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Lean Thinking Approach to Waste Reduction in the Production Process at Transformer Companies

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ABSTRACT

Minimizing all waste (waste) is mandatory for the company. The results of the study using a lean approach, followed by looking at the winding process as a whole, Big Picture Mapping and identification of waste that occurs in business processes, carried out by comparing the actual time to the standard time for the winding process, the value-adding time for the winding process is 21310 minutes. In contrast, the total production time is about 22995 minutes. The non-value-adding time ,which does not add value to the product, is 1685 minutes, and identified the cause for the delay using Root Cause Analysis. Waste waiting is the most waste among other wastes.

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Key Words: Lean manufacturing, Big Picture Mapping, Root-cause analysis, Waste reduction.

1. INTRODUCTION

The growth of the manufacturing industry that occurs causes competition between industry players to increase, creating the need for an improvement method that can maintain the company's competitiveness. The improvement method applied must be able to overcome problems regarding quality in the company so that the products offered can be accepted by customers [1]. The improvement in quality, performance, and productivity is closely related to the lack of Waste teame. The success of the industry depends on its productivity [2]. Productivity can be one of the indicators of a company's success. The current condition at transformer enterprises is that the production process time is less efficient. The cause of the inefficiency of the production process is due to the large amount of waste time [3].

The amount of waste time certainly greatly affects productivity. Along with the number of competitors in the same product, the amount of waste time will certainly greatly affect the company's competitiveness in competing for orders.

Figure1 shows the number of lost hours in each month. The total in a year reaches 18093 hours. Due to the loss of hours, the transformer production in 2021 has decreased from the total installed capacity of 175 units to only 136 units. To overcome the existence of waste, it is necessary to identify waste, added value processes and non-added value processes with a lean manufacturing approach that can be used as improved methods and techniques that are effective for increasing the competitiveness of manufacturing companies [4-6]. Based on the explanation above, it is necessary to research transformer companies.

Based on the background above, the formulation of the problem used in this study is:

1. Which activities cause waste.
2. How to repair reduces waste.

So that the problems studied are narrow enough and follow the predetermined theme, researchers need to limit the problems discussed in this research. The limitations of the problems used in this study are as follows:

1. This research only focuses on the winding production process at the Indonesian Transformer Factory.
2. The data used are primary data for discussion with speakers and secondary data from the 2021 period.

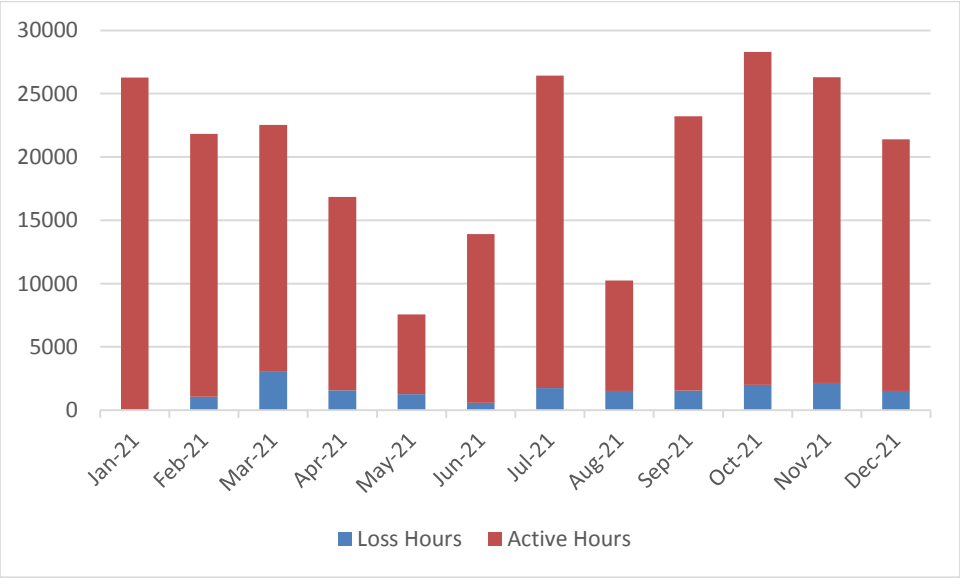

Figure1.1: Loss Hours 2021

2. LITERATURE REVIEW

2.1 Winding

Winding is the central part of a transformer. Winding consists of several coils of copper wire that insulate and form a coil. Winding must be designed in such a way as to be able to withstand, among others, short circuits, induce overvoltage dan lightning impulse [7].

For Transformer 60 MVA PLN, consisting of 5 windings for each phase, there are 3 phases in transformers 60 MVA PLNA, bringing the total number of windings in 1 Transformer to 15 units. Types of winding in 1 phase Transformer consists of : Tertiary Winding, Low Voltage Winding, Hight Voltage Winding, Coarse Regulation Winding dan Fine Regulation Winding.

