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Waste analysis of tapioca unloading process with lean supply chain approach in Makassar Port

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Abstract: In the process of dismantling tapioca flour, waste occurs due to activities that do not provide added value (Non-Value Added). The purpose of this study is to identify and analyze the types of waste and then propose improvements to eliminate activities that do not provide added value. By using the concept of lean supply chain and value stream mapping (VSM) it is expected to eliminate activities that do not provide added value and make the company more productive. Through the analysis of seven wastes and fishbone diagrams, it is known that the biggest causes of waste are waiting for the arrival of workers, waiting for pilot/tug boats, waiting for trucks to arrive, and working on sacks that have fallen and torn. Meanwhile, the recommendations given are to coordinate and evaluate the performance of workers, increase the number of pilot/tug boats and trucks, and supervise the unloading process to minimize mistakes made by workers. With the proposed improvement, the cycle time, which was originally 335.34 minutes decreased to 271.97 minutes, and for Process Cycle Efficiency (PCE) which was originally 68.30% increased to 84.22%.

1 Introduction

Gelora Samudera Company is engaged in loading and unloading services at Makassar Port. Makassar Port is one of the ports in Indonesia which is located in Makassar, South Sulawesi for loading and unloading activities. One of the problems that exist here is that there is waste in the process of demolition activities that are here, namely the existence of waste in the process of demolition activities that do not provide value added (Non-Value Added) and have an impact on waiting times and cause losses.

Martono [1] found that waste is an activity that does not add value to business and manufacturing processes. By using Value Stream Mapping, it can be seen what kind of waste that occurs in the process of dismantling tapioca activities. The process of dismantling activities at Gelora Samudera Company still has waste, so research is needed that can increase company productivity in terms of effectiveness and efficiency. This research applies the concept of Lean Supply Chain and Value Stream Mapping. In addition, Anne-Marie et al [2] concluded that lean supply chain is an overall supply chain strategy to increase effectiveness. Lean Supply Chain also aims to optimize all processes from all supply chains, seek simplification, reduce waste and reduce activities that do not provide added value.

Moreover, Irvansyah [3,4] recommended the value stream mapping is a tool used to describe or describe the entire system and value stream in the supply chain. Therefore, this method could be used to show the detailed time of each activity to determine the type of waste that occurs in the unloading process at Gelora Samudera Company in Makassar Port and analyze the main problems using seven waste and fishbone diagrams.

2 Methodology

2.1 Data collection dan processing

This study was conducted in August-September 2021, this research was conducted at Gelora Samudera Company, which is located at Makassar Port, Jl. Nusantara No. 378 Makassar City, South Sulawesi. In this study, the primary data in this study were obtained directly from the research object through observation and interviews, while secondary data were sequence of unloading activity process and unloading activity process time.

Furthermore, data processing used in this study uses a Lean Supply Chain approach which consists of:

1. Current State Mapping
   Process Activity Mapping or Big Picture Mapping is used as a tool to describe or describe the entire system and value flow in the supply chain [3,5,6].

2. Waste Identification
   There are seven types of waste in the manufacturing process [1,7]:
   a. Overprocessing,
   b. Transportation,

c. Unnecessary Motion,
d. Defect,
e. Waiting Time,
f. Overproduction.

3. Inventory
   Determining the Most Influential Waste After that is the processing of questionnaires that have been distributed to the Chief Officer, Chief Stevedoring, and Foreman, to find out what type of waste is the most influential and with the highest level of urgency.

4. Root Cause
   Fishbone diagram is an analysis that can make it easier to find the causes of a problem that arises [3,8].

5. Proposed Improvements
   Proposed improvements are given based on the most influential waste and the highest level of urgency, with the hope that the company will become smoother, more productive, effective, and efficient.

6. Future State Mapping
   In the Activity Mapping Future State process, it provides a physical flow of information, the time required for each activity, the distance traveled in each stage of the process in the post-repair state.

