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ANALYSIS OF WASTE IN TRAFFIC SERVICES ON THE SURABAYA-GESIK TOLL ROAD FOR OPTIMIZATION WITH LEAN SERVICE METHOD AT PT MARGABUMI MATRARAYA

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Abstract

PT Margabumi Matraraya is a company engaged in the management and operation of the Surabaya-Gresik toll road. This company is responsible for ensuring that the toll road operations run smoothly in accordance with the established service standards. However, in the toll road traffic service process, inefficiencies are still found, such as long customer waiting times, miscommunication, repeated reporting, inefficient routes, less than optimal workforce performance, and excessive service. This study aims to apply the lean service concept to improve efficiency in the toll road service process and provide recommendations for improvements to reduce waste. The methods used include Value Stream Mapping (VSM), Value Stream Analysis Tools (VALSAT), and Root Cause Analysis (RCA). The results of the analysis using VSM showed that the initial service lead time was 265 minutes with non-value-added activities of 5.96%. After the implementation of the improvement recommendations, non-value-added activities were eliminated, so that the lead time was reduced to 228.2 minutes, or equivalent to a time reduction of 13.89%. The proposed improvement recommendations are optimization of communication systems, application of GPS technology for real-time location monitoring, and improvement of training for officers to maximize human resource potential.

Keywords: Efficient, Lean Service, Toll Road, Value Stream Mapping, Waste

INTRODUCTION

Traffic services on toll roads have an important role in supporting community mobility and efficient transportation of goods. High service quality standards in traffic services to foster customer loyalty and improve overall service performance (Zahra et al., 2023). The dense number of vehicles traveling on toll roads can increase the risk of accidents and vehicle problems. Toll roads are made to be barrier-free. Toll road traffic services are needed to keep traffic flowing smoothly, prevent vehicle buildup, and ensure that the toll road continues to operate as intended as a freeway.

PT Margabumi Matraraya, the company managing the Surabaya-Gresik toll road, faces challenges in the form of accidents and broken-down vehicles. Based on data from January to June 2024, more than 400 vehicles broke down each month, with an average breakdown time of 30 minutes. Toll road traffic services, such as rescue vehicles, ambulances, tow trucks, patrols, and security and order, are very important to maintain smooth traffic. However, some waste is still found in the service process. To overcome these problems, the implementation of the lean service method is proposed as an effective solution to increase efficiency, reduce waste, and accelerate service response. The implementation of this method has the potential to increase customer satisfaction and optimize the performance of PT Margabumi Matraraya's towing service, as well as provide benefits to the company and toll road users.

REVIEW OF LITERATURE

Lean is an approach to eliminate waste and increase value-added to provide maximum value to customers (Budiarto & Santoso, 2020). This concept applies to both manufacturing and services, with a focus on efficiency (Ashari, 2023). The stages of lean thinking include understanding waste, setting goals, understanding the big picture, mapping details, involving related parties, and reviewing plans (Restudana & Darma, 2022). There are three types of value activities in lean service, namely Non-Value Added (NVA), Necessary but Non-Value Added (NNVA), and Value Added (VA) are all product or service activities that provide added value in the view of customers (Nugroho & Safiq, 2019).

Lean service aims to reduce costs, improve performance, and eliminate waste for quality service (Ashari, 2023). The basic principles include determining value, identifying

value streams, ensuring flow, implementing pull, and striving for perfection (Lavinia et al., 2021). Waste is everything that must be eliminated because it can increase service waiting time (Imah, 2023). Duplication is the same process performed more than once, Overservices/Overprocessing occurs when additional actions or steps are performed beyond what is required by the customer or procedure, Waiting is unproductive waiting time or delays, Underutilized Resources is not utilizing the talents and potential of employees, Incorrect Inventory is a mismatch in the number, type, or management of inventory of tools and resources needed in the service process, Transportation is movement or movement that does not add value, Unclear Communication is information not conveyed clearly enough or completely.

Big picture mapping is a tool that serves to helps companies to visually see the service value stream, see existing waste, assist in the selection of implementation teams, link information flow and physical flow (Odi et al., 2019). Value stream Analysis Tools (VALSAT) is a tool that serves to select tools from process flow mapping, which will later be used as a guide in identifying waste (Odi et al., 2019). In principle, the value stream analysis tool is used as a tool to map in detail the value stream that focuses on the value-adding process. Process Activity Mapping is a technical approach used to identify lead time and productivity, both physical product flow and information flow, The basic concept of this tool is to map every stage of activity that occurs starting from operations, transportation, inspection, delay, and storage, then grouped into types of activities that exist starting from value adding activities, necessary non-value adding activities, and non-value adding activities (Riyadi, 2020).