2.2 Lean Thinking Concept

The principle of lean is to look for ways to create value in the best order, compose its activity without interruption, and carry it out more effectively and efficiently. Lean provides a way to do more and more with minimal human effort, equipment and time but is getting closer to the consumer's desire. The lean concept was introduced by Taiichi Ohno and Shigeo Shingo at Toyota Motor Corporation. The concept gave birth to a self-sustaining culture by emphasizing 5S: set, sort, shine, standardize and sustain. This positively impacts employee motivation to work more effectively and efficiently [8]. Lean is a production streamlining concept that originated in Japan. This concept is an adoption concept of the Toyota production system. The concept of this approach is oriented towards eliminating waste (waste) in the production system.

2.3 Waste

In lean applications, waste must be eliminated. Waste is an activity that has no added value. Therefore, waste must be eliminated because it can cause the production process to be more efficient [9]

2.4 Process Activity Mapping

Process activity mapping (PAM) is used to find out all activities that occur during the production process, then classify these activities based on the type of waste. This tool aims to eliminate unnecessary activities, identify whether a process can be more efficient, and look for improvements to reduce waste [8]

Table 1. Activity Type

No	Activity Type	Symbol
1	Operation	O
2	Transportation	T
3	Inspection	I

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4	Storage	S
5	Delay	D

2.5 Root Cause Analysis (RCA)

Root Cause Analysis (RCA) is a method to determine the root cause of the problem that ccurs. To perform RCA, a Cause and Effect Diagram, Fishbone Diagram, or 5 Why's can be used [2][9].

3. METHOD

Based on the nature of the problem, this research is classified as a type of descriptive research (descriptive research), which is research that seeks to explain problem-solving to a problem that exists now in a systematic and factual based on data. So this research includes collecting, presenting, processing data, and analyzing. Meanwhile, according to the type of data and analysis, this research is classified as quantitative research because the data needed in the data processing process will use quantitative data. Hence, the data analysis uses quantitative analysis.

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3.1 Types of Data and Information

Types of data and information can be grouped by nature, source, how to obtain them, and the time they were collected. The data used in this study based on the source consists of 2 types of data: Primary Data and Secondary Data.

3.2 Data Collection Methods

Data collection is carried out as the first step in a study, and supporting materials in this study. The data used in the study is primary data obtained from direct observations made by researchers. Observation, interviews, and literature studies carried out data collection.

3.3 Data Processing and Analysis Metohds

After all the data needed, both primary and secondary is collected, the next stage is data processing. The measuring stage is carried out to measure and process the data used.

4. RESULTS AND DISCUSSION

4.1 Big Picture Mapping Analysis

Significant picture mapping is the first step to understanding information and physical flow in the production process. The significant picture mapping that is described is an overview of the overall production process at the transformer factory.

The overall description of the extensive picture mapping is in Appendix 1. From the picture, the value-adding time for the winding process is 21310 minutes. At the same time, the total production time is around 22995 minutes. So the difference between production time and value-adding time can be said to be the time that does not add value to the product, which is 1685 minutes or 7.3%.

The time used to carry out production process activities but not add value to the product indicates that waste impacts the production process. However, the significant picture mapping does not show any waste that occurs, so it is necessary to carry out other data processing to describe the types of waste that occur in the production process.

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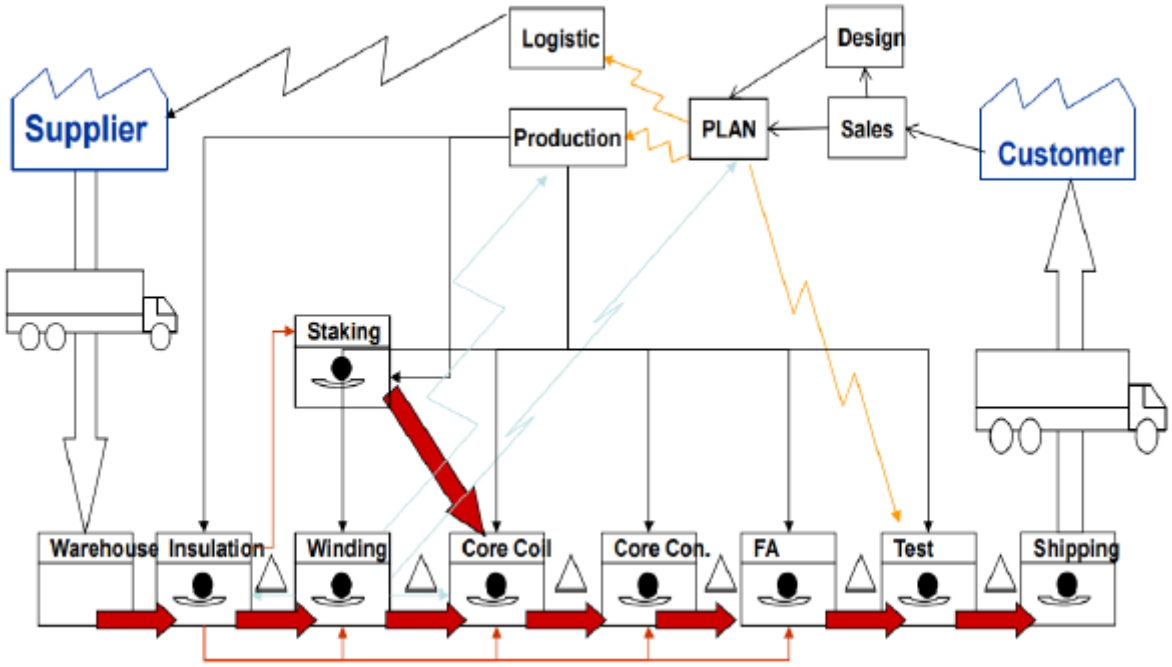