7. Process Cycle Efficiency (PCE)
   This calculation is carried out to compare the company's performance before and after the improvement by using the efficiency of the process cycle (Process Cycle Efficiency) [4,9,10], with the following formula:

$$\text{Process Cycle Efficiency} = \frac{\text{Value Added Time}}{\text{Total Lead Time}} \text{ x } 100\% \quad (1)$$

3 Result and discussion

3.1 Process activity mapping current state

Following are the results of direct observations that will be described in the table above, there are 32 activities consisting of 21 operating activities or 50.71% with a total time of 170.04 minutes, 8 transportation activities or 34.49% with a total time of 170.04 minutes, and 3 delay activities or 14.81% with a total time 49.65 minutes.

3.2 Big picture mapping current state

The Big Picture Mapping above illustrates the flow of the tapioca unloading process at the Makassar Port which is divided into several stages, namely the preparation of the docking ship starting from the ship preparing to dock to the dock by turning on the main engine, then pulling the ship with a pilot/tug ship to the dock, after the ship is leaning then the process of anchoring and tying the rope to the pier is carried out. The next activity is the work preparation process starting with a work agreement discussion between the Chief Officer and Chief Stevedoring, after the discussion, the Chief Officer will instruct the operator to open the hatch cover/pontoon with a crane, after the hatch is open, Foreman will install protective nets on the side of the hatch. Hull. The next activity is the unloading activity. After the hatch is open and the hull nets are installed, the next activity is sea workers arranging and stacking tapioca sacks on sling ropes, after the sacks are arranged the next process is lifting the sacks using a crane, while the sacks are lifted using a crane, tallyman counts and records the number of sacks lifted, then the sacks are lowered into the back of the truck, after the sacks are unloaded in the trunk, the land workers arrange the unloading of the unloaded sacks, after the truck is fully loaded the tallyman will make a road transport bill to the driver. The next activity is the driver sending tapioca flour to the destination warehouse. From the observations made, the delivery of tapioca flour to the destination warehouse takes 45 minutes.

Figure 1 describes the process flow of tapioca unloading activities at Gelora Samudera Company at Makassar Port. So, it is known that the total value of the value-added activity is 335.34 minutes. While the unloading is 106.27 minutes. From this description, it indicates that in the process of unloading activities, there is still waste that can be reduced if possible.

Table 1 Activity data (unloading) tapioca

No	Activity	Time (Minutes)	Total	Activity Category					Activity Type
				O	T	I	S	D	
Preparation of the Vessel									
1	Ship Preparation	30.25	153.85	O					VA
2	Waiting for the guide/tug boat	30.71						D	NNVA
3	Pulling Ship	61.56			T				VA
4	Ship docks and tie ropes	31.33		O					VA
Work preparation									
5	Work agreement talks between Chief Officer and Chief Stevedoring	3.27	73.71	O					VA
6	Operator prepares Crane	14.36		O					NNVA
7	Opening and folding hatch tarps	20.14		O					NNVA
8	Open hatch/pontoon hatch	21.37		O					VA
9	Attaching the Hook to the Crane	2.49		O					NNVA
10	Attaching the sling to the crane	1.19		O					NNVA
11	Installing the ship's hull nets	10.90		O					VA
Unloading									
12	Waiting for Labor to come	8.42	62.77					D	NVA
13	Marine Workers enter the hold	3.95			T				NNVA
14	Waiting for Trucks	10.52						D	NVA
15	Foreman steers Truck in	2.54			T				NNVA
16	Land workers get on the Truck	0.21			T				NNVA
17	Marine workers arrange tapioca sacks on rope slings	13.46		O					VA
18	Lifting tapioca sacks from ship to truck using a crane	2.38		O					VA
19	Tallyman counts and records the number of sacks lifted	2.04		O					VA
20	Removing the sling	0.25		O					NNVA
21	Dropping the sack onto the Truck	0.60		O					VA
22	Sewing the sack that was torn from the fall	2.00		O					NNVA
23	Picking up a fallen sack	2.63		O					NVA
24	Attaching the sling to the boat	0.17		O					NNVA
25	Returning the sling strap to the Ship	1.51		O					NNVA
26	Land workers arrange unloading sacks in the Truck	5.13		O					VA
27	Land workers get off the Truck	0.15			T				NNVA
28	Foreman steers Truck out	1.70			T				NNVA
29	Tallyman makes a road transport bill to the driver	1.78		O					VA
30	The driver put the rope and tarp on the truck	2.81		O					NNVA
31	The driver took the transport receipt from Tallyman	0.54			T				NVA
Flour Delivery To Storage Warehouse									
32	Transportation of Tapioca Flour to Destination Warehouse (Parangloe)	45.00	45.00		T				VA
Total			335.34	21	8	0	0	3	32

