

Applied Lean Warehousing-Based Optimization of Warehouse Processes at PT. XYZ Using Value Stream Mapping

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Abstract—Incoming warehouse operations are essential for maintaining material readiness in manufacturing systems. In practice, inefficiencies within these operations may increase lead time and generate activities that do not contribute to value creation. This study focuses on enhancing the performance of the incoming warehouse process at PT. XYZ through the application of lean warehousing supported by Value Stream Mapping (VSM). The study was carried out by examining the actual condition of receiving, recording, and storage activities using direct observation, time measurement, and process mapping. All identified activities were categorized according to their contribution to value creation. Process performance was assessed using Process Cycle Efficiency (PCE) to quantify the ratio of value-added time to total lead time. The results indicate that the existing incoming warehouse process required 296 minutes to complete, with a PCE of 74.66%, reflecting the presence of non-value-added activities, particularly related to waiting and unnecessary movement. Improvement actions were then formulated using future state value stream mapping and workplace organization. The proposed future condition reduced the total lead time to 273 minutes and increased the PCE to 80.95%. These findings show that lean warehousing implementation can effectively improve process efficiency by reducing non-value-added activities in incoming warehouse operations. The study provides practical insight for manufacturing companies seeking to improve inbound warehouse performance through structured waste reduction initiatives.

Keywords: *Lean warehousing; Value stream mapping; Incoming warehouse; Process cycle efficiency; Lead time minimization.*

I. INTRODUCTION

Warehousing plays a crucial role in supporting logistics and production performance in manufacturing industries. Inefficient warehouse operations can increase lead time, raise operational costs, and disrupt material availability for production activities. The incoming warehouse process, in particular, is a critical control point because it handles material reception, inspection, recording, and storage before materials are released to production. Inefficiencies at this stage may propagate throughout the supply chain and negatively affect overall operational performance.

In warehouse operations, various forms of waste frequently occur, including waiting, unnecessary motion, and overprocessing. These activities don't add value to the product but consume significant time and resources. Barry et al. (2023) identified waiting time as a dominant source of inefficiency in inbound warehouse activities, particularly during document verification and material handling processes. Similarly, Mahen et al. (2023) reported that excessive non-value-added activities increase total lead time and reduce productivity in warehouse operations. These results emphasize the need for a structured approach to identifying and reducing waste within incoming warehouse operations.

Lean warehousing is an approach derived from lean principles that aims to improve warehouse performance by minimizing waste and maximizing value-added activities. Lean warehousing emphasizes process simplification, work standardization, and continuous improvement to enhance operational efficiency. (Afif & Sudarto, 2022). Putra & Widjajati (2025) Further emphasized that lean warehousing implementation can reduce operational inefficiencies by focusing on eliminating activities that do not contribute directly to customer value.

Recent studies emphasize that lean warehousing has become a dominant approach for improving

warehouse operational efficiency by focusing on waste elimination and flow optimization. Ikatrinasari (2023) demonstrated that warehouse activities such as receiving, storage, and material handling often contain a high proportion of non-value-added activities, which can be effectively identified using value stream mapping (VSM) and improved through 5S implementation.

Furthermore, Adeodu et al. (2023) showed that applying lean-oriented warehouse improvement frameworks results in notable gains in key performance metrics, especially lead time and process cycle efficiency (PCE), by systematically reducing waiting time and unnecessary movements. These findings are supported by Julião & Reis (2025), who proposed a structured lean-driven framework for warehouse optimization, emphasizing the importance of visual process mapping and continuous improvement to sustain performance gains.

Although previous studies have extensively discussed lean implementation in warehouse environments, research focusing on detailed optimization of incoming warehouse processes in manufacturing companies remains limited. This gap indicates the need for applied studies that integrate VSM and efficiency measurement to improve inbound warehouse performance, such as the case examined at PT. XYZ.

