Identification and Waste Reduction on Rubber Industry

K Syahputri*, R M Sari, I Rizkya and I Siregar
Department of Industrial Engineering, Faculty of Engineering, University of Sumatera Utara
*khalida@usu.ac.id

Abstract. Lots of activities in production process can be lead to waste activities. The waste may cause a degree of efficiency of an industry to be low. This research was conducted in the rubber industry. In the rubber industry has been a decline in the level of efficiency. Decreased levels of efficiency occurs because many inefficient activities that take place during the production process. Activities that were not contributed to the value of the product lead to waste during the production process. Identification by the activity is a way to minimize the waste that occurs so that the efficiency of the production process can be improved. Process activity mapping in the rubber industry used to identify the activities that take place on the floor of production in order to reduce waste and propose improvements that can be done to improve efficiency. The total waste that occurs in crumb rubber industry amounted to 94 minutes or 1.56 hours. For the proposed improvements in order to reduce waste are based on two activities, such as transport and unnecessary motion. Transport activities proposed use of material handling in their daily activities and to unnecessary motion by doing a variety of work on the operator.

1. Introduction
Indonesia is the largest producer of rubber, number two in the world after Thailand. Statistics show that the total world production of natural rubber in 1994 was 5.71 million tons, 1.7208 million tons donated from Thailand (30.13 %), 1.360.800 ton donated from Indonesia, 1.1006 million tons donated from Malaysia (19.27 %), and the other countries (Latin America, Africa, Asia) amounted to 1.5278 million tons, or 26.75 %. It was announced by Assistant Executive Director of the Gabungan Perusahaan Karet Indonesia (Gapkindo) Center, Ir Erwin Tunas. From natural rubber produced in Indonesia, a total of 1.2448 million tons (91.48 %) is exported, while domestic consumption is only about 116,000 tons (8.52 %) [1].

Thus, crumb rubber is the main quality types produced in Indonesia. Crumb rubber is an important commodity for Indonesia because most of the raw materials are provided by our local farmer. Based on this fact, every crumb rubber industry should continue to maintain the quality of crumb rubber to be able to continue to survive in the competition. The competitive advantage is signed by the low cost and high working efficiency, while operations were oriented consumer in terms of quality. In the rubber industry has been a decline in the level of efficiency. Decreased levels of efficiency occurred because of many inefficient activities that take place during the production process. Activities that were not contributed to the value of product leads to waste during the production process. The solution of this problem may be resolved by applying the lean thinking, using the available resources by reviewing their maximum efficiency, and improving the value added activities by reducing the waste in the production [2].
Before reducing the waste, first, the waste must be identified during the process. Based on the sentences above, it is necessary to identify the waste that occurs in crumb rubber industry. Waste identification can be done by the description of the activities occurred during the production process into value-added activities or non value-added activities. Non value-added activities are referred to activities which absorb resources without adding value to the customer [3,4,5,6] defined non value-added activities as all reviews those activities that absorb time and resources and generate direct or indirect costs but not contributed value to the product [7].

Based on the literature, there are several types of waste contained in the manufacturing industry. There are seven commonly accepted wastes:

- Overproduction;
- Waiting;
- Transport;
- Inappropriate processing;
- Unnecessary inventory;
- Unnecessary motion;
- Defects [8]

This research objective are to identify the factors that cause waste in crumb rubber industry and also provides a proposal to reduce the waste so that it can improve efficiency in crumb rubber industry. Many previous studies have been done to identify waste in the field of construction. Redundancies have resulting in financial losses, such as transportation costs and storage costs of materials [9,10] The same study has also been conducted in an investigation into the factors that cause the waste of the material costs of the Residential Building Frame [11] But the waste identification has not been done in a crumb rubber industry.

2. Methodology

There are many approaches that can be done to identify waste. Based on Peter Hines there are seven value stream mapping tools. The tools are drawn from a variety of origins as show in Table II [12] Reviews of these include engineering origins, action research / logistics and operations management, and two that are new. The seven stream mapping tools as shows in table 1.

| Mapping tool                      | Origin of mapping tool                        |
|-----------------------------------|-----------------------------------------------|
| (1) Process activity mapping      | Industrial engineering                        |
| (2) Supply chain response matrix  | Time compression/logistics                     |
| (3) Production variety funnel     | Operations management                         |
| (4) Quality filter mapping        | New tool                                      |
| (5) Demand amplification mapping  | Systems dynamics                              |
| (6) Decision point analysis       | Efficient consumer response/logistics          |
| (7) Physical structure mapping    | New tool                                      |

The table above shows there are seven mapping tool for a wide range of fields. Each stream mapping should be tailored to the objectives of a study. Based on the table above, it appears for this study that the most appropriate used is Process Activity Mapping (PAM). Process activity mapping has its origins in industrial engineering. Industrial engineering comprises a group of techniques that can be used to eliminate from the workplace waste, inconsistencies and irrationalities, and provide a high-quality goods and services easily, quickly and inexpensively [13].