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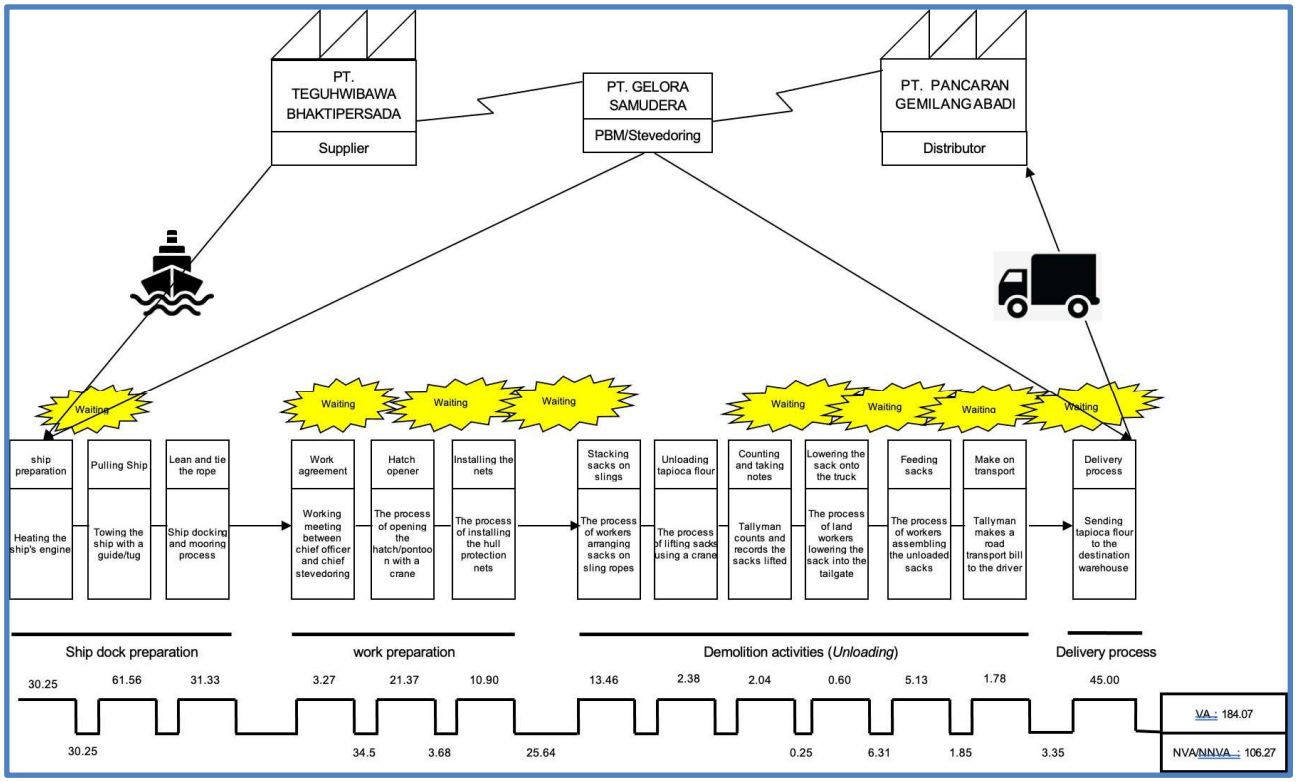

*Figure 1 Big **p**icture **m**apping **c**urrent **s**tate*

3.3 Determination of the most influential waste

The following are the results of the weighting of waste which will be presented in Figure 2.