Value Stream Mapping (VSM) is commonly applied in lean warehousing to visualize material and information flows throughout a process and to distinguish between value-added activities, non-value-added activities, and necessary non-value-added activities. (Ramadhanti et al., 2023). Pamungkas & Aryanny (2025) demonstrated that VSM is effective in identifying waste and process imbalance in warehouse flow activities, thereby supporting data-driven decision-making for process improvement.

Several studies have confirmed the effectiveness of lean warehousing and VSM in improving warehouse performance. Ardysti & Ernawati (2025) reported that lean warehousing implementation successfully reduced waiting and motion waste in warehouse operations. In addition, Nurulita (2024) found that the application of lean principles improved operational efficiency and process consistency in logistics service providers. However, most existing studies focus on general warehouse operations or outbound logistics, while detailed quantitative evaluations of incoming warehouse

processes in manufacturing environments remain limited.

In manufacturing companies that have partially adopted digital warehouse systems, inefficiencies may persist due to system connectivity limitations, unstandardized administrative procedures, and an imbalance in workload distribution. These conditions create a gap between the potential efficiency offered by digitalization and the actual operational performance observed in daily activities. Therefore, an integrated analysis combining lean warehousing principles and Value Stream Mapping is required to comprehensively evaluate incoming warehouse processes and identify practical improvement opportunities.

Considering the identified challenges, this study examines the optimization of the incoming warehouse process at the company by implementing a lean warehousing framework based on Value Stream Mapping. The objectives include analyzing activity classifications, measuring process efficiency through Process Cycle Efficiency (PCE), and formulating improvement proposals aimed at reducing lead time and waste. The findings of this research are expected to provide practical insights for improving incoming warehouse performance and contribute to empirical studies on lean warehousing implementation in manufacturing logistics systems.

II. RESEARCH METHOD

A. Research Design

The study was conducted by examining a specific case of an incoming warehouse process to assess its performance and identify opportunities for improvement. The descriptive approach was used to capture the actual conditions of warehouse activities, while the analytical approach was applied to identify inefficiencies and propose improvement initiatives. This research integrated quantitative analysis, in the form of time measurement and efficiency calculation, with qualitative analysis, including observation and process interpretation, to obtain a comprehensive evaluation of warehouse performance. (Afif & Sudarto, 2022).

The research framework was based on lean warehousing principles, which focus on waste elimination and process efficiency improvement. The study utilized Value Stream Mapping (VSM) as the principal analysis tool, as it allows process flows to be mapped in detail and supports the

identification of non-value-added activities. (Ramadhanti et al., 2023).

B. Research Object and Scope

The object of this research was the incoming warehouse process at PT. XYZ, specifically within the Warehouse Part area. The incoming process consisted of receiving, recording, and storing activities. The scope of the study was limited to internal warehouse operations, excluding external transportation activities, to maintain analytical focus and data consistency.

The research emphasized the evaluation of process lead time, waste occurrence, and process efficiency, as these indicators are commonly used to assess warehouse operational performance. (Mahen et al., 2023). The limitation of scope allowed for detailed observation and precise measurement of activities that directly contribute to incoming warehouse performance.

C. Data Collection Methods

Data collection was conducted through direct observation, time study, and document review. Direct observation was carried out to understand the actual workflow and operational practices within the incoming warehouse process. A time study was performed to measure the duration of each activity, enabling the identification of bottlenecks and time-consuming tasks.

Document review included the examination of work instructions, operational records, and system-generated data to validate the observed process flow. This combination of data collection methods ensured data reliability and minimized observation bias, as recommended in warehouse efficiency studies. (Barry et al., 2023).

D. Process Mapping Using Value Stream Mapping

Value Stream Mapping (VSM) was applied to represent the sequence of material and information flows throughout the incoming warehouse process, starting from receiving activities to storage. The mapping process involved identifying each operational step, determining cycle time, and documenting information flow between operators and systems.

