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Warehouse Performance Improvement Using the Value Stream Mapping Method to Reduce Response Time for Third-Party Logistics Company

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Abstract

Lean Warehousing is a principle that aims at improving the efficiency of the warehousing system by eliminating wasteful activities within it. The principle of Lean Warehousing can be combined with the Value Stream Mapping (VSM) method to enhance efficiency in warehousing processes, including those in third-party logistics companies. The high demand for third-party logistics services and the intense competition among logistics service providers require companies to optimize their systems to remain competitive. The issue of wasteful activities in warehousing poses a significant challenge for third-party logistics providers, particularly in the categories of waiting, over-processing, and transport waste. Therefore, the Value Stream Mapping Method is used in the initial stage of the research to map the current warehousing processes comprehensively, followed by an analysis of the root causes using a Fishbone Diagram. Finally, the concept of Lean Warehousing is implemented to eliminate the existing waste in the processes. The objective of this research is to identify and eliminate waste, as well as reduce response time in the inbound and outbound processes of the third-party logistics company's warehousing system. The improvement design obtained through the analysis using Lean Warehousing and Value Stream Mapping, includes the creation of scheduling Standard Operating Procedures, the implementation of Lean 5S principles, and the use of barcodes for data input in the inbound and outbound processes. The research results indicate a reduction in process time by 25.5%, a decrease in response time by 29.4%, and a 39% improvement in the efficiency (value-added ratio) of the warehousing system.

Keywords
Warehouse, Third-Party Logistics, Value Stream Mapping, Process Efficiency, Root Cause Analysis

1. Introduction
Digital trading activities, commonly known as e-commerce, are a trend that is increasing in Indonesia. This trend began to develop significantly since the COVID-19 pandemic occurred in 2020 and will continue to grow until 2022. Indonesia occupies the first position in the percentage of e-commerce usage in the world compared to other countries, such as the UK, the Philippines, Thailand, Malaysia, and several other countries (We are Social, 2021). Data shows that Indonesian people have the highest percentage level of e-commerce use in the world with a percentage of 88.1%. This percentage beats other countries in the world such as the UK which has a percentage of 86.9%, the Philippines with 86.2%, and several other countries (CNN Indonesia, 2021). In addition, an increase also occurred in Indonesia's export activities. During 2022, Indonesia recorded an increase in export value of 26.07% compared to 2021 (BPS, 2022). This is a new achievement for Indonesia due to a significant increase compared to previous years.

The increasing trend of digital trade and export-import activities is directly proportional to the increase in demand for third-party logistics (3PL) services in Indonesia. Seven 3PL companies control 80 percent of the third-party logistics services market in Indonesia by 2022 (Puspa, 2022). The data shows that market competition for logistics delivery services is very tight, requiring each company to make improvements to increase customer satisfaction and become the first choice in fulfilling third-party logistics services.

One important aspect that needs to be considered by companies to increase customer satisfaction in 3PL companies is a short response time (Extensiv, 2022). Response time is the time it takes between a customer placing an order until the order arrives at the customer (Kim & Tang, 1997). One of the problems faced by 3PL companies in Indonesia is the slow process of handling goods which makes the duration of the warehousing process longer and causes accumulation in the process of loading and unloading goods (Purwanti, 2023). Increasing the efficiency of warehousing is one of the ways companies can reduce the duration of response time in the warehousing system. A short response time in the warehousing system will speed up product delivery to customers in a shorter time.

The implementation of an efficient warehousing system is a must for companies to be able to reduce the response time of their warehousing systems to increase customer satisfaction. Warehousing efficiency can be done by eliminating the main waste to increase efficiency in inbound and outbound processes, as well as handling goods in it. Companies can apply the value stream mapping (VSM) method, which is a lean tool that is commonly used to visualize a system in an integrated way to improve control in the overall operational process (Seth & Gupta, 2005). Therefore, this research aims to identify and eliminate waste in the 3PL company's warehouse system to increase efficiency and produce a shorter response time than the current situation.

1.1 Objectives

The objective of this research is to identify and eliminate waste in the 3PL company's warehouse system to increase efficiency and produce a shorter response time than the current situation.