Figure4.1: Information Flow

4.2 Comparative Analysis of Standard Time with Actual Time

A comparison is made between the standard time and the actual time to find out which processes have waste. There are several differences between the actual time and the standard time. Table 2. below describes the time difference.

Table 2 Comparision Standard Time with Actual Time

No	Process / Mesin	Standard Time (minutes)	Actual Time (minutes)
1	Winding tertiary	980	1285
2	Winding low voltage	8620	7425
3	Winding high voltage	10390	10995
4	Winding coarse regulation	1190	1465
5	Winding fine regulation	1550	1825

4.3 Waste identification Analysis

Identification of the 7 wastes was carried out based on non-value-adding activity and interviews with various parties from the company. These results found 4 types of waste: waiting, excessive transportation, defects, and unnecessary motion.

Waiting is found in activities waiting for the isolation of materials that experience delays in delivery. This activity is a waste of waiting because there is no production process while waiting. The company suffered a total loss of 15 hours or 900 minutes from the calculations. Another disadvantage is the wasted disposal of electrical energy due to the absence of a production process. This study has not carried out losses due to the wasted use of electrical energy.

Excessive transportation is found in the transfer of the winding during unloading. The unloading process occurred 2 times due to the tilting machine's and crane's limited capacity. Losses experienced by the company amounted to 90 minutes.

The defect found was insulation damage to the copper caused by excess pressure on the pneumatic press. This waste causes rework on the winding.

An unnecessary motion found is the movement of the operator to adjust the hydraulic press, the distance from the winding machine to the hydraulic press regulator is quite far. As a result of this waste, the company loses.

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4.4 Waste Root Cause Analysis

Of the four types of waste found, identifying the root causes is carried out using the root causes analysis method, which is a method to find the reasons for the most basic causes of waste.

There are several causes for the occurrence of the 4 wastes found, which are explained in Table 3.

Table 3. 5 Why Analysis

Problem	Why 1	Why 1	Why 1	Why 1	Why 1
Waiting Crane	Poor coordination between material handling operators and operators warehouse	Limitations of cranes operating in *windings* and *warehouses*	There is no schedule for the use of cranes yet	No one cares about scheduling the use of cranes yet	Don't understand the impact of waiting cranes
Delay Suply Insulation Material	Drawing from *design* to supplier late	There is a jumping *schedule* due to demand *customer*	The location of the transformer unit placement is not ready	The project contractor has not yet started	Land still indispute
Waste Transportation	There was a queue in the *tilting* machine	*Finish winding* together	*Start winding* together	Planning that does concurrent start	The transformer consists of 3 *phases*
Defect	Copper dimensions especially *CTC (Continous Transpose Cable) via from tolerance*	Copper *CTC* is less *flexible*	The distance between the *strands* in *the cable CTC* is too close	Suppliers have their own standard strand distance	There is no specification request from the customer

4.1 Process Activity Mapping

Table 4 Recap of Process Activity Mapping Winding Results

No	Activity Type	Activity Amount	Percentage (%)
1	*Operation*	10	92,67
2	*Delay*	6	1,76
3	*Transportation*	15	4,39
4	*Inspection*	5	0,85
5	*Storage*	5	0,33

The recapitulation table above shows the proportion of each type of activity that takes place in the winding process. There are a total of 41 activities consisting of 10 operations (92.67%), transportation 15 activities (4.39%), inspection 5 activities (0.85%), storage 5 activities (0.33%) and delay 6 activities (1.76%). In other words, the winding production process is 92.67% value-adding activity, 5.24% necessary non-value adding activity consisting of transportation and inspection activities. Meanwhile, non-value-adding activity was 2.09%.

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5. CONCLUSION

Several activities in the Winding process cause waste, based on non-value adding activity, in material handling activities to get waste due to waiting cranes, in the winding process activities to get waste due to defects caused by isolation damage so that it must be re-isolated, in addition to that, waste unnecessary motion is also obtained due to the distance of the pneumatic regulator that is too far, waste is also obtained in unloading winding activities, this waste occurs due to the presence of waiting cranes and queues on tilting devices.

6. SUGGESTION

The following is the advice given from the results of this study. It is necessary to evaluate scheduling winding, so there is no waiting time when loading material or unloading winding.

For the following research, research can be carried out based on risk analysis of the occurrence of waste.

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