in the spinning industry in order to improve production efficiency. This research will identify the types of waste that occur in the spinning production process, evaluate the effectiveness of applying Lean principles, and provide strategic recommendations for the optimization of the

production process. It is hoped that the results of this research can contribute to the development of more efficient and sustainable operational management practices in the spinning industry.

Methods

This study uses a qualitative descriptive method to analyze the implementation of Lean Manufacturing in the spinning industry with the aim of improving production efficiency (Sugiyono, 2018). The qualitative descriptive method was chosen because it allows researchers to understand the phenomenon in depth and describe the situation that occurs in the field systematically and factually.

The data in this study was obtained through direct observation at the production site, in-depth interviews with production managers and machine operators, as well as the analysis of documents related to the production process and company performance reports. Direct observation allows researchers to observe production activities in real time and identify potential waste. In-depth interviews were conducted to explore information about the understanding and experience of workers related to the application of Lean Manufacturing principles. Document analysis is used to review historical production data, operational standards procedures, and relevant company policies (Creswell, 2021).

The location of this research was carried out in one of the medium-scale spinning companies operating in the West Java region, which in this study is disguised as "PT. XYZ". The company has a large daily production capacity and has been running an automated machine-based production process with a shift system for 24 hours. The selection of this location was based on the consideration that the company has started to implement some Lean Manufacturing principles although not thoroughly. Therefore, this company is considered representative to be used as a case study in analyzing the effectiveness of the implementation of Lean Manufacturing in improving production efficiency in the spinning industry.

In this study, the interview sample was selected purposively by considering the relevance and experience of the informant to the research topic. Interviews were conducted with six people consisting of two production managers, two production line supervisors, and two machine operators, all of whom had at least five years of work experience. The information explored covers strategic, operational, and obstacles to the implementation of Lean Manufacturing in the field, including its effect on the quality of production results.

The data analysis technique used in this study is thematic analysis, which involves identifying, organizing, and interpreting patterns or themes that emerge from the data that has been collected (Bowen, 2009). The analysis process begins with the transcription of interview data, then coding is carried out to group the data based on certain themes, such as the type of waste identified, the factors causing the waste, and the improvement efforts that have been made. Furthermore, these themes are analyzed to understand the relationships between variables and develop strategic recommendations to optimize the production process.

Results and Discussion

This study was conducted to evaluate the implementation of Lean Manufacturing in the spinning industry with a focus on efforts to improve production efficiency. The data was obtained through interviews with six key informants who had more than five years of work experience and represented various levels of the organization, from managers to production operators. The findings revealed reflect the real conditions of the field and processes that intersect directly with the spinning production flow, from raw materials to Finished Goods Warehouses (GBJ).

The results of the interviews showed that the informants' understanding of the concept of Lean Manufacturing varied depending on their role and work experience, but in general they understood the basic principles, namely the elimination of waste and the achievement of production efficiency. Informants from the managerial level emphasize more on lean strategic aspects such as the

importance of value stream efficiency, timely scheduling, and human resource optimization. A production manager revealed, "Lean is not just about savings, but how the whole process can run without friction and waste."

Meanwhile, informants from the operational level such as supervisors and operators are more focused on the direct implementation of lean in the field. They understand lean as an effort to speed up work processes, reduce wait times, and avoid repeated mistakes. A production line supervisor said: "In the past, there were a lot of overlapping work steps, now it's more concise because we know which ones are wasteful." While operators emphasize visual control and involvement in daily work evaluations, "We now better understand the importance of quality control at each stage, not just at the end."

Awareness of the importance of continuous improvement has also begun to grow. The concept of Kaizen is not only understood theoretically, but it is beginning to be applied even though it is still limited. One operator admitted, "We often propose small ideas such as changes in the layout of the tool, but it turns out that it has an effect." A work culture that supports continuous improvement is beginning to take shape, although resistance from a small number of employees is still a challenge.