2. Literature Review

2.1 Value Stream Mapping (VSM)

Value Stream Mapping (VSM) is a lean tool that is commonly used to increase the efficiency of a system. Seth & Gupta (2005) argue that VSM is a tool used to visualize a system in a unified way and can improve overall operational control. There are four main stages in implementing the VSM method: product grouping, mapping the current state map, mapping the future state map, and planning the implementation of system improvements (Rother & Shook, 2003).

2.2 Value Stream Mapping Analysis Tool (VALSAT)

Value Stream Mapping Analysis Tools (VALSAT) is a tool that can be used to identify waste in the system and find ways to eliminate or minimize this waste. VALSAT was first developed by Hines & Rich (1997) and is used to analyze the causes of waste by focusing attention on value-added activity (VA).

2.3 Lean Thinking

The Lean Concept or Lean Thinking was first introduced by Toyota through its production system called Toyota Production System (TPS). TPS was created to build a production system that focuses on processes that have a high level of discipline, which is then popularly known as Lean Manufacturing. According to Gaspersz and Fontana (2011), lean is an ongoing effort to eliminate waste and increase the value (value-added) of a product or service in order to produce value for the customer (customer value). The concept of Lean Thinking consists of five basic principles (Womack, Daniel & Jones, 1996), namely define value, map value stream, create flow, establish pull, and pursue perfection.

2.4 Waste dan Waste Relationship Matrix

Waste is a condition where an activity in a system is non-value added (NVA). Hines and Taylor (2000) classify activities within an organization into three types, namely: (1) value-added activities (VA), namely activities that provide added value, (2) non-value-added activities (NVA), namely activities that do not provide added value, and (3) necessary but non-value-added activity (NNVA), namely activities that do not provide added value but are important to do. Further research related to waste was conducted by Rawabdeh (2005) who concluded that there is a relationship between one waste and another that influences each other.

2.5 Westinghouse Systems of Rating

Westinghouse's system of rating is a tool that can be used to measure workforce performance. Sritomo (2008) explained that Westinghouse added factors of working conditions and consistency in addition to skill and effort in the process of calculating operator performance at work. Therefore, according to Freivalds (2009), the Westinghouse performance measurement system considers four main factors in evaluating worker productivity: skills, effort, working conditions, and consistency.

3. Methods

The research was conducted at PT Citrabati Logistik Internasional which is a third-party logistics company that offers several services, namely warehousing, freight forwarding, shipping logistics, and others. One of the warehouses operated by PT Citrabati Logistik Internasional is in Pondok Ungu, Bekasi, which is the object of this research. This warehouse is used to store supporting products for BTS towers and cooperates with one of the private telecommunication service providers in Indonesia.

The data used in this research is in the form of primary and secondary data. The data collection process begins with making direct observations at the company to find out the work system that is being implemented and the problems that are currently happening in the company. After knowing the main problems faced by the company, the next step in this research is collecting primary data by conducting a time study of inbound and outbound activities as well as interviews and questionnaires with experienced workers.

4. Data Collection

The data utilized in this research consists of primary information collected during the company's warehousing activities from March to May 2023.

5. Results and Discussion

5.1 Numerical Results

5.1.1 Standard Time and Normal Time

Standard time and normal time calculations are performed to determine the minimum time needed to complete each process in the warehouse system. The results of these calculations will later be used in mapping the current state map. The calculation of standard time and normal time is carried out using the Westinghouse Rating by taking into account certain aspects experienced by workers, such as conditions, effort, competence, and consistency carried out by workers in completing their work. The assessment of each aspect in the Westinghouse Rating is based on the rating stated in the theoretical basis chapter.

The weight of each aspect is determined through discussions with the head of the PT Citrabati Logistik Internasional warehouse, who is an individual who understands the working conditions and characteristics of the operational staff in the warehouse. Allowances given are 10% and the standard and the normal time calculations for each activity in the warehouse are shown in Table 1 below.