Root Cause Analysis (RCA) is a process of identifying and determining the root causes of certain problems to develop and implement solutions that will prevent the problem from recurring. Methods that are often used in RCA are 5 Whys and fishbone diagrams (Nisanti & Puspitasari, 2021). 5 Whys is a problem-solving technique used to find the root cause of the problem. In essence, every time there is a problem, we must continue to ask "why?" five times to find the real root of the problem (Ibrahim, 2019). Fishbone diagrams are a technique for generating ideas and promoting a balanced approach in a brainstorming session. In the brainstorming session, individuals in the group list the causes and impacts of the problem. Several factors cause waste in the Fish Bone Chart, namely Man (Human factors

that are the root causes of waste include food consumed, rest time, and health), Machine (Machine factors that are the root causes of waste are machine conditions and machine operations), Methods (The work method factor that is the root cause of waste is the implementation and organization of work methods), Materials (The raw material factor that causes waste is the hardness of the material), Environment (The work environment factor that is the root cause of waste is noise pollution and extreme temperatures).

RESEARCH METHOD

This research was conducted at PT Margabumi Matraraya located at Romokalisari Toll Gate, Surabaya-Gresik Toll Road, Surabaya, East Java, 60192. Data collection was carried out in June 2024 until the data was sufficient. This research is a quantitative-descriptive method with the Value Stream Analysis method, Value Stream Mapping Analysis Tools, and Root Cause Analysis. The dependent variable in this study is waste in toll road traffic services, and the independent variables are waiting, unclear communication, underutilized resources, overservices/overprocessing, incorrect inventory, transportation, and duplication.

RESULTS AND DISCUSSION

The data obtained includes toll road service flow data, toll road service time data, questionnaire data, and data on the causes of service waste. These data are used to reduce activities that are included in non-value added and eliminate waste that arises in the toll road service process.

Toll Road Service Time Data

Traffic service process time data is taken from the company's secondary data, from the information received until the service process is completed. Service time information can be seen in Table 1.

Table 1.
Service Activity Time

No	Activity	Time		Activity Type
		Minute	Second	
	Information Received			
1	Road users contact the Communication Center (SENKOM)	2	120	Operation
2	SENKOM receives an incident report	1	60	Operation
3	Verify the report with the reporter	0,5	30	Inspection

No	Activity	Time		Activity Type
		Minute	Second	
4	Give the command to the LJT unit	0,5	30	Operation
5	Waiting for LJT Unit preparation	1	60	Delay
	Unit Delivery to Incident Scene			
6	LJT unit calls the field officer	1	60	Operation
7	Waiting for the field officer	2	120	Delay
8	Officers check operational vehicles	2	120	Inspection
9	Checking equipment inventory	2	120	Inspection
10	The officer reports unit readiness	0,7	42	Operation
11	The unit starts to leave the post	1	60	Transport
	Travel to the incident scene			
12	The officer activates the GPS	0,5	30	Operation
13	Vehicle to the scene of the incident	13	780	Transport
14	Provide current position update to SENKOM	2	120	Operation
15	Reconfirm the location point	1,5	90	Delay
16	Approaching the incident scene	2	120	Transportation
	LJT unit arrives at the scene			
17	The vehicle stops at a safe location	2	120	Operation
18	Quick survey on site	5	300	Operation
19	Report arrival at SENKOM	2	120	Operation
20	Reconfirm the safe area	1	60	Delay
	Handling the scene of the incident			
21	Identify priority measures	30	1800	Inspection
22	Issue inventory for incident management	16	960	Operation
23	Carry out primary response	93	5580	Operation
24	Evaluate progress	25	1500	Operation
25	Report back on progress	7,3	438	Delay
	Clean Incident Scene			
26	Ensure the scene is clean	24	1440	Operation
27	Documentation	9	540	Operation
28	Provide the final report to the control center	2	120	Storage
29	Waiting for confirmation that the scene is clean	3	180	Delay
30	Leaving the incident scene	13	780	Transportation
	Total	265	15900	

Source: PT Margabumi Matraraya

Table 2.
Causes of Waiting

No	Activity	Waiting (Second)
1	Waiting for LJT Unit preparation	60
2	Waiting for field officers	120
3	Reconfirm the location point	90
4	Reconfirm that the area is safe	60
5	Report back on progress	438