Process mapping activity involves the following simple steps: first, a preliminary analysis of the process is undertaken, Followed by the detailed recording of all the items required in each process. Process Activity Mapping will show the type of activity are the production floor. Based on it, we can acknowledge the types of waste on the production floor. From the results of the identification of waste,
it can take appropriate measures to reduce waste, thereby increasing the efficiency of the crumb rubber industry.

3. Results and Discussion

3.1. Big Picture Mapping
Flowchart of the production process of Crumb Rubber based on the activities that occur. Big Picture Mapping was conducted to study the flow of the operating system on the product. Figure below shows the big picture mapping of the production process of crumb rubber industry.

![Big Picture Mapping Diagram](image)

Figure 1. Big Picture Mapping Diagram
The above picture shows the production process of crumb rubber industries ranging from costumer demand to the final product. From Big Picture Mapping can be seen the general processes occurring in the company's operating system. The depiction is very important to analyze the overall activity in the company, from ordering products from the consumer up to the final product.

3.2. Waste identification on Crumb Rubber Production Process
Based on the type of waste described in previous chapters, we can identify the waste in the operating system of Crumb Rubber production as follow:
- **Time delay**
  Waiting process occurs when material, workpiece, operator, or working facility are in a condition to stop and does not happened any other activities while wait. This activity usually lasts temporary (transient), where the object is forced to wait or temporarily abandoned until a time is done / required return.
- **Time Transport**
  Event occurs when the workpiece transport, labor or equipment moving analyzed experienced displacement that are not part of an operation. A movement that is part of an operation or due to the worker at the workplace during operation or inspection takes place, not the transportation.
• Unnecessary motion

Unnecessary motion is the motion of a human or an individual (operator, foreman, and the people who are directly related to production) or equipment redundant, ineffective, and non-value added to the production process. Unnecessary motion can lead to disruption of the flow of production, production time is not efficient, and the production lead time increases.

All three types of waste that have been identified are determining the level of importance to do remedial measures (improvement) by eliminating or reducing the waste.

3.3. Process Activity Mapping (PAM)

PAM is a technical approach which is used for activities on the production floor. This tool maps each stage of the activity that occurred from operations, transportation, inspection, delay, and storage, and then group them into types of activities that exist ranging from value adding activities, Necessary non-value adding activities, and non-value adding activities.

Furthermore, each of these activities are grouped into five categories which consist of operating activities, delay, transport, storage, and inspect. Process mapping activity made a reference to the proposed improvement. Process mapping activity can be seen in Table 2. (O=operation, D=Delay, T=transportation, S= storage, I=inspection)

| No. | Activities                                                                 | Time (Minutes) | Explanation | O  | D  | T  | S  | I |
|-----|----------------------------------------------------------------------------|----------------|-------------|----|----|----|----|---|
| 1.  | Receive the station to bring Latex Tank using montik                         | 10             | Operator    |    |    | T  |    |   |
| 2.  | Montik moved from machine to stearer using a compressor                     | 5              | Machine     |    |    | T  |    |   |
| 3.  | Stirred in the machine stearer                                              | 60             | Machine     | O  |    |    |    |   |
| 4.  | Stearer moved from machine to freezing station by using a connecting pipe   | 7              | Machine     |    |    | T  |    |   |
| 5.  | Acetic acid is brought to a freezing station                               | 3              | Operator    |    |    | T  |    |   |
| 6.  | Frozen latex with acetic acid with pipe                                     | 360            | Machine     | O  |    |    |    |   |
| 7.  | Moved from station to station freezing enumeration by using a conveyor      | 5              | Machine     |    |    | T  |    |   |
| 8.  | Chopped by machine Prebreaker                                                | 75             | Machine     | O  |    |    |    |   |
| 9.  | Water was brought to the station by using a pipe Blending                    | 7              | Machine     | T  |    |    |    |   |
| 10. | Washed station Blending                                                     | 40             | Machine     | O  |    |    |    |   |
| 11. | Blending moved from station to station by using a cutting Bucket Elevator    | 10             | Machine     | T  |    |    |    |   |
| 12. | Chopped by machine extruder into Crumb                                       | 60             | Machine     | O  |    |    |    |   |
| 13. | Crumb separated water by using a static pump                                | 15             | Machine     | O  |    |    |    |   |
| 14. | Water transferred onto the conveyor at the station enumeration by using a pipe | 5              | Machine     | T  |    |    |    |   |
| 15. | Moved from the pump station to the static drying by using pan               | 7              | Machine     | T  |    |    |    |   |
Table 2. Cont.

