Waste assessment using a lean approach in receiving process of container terminal: a case of Teluk Bayur Port

E Amrina, I Kamil and D Rahmad

Department of Industrial Engineering, Faculty of Engineering, Universitas Andalas, Padang 25163, West Sumatra, Indonesia
E-mail: elita@eng.unand.ac.id

Abstract. This paper aims to assess wastes in receiving process of container terminal using lean approach at Teluk Bayur port. It begins with developing the Value Stream Mapping (VSM) of receiving process of a container terminal in Teluk Bayur port. Value Added Assessment (VAA) is used to identify the wastes that classified into Value Added (VA), Non-Value Added (NVA), or Necessary but Non-Value Added (NNVA). Finally, Failure Mode and Effect Analysis (FMEA) is applied to evaluate the failure modes of wastes and develop the proposed improvements. Through the VSM stage, it is identified eight processes with a total of 28 activities in the receiving process of a container terminal in Teluk Bayur port. The results of VAA show there are a total of 14 non-value activities consist of nine NVA activities and five NNVA activities. In FMEA, it is obtained four failure modes with the highest Risk Priority Number (RPN) related to failed in open stack process, machine problems, failed to manage documents of receiving card and system crashes. It is suggested to update the information in website and notice board, perform regular maintenance to machines, upgrade the machines, provide the proper information of receiving process procedure, conduct routine maintenance to the website, and provide generator engines.

1. Introduction
Infrastructure is one of key success factor of a nation. As an archipelago country, improving the port infrastructure is urgently needed by Indonesia, since it directly related to the flow of trading in the global. Currently, one of the main focuses of the Indonesian government is to improve the performance of the port. The ports have become one of the facilities for logistics activities connecting the land and the sea. Therefore the logistics activities, including transportation and storage can be conducted in the port. Excellent services at the port would support the objective of the logistics that is to deliver the goods in the right quantity and at the required time. Activities in the port consist of ship services and unloading of goods. Ship services start from the ship enter the waters of port until the vessel leaves the port while loading and unloading activities conducted after the ship docked at a mooring.

Ports in Indonesia are managed by the State Owned Enterprise, namely PT Pelabuhan Indonesia (Pelindo). The company has four operating regions, which is responsible for providing and commercializing the port services. PT Pelindo II has been operated in 10 provinces and managed 12 ports in Indonesia. One of the ports managed by PT Pelindo II is Teluk Bayur port. Teluk Bayur port has a role as one of the economic gates in the Western area of Indonesia and one of the busiest seaports as well as the largest port on the west coast of Sumatra Island. Teluk Bayur port becomes the
most important commercial port that can aid the economic development of West Sumatra Province and surrounding areas [1].

One of the critical terminals in Teluk Bayur Port is the container terminal. The container terminal is a terminal which has a series of containers to transport goods from hinterland port to the next destination. The container is an alternative widely used by economic actors to distribute the goods to many destination areas. This is because the function of these containers plays an important role in the quality of distributed goods [1]. One of the activities in the container terminal is the receiving process. The process starts with the documents submitted by the forwarding agent until the open stack process. The activities of the receiving process include the submission of receiving orders documents, payments, and printing receiving a card. Open stacks activities include checking documents, weighing, and stacking.

Based on preliminary study, there are some problems occurred in receiving process of container terminal of Teluk Bayur port such as forwarding agent waiting in TPK counter and waiting in financial counter to get the receiving note and the paid status. Besides, the forwarding agent has to wait in cashier for payment. After forwarding agent gets the receiving card, trucks carrying containers must wait during open stack process. A truck waits in the gate in of container terminal. Usually, it occurs at a busy time. The waiting time will affect the service quality of the receiving process. In addition, waiting is a non-value added activity and must be eliminated to increase the satisfaction of the forwarding agent. According to [2] waste is any activity which can be eliminated without reducing customer value.