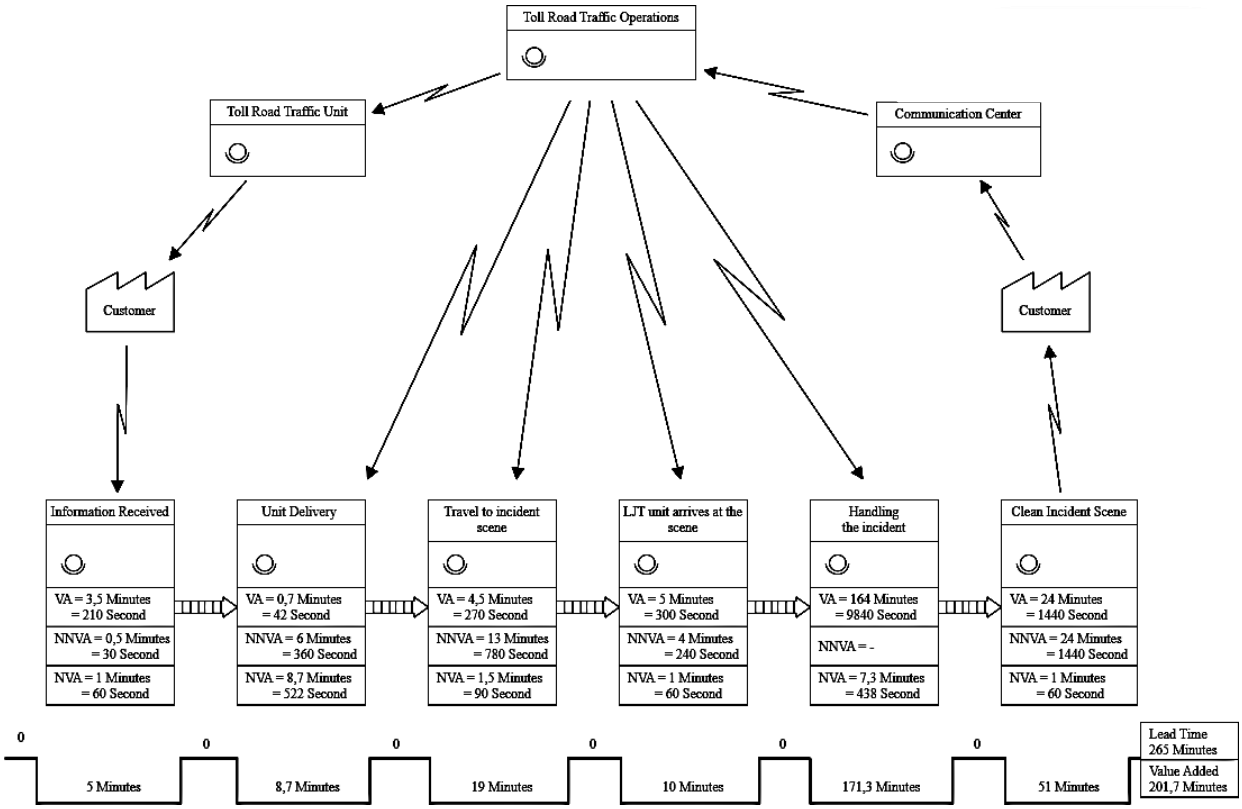
6	Waiting for confirmation from the control center that the location is clear	180

Source: PT Margabumi Matraraya

Initial Big Picture Mapping

After collecting service time data and questionnaire data, make Big Picture Mapping. The initial Big Picture Mapping shows the flow of the toll road traffic service process in the traffic operations field of PT Margabumi Matraraya.

Figure 1.
Initial Big Picture Mapping



Source: PT Margabumi Matraraya

The main processes that occur during the service process are 6 processes. The process starts with the process of receiving information until the scene is clean. The lead time for toll road traffic services is 15900 seconds, or equivalent to 265 minutes, and the Value-Added time is 12102 seconds, or equivalent to 201.7 minutes.

Questionnaire

The questionnaire contains types of waste and a score table using a Likert scale with a minimum score of 1 and a maximum score of 5. The questionnaire distribution involved 20 correspondents. The respondents can be seen in Table 3.