Table 1. Time Study of the Cycle Time in the Warehousing Process

Proses	Rating	Observed (Average) Time	Normal Time	Allowance	Standard Time (s)
Administrasi Inbound	108%	151,98	164,14	10%	180,55
Checking Dokumen	113%	329,78	372,65	10%	409,92
Unloading	106%	353,16	374,35	10%	2470,71
Checking Barang	116%	272,34	315,91	10%	2085,02
Put Away	108%	149,18	161,12	10%	1063,38
Administrasi Outbound	106%	405,66	430,00	10%	473,01
Checking Kondisi Barang	102%	435,87	444,59	10%	489,05
Loading	88%	172,48	151,78	10%	1001,74
Checking Dokumen	113%	59,76	67,53	10%	445,69
Dokumentasi Outbound	99%	37,02	36,65	10%	40,31

5.1.2 Critical Waste Analysis

Identification of critical waste in the warehousing system is carried out to determine which waste affects other waste. The identification process was carried out by conducting discussions and filling out questionnaires for three stakeholders in the warehousing system owned by PT Citrabati Logistik Internasional. The three stakeholders are Mr. Andy Wijaya (warehouse head, 20 years of service), Mr. Angga (warehouse administrator, 11 years of service), and Mr. Iwan (warehouse operations staff, 16 years of service).

The next step is to analyze which waste has the greatest influence on existing waste. The analysis was carried out using the waste relationship matrix (WRM) method approach which was carried out by distributing questionnaires and discussions with the three existing stakeholders. The results of filling out the questionnaire are then quantified using the value that has been assigned to each answer to the questionnaire. The value of each category of waste is then added to determine the final score for each category of waste. The higher the value obtained, the greater the influence given by this waste to other wastes. Table 2 shows the recapitulation results of calculating the value of wastage based on the results of the questionnaire.

Table 2. Ranking Value of Waste Relationship Matrix

Type of Waste (F/T)	O	I	D	M	T	P	W	Score	%	Ranking
O	10	2	4	4	2	0	4	26	11,71%	6
I	8	10	6	4	4	0	0	32	14,41%	4
D	4	4	10	2	2	0	2	24	10,81%	7
M	0	6	6	10	0	6	2	30	13,51%	5
T	6	4	4	4	10	0	6	34	15,32%	3
P	6	4	4	4	0	10	8	36	16,22%	2
W	10	10	10	0	0	0	10	40	18,02%	1

The conversion results of the value of the waste relationship matrix can show which type of waste has the greatest influence on other waste. Based on the conversion results in Figure 1, the waste that has the greatest influence and is a critical waste in the PT Citrabati Logistik Internasional warehousing system is waiting with a percentage of 18.02%, overprocessing with a percentage of 16.22%, and transportation with a percentage of 15.32%.

5.1.3 Value Stream Analysis Tool (VALSAT)
After knowing the three types of critical waste that occur in PT Citrabati Logistik Internasional' warehouse, the next step is to determine which tool is suitable for analyzing the current state map that was created in the previous stage. The determination is made using the matrix found by Hines and Rich (1997) by calculating the results of calculating the waste value in the Waste Relationship Matrix. Furthermore, calculations are carried out based on the VALSAT matrix shown in Figure 2. Based on the results of these calculations, the tool that has the highest score is Process Activity Mapping. Therefore, the tool that will be used to analyze the current state map of the warehousing process in this study is Process Activity Mapping (Table 3).

5.1.4 Process Activity Mapping
Based on calculations using the Waste Relationship Matrix and the VALSAT matrix, the tool that will be used to analyze the current state map is Process Activity Mapping. Process Activity Mapping is one of the lean tools that details the time in each process in the system in detail and classifies these activities into three types, namely value-added activities (VA) which are value-added activities, non-value-added activities (NVA) which are activities that include waste, and necessary but non-value-added activities (NNVA) which are activities that do not add value but need to be done.

Process Activity Mapping results show that there is still a lot of waste in warehousing activities as shown in the percentage of non-value-added activity. This shows that the efficiency of the warehousing process is not optimal, and modifications are needed to the process. Process activity mapping data shows that the ratio of value-added activity in the entire warehousing process is 49%. Table 4 shows the overall process activity mapping in the warehousing process.