It has identified some wastes occurred through the receiving process of container terminal [3]. The principal activities are excessive transportation, waiting, and motion. The lean approach can be used to improve the performance of the receiving process of the container terminal. The lean approach can satisfy all the operational level, strategic, and tactical. Besides, the lean approach also reaches business units, manufacturing, and organization core (www.leanindonesia.com). Lean approach prioritizes the process flows because the services can work well if the process flows smoothly and efficiently. The objective of the lean method is to eliminate non-value added activities during the process, so each activity in the process adds value from the customer's perspective. Waste identification based on a lean approach principle is divided into seven types consists of overproduction, waiting, inventory, transportation, over processing, motion, and defective products [4]. To improve service, a company is required to understand what kind of activities can increase the value (value added) to the service [5]. Therefore, it is needed to assess the wastes occurred during the receiving process of the container terminal. In this study, the lean approach is applied to assess the wastes in the receiving process of container terminal of Teluk Bayur port.

2. Methodology
This study has three main stages.

2.1. Value Stream Mapping
Value Stream Mapping (VSM) is a structured diagram used in mapping related to the flow of products and information from beginning to end. In this case, it starts from the forwarding agent submit documents until the open stack process. The purpose of VSM is to obtain the description of process stages and process times, so that it can be seen the activities classified as Value Added and Non-Value Added. The time measurement of each process is conducted to a total of 96 receiving cards.

2.2. Value Added Assessment
In this stage, a questionnaire of Value-Added Assessment (VAA) is developed and distributed to a total of 11 staffs of Teluk Bayur port that directly involved in the receiving process. The questionnaire is used to determine the types of activities that occur throughout the receiving process, whether classified as Value Added (VA), Non-Value Added (NVA), or Necessary but Non-Value Added (NNVA) [6].
2.3. Failure Mode and Effect Analysis

Based on the wastes identification from VSM and VAA, a questionnaire of Failure Mode and Effect Analysis (FMEA) is developed. The FMEA questionnaire is aimed to determine Severity (S), Occurrence (O), and Detection (D) of the identified wastes. The scale ranging from 1 to 10 adopted from [7]. The questionnaire is then distributed to the four experts of Teluk Bayur port. They are chosen based on their knowledge and experience in the receiving process of the container terminal. The proposed improvements are then developed to overcome the wastes occurred in the receiving process of the container terminal.

3. Results and discussions

3.1. Value Stream Mapping

The Value Stream Mapping (VSM) of receiving process of the container terminal in Teluk Bayur port is shown in Figure 1.

![Figure 1. The crumb rubber production flow](image)

The VSM shows all processes and activities conducted through the receiving process flow of container terminal in Teluk Bayur port. It consists of eight processes with a total of 28 activities. The maximum and minimum time of each process are also presented. It can be seen that the most frequent activity occurred in the receiving process of the container terminal is waiting. It is classified as waste and thus, need to be eliminated.

3.2. Value Added Assessment

Based on the results of Value Stream Mapping (VSM), Value Added Assessment (VAA) is conducted to the receiving process of the container terminal in Teluk Bayur port. The activities performed during the process are classified into Value Added (VA), Non-Value Added (NVA), and Necessary but Non-Value Added (NNVA). The results are shown in Table 1.

The results show there are a total of 14 non-value activities consist of nine Non-Value Added (NVA) activities and five Necessary but Non-Value Added (NNVA) activities. Those non-value activities are regarded as wastes and thus, should be eliminated. An analysis is performed to relate those non-value activities with the seven wastes. The results are shown in Table 2.
Table 1. The results of Value-Added Assessment.