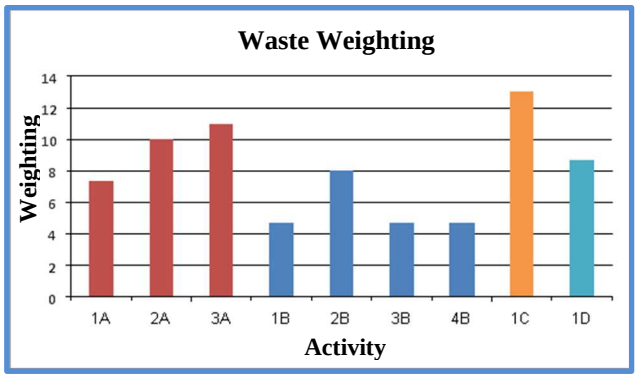

Figure 2 Critical waste weighting

Based on the graph above, it can be seen that the total average weight of the waste waiting is 28.33, then the total average weight of the unnecessary motion waste is 22, then the total average weight of the overprocessing waste is 13 and the total average weight, waste defect is 8, 67. It can be seen that waste waiting has the largest average weight with a total of 28.33.

3.4 Root cause

The problem-solving concept used in this research uses a Fishbone Diagram which is useful for finding the root of the main problem, namely Waiting Time.

1. Man Factor

a. Waiting for the arrival of workers, the lack of coordination between the foreman, labour foreman and other workers causes workers to often arrive late during shift changes and during breaks, the arrival of workers one by one causes workers to sometimes not be available to work immediately. This has a direct impact on the delay in unloading activities.

2. Machine Factor

a. Waiting for scouts/tugs, scouts/tugs are often not available due to the demand for the use of scouts/tugs at the same time, while another reason is the lack of available scouts/tugs causing ships to wait a long time and the incoming and outgoing flow of the pier to be hampered.

b. Waiting for the arrival of trucks, the minimal number of trucks available and the large number of simultaneous use of trucks at other loading and unloading companies (PBM) are the reasons why tapioca unloading activities have to wait for the unloading process to be carried out on trucks. Another cause is the lack of maintenance and regular checks carried out by the truck provider which causes trucks to often break down and have trouble, resulting in trucks often arriving late.

3.Factor Methods

a. The sacks fell and were torn, the piles were too high and too heavy to cause the sacks to fall and tear when they were lifted using a crane and when they were unloading the load on the truck, this was because the workers were chasing production targets. A pile that is too high and too many causes the sacks to fall and tear frequently, if this happens, rework will be carried out, as a result, the work takes longer and requires more energy [11,12].

3.5 Proposed problem fix

Based on the cause analysis that has been described using a fishbone diagram, Table 2 shows the result of problem solution for the company:

Table 2 Recapitulation of suggestions for repairing problems

The main problem	Sub Problem	Repair
Waiting time	Waiting for the Arrival of Workers	Coordination
		Labour performance evaluation
	Waiting for the Guide/Tugboat	Increase the Number of Fleet
		Adding Ship Master
	Waiting for Truck	Increase the Number of Fleet
		To do
	The sack fell and was torn	Maintenance regularly
		Supervise

In addition to fixing the main problem in waiting time, other improvements that can be made to minimize the types of waste other than waiting time to improve the process, including (Table 3):