Table 3. VALSAT Matrix Calculations

Wastes/Structure	Process Activity Mapping	Supply Chain Response Matrix	Production Variety Funnel	Quality Filter Mapping	Demand Amplification Analysis	Decision Point Analysis	Physical Structure
Overproduction	26	78		26	78	78	
Time Waiting	360	360	40		120	120	
Transport	306						34
Inappropriate Processing	324		108	36		36	
Unnecessary Inventory	96	288	96		288	96	32
Unnecessary Motion	270	30					
Product Defects	24			216			
Total	1406	756	244	278	486	330	66

Table 4. Process Activity Mapping on the Warehousing Process

Classification	Total	Time (minute)	Percentage
Value Added (VA)	17	68,45	42%
Non-Value Added (NVA)	6	26,46	16%
Necessary but Non-Value Added (NNVA)	10	66,49	41%
Total	**33**	**161,41**	**100%**

5.2 Graphical Results
5.2.1 Current State Map
After collecting time study data for the warehousing process and performing statistical tests and calculating normal time and standard time, the current state map can be mapped. Figure 2 shows the results of mapping the current state map of PT Citrabati Logistik Internasional' warehousing system. On the mapping of the current state map, there is some information indicating activities that are classified as value-added activities and non-value-added activities.

5.2.2 Root Cause Analysis of Critical Waste
The results of the root cause analysis carried out on critical waste in the overprocessing category show that there are 3 root problems found based on the symptoms that arise in the current warehousing process, namely the inadequate number of workers, the administration system which is still manual, and input administration of goods receive (GR) and goods issue (GI) data into WMS manually. Figure 3 shows the results of the analysis of the root causes of the overprocessing category.