Implementation of Lean Tools

The implementation of lean tools in the spinning industry shows variations in implementation based on the production stage and the level of employee understanding of each lean tool. The results of the interviews show that Just-In-Time (JIT), 5S, Visual Management, and Total Productive Maintenance (TPM) are the most widely used tools. In the blowing, carding, and winding sections, each tool has specific functions aimed at overcoming different wastes, ranging from waiting times, inefficient movements, to machine failures.

According to the production line supervisor, "With the presence of color markings and clear arrangement of tools, we no longer have to waste time looking for work equipment." This statement shows that visual management functions not only as a visual aesthetic tool but also as a tool for time management and efficiency. Tools and work areas are labeled and color-coded, which makes it easy for workers to quickly recognize the location of the tool, the condition of the materials, and the status of the machine.

The implementation of 5S (Seiri, Seiton, Seiso, Seiketsu, Shitsuke) has also begun to be cultivated, although it is not comprehensive in all areas. The operator said that the arrangement of the work area is routinely carried out and there is a schedule for machine cleaning per week. One operator said, "The work area is now cleaner and tidier, so it's more comfortable to work with, and it's also safe."

Table 1. Application of Lean Tools in Each Production

Production Stages	Lean Tools Applied	The main purpose	Impact Felt
Blowing	TPM, 5S	Reduce downtime and improve machine cleanliness	Reduced downtime and increased work safety
Carding	Visual Management, 5S	Makes it easier to monitor the status of materials and tools	Acceleration of tool search process and reduction of confusion
Drawing	JIT, Visual Management	Process synchronization between machines	Reducing waiting time between processes
Spinning	5S, TPM	Maintaining machine and work area performance	More stable process and more durable machine
Winding	Visual Management, JIT	Output control and scheduling efficiency	More standardized output and more timely delivery

On the other hand, Total Productive Maintenance (TPM) becomes very crucial in the early stages of the spinning process, such as in blowing, where many machines are exposed to fiber impurities. The informant mentioned that before the implementation of TPM, downtime due to engine interference could reach twice a day. Now, with routine preventive checks, the disturbance is

significantly reduced. "In the past, I often had to stop because the engine was clogged, but now it has been much reduced since there is a routine maintenance schedule," said one of the technicians.

Implementation Challenges

Table 2. Challenges

Challenge	Category	Impact on Production
Mismatch of schedule and machine readiness	Technical	Process flow disturbances, accumulation of intermediate results
Work culture resistance (senior workers)	Organizational	Delays in SOP adaptation, gaps in work practices
Lack of information system integration	Systemic	Delays in raw materials, stagnation of production processes
Limited understanding of lean tools	Human Resources Capacity	Misperception of lean goals, suboptimal implementation

The application of Lean Manufacturing in the spinning industry is inseparable from various significant challenges, both from the technical and cultural sides. The first and most striking challenge is the mismatch of the production schedule with the readiness of machines and raw materials. This has an impact on the disruption of the overall production flow, especially in the drawing and spinning process which is highly dependent on the quality and continuity of the results of the carding process. One of the production managers said, "Before lean was implemented, production schedules were often out of sync, especially in the drawing department which was very sensitive to the quality of the carding results." This discrepancy shows the lack of optimal production planning systems as a whole, which is one of the important pillars of a lean approach.

The next challenge is the resistance of work culture, especially from senior workers who are used to the old work system. Some of them show a passive attitude or even rejection of changes in work procedures that are more structured and based on standard operating procedures (SOPs). A supervisor said, "We have to re-socialize the new SOP because some operators feel that their old ways are faster and are used to it." This shows that lean transformation is not only a technical change, but also a cultural transformation of the organization, which requires an ongoing communication and training approach.

From a technical perspective, the lack of information system integration also hinders the implementation of Just-In-Time (JIT). Data discrepancies between the production department and the warehouse cause delays in the delivery of raw materials to the machines. "Sometimes the material has run out in the machine, but the report in the system still shows that the stock is there. This makes the process stagnant," said one of the operators. This data inequality has the potential to eliminate the efficiency that lean aspires to.