Table 3 Fixes for other types of waste

Types of Wasting	Troubleshooting
Defect	Supervise and evaluate the performance of workers
Overprocessing	Supervise and evaluate the performance of workers
Unnecessary Motion	Mark the unloading area
	Add lighting facilities
	Supervise and evaluate the performance of workers
	Tallyman gives the bill directly to the driver

3.6 Future state mapping

The following is a description of the prediction of the future state or condition of the supply chain system from the unloading process flow of tapioca (Figure 3). The conditions in the value stream mapping are the results of predictions (not yet implemented by the company) which are expected to reduce the waste that occurs.

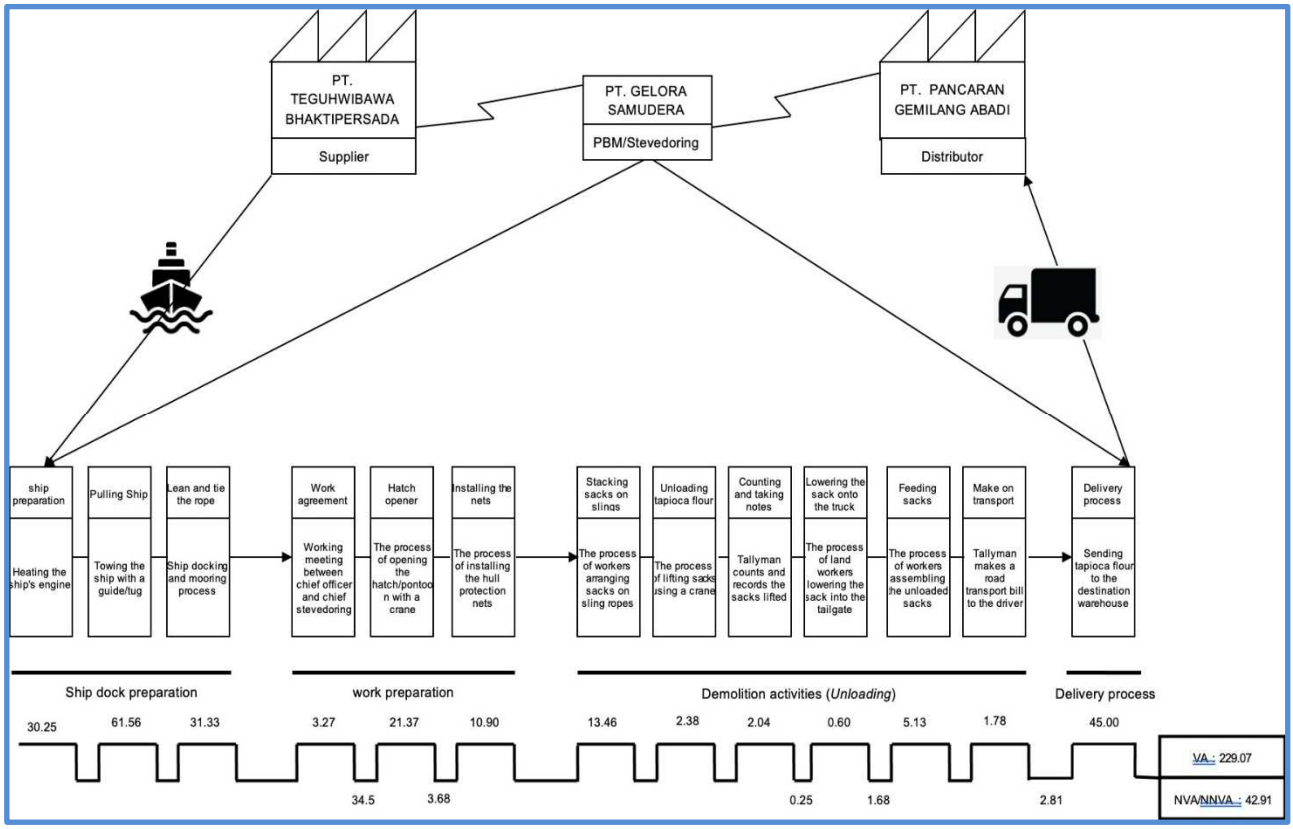

Figure 3 Future state mapping

Future State Mapping provides an overview of the new process flow, namely after the proposed improvement, where the time for activities that are not added value but are processes that cannot be eliminated, have been reduced and have discarded processes that are considered unimportant. By looking at the Future State Mapping in the picture above, it can be seen that with the proposed improvements, it is able to reduce the time of non-value-added activities by 59.62%. It is known that based on the Current State Mapping that has been discussed, the amount of time from non-value added (NVA) is 106.27 minutes, and the future state mapping can be reduced to only 42.91 minutes. However, this condition is only a prediction because the proposals given have not been implemented by Gelora Samudera Company itself.

3.7 Process cycle efficiency

Process cycle Efficiency (PCE) is a comparison between Value Added (VA), Necessary Non-Value Added (NNVA), Non-Value Added (NVA) and Total Lead Time or cycle time. Based on the data above, the PCE calculation is as follows:

a. Before repair

$$Process\ Cycle\ Efficiency\ (Before) = \frac{Value\ Added\ Time}{Total\ Lead\ Time}\ x\ 100\% \quad (2)$$

$$Process\ Cycle\ Efficiency\ (Before) = \frac{229.07}{335.34}\ x\ 100\%$$

$$Process\ Cycle\ Efficiency\ (Before) = 68.30\%$$

b. After repair

$$Process\ Cycle\ Efficiency\ (After) = \frac{Value\ Added\ Time}{Total\ Lead\ Time}\ x\ 100\% \quad (3)$$

$$Process\ Cycle\ Efficiency\ (After) = \frac{229.07}{271.97}\ x\ 100\%$$

$$Process\ Cycle\ Efficiency\ (After) = 84.22\%$$