Table 3.
Questionnaire

No	Waste Type	Respondents														Mean	Rank
		1	2	3	4	5	6	8	9	10	11	12	13	14	15		
1	Waiting	5	4	5	5	4	5	3	4	3	2	3	4	5	4	4,00	1
2	Transportation	3	4	5	4	4	5	5	4	3	4	4	4	3	4	3,93	2
3	Underutilized Resources	3	4	4	5	4	3	5	4	5	4	2	1	3	4	3,73	3
4	Unclear Communication	3	3	3	5	2	5	4	4	4	5	5	4	3	1	3,60	4
5	Overservices /Overprocessing	3	4	5	3	3	4	2	1	4	5	3	2	1	1	2,87	5
6	Incorrect Inventory	2	1	2	3	2	1	3	3	1	2	3	2	2	1	2,00	6
7	Duplication	2	2	1	2	1	2	1	1	2	2	5	2	1	2	1,87	7

Source: Processed primary data, 2024

Value Stream Analysis Tools (VALSAT)

After calculating the score value of the questionnaire, the next step is to process the score value data from the questionnaire. The average score data that has been obtained will be analysed using Value Stream Analysis Tools (VALSAT) to determine the most appropriate VALSAT tools to use.

Table 4.
Value Stream Analysis Tools (VALSAT)

Waste	Weight	PAM	SCRM	PVF	QFM	DAM	DPA	PS
Waiting	4,00	36,00	36,00	4,00	-	12,00	12,00	-
Transportation	3,93	35,40	3,93	-	35,40	-	-	-
Underutilized Resources	3,73	33,60	-	-	-	-	-	3,73
Unclear Communication	3,60	32,40	-	10,80	3,60	-	3,60	-
Overservices/ Overprocessing	2,87	2,87	8,60	-	2,87	8,60	8,60	-
Incorrect Inventory	2,00	6,00	18,00	6,00	-	18,00	6,00	2,00
Duplication	1,87	1,87	-	-	-	-	-	-
Weight Total		148,13	66,53	20,8	41,8	38,6	30,2	5,73

Source: Processed primary data, 2024

VALSAT scores are then ranked from the highest score to the lowest score. The highest score will be the first rank, and so on. The highest weight value will be selected as the VALSAT tool. VALSAT rankings can be seen in Table 5.

Table 5.
VALSAT Tools Determination

No	VALSAT	Weight	Rank
1	Process Activity Mapping (PAM)	148,13	1
2	Supply Chain Response Matrix (SCRM)	66,53	2
3	Quality Filter Mapping (QFM)	41,87	3
4	Demand Amplification Mapping (DAM)	38,60	4
5	Decision Paint Analysis (DPA)	30,20	5
6	Production Variety Funnel (PVF)	20,80	6
7	Physical Structure (PS)	5,73	7

Source: Processed primary data, 2024

Based on the calculation results in Table 5, the ranking of each VALSAT matrix is obtained. The matrix or tools that have the highest VALSAT value are Process Activity Mapping (PAM) with a total VALSAT value of 148.13. Of the seven tools, the top-ranked tool was chosen to be selected and analyzed further, namely the Process Activity Mapping (PAM) tool. Then calculate the percentage of each activity group. The results of the calculation of the percentage of frequency and time for each activity can be seen in Table 6.

Table 6.
Frequency, Percentage, and Time Result of Each Activity

No	Activity	Frequency	Percentage	Times (Minutes)	Percentage
1	Operation	15	50,00%	183,7	69,32%
2	Transportation	4	13,33%	29	10,94%
3	Inspection	4	13,33%	34,5	13,02%
4	Storage	1	3,33%	2	0,75%
5	Delay	6	20,00%	15,8	5,96%
	Total	30	100,00%	265	100,00%

Source: Processed primary data, 2024

Based on Table 6. It was obtained that the frequency of operation activities was 50.00% with a time of 69.32%, the frequency of transportation activities was 13.33% with a time of 10.94%, the frequency of inspection activities was 13.33% with a time of 13.02%, the frequency of storage activities was 3.33% with a time of 0.75%, and the frequency of delay activities was 20.00% with a time of 5.96%.

By knowing the number of activities and the time required for each activity, the value-added activity, non-value-added activity, and necessary but non-value-added activity can be identified.

Table 7.
Frequency, Percentage, and Time Results: Activity Type

No	Activity	Frequency	Percentage	Times (Minutes)	Percentage
1	Value Added Activity	13	43%	201,7	76,11%
2	Necessary but Non-Value-Added Activity	11	37%	47,5	17,92%
3	Non-Value-Added Activity	6	20%	15,8	5,96%
	Total	30	100%	265	100%

Source: Processed primary data, 2024

Based on the results of Table 7, the percentage of value-added activity types is obtained, with a frequency is 43% with a time of 76.11%. Necessary but non-value-added frequency of 37% with a time of 17.92%. Non-value-added activity of 20% with a time of 5.96%. From these results, there are non-value-added activities that need to be reduced.