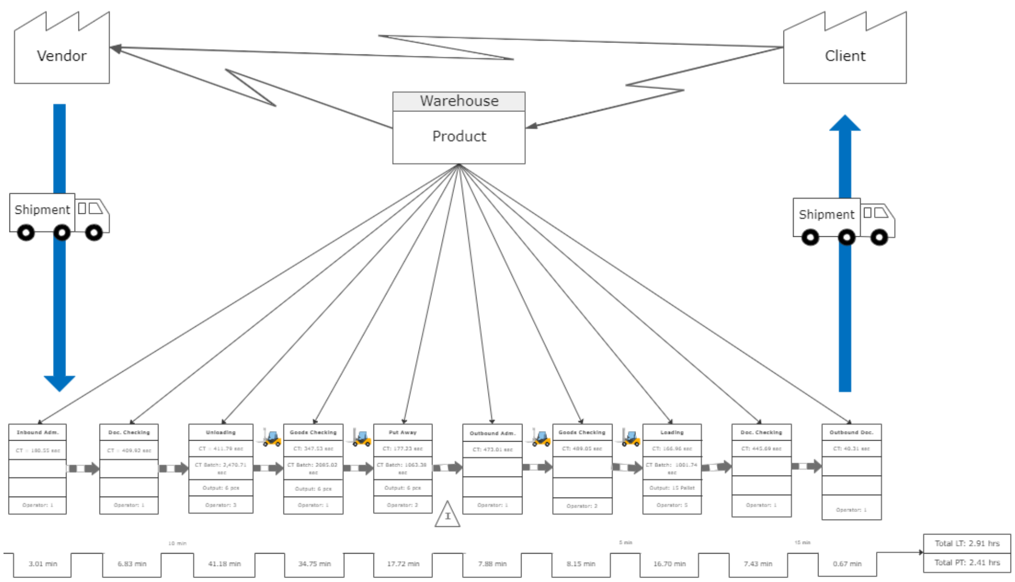

Figure 1. Current State Map

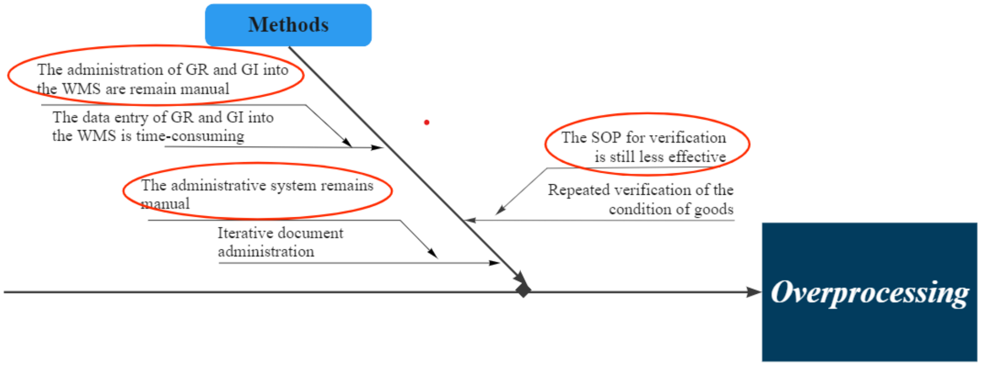

Figure 2. Fishbone Diagram of Overprocessing

The root cause analysis is then carried out on the waiting category of critical waste. The analysis shows that there are 3 root problems found based on the symptoms that arise in the current warehousing process, namely there is no scheduling regarding accurate loading and unloading times of goods, there is no special storage area for equipment supporting the warehousing process, and data related to the layout of goods in the warehouse is not optimal.

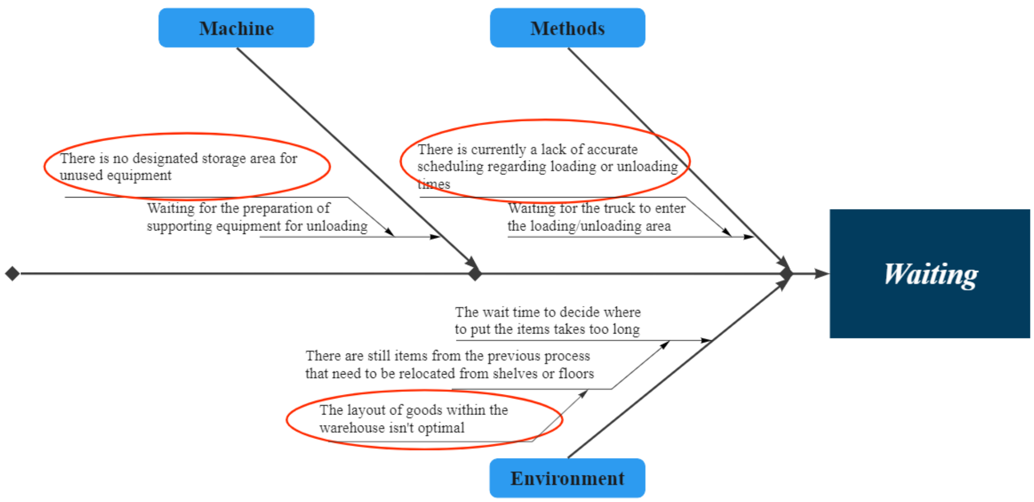

Figure 3. Fishbone Diagram of Waiting

Furthermore, root cause analysis was carried out in the critical waste of the transport category which showed that there were 2 root problems found based on symptoms that arise in the current warehousing system, namely the absence of adequate daily scheduling SOPs and inaccurate data on the location of goods storage at the WMS (Figure 4).