| No | Actor | Location | Activities | Type of Activities |
|----|-------|----------|------------|--------------------|
|    |       |          |            | VA | NVA | NNVA |
| 1  | TPK Counter Officer | TPK Counter | Request into SIMOP TPK System | x |      |      |
|    |       |          | Note result of a request | x |      |      |
|    |       |          | Giving result of the request to Financial Counter Officer | x |      |      |
| Forwarding Agent waiting until their process to get the result of request SIMOP TPK System | x |      |      |
| 2  | Financial Counter Officer | Financial Counter | Input result of the request to SIMOP TPK System | x |      |      |
|    |       |          | Printing Nota Receiving | x |      |      |
|    |       |          | Giving Nota Receiving to Forwarding Agent | x |      |      |
| Forwarding Agent waiting until their process to get Nota Receiving | x |      |      |
| 3  | Cashier | Cashier counter | Input Data to System based on Nota Receiving | x |      |      |
|    |       |          | Receive payment from Forwarding Agent | x |      |      |
|    |       |          | Printing Nota Payment | x |      |      |
|    |       |          | Giving Nota Payment to Forwarding Agent | x |      |      |
| Forwarding Agent waiting until their process to get Nota Payment | x |      |      |
| 4  | Financial Counter Officer | Financial Counter | Receiving Nota Payment from Forwarding Agent | x |      |      |
|    |       |          | Input Paid Status to system | x |      |      |
|    |       |          | Giving Back Nota Payment | x |      |      |
| Forwarding Agent waiting until their process to get paid status | x |      |      |
| 5  | TPK Counter Officer | TPK Counter | Print Receiving Card | x |      |      |
|    |       |          | Giving Receiving Card | x |      |      |
| Forwarding Agent waiting until their process to get receiving the card | x |      |      |
| 6  | Gate in Operator | Gate in | Input Container Number Data to system | x |      |      |
|    |       |          | Weighing | x |      |      |
|    |       |          | Note Layout Container Number at Receiving Card | x |      |      |
|    |       |          | Signature and Stamp Receiving Card | x |      |      |
|    |       |          | Print Job Slip | x |      |      |
|    |       |          | Giving Receiving Card and Job Slip | x |      |      |
|    |       |          | Open Portal Gate in | x |      |      |
| Trucks waiting in Gate in | x |      |      |
| 7  | Operator and Assistant Operator | Container Yard | Check and Taking Receiving Card | x |      |      |
|    |       |          | Setup Rich Stacker | x |      |      |
|    |       |          | Stacking Container in Yard | x |      |      |
| Trucks waiting until their process | x |      |      |
| 8  | Gate Out Operator | Gate out | Take Job Slip | x |      |      |
|    |       |          | Input Container Number Data to System | x |      |      |
|    |       |          | Open Portal Gate out | x |      |      |
| Trucks go to the container yard | x |      |      |
| Trucks waiting in Gate out | x |      |      |
| Trucks go to gate out. | x |      |      |
| Trucks waiting in Gate out | x |      |      |

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Table 2. Results of non-value activities based on seven wastes.

| No | Type of waste | Activities |
|----|---------------|------------|
| 1  | Waiting       | Forwarding agent waiting to get the result of request SIMOP TPK System  
                      | Forwarding agent waiting to get Nota Receiving  
                      | Forwarding agent waiting to get Nota Payment  
                      | Forwarding agent waiting to get paid status  
                      | Forwarding agent waiting to get receiving the card  
                      | Trucks waiting in the gate in  
                      | Trucks waiting to stack container in the yard  
                      | Trucks waiting in gate out |
| 2  | Transportation| Forwarding agent walks to the cashier  
                      | Forwarding agent walks to the financial counter officer  
                      | Forwarding agent comes to container terminal after getting the receiving card  
                      | Trucks go to the container yard  
                      | Trucks go to gate out |
| 3  | Motion        | Setup rich stacker |

It is obtained there are three types of wastes related to the non-value activities consist of waiting, transportation, and motion. Eight activities are compared to waiting waste, five activities are related to transportation waste, and one activity is related to motion waste. The wastes occurred through receiving process of the container terminal in Teluk Bayur port are causing the receiving process to becomes inefficient. If the problem is not eliminated, then the problem will continue to repeat. The problem must be solved to increase the efficiency of the receiving process as well as to improve customer satisfaction.

3.3. Failure Mode and Effect Analysis

Based on the wastes identified in the Value Added Assessment (VAA) stage, it is determined the failure modes during the receiving process of the container terminal in Teluk Bayur port. A total of 9 failure modes are determined, and then potential causes dan effects of failure are developed through the interview with the industry experts. A questionnaire of Failure Mode and Effect Analysis (FMEA) is then developed to determine Severity (S), Occurrence (O), and Detection (D) of the failure modes. Four experts from the rubber company are consulted, and the results in descending order are presented in Table 3.