Root Cause Analysis (RCA)

The analysis carried out is an analysis of the factors that cause waste in toll road traffic services, which will be discussed in this section to find the root cause of the problem using Root Cause Analysis (RCA). The tools used in analyzing the root causes of problems include the 5 Whys method and the fishbone diagram.

Table 8.
Waste Analysis with 5 Whys

Waste	Activity	Why 1	Why 2	Why 3	Why 4	Why 5
Waiting	Waiting for LJT Unit preparation	Officers are not ready when needed	Waiting for a call for the LJT unit	Officers do not prepare before duty	No schedule or routine procedure to ensure LJT unit readiness before needed	SOP is not implemented by officers
	Customers wait for officers to arrive	There are two simultaneous events for road users	Call overlap occurs	Road users report the same incident simultaneously to the communication center (SENKOM)	Insufficient manpower available to handle simultaneous calls.	Insufficient number of human resources

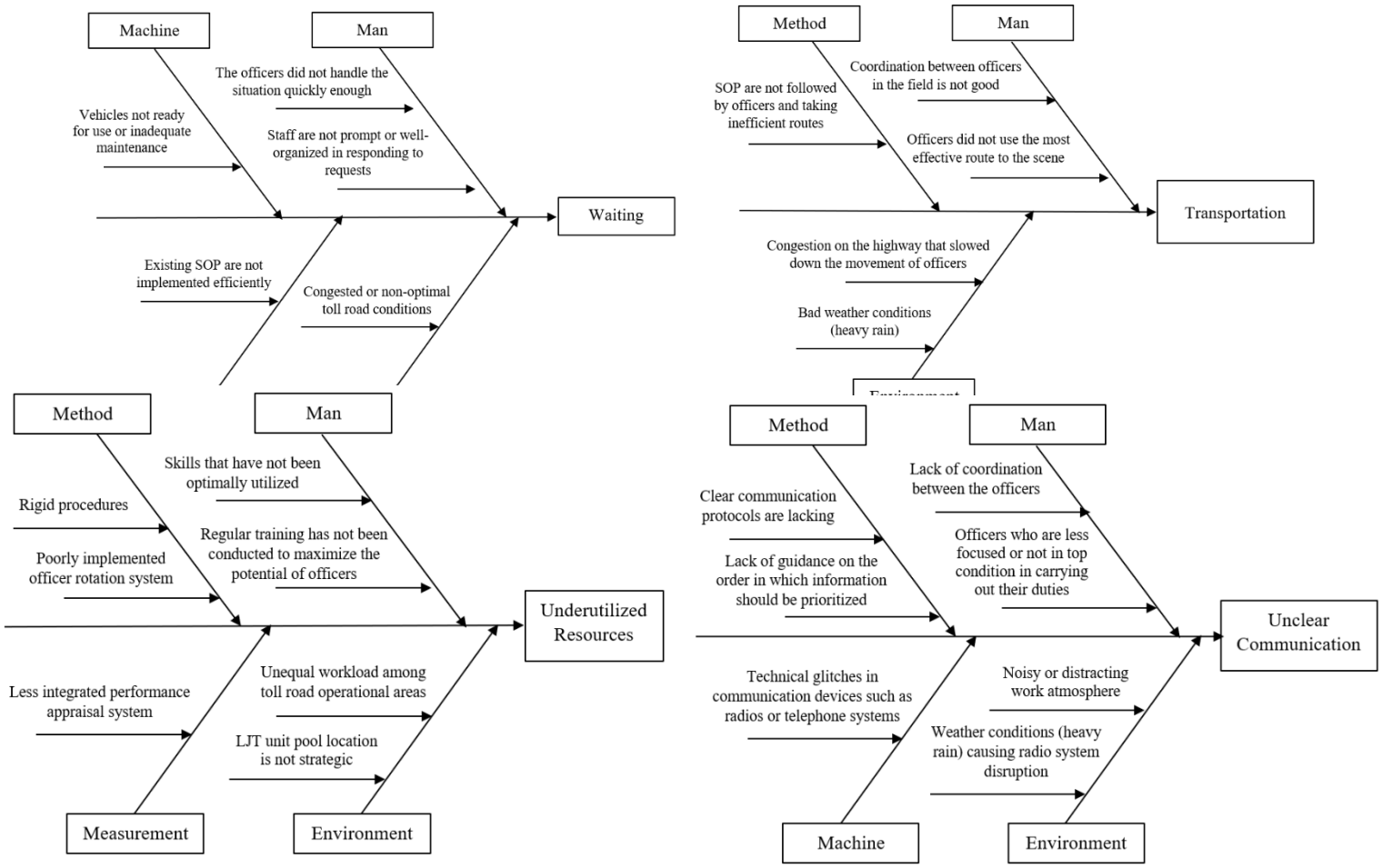
Waste	Activity	Why 1	Why 2	Why 3	Why 4	Why 5
Transportation	The route to the incident scene is not traveled in an effective distance position	Officers do not choose the fastest or shortest route	Available traffic information is not complete or accurate	Officers do not get immediate updates on road conditions	There is no system to provide real-time traffic data	The traffic information system used is not updated regularly
Underutilized Resources	Uneven potential and skill of officers	Officers have different skill levels	Different training levels of officers	Officers have not received skill training evenly	Skill training is conducted alternately	Lack of motivation for skill development
Unclear communication	Error in receiving information	Delivery of information in a short time	Information received without full confirmation	Important information is not conveyed	Poor signal quality or connection	Radio system disruption
Overservices /Overprocessing	Excessive field observation	Officers conducting field observations for longer than the prescribed procedure	Failure to understand what needs to be considered in the field	Delay in handling time	Inefficient management of officer time	Additional work to improve service quality
	Towing is not following the vehicle class (exceeding the KR mutant)	Tow truck delivery does not match vehicle tonnage	Tow is still under repair/maintenance	The vehicle maintenance or repair process is late	Maintenance schedule management is not on time	Lack of monitoring or a system to ensure vehicles are ready for use
Incorrect Inventory	Long inventory search for LJT	Officers have to search for service equipment (jacks, traffic	Erratic placement of LJT service tools/inventory	Untimely return of service equipment to storage after use	Lack of control over the status or location of available inventory	There is no tracking system regarding the whereabouts of