The VSM analysis was carried out through two stages. The current state mapping captured the actual operating conditions and identified sources of inefficiency, while the future state mapping depicted the redesigned process following

improvement initiatives. The use of VSM enabled a structured visualization of process performance and supported systematic improvement planning. (Pamungkas & Aryanny, 2025).

E. Activity Classification and Waste Identification

Activities mapped using VSM were categorized into three types based on their contribution to value creation, namely VA, NVA, and NNVA. This classification aims to distinguish productive activities from those that do not contribute directly to customer value.

Waste identification focused on activities categorized as NVA and NNVA. The dominance of waste was identified based on the frequency and duration of non-value-added activities, with particular attention to waiting, overprocessing, and motion. These waste types are commonly found in warehouse operations and significantly affect lead time and productivity. (Ardysti & Ernawati, 2025).

F. PCE (Process Cycle Efficiency)

Process efficiency was assessed using Process Cycle Efficiency (PCE), a metric that represents the proportion of value-added time relative to the overall process lead time. The PCE value was determined using the following equation.:

$$P = \frac{V}{T} \times \frac{A}{T_i} \times 100\% \quad (1)$$

PCE was applied as the main indicator to examine incoming warehouse efficiency, with calculations performed under existing conditions and after the proposed improvements to assess their impact. PCE is widely used in lean-based warehouse studies to quantify process efficiency and identify improvement potential (Putra & Widjajati, 2025).

G. Root Cause Analysis

To identify the sources of waste, a root cause analysis was carried out using a fishbone diagram that categorized inefficiencies into man, machine, method, and material factors. This approach facilitated structured problem identification and supported the formulation of targeted improvement strategies.

The fishbone analysis enabled the identification of issues such as administrative delays, limited equipment availability, unstandardized procedures, and material handling constraints.

Similar analytical approaches have been applied effectively in warehouse waste reduction studies. (Nurulita, 2024).

H. Development of Improvement Proposals

The proposed improvements were derived from the results of waste analysis and the identification of underlying causes. Lean warehousing principles were applied to redesign the process flow, focusing on reducing waiting time, minimizing overprocessing, and improving workplace organization. The proposed improvements incorporated process standardization and workplace organization concepts, such as 5S, to support sustainable efficiency improvement.

The proposed improvements were visualized using Future State Value Stream Mapping, which illustrated the expected process condition after implementation. This approach aligns with previous studies that emphasize the importance of visual tools in supporting lean-based improvement initiatives. (Dzulkifli & Ernawati, 2021).

I. Evaluation of Improvement Results

The effectiveness of the proposed improvements was evaluated by comparing Current State and Future State performance indicators. The primary indicators used were total lead time and PCE. The comparison aimed to assess the extent to which lean warehousing implementation reduced waste and improved overall process efficiency.

This evaluation approach enabled objective assessment of improvement outcomes and

provided quantitative evidence of the effectiveness of the proposed solutions, consistent with methodologies used in applied industrial engineering research. (Shafalah et al., 2025).

The selection of value stream mapping (VSM) as the primary analytical tool in this study is consistent with recent warehouse optimization research. Ikatrinasari (2023) showed that Value Stream Mapping enables the visualization of process flows and facilitates the categorization of warehouse activities into value added activities and non-value-added activity types.

Furthermore, PCE serves as a quantitative metric for examining the performance outcomes of lean implementation in warehouse activities. Adeodu et al. (2023) utilized PCE to assess efficiency improvement in warehouse operations and confirmed its suitability for measuring the impact of waste reduction initiatives. The use of fishbone diagrams for root cause analysis in this study also aligns with the lean-driven warehouse frameworks proposed by Julião & Reis (2025), which integrate cause-effect analysis to identify sources of inefficiency systematically.

