Reducing waste with the lean manufacturing approach to improve process cycle efficiency

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Abstract. In general the main fodder raw materials used in the process is the corn imports. Fodder dependence toward imported raw materials cause increased production costs and ultimately have an impact on the price of animal feed. To maintain the stability of the production costs, industry fodder must be able to maintain and increase efficiency in the production process. The efficiency of the production process can be improved by manage waste. The purpose of this research is to minimize waste that occurs in livestock feed production process and to improve the process cycle efficiency in animal feed products. It can be done with a lean approach. Lean principles can be expressed as a process of continual improvement by eliminate the waste contained in the value stream. The results shows there are activities that are categorized as value added activity, necessary non-value added, and non-value added. Each activity consists of 11 activities for value added activity, 12 events for the necessary non-value added activity, and 3 activities for non-value added activity. The overall total time of 2434.4 minutes though the actual efficiency of 85.4%. The proposed improvements are being made to eliminate non value added activity is to use five Rev. The charts and tables with results in the form of her 5W1H, 3 activity contains the non value added activity. Through these improvements, the retrieved value process cycle efficiency improvement of 87.49% and increased by 2.09%.

1. Introduction
The increasingly fierce and growing business competition in the animal feed industry requires every company to always improve and improve its performance so that it can develop better and compete with other competitors. The domestic animal feed industry is very instrumental in supporting the development of the livestock industry in providing the availability of consumption of meat and derivative products. Feed greatly determines the quality of livestock products, livestock productivity and profits of livestock entrepreneurs.

The animal feed industry located in the city of Medan produces a variety of animal feed products. The products produced include chicken feed, duck feed, quail feed, cow feed and pig feed. All products produced generally go through the same process stages, namely pouring raw materials, filtering raw materials, drying raw materials, weighing raw materials, grinding, mixing, pellet formation, crumble formation, finase spraying, animal feed packaging. In general, the main raw material for animal feed used in the process is imported corn. This causes the price of animal feed will continue to soar in the Indonesian market due to a surge in the exchange rate of the dollar against the rupiah. The dependence of animal feed on imported raw materials causes increased production costs and ultimately impacts on animal feed prices. In addition, reworked animal feed production will experience a decline in quality so that it can only be sold at a lower grade. To maintain the stability of
production costs, the animal feed industry must be able to maintain and improve efficiency in the production process. The efficiency of the production process can be improved by minimizing waste (waste) that occurs along the supply chain of animal feed. To minimize waste, it is necessary to identify waste first in the animal feed production process to find out the most common waste and cause the production process to be disrupted so that immediate repairs can be made. Waste identification can be done using description of activity that occurs during production process into value added activity, necessary but not value added, and nonvalue added activity using lean manufacturing [1].

Lean is defined as a strategy for achieving significant continuous improvement in performance through the elimination of all wastes of resources and time in the total business process [2]. The term “lean” is a concept that implies a series of activities or solutions for eliminating waste and non-value-added operations [3] [4] [5]. The concept of Lean manufacturing is derived from the methods developed at the shop floor of Toyota, which are described in detail by the authors like Taiichi Ohno and Shiego Shingo. But these concepts in the form of lean manufacturing system (LMS) got an international recognition, as a result of the book, the machine that changed the world” written by the researches Womack et al. Salah satu metode yang digunakan dalam menyelesaikan permasalahan lean manufacturing adalah value stream mapping. VSM is a powerful tool that enables the visualisation and understanding of the flow of material and information through the value chain. It is used to provide a global vision of the activities involved in the production process, and so, it enables the identification of wastes’ sources [6] [7]. The use of VSM came in to existence after the success of the Toyota Company in Japan since 1980’s. It was developed by the Toyota Company between 1960 and 1970. At the beginning VSM was used as a methodology which identifies waste time and unneeded actions occurring in the process. But now a day’s VSM is being used as a re-engineer business for identifying the unnecessary work and resources being used for the process of the operation [8].

Many previous studies have been carried out with a lean manufacturing approach. [9] The study was conducted to improve the process of a case study in foundry with the application of value stream mapping tools. [10] research is also conducted on companies that produce golf gloves by implementing lean manufacturing to eliminate waste on the production line. [11] other research is also done with lean manufacturing tools for repairing operations in paper companies. However, not much research with a lean manufacturing approach is carried out in the animal feed industry, especially in the city of Medan. This study aims to identify waste on the production line to determine the waste that most often occurs on the production line and cause the production process of animal feed to be disrupted.

2. Methodology

The research was conducted at one of the companies that produce animal feed in the city of Medan with the object being examined is the production line for making animal feed. The research begins with observations directly to the production floor to gather information related to the animal feed production process. Activities carried out at this stage are observing the circumstances that occur in the company.