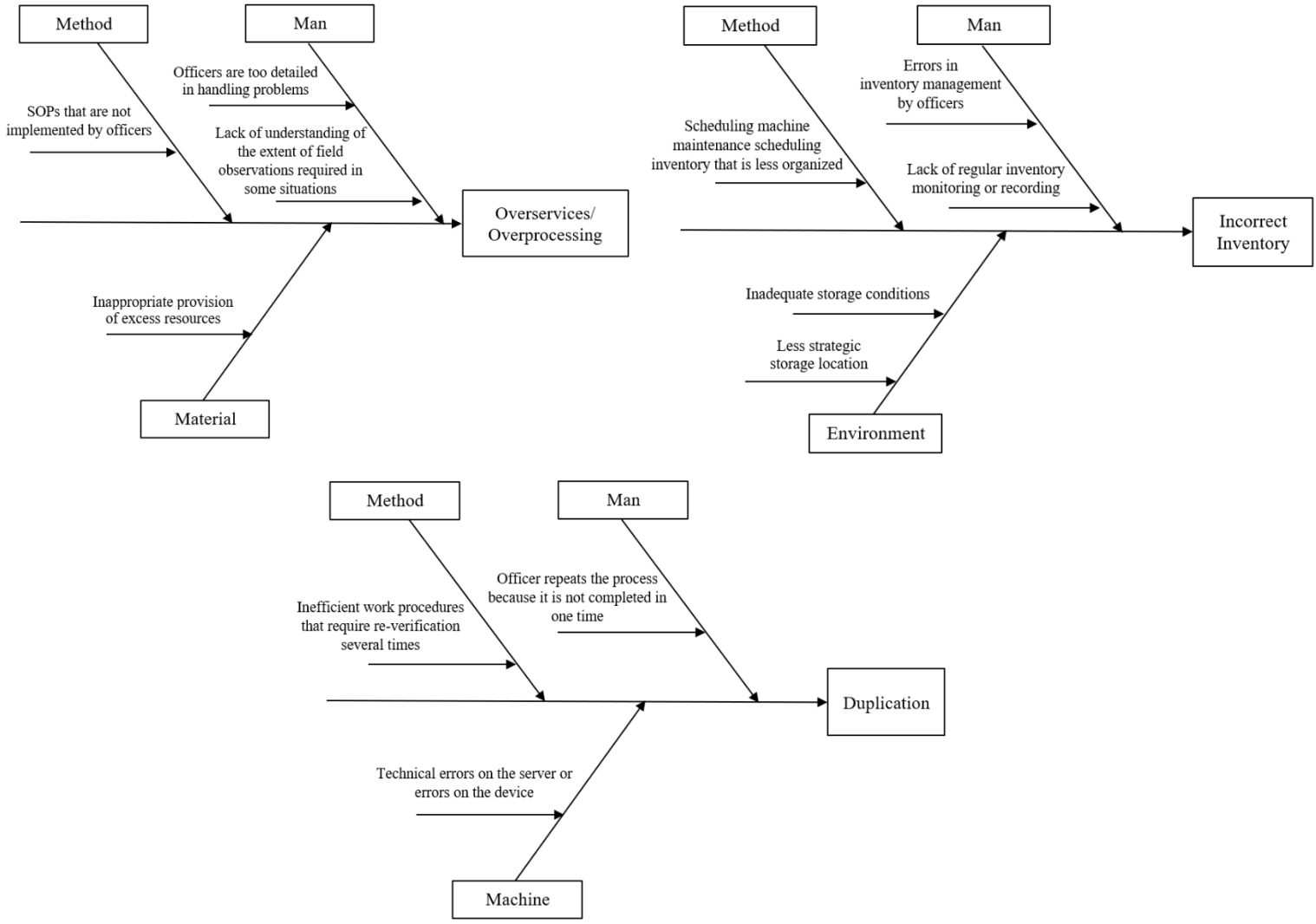
Waste	Activity	Why 1	Why 2	Why 3	Why 4	Why 5
		cones, etc.)				LJT equipment
Duplication	Officers are not complete in one-time reporting (repeated confirmation / repeated reports)	Officers did not get enough information in the initial report	Officers ask repeated questions	Miscommunication between officers in the reporting process	Detailed information is not conveyed	Poor delivery and reception of information