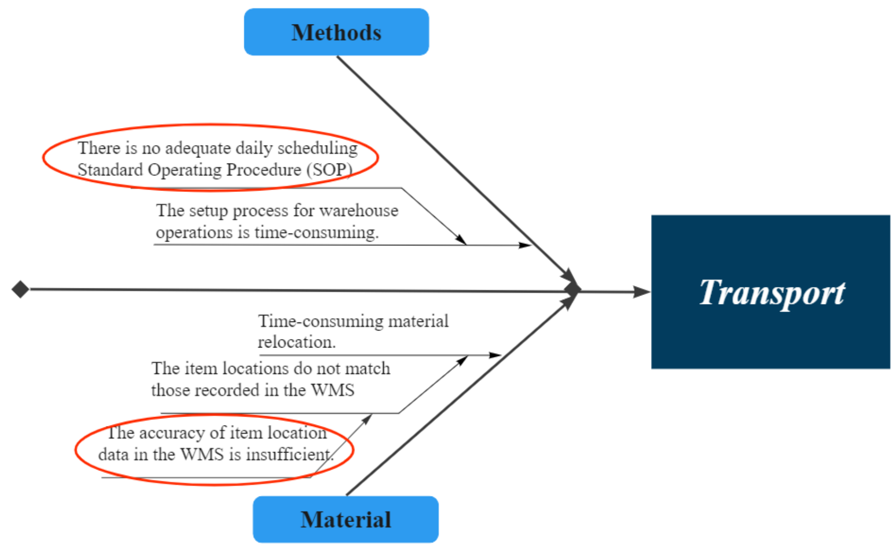

Figure 4. Fishbone Diagram of Critical Waste for Transport Category

5.3 Proposed Improvements

After analyzing the root causes of wasteful warehousing activities using the Fishbone Diagram, companies will then design improvements that can be made to improve the efficiency of their warehousing systems. The improvement plan will be used to deal with the root causes found and as a reference in making a future state map. The following are some suggestions for improvements that can be made by the company:

5.3.1 Standard Operating Procedures (SOP) for Daily Scheduling

Making SOPs for the daily scheduling of incoming and outgoing goods can be a solution to the problem of waste of waiting category activities. The problem that can be solved with this solution is the waiting time for trucks to arrive at the loading/unloading area for the process of loading and unloading goods. In addition, daily scheduling can also overcome the waste of transport category activities, namely the preparation of equipment to support the warehousing process which often takes time due to scattered storage locations.

5.3.2 Implementation of Lean 5S in the warehouse system

The application of Lean 5S to the warehouse system will create a more concise warehouse system and can be a solution to critical waste problems in warehouse activities, namely overprocessing, waiting, and transport. This can be achieved because the application of Lean 5S culture in the warehouse can help all parties involved in the warehousing process to work according to the applicable provisions based on the 5 basic principles of Lean 5S itself.

The process of implementing the Lean 5S principles can be started by conducting socialization and instructions by the warehouse manager to all workers involved in the warehousing process to apply these principles in their respective work areas and throughout the warehouse area. The Lean 5S principle that has been socialized should become a new guideline and culture for these workers in their activities in the warehouse. In addition, clear scheduling of cleaning and maintenance activities for equipment and the warehouse environment also needs to be done so that these activities can be carried out regularly. This will ultimately create a better work environment in terms of cleanliness and comfort while minimizing the emergence of wasteful activities in the warehouse system.

5.3.3 Use of Barcodes on Storage Racks and Goods

Installing a barcode can be a solution to the problem of wasting waiting category activities. The problem that can be solved with this solution is the waiting time in filling in and out of goods data into the warehouse management system (WMS). The use of barcodes will minimize the time used by operational staff to input data into the WMS because the data will be automatically inputted into the WMS when the barcodes for goods and storage shelves are scanned using a scanner. This will ultimately facilitate the process of collecting data on the number and types of goods available along with the storage locations for these goods.

5.4 Validation

4.4.1 Future State Map

The drafting of the future state map will be carried out after the process of analyzing the root causes of each waste and designing improvements has been carried out. Figure 5 shows the design of the future state map of the warehousing process that can be implemented by the company.