Based on the results of the above processing, it can be obtained an initial comparison (Table 4) with the proposed improvement which can be seen in the table below.

Table 4 Comparison of initial before and after improvements

Indicator	Before Improvement	After Improvement
PCE	68.30%	84.22%
VA	299.07	229.07
NNVA	84.16	42.91
NVA	22.11	0
Cycle Time	335.34	271.97

4 Conclusions

This study concluded that there were several wastes that did not provide added value to the tapioca unloading activity process, namely waste of waiting (waste caused by the waiting process), including the following: man factors such as waiting for the arrival of workers, machine factors such as waiting for pilot boats / tugs and waiting for trucks to arrive and methods factors such as sacks falling and torn.

From the results of data processing, the total processing time of 32 activities and the total time of the entire process is 335.34 minutes after repairs can be reduced to 21 activities and the total time of the whole process is 271.97 minutes. PCE initial conditions were the total processing time from 68.30% increased by 15.92% to 84.22%, the VA value remained the same at 229.07 minutes, the NNVA which was originally 84.16 minutes decreased to 42.91 minutes, the NVA which was originally 22.11 minutes was removed.

The improvement proposals given to reduce and eliminate waste that exist in the process of unloading tapioca activities include the man factor, namely by coordinating and evaluating the performance of workers, from the machine factor, namely by increasing the number of pilot / tugboat fleets, increasing the number of ships. pilot/tug boat captain, increase the number of truck fleets and carry out service and maintenance regularly and the methods factor, namely the foreman must supervise to minimize errors made by workers.

Based on the research that has been done, the researcher feels that there are still many shortcomings, therefore, the following are suggestions that are expected to be input in an effort to reduce waste in the future and to be able to develop and use new methods which can vary other methods to analyze and identify the types of waste found in the process of unloading tapioca. In addition, deeper waste analysis including the distribution process until the goods arrive at the destination warehouse.

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Review process
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