Source: Processed primary data, 2024

The following is an identification of the causes and consequences of waste that occurs in the service process using a cause-and-effect diagram

Figure 2.
Fishbone Diagram





Sources: Processed primary data, 2024

Recommendation for Improvement

Improvement recommendations are corrective solutions to problems that occur. The proposed improvements aim to solve the root cause of the problem. The following are proposed improvements based on analysis using 5 whys and fishbone diagrams (cause-and-effect diagrams)

Table 9.
Recommendations for Correction of Waste

Waste	Activity	Recommendation for Improvement
Duplication	Officers are not complete in 1 time reporting (repeated	Implement clear and standardized communication standards in the reporting process

	confirmation/repeated reporting)	
Overservices/ Overprocessing	Excessive field observation	Optimize the use of remote monitoring technology
	The towing is not in accordance with the vehicle class (exceeding the KR mutant)	Establish strict operational standards based on vehicle class categories
Waiting	Waiting for LJT Unit preparation	Assign supervisors to ensure the SOP is running properly
	Customers are waiting for the arrival of officers	Establish an optimal work shift system for human resources or optimize the role of technology to reduce dependence on human resources
Underutilized Resources	Uneven potential and skills of officers	Organize periodic training programs to improve skills and provide incentives for outstanding employees
Incorrect Inventory	Inventory search for old LJT	Implement an RFID or GPS technology-based tracking system and create a regularly updated inventory list
Transportation	Travel routes to crime scenes are not travelled within the effective distance	Using a real-time updated traffic information system
	Workers are moving back and forth	Apply the 5S method (Sort, Set, Shine, Standardize, Sustain)
Unclear Communication	Error in receiving information	Replace or update radio communication devices with the latest technology