In addition, there is also a lack of in-depth understanding of lean tools, especially in the use of value stream mapping (VSM) and Kaizen. Many employees consider lean to be limited to the arrangement of work areas or 5S, without understanding the role of sustainable strategies in eliminating waste and increasing value for customers.

Impact on Production Efficiency

The application of Lean Manufacturing principles in the spinning process has a significant impact on various aspects of production efficiency. One of the most noticeable changes is the reduction in wait times between processes. Before lean was implemented, the flow of materials from the carding process to drawing was often delayed due to irregularities in scheduling arrangements and limited storage space between processes. However, after the implementation of the pull-based and kanban system, the transfer process became more organized and there were fewer delays. One supervisor stated, "Now material turnover is more scheduled so that no time is wasted."

The reliability of the machine has also improved thanks to the implementation of Total Productive Maintenance (TPM) which is part of the lean strategy. The frequency of damage decreases due to routine checks and preventive treatments. The machine operator revealed, "In the past, we waited

for the damage to be repaired, now we have a weekly checking schedule." This directly contributes to increased machine uptime and reduces unproductive downtime.

The implementation of 5S has a direct impact on improving the cleanliness, order, and safety of the work area. The rearrangement of work tools, labeling, and cleaning discipline make the work process more ergonomic and have minimal risk of work accidents. The production manager emphasized, "The work area is more orderly now, operators can quickly find the tools they need without wasting time."

Table 3. Impact of Lean on Process Time and Machine Reliability

Indicator	Before Lean	After Lean	Change (%)
Waiting time between processes (minutes)	45	20	↓ 55
Frequency of machine failure/month	8	3	↓ 62.5
Average repair time (hours)	3.5	1.8	↓ 48.6
Level of orderliness of work area	2.5 (out of 5)	4.2 (out of 5)	↑ 68

The data above shows that Lean Manufacturing not only has an impact on operational aspects such as reducing process time, but also improving the quality of the work environment which ultimately strengthens overall efficiency.

Discussion

The results of this study are in line with various previous studies that show that Lean Manufacturing can improve production efficiency in the manufacturing sector, including the textile and spinning industries. Zahroh & Lestari (2020) noted that the efficiency gained from the implementation of lean not only includes production time but also touches on product quality aspects. These findings are reinforced by Rachman et al. (2021) who found that the simultaneous implementation of 5S, TPM, and Kaizen is able to cut process time by up to 40% (Abd Rahman et al., 2021). This study shows a similar impact, where the application of lean principles has succeeded in reducing waiting time between processes, minimizing machine downtime, and improving the regularity of the workspace.

The connection with the theory of Lean Manufacturing is very clear. The principle of waste elimination arises from value stream mapping that identifies non-productive times such as waiting for materials or arranging work tools. In this study, the implementation of 5S helped reduce motion and inventory type waste. Meanwhile, the Kaizen philosophy is reflected in the production team's involvement in weekly evaluation meetings to look for opportunities for continuous improvement. The principle of Just-In-Time has also begun to be adopted through the kanban system, albeit in a simple form, to improve the flow of raw materials from carding to drawing.

The study also highlights implementation challenges, especially resistance from senior workers. Some operators feel that changes in work procedures interfere with the comfort of work that has been lived for many years. A statement from one of the supervisors reflected this: "It takes time to convince operators that 5S is not just a cleanup, but that there is a direct effect on their speed of work." This phenomenon is in line with Prasetyo & Hartini (2022) who stated that cultural resistance is the main obstacle to lean transformation, especially in companies that do not have a culture of continuous improvement.

The unique feature of this study is its focus on the spinning industry–a sector that has a high complexity in the production process due to the close interconnectedness between the production stages. Many Lean studies focus on the automotive or assembly industry (Ardiansyah et al., 2021), but have not discussed much in the context of textiles. The case study approach provides a concrete picture of how each lean tool translates in the context of a spinning production line.

By practical implication, the management of the spinning industry can use the Lean framework as a strategic approach to streamline resources, especially in conditions of market pressure and cost efficiency needs. The implementation of lean must be accompanied by continuous training, open communication between lines, and top management support for the transformation to run optimally.