III. RESULTS AND DISCUSSION

A. Analysis of Current State Incoming Warehouse Process

The analysis of the incoming warehouse process at PT. XYZ was initiated by mapping the existing condition using Current State Value Stream Mapping (VSM). The incoming process consists of three main stages, namely receiving, recording, and storage. Each stage involves several activities that contribute differently to process performance.

Table 1. Incoming Process Activity Table

No	Incoming Activity Detail	VA	NVA	NNVA
Receiving				
1	Driver reports to receiving officer and submits the delivery note for verification.			2
2	Receiving officer checks vehicle condition, KIR document, and the condition of the goods inside the vehicle.			5
3	Driver moves pallets in preparation for unloading.			10
4	Unloading process is performed by the driver	61		
5	The receiving officer checks the completeness and condition of goods according to the delivery documents	46		
6	Transfer of inspected goods to temporary warehouse area (direct items) and to designated locations (indirect items)	32		
7	Receiving officer documents the delivery note through MITA Insight system.		5	
8	Receiving officer hands over the delivery note to the warehouse admin for the data entry process			2
Record				
1	Input incoming goods data into the nice system	25		
2	Scanning delivery notes for digital archiving			14
3	Sorting delivery notes and invoices to be sent to Purchasing & Logistics department		5	
Storage				
1	Move goods to the designated warehouse location	12		
2	Unpacking goods by packaging unit		20	
3	Checking quantity and type of goods against labels			8
4	Material testing by Quality Control	30		
5	Registration process in the My Warehouse system		4	
6	Storing goods according to the assigned location	15		

Based on time study results, the total lead time of the current incoming warehouse process was 296 minutes. Activity classification showed that 221 minutes were categorized as Value Added (VA), while the remaining time consisted of Non-Value Added (NVA) and Necessary Non-Value Added (NNVA) activities. Using these data, the Process Cycle Efficiency (PCE) of the current process was calculated at 74.66%, indicating that more than one-quarter of the process time did not

directly contribute to value creation.

These findings suggest that although the incoming process already demonstrates a relatively high proportion of value-added activities, there remains significant potential for improvement through waste reduction. Similar conditions have been reported in warehouse operations where administrative delays and waiting time dominate non-value-added activities (Barry et al., 2023).

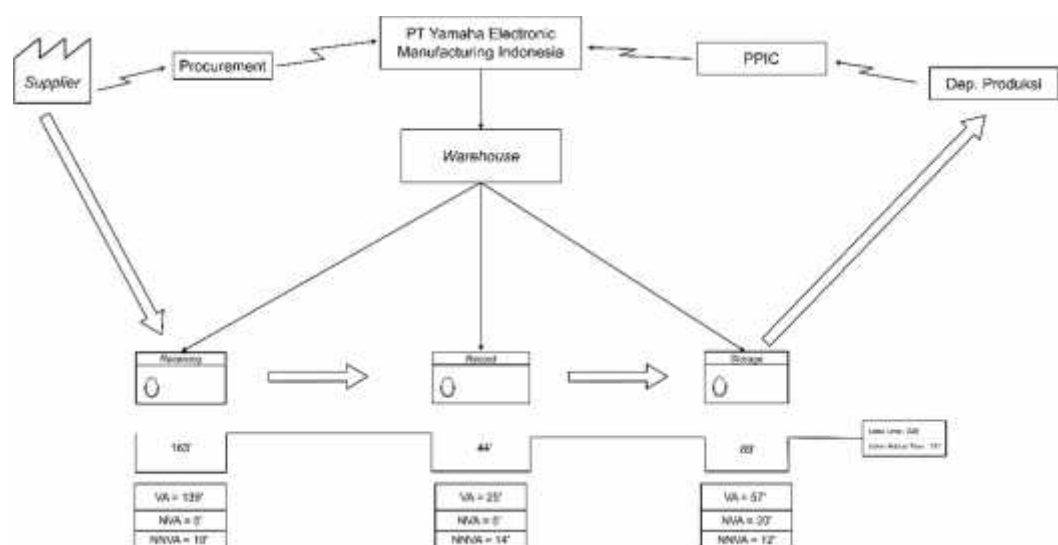


Figure 1. Current Value Stream Mapping

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B. Waste Identification in the Incoming Warehouse Process