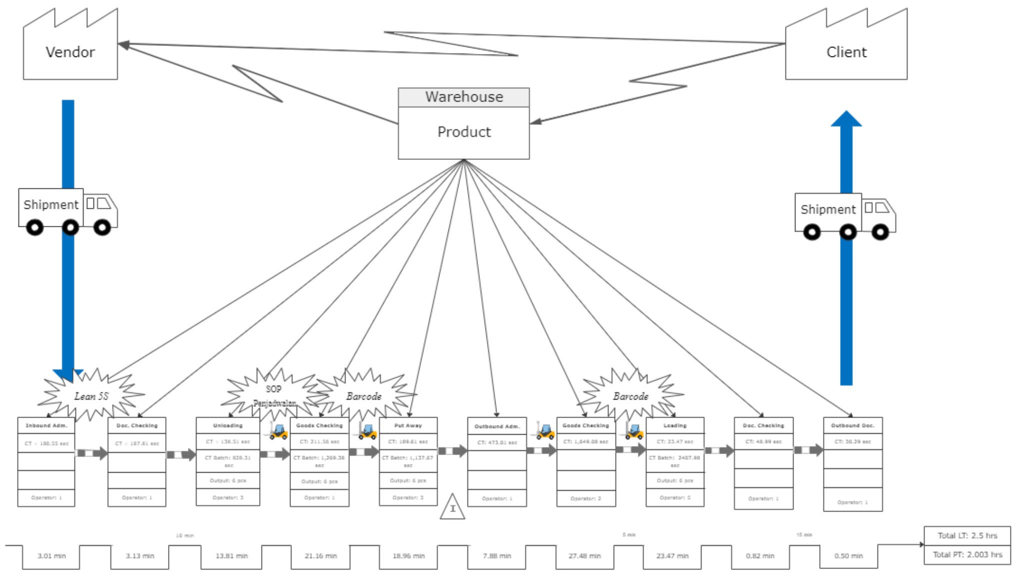

Figure 5. Future State Map of Warehousing Process

The Future State Map is a mapping of the process flow of a system after eliminating waste (non-value added activity) in it. Furthermore, an analysis is carried out on the results of the future state map mapping so that comparisons between conditions before and after improvements can be seen more clearly. Table 5 shows a comparison of the total warehousing processing time on the current state map and the future state map.

Table 5. Comparison of the Duration of Value-added Activity and Non-value added Activity on the Current State Map and the Future State Map

Category	Process	Current Process Time		Future Process Time	
		Value-added (sec)	*NVA + NNVA* (sec)	*Value-added* (sec)	*NVA + NNVA* (sec)
Inbound	Inbound Administration	180,55	0,00	180,55	0,00
	Checking Dokumen	133,09	276,83	133,09	54,73
	Unloading	505,97	903,92	828,31	0,00
	Goods Checking	21,78	1896,51	21,78	1247,60
	Put Away	873,92	910,74	873,92	263,75
Outbound	Outbound Administration	473,02	0,00	473,02	0,00
	Goods Checking	97,56	1400,74	1649,08	0,00
	Loading	1407,98	486,85	1407,98	0,00
	Document Checking	74,29	0,00	48,99	0,00
	Outbound Documentation	19,97	20,64	11,23	19,05
Total		**3788,12**	**5896,24**	**5627,94**	**1585,14**
Percentage		**39%**	**61%**	**78%**	**22%**

In addition, changes also occur in the total lead time or response time for the entire warehousing process after repairs are carried out. Table 6 illustrates the comparison of the time and percentage of lead time for the warehousing process before and after repairs are carried out.

Table 6. Comparison of Warehousing Process' Lead Time Before and After the Improvement

Classification	Time (Sec)		Percentage	
	Current State Map	Future State Map	Current State Map	Future State Map
Value-Added (VA)	3788,12	5627,94	33%	69%
Non-Value Added (NVA) + Necessary but NVA (NNVA)	7696,24	2485,14	67%	31%
Total Lead Time	11484,36	8113,08	100%	100%

6. Conclusion

This study succeeded in identifying and eliminating several activities classified as non-value added with three main types of waste, namely waiting at 18.02% with a duration of 24.12 minutes, overprocessing at 16.22% with a duration of 53.01 minutes, and transportation at 15 .32% with a duration of 15.83 minutes. In addition, there was also an increase in process efficiency (value added ratio) of 39%, from previously 39% to 78%, a decrease in response time of 3,371.3 seconds (56.19 minutes) or 29.4%, and a decrease in process time of 2,471.28 (41.19 minutes) or 25.52%. There are 3 types of improvement plans that need to be implemented, namely making SOPs for scheduling goods handling, applying the Lean 5S principles in the warehousing system, and using barcodes in the process of inputting goods data in inbound and outbound processes.

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