The results show the activity of checking and weighing document has the highest average RPN with a value of 154. This is the first activity in receiving process of the container terminal in Teluk Bayur port and thus become an important activity because it will affect the next activities. The failure mode of this activity is open stack process is failed. The potential causes of this failure mode are the truck driver come at the closing time, the container loads exceed the capacity of the rich stacker, the container in damaged condition, the operator of the gate it is not checking container, and the truck driver does not know the position of block container. The trucks often arrive at the closing time due to the low updated information on the ship arrival time at the dock and the closing schedule of open stack process. This failure can be solved by updating the information. The information should be uploaded in the website and the information board, so the forwarding agent can get the correct information quickly to avoid the truck coming late. Besides, the forwarding agent must be informed about the fine imposed if the trucks arrive at the closing time. This intended to minimize the number of trucks arriving late.
Regarding the container, loads exceed the capacity of the rich stacker and the container in damaged condition, the condition and maximum load of containers must be informed to the forwarding agent. The current information available is not sufficient. Information about containers should be provided in open discussions, websites and information boards in the Container Terminal Division Office. To solve the problem of the gate in operator is not check the containers, staff performance evaluation must be performed regularly because most operators do not check containers before stacked in the terminal. Besides, operators must know and understand the standard operating procedures of their work. Finally, the gate in the operator must direct the truck driver about the position of block container, so that the truck driver does not take the longest time to find the position of container block. In addition, the display position of block container also should be printed like an order receipt process, so that it will be easier for the truck driver to remember and find the position of container block.

The second highest RPN is the activity of stacking container with a value of 150. The failure mode of this activity is machining get trouble. The stacking container is conducted in the field and requires machining. The damage of this machine will cause the open stack process to be interrupted. The proposed improvement to this failure is performing regular maintenance. The maintenance is usually conducted to avoid machine damage. In addition, it also suggested buying a new machine to replace the old machine, so that the machine breakdown can be minimized.

The third highest RPN is the activity of receiving order submission with a value of 136. The failure mode of this activity is the failure to manage the receiving card documents. The activity of receiving card starts from receiving the order submission. It is the first activity in managing the receiving card documents so that the potential cause of failure occurs in this activity will cause interference in the subsequent activities. The potential causes of failure are the failure to manage the documents of receiving the card, the forwarding agent provides incomplete documents, and forwarding agent provides the unclearly written documents. This is caused by the forwarding agents do not know the...
procedure in managing the receiving card documents. Lack of information obtained by forwarding agents on how to manage the receiving card documents due to the less information provided. The proposed improvement can be conducted by providing information about the process of receiving activities including the procedure of the receiving card submission, the required documents, and the costs of the receiving card submission. That information can be published on the information board and the port website. The unclearly written documents caused by handwriting can be solved by adding the instruction to write documents in block letters as well as providing the option.

The fourth highest RPN is the activity of system crashes with a value of 135. The failure modes of this activity are having internet network problem and electricity network turned off. Almost all activities require internet networks and electricity, thus demanding the high availability of internet networks and electricity. The disruptions in this system will affect the process of receiving card become longer and reducing the satisfaction of forwarding agents. The internet network problems can be solved by routine maintenance of the website. In addition, the bandwidth must also be improved to increase the internet speed. The problem of power outages can be solved by providing generator engines in the field.

4. Conclusions
This paper has applied the lean approach to assessing wastes in the receiving process of container terminal of Teluk Bayur port. Value Stream Mapping (VSM) is used to mapping all activities conducted through the receiving process of the container terminal in Teluk Bayur port consist of eight processes with a total of 28 activities. Value Added Assessment (VAA) is then applied to identify the wastes during the receiving process. The results show there are a total of 14 non-value activities consist of nine Non-Value Added (NVA) activities and five Necessary but Non-Value Added (NNVA) activities. Finally, Failure Mode and Effect Analysis (FMEA) is conducted to evaluate the failure modes of wastes identified in the VAA stage and develop the proposed improvements. It is determined the failure modes during the receiving process of the container terminal in Teluk Bayur port. A total of 9 failure modes are determined, and then potential causes dan effects of failure are developed. The activities are ranked in descending order based on the Risk Priority Number (RPN). The priority improvements suggested are updating the information in website and notice board to handle the problem in open stack process, performing regular maintenance to machines, upgrading the machines, providing the proper information of receiving process procedure to overcome the problem in receiving card, conducting routine maintenance to website, and providing generator engines to deal with power outages. It is hoped the Teluk Bayur port can continuously improve their performance to be more efficient and effective.

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