Waste identification was conducted based on

activity classification results. The dominant waste types identified in the current incoming process were waiting, overprocessing, and motion. Waiting waste occurred primarily during document verification, pallet availability, and system input processes. Overprocessing waste was found in repetitive document scanning and manual administrative procedures, while motion waste resulted from unnecessary material handling during unloading and storage preparation.

Table 2. Waste Identification in Incoming Warehouse Activities

No	Waste Type	Incoming Activity Detail	Operation
1	Waiting	Driver reports to the receiving officer and submits the delivery note for verification.	Receiving
2	Waiting	The receiving officer checks vehicle condition, KIR documents, and the condition of the goods inside the vehicle.	Receiving
3	Waiting	Driver waits for pallets in preparation for unloading	Receiving
4	Waiting	The receiving officer documents the delivery note through MITA Insight, delayed due to a poor signal.	Receiving
5	Waiting	Receiving officer hands over the delivery note to the warehouse admin for the data input process	Receiving
6	Overprocessing	Scanning delivery notes for digital archiving	Record
7	Overprocessing	Sorting delivery notes and invoices to be sent to the Purchasing & Logistics department	Record
8	Motion	Unpacking goods by packaging unit without nearby trash bins	Storage
9	Waiting	Checking the quantity and type of goods against labels	Storage
10	Waiting	The registration process in the My Warehouse system is delayed due to a poor signal.	Storage

Waiting waste was identified as the most significant contributor to inefficiency, particularly during receiving and storage activities. These results align with previous studies that identified waiting as the most dominant waste in warehouse inbound processes. (Ardysti & Ernawati, 2025). Excessive waiting increases lead time without adding value and negatively impacts warehouse productivity.

C. Root Cause Analysis of Identified Waste

To identify the underlying causes of waste, a fishbone diagram was developed focusing on four

main factors: man, machine, method, and material. From the human factor, inefficiencies were caused by limited coordination between operators and incomplete document preparation by drivers. Machine-related issues included limited availability of pallets and forklifts, as well as unstable system connectivity. From the method perspective, unstandardized document formats and administrative procedures extended processing time. Material-related factors included improper material arrangement and the delayed arrival of goods.

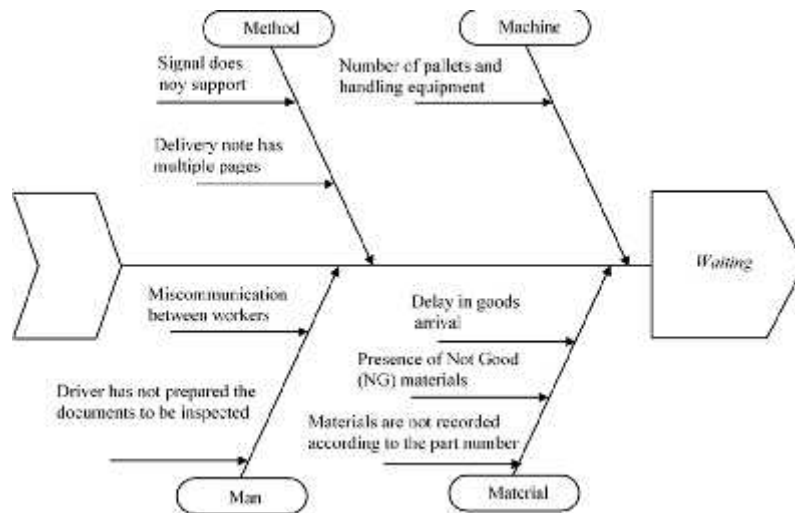


Figure 2. Fishbone Diagram of Waste Causes in Incoming Warehouse Process

This analysis confirms that waste in the incoming warehouse process is not caused by a single factor but by an interaction of operational, technical, and procedural issues. Similar findings were reported by Nurulita (2024), who emphasized the importance of addressing both technical and human factors in warehouse waste reduction initiatives.