After observation, the topic and purpose of the study are determined according to the conditions on the production floor. Later on, the determining topic and purpose of the study, data collection is needed to identify waste that occurs in the production line. Data needed for the time cycle of making animal feed and the flow of animal feed production processes. Afterward it has been collected, waste identification is then carried out. Waste identification is done by first mapping the overall flow of the plant with the current state mapping. Current State Map (CSM) charts the present flow of information and material as a product goes through the manufacturing process. This is vital both to understand the need for change and to understand where opportunities lie [12]. At this stage, each process is combined with material flow and information flow so that it becomes a single unit flow in the factory. Furthermore, mapping of the flow for the entire process in the plant. The next step is to identify waste in the production process flow. Identification is done based on the results of the current state mapping
using fishbone diagrams. The causal diagram (fishbone diagram) is used to help organize information about potential causes of a problem. From this fishbone diagram, the causes of waste will be obtained in making animal feed. Next is the manufacturing lead time calculation and process cycle efficiency to see the total process of making animal feed and the efficiency value of the process. Based on these results, a proposal will be made to improve efficiency in the process of making animal feed analyzed using five why and table 5W1H. From the results of this proposed improvement, a comparison of the results of the total time of the whole process and the actual process cycle efficiency with the proposals is given.

3. Results and Discussion
Research in identifying waste with value stream mapping is done by describing the current state mapping first. The current state mapping is used to describe the system as a whole and the value streams in the company. With the current state mapping, information and physical flow can be known in the system, the lead time needed from each process that occurs. Current state mapping of animal feed production process can be seen in Figure 1.

![Figure 1. Current state mapping the animal feed production process.](image)

Based on the above mapping, identification of waste that occurs during the animal feed production process is carried out. Identification is done using fishbone diagrams. The results of identification of waste that occur using fishbone diagrams, can be seen in Table 1.

| Part               | Description of Waste                      | Types of Waste |
|--------------------|-------------------------------------------|----------------|
|                    |                                           |                |

Table 1. Waste in the animal feed production process.
By using fishbone diagrams in analyzing the causes of failure, it was found that most of the waste that occurs during the process of making animal feed is caused by humans, methods, machines, and also materials. The human cause is because operators in producing animal feed are still unskilled and work slowly due to the absence of training provided by the company to operators. The cause of the method is because the work procedures in making animal feed are unclear due to the absence of SOPs applied by the company on the production floor. The cause of the machine is because the engine is often damaged so that there is delay and buildup caused by a lack of maintenance on the engine. And the material cause is the number of finished products that accumulate in the warehouse due to excess production.

3.1. Manufacturing lead time and process cycle efficiency
Manufacturing lead time is the time needed to carry out the production process from beginning to end based on standard time. The calculation of manufacturing lead time is done by summing all work process time which consists of 26 work processes. Based on the results of the classification of activities into three activities, it was found that the sum of the process time obtained from 26 activities was 2439.1 minutes with the process cycle efficiency value of 85.4%.

3.2. Proposed improvements with five why and table 5W1H
Proposed improvements will be formulated based on data obtained from processing results. Proposed improvements are formulated with five why diagrams and 5W1H tables. The Five Why diagram is a diagram that is used to identify the root causes of nonconformities, which are obtained from causal diagrams so that they can be corrected correctly by asking why some discrepancies occur until the root causes of the root cause of the discrepancy are found. Repairs using table 5W1H and can be seen in Table 2.

| Types of Waste (What) | Source of Waste (Where) | Person in charge (Who) | Time occurs (When) | Cause (Why) | Recommendation for Improvement (How) |
|-----------------------|------------------------|------------------------|--------------------|-------------|--------------------------------------|
| Waiting/Delay         | Mixing Station         | Mixing operator         | Transfer from stacking before raw materials are mixed | SOPs for mixing raw materials have not been implemented by the company and training programs for employees are not well programmed | It is necessary to implement SOP for mixing raw materials and improving operator skills through a training program |
| Waiting/Delay         | Packaging Station      | Packaging operator      | Transfer from spraying finase liquid before packaging | Supervisors focused on the output of product packaging stations and training programs for employees not well programmed | Supervision of procedural activities must be improved and improved operator skills through a training program |

Table 2. Table 5W1H for waste.
Waiting/Delay | Warehouse
--- | ---
Operator of transporting finished products | Transfer from stacking before manually shredded | The implementation of production planning is not optimal, training programs for employees are not well programmed, and supervisors only focus on providing maintenance to the machine | It is necessary to apply production planning well, create training programs for operators and check all machinery and equipment and are available

### 3.3 Manufacturing lead time and process cycle efficiency improvement

The calculation results for proposed improvements with 23 activities indicate that an increase in process efficiency cycle of 2.09% through eliminating non-value added activities. In addition, the improvement results show that the manufacturing lead time is reduced by 56 minutes and the time before repair becomes 2383.1

### 4. Conclusion

Lean principles can be expressed as a process of continual waste management contained in the value stream. In the process of making animal feed, there are activities that are classified as value added activity, necessary non-value added, and non-value added. With each activity totaling 11 activities for value added activity, 12 activities for necessary non-value added activity, and 3 activities for non-value added activity in the form of waiting to be mixed in mixer machines, waiting to be packed, and waiting to be brought to the warehouse the finished product where the total total time is 2434.4 minutes with the actual process cycle efficiency value of 85.4%. The proposed improvements are carried out using five why diagrams and 5W1H tables with the results of eliminating 3 activities included in non-value added activities. With this improvement, the value of repair process cycle efficiency was obtained by 87.49% and increased by 2.09%

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