| No. | Activities                                      | Explanation          | Number | Duration (Minutes) |
|-----|------------------------------------------------|----------------------|--------|--------------------|
| 16. | Crumb has been fully ensured in the Pan        | 5 Operator           | T      |                    |
| 17. | Crumb dried with a dryer with a temperature of 1400°C engine became Crumb Ball | 310 Machine          | O      |                    |
| 18. | Moved from dryer machine to a packing station by means of manual | 5 Operator           | T      |                    |
| 19. | Cut and weighed using a knife and scales weighing 35 KG | 3 Operator           | I      |                    |
| 20. | Moved from Scales to manually Press Machine    | 2 Operator           | T      |                    |
| 21. | Pressed by the Press Machine                   | 3 Machine            | O      |                    |
| 22. | moved from Press machine to packaging manually | 2 Operator           | T      |                    |
| 23. | Packing brought to the station manually        | 10 Operator          | T      |                    |
| 24. | Crumb Ball Packed using plastic                | 2 Operator           | O      |                    |
| 25. | Brought to the interlayer Plastic Packing station manually | 3 Operator           | T      |                    |
| 26. | Crumb Ball created a barrier between the plastic interlayer | 4 Operator           | O      |                    |
| 27. | Plastic Jacket brought to the packing station manually | 3 Operator           | T      |                    |
| 28. | Crumb Ball Packed with Plastic Jacket          | 4 Operator           | O      |                    |
| 29. | Crumb Ball moved to the warehouse by using Forclift | 5 Operator           | T      |                    |

According to the table above, shows that in the process of crumb rubber production, there are twenty-nine (29) activities with various types of activities. From the results of PAM, each activity grouping by the type of activity and the amount of time can be seen in Table 2 below.

Table 3. Number of Activities and Duration of Activities

| No. | Activities    | Explanation | Number | Duration (Minutes) |
|-----|---------------|-------------|--------|--------------------|
| 1.  | Operation     | Operator    | 3      | 10                 |
|     |               | Machine     | 8      | 937                |
| 2.  | Inspection    | Operator    | 1      | 3                  |
| 3.  | Transportation| Operator    | 10     | 48                 |
|     |               | Machine     | 7      | 46                 |
| **Total** |                |             | **29** | **1.044**          |

The above table shows each activity grouped by the operator and the machine. This was done to facilitate the reduction of waste and the proposed improvement. Map of operator activity category of crumb rubber production process can be seen in Figure 2.
Figure 2 above shows the activity performed by operator. The figure above shows that the largest operator activity is transportation activities, while the smallest is the activity of inspection. Map of machine activity category of Crumb Rubber production process can be seen in Figure 3.

Figure 3 above shows the activity performed by the machine. Activities of the largest engine is operating while the smallest is transportation activities. The machine does not perform inspection activities. Based on the data processing, we can conclude the summary of working hours spent on waste.

\[
\text{Waste} = \text{delay} + \text{transportation} \\
= 0 + 94 \\
= 94 \text{ Minutes} \\
\text{Waste} = 1.56 \text{ hours}
\]

It can be seen that there is waste in the crumb rubber production process for 94 minutes or 1.56 hours. With the onset of waste for 1.56 hours will be experience losses for the company. Based on the results obtained, it is necessary to waste reduction. Waste reduction is based on activities that occur of the production process in crumb rubber industry.

3.4 Waste Reduction
To identify waste, this method also gives the proposed improvements that can reduce or eliminate the waste that occurred. Efforts to reduce waste, defective products and increased inventory, improve productivity, customer satisfaction, and superior quality has become increasingly important [14] Waste reduction is based on the identification of the activity in this study are as follows.
3.4.1. Transport, activity transport spent about 1.56 hours. The amount of transport activities is due to the lack of good equipment on the company. Proposed improvements implemented to reduce waste is used to:

- In the production process of the proposed improvements are made is the procurement of such machines Hydraulic when lifted from the pan Crumb Rubber in drying stations to reduce the transfer of material from drying station to the packing station
- Using material handling such as forklifts to transfer clear plastic, interlayer and jacket to the packing station.
- Replacing Montik to pick up due to slow speed to make the time wasted.

3.4.2. Unnecessary motion, unnecessary motion in employees generally occurred because operators feel tired and bored doing the same work in a long time period continuously. Proposed improvements given to complaints that operator fatigue and tired is as follows,

- Operator fatigue can be overcome by providing vitamin supplements as well as from the company to the operator.
- Saturation is felt by the operator due to do the same job in a long period continuously. Proposed improvements that can be implemented is by doing a variety of work on the operator. For example, by exchanging the filling station crumb rubber operator to a packing station. Therefore, companies must equip all operators to know and understand all the elements of production in order to exchange what operator can do instead.

4. Conclusion
This research is identifying the waste found during the production of crumb rubber. Studies differ on 2 (two) activity is the activity of the machine and operator activity. In the machine activity, transport waste that occurs is equal to 46 minutes. While in the operator activities, waste that occurs in the form of unnecessary motion for 48 minutes. So the total waste that occurs in crumb rubber industry amounted to 94 minutes or 1.56 hours. For the proposed improvements in order to reduce waste is done based on two activities, such as transport and unnecessary motion. Transport activities proposed use of material handling in their daily activities and to unnecessary motion by doing a variety of work on the operator.

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