The implementation of 5S was aimed at reducing waiting and motion waste by improving workplace organization and ensuring that necessary tools and materials were readily available. Previous studies have demonstrated that the application of 5S effectively supports waste reduction and operational efficiency in warehouse environments. (Dzul kifli & Ernawati, 2021).

D. Improvement Proposals Based on Lean Warehousing

Based on waste identification and root cause analysis, improvement proposals were developed using lean warehousing principles, particularly through the application of 5S and process standardization. The proposed improvements included optimizing pallet allocation, standardizing document formats, improving material layout based on part number visibility, and enhancing system access for administrative activities.

E. Future State Analysis and Process Improvement Results

The proposed improvements were visualized using Future State Value Stream Mapping. After improvement, the total lead time was reduced from 296 minutes to 273 minutes, representing a reduction of 23 minutes. Process Cycle Efficiency (PCE) increased from 74.66% to 80.95%, indicating a substantial improvement in process efficiency.

Table 3. Future Incoming Warehouse Activity Details

No	Incoming Activity Detail	V A	NV A	NNV A
Receiving				
1	The driver reports to the receiving officer and submits the delivery note for inspection.			2
2	The receiving officer checks the vehicle condition, the KIR document, and the condition of the goods inside the vehicle			2
3	The driver moves pallets in preparation for unloading.			2
4	The unloading process is carried out by the driver	61		
5	Receiving officer checks the completeness and condition of goods in accordance with the delivery documents	46		
6	Transfer of inspected goods to the temporary warehouse area (direct items) and to designated locations (indirect items)	32		
7	The receiving officer documents the delivery note through the MITA Insight system.		3	
8	The receiving officer hands over the delivery note to the warehouse admin for data entry			2
Record				
1	Input incoming goods data into the nice system	25		
2	Scanning delivery notes for digital archiving			14

The increase in PCE demonstrates that the reduction of non-value-added activities significantly improved the performance of the incoming warehouse process. These results are

consistent with previous studies that reported improved efficiency following the implementation of lean warehousing and VSM (Shafalah et al., 2025).