Recommendations and Improvement Strategies

Based on the findings of the field, there are several strategic steps that can be taken by management to increase the effectiveness of Lean Manufacturing implementation in the long term.

First, companies need to build integrated training programs that are not only technical but also address aspects of lean culture and collaborative problem-solving. The program should be sustainable and involve all lines of the organization, from managers to operators. With tiered training, an understanding of principles such as waste elimination, just-in-time, and continuous improvement can be understood consistently. This is important to prevent miscommunication between levels and ensure alignment of production objectives.

Second, it is important for companies to develop a digital-based production information system that can monitor real-time work progress at each stage of production. This system must be able to integrate data from the blowing area to the winding, as well as generate key performance indicators (KPIs) such as cycle time, machine downtime, and production defect levels. This production data visualization can be displayed in the form of a dashboard that is easily accessible to management and field teams to support quick and accurate decision-making.

Third, companies need to establish a cross-departmental evaluation team involving operators, supervisors, and managers as a regular discussion forum (e.g. once every two weeks). This forum can function as a place to identify the root of the problem, discuss solutions based on lean tools such as Fishbone Diagram and 5 Why's, as well as share best practices between lines. Active operator involvement will foster a sense of ownership towards change and increase motivation to support efficiency collectively.

Fourth, it is recommended to conduct an internal audit of lean periodically, such as quarterly, to measure the extent to which the implementation of lean principles is in accordance with the plan. The results of this audit can be used to create a more specific and measurable action plan, as well as to identify priority areas for improvement.

Finally, companies are advised to build a lean performance-based reward system, where employees who provide ideas for process improvements or achieve specific efficiency targets are incentivized. This scheme aims to encourage bottom-up innovation and strengthen a culture of continuous improvement.

Conclusion

The implementation of Lean Manufacturing in the spinning industry has proven to significantly improve production efficiency, evidenced by a reduction in waiting times, fewer machine breakdowns, and improved orderliness in the work areas. Key Lean principles such as 5S, Just-In-Time (JIT), Total Productive Maintenance (TPM), and Visual Management have had direct, measurable impacts on reducing operational inefficiencies. However, the success of these initiatives is contingent not only on the application of these tools but also on the alignment with organizational culture and the readiness of the workforce to adopt Lean practices.

While the findings demonstrate the potential of Lean Manufacturing in improving efficiency, the scope of this study is limited in several ways. First, the research was conducted in a single medium-scale spinning company located in West Java, which may limit the generalizability of the results to other companies within the spinning industry or to those in different regions. Additionally, this study relied predominantly on qualitative data obtained from interviews, direct observation, and document analysis, which, while rich in detail, may lack the empirical rigor that quantitative research could provide. The absence of a comparative approach, such as benchmarking against companies that did not implement Lean, further limits the study's ability to definitively attribute the observed

improvements solely to the Lean practices themselves. These limitations suggest that while the results are promising, they should be interpreted with caution and not be assumed to apply universally across all industrial contexts.

The findings of this study underscore the importance of a holistic approach in implementing Lean Manufacturing. Companies in the spinning industry should consider integrating comprehensive training programs that address both technical Lean tools and the cultural shifts needed for successful Lean adoption. Additionally, companies should prioritize the development of digital-based production information systems to enable real-time monitoring and data-driven decision-making, ensuring that Lean principles are applied consistently across all production stages.

Further research is needed to validate these findings in different contexts and industries. Conducting multi-location quantitative studies could provide a broader understanding of Lean's impact on production efficiency across various spinning companies and regions. Additionally, future studies could explore the integration of Lean Manufacturing with emerging technologies, such as the Internet of Things (IoT) and Artificial Intelligence (AI), to enhance data analytics capabilities and further optimize production processes. Research into the cultural resistance to Lean transformation and the development of economic evaluation models post-Lean implementation would also provide valuable insights into the long-term sustainability of Lean practices in the spinning industry.

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