Sources: Processed primary data, 2024

Table 10.
Toll Road Traffic Service Time Adjustment

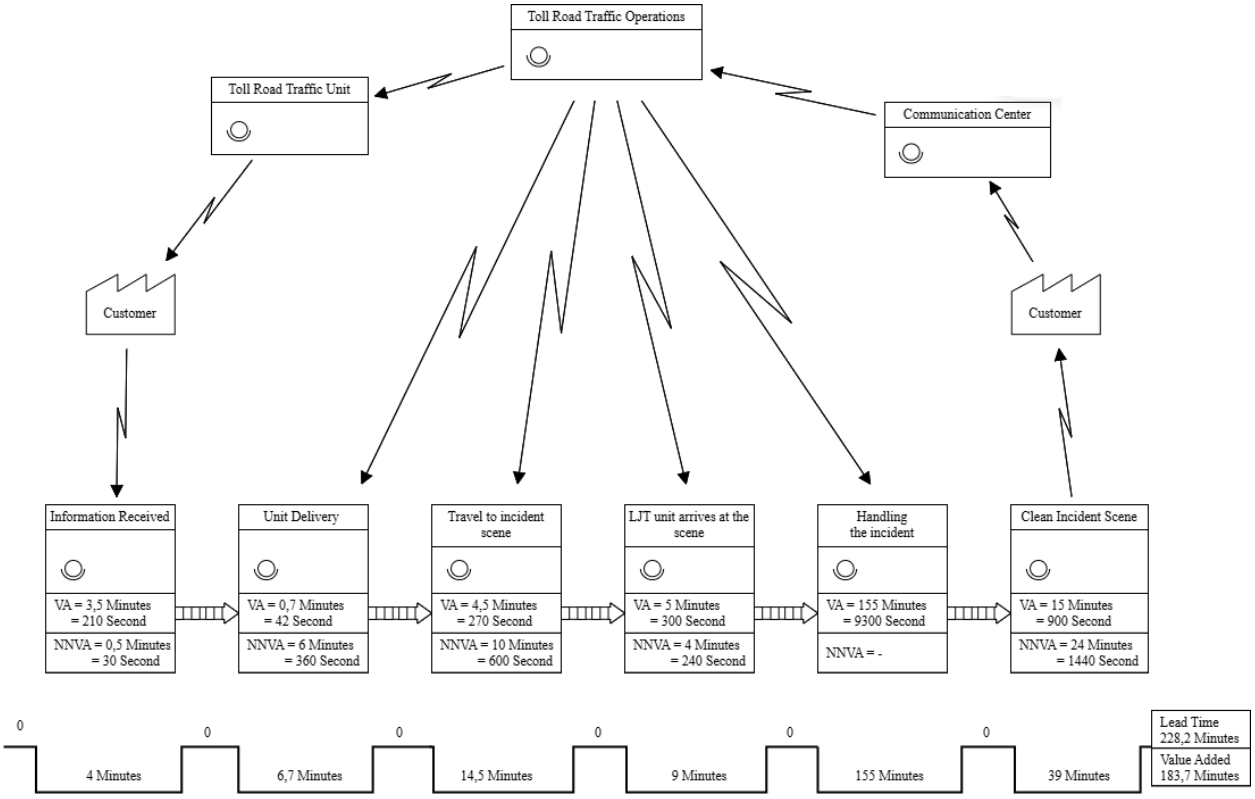
No	Activity	Waiting (Minute)	
		Before	After
1	Waiting for LJT Unit preparation	1	0
2	Waiting for field officers	2	0
3	Reconfirm the location point	1,5	0
4	Reconfirm that the area is safe	1	0
5	Report back on progress	7,3	0
6	Waiting for confirmation from the control center that the location is clear	3	0

Sources: Processed primary data, 2024

Proposed Big Picture Mapping

After making the proposed improvement recommendations, the proposed big picture mapping is made, namely, the idea of the results of the improvement of the Surabaya-Gresik toll road traffic service process at PT Margabumi Matraraya can be seen in Figure 4.

Figure 4.
Proposed Big Picture Mapping



Sources: Processed primary data, 2024

After obtaining the calculation of time after improvement, the next step is to compare the initial time with the time after improvement.

Table 11.
Comparison of Total Service Process Time Before and After

Initial Time	Time After Improvement
265 Minutes	228,2 Minutes
15900 Second	13962 Second

Sources: Processed primary data, 2024

The proposed improvements using the root cause analysis method with 5 whys tools and fishbone diagrams get comparative results before the proposed service time process for 265 minutes or the equivalent of 15900 seconds then after the proposed improvements are implemented it can cut the time to 228.2 minutes or the equivalent of 13962 seconds.

CONCLUSION

Based on the results of the research conducted, it can be concluded that the toll road traffic service process at PT Margabumi Matraraya still has several types of waste that affect

time efficiency and service quality. The types of waste with the highest impact are Waiting, Transportation and Underutilized Resources. Through analysis using the Value Stream Mapping (VSM) method and the Value Stream Analysis Tools (VALSAT) approach, it was found that before improvements were made, the service lead time was 265 minutes with a percentage of non-value-added activities of 5.96%. After the implementation of improvement recommendations, non-value-added activities were completely eliminated, so that the lead time was reduced to 228.2 minutes or equivalent to a time reduction of 13.89%. Improvement recommendations in this study are proposed to improve service efficiency. The proposed improvement recommendations are optimizing technology-based communication systems, using GPS for real-time location tracking, as well as regular training for officers, establishing clearer procedures and utilizing technology such as RFID also helps speed up the process and avoid other waste in time-consuming inventory searches.

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