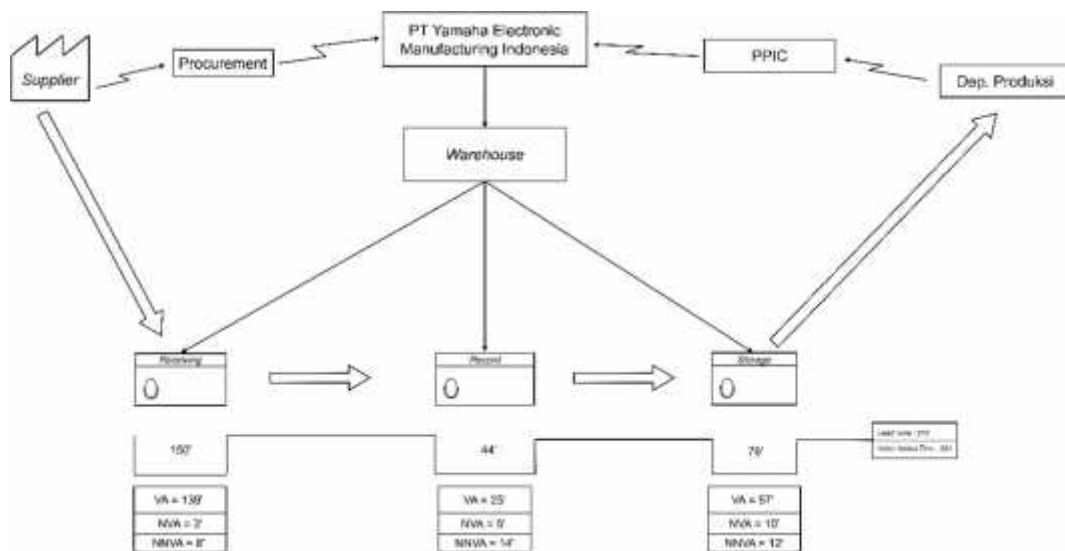


Figure 3. Future State Value Stream Mapping

The improvement results obtained at PT. XYZ is consistent with previous warehouse improvement studies applying lean warehousing principles. Adeodu et al. (2023) found that warehouse performance improved substantially, as indicated by shorter lead times and higher process cycle efficiency following the elimination of non-value-added activities. Similarly, Purnomo & Kien (2025) found that the application of lean warehousing and value stream mapping in Indonesian warehouse settings led to measurable improvements in value-added time and overall process efficiency.

From a process flow perspective, improvements achieved through layout adjustment, workplace organization, and reduction of unnecessary movement in this study align with findings by Briones-chávez et al. (2025), who emphasized that optimized material flow and reduced motion waste are critical factors in improving warehouse performance. These similarities indicate that the proposed lean warehousing improvements at PT. XYZ are not only contextually relevant but also empirically supported by prior studies.

F. Discussion of Findings

The results of this study confirm that lean warehousing combined with Value Stream

Mapping is effective in improving incoming warehouse performance. The reduction in lead time and increase in PCE indicate that waste elimination directly contributes to improved operational efficiency. Compared to previous studies, this research provides a detailed quantitative evaluation of incoming warehouse processes in a manufacturing environment that integrates both manual and digital systems.

From a practical perspective, the findings highlight the importance of standardizing administrative procedures and improving material handling coordination. Theoretically, this study confirms that lean warehousing provides a systematic means of improving efficiency in inbound warehouse operations.

IV. CONCLUSION

The findings show that implementing lean warehousing supported by Value Stream Mapping (VSM) enhances the efficiency of the incoming warehouse process at PT. XYZ. An assessment of current operations identified several non-value-added activities that contributed to longer lead times and lower process performance. The mapping of material and information flows enabled a systematic identification of

inefficiencies within receiving, recording, and storage activities.

The analysis indicates that the initial incoming warehouse process required a total lead time of 296 minutes, with a Process Cycle Efficiency (PCE) of 74.66%. Following the implementation of improvement initiatives based on lean warehousing principles—such as process standardization and workplace organization—the total lead time decreased to 273 minutes, while the PCE increased to 80.95%. These results demonstrate a substantial decrease in non-value-added activities and a more streamlined workflow within the incoming warehouse process.

The findings further emphasize that the elimination of waste, particularly waiting, overprocessing, and unnecessary motion, is essential for improving warehouse operational performance. Lean warehousing tools, including Value Stream Mapping (VSM) and 5S, enable a systematic approach to identifying inefficiencies and designing improvement actions within inbound warehouse processes.

Despite the positive results, this study has several limitations. The analysis was limited to internal incoming warehouse activities and did not

consider external transportation or supplier-related factors that may influence warehouse performance. In addition, the evaluation of improvement effectiveness was based on simulated future-state conditions rather than long-term implementation results.

The findings of this study further support existing evidence that lean warehousing is an effective approach for improving warehouse operational performance. Consistent with prior studies, the integration of value stream mapping, process cycle efficiency analysis, and structured improvement initiatives has been shown to reduce non-value-added activities and enhance process efficiency in warehouse environments (Ikatinasari, 2023).

Future research is recommended to extend the scope of analysis to include outbound processes and supplier coordination, as well as to evaluate the long-term sustainability of lean warehousing implementation. Further studies may also integrate advanced digital warehouse technologies to enhance real-time data accuracy and decision-making in inbound logistics processes.

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