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Waste Minimation in Production Process Electrical Panel Box at PT. X with Value Stream Mapping (VSM) Approach

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ABSTRACT

PT. X is a medium-sized company that produces electrical panel boxes. Make To Order (MTO) is considered a production process. The production process includes plate cutting, bending, welding, grinding, powder coating and assembly part by part processes. Lean Manufacturing is a philosophy started in Japanese manufacturing, to eliminate all waste from its processes while pursuing quality improvements in producing finished products. Value Stream Mapping is an important step in the lean transformation process before entering the waste elimination stage. The bottleneck that occurs can result in a lack of productivity from the company. The impact of the bottleneck is that the box panel product is not directly carried out by workers on the same day, so the box is at risk of piling up. The time required for the production process of APPL Box is 3047 minutes if converted in days is 2.1 days. This procurement process experienced a delay of 1 day from the target set by the company. There are 2 types of waste identified, namely waiting time and lack of powder coating machines.

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1. Introduction

Increasingly fierce business competition and current scientific developments force companies to make quality improvements to maintain and increase profits. Therefore the company increases production capacity, if the company experiences an increase in production capacity it will automatically appear a lot of waste on the company's production line. Therefore, every process in the production line must apply the principles of efficiency and effectiveness in each process to be more competitive and increase profits (Debnath et al., 2023; Hariyani & Mishra, 2022b; Voronova, 2022). PT. X is a medium-sized company that produces electrical panel boxes. Make To Order (MTO) is considered a production process. The production process includes plate cutting, bending, welding, grinding, powder coating and assembly part by part processes. In addition, the company is also challenged with inconsistency in producing good quality products (Dillinger et al., 2022; Lai et al., 2022). The problem found by manufacturing companies is that frequent waste in each production activity causes the lack of achievement of an effective and efficient production process (Bokhorst et al., 2022; Dossou et al., 2022; Hariyani & Mishra, 2022a; Naciri et al., 2022).

2. Literature Review

a. Lean manufacturing

Lean Manufacturing is a philosophy started in Japanese manufacturing, to eliminate all waste from its processes while pursuing quality improvements in producing finished products. The essence of implementing a lean manufacturing system is where this system focuses on identifying and eliminating all forms of waste so as to form a lean and efficient manufacturing system (Akram et al., 2022; Bao et al., 2022; Choi & Lee, 2022).

b. Work Measurement

The measurement of work meant here is the measurement of working time (time study) which is an activity to determine the time required by an operator (who has average skills in well-trained). Direct time measurement is a measurement that is carried out directly on the work being done or on representative samples. Direct measurement, there are two kinds, namely:

- Standard Time Measurement with Stopwatch.
- Working Time Measurement with Work Sampling

c. Cause and Effect Diagram and 5W + 1H

Value Stream Mapping is an important step in the lean transformation process before entering the waste elimination stage. Toyota, as a pioneer of lean thinking, has been using this method since 1970. Value Stream Mapping consists of 2 types according to (Anugrah, 2016) as follows:

- Mapping Current State Map, aims to determine the flow of the production process and process information from ordering to delivery to the hands of consumers.
- The design of the Future State Value Stream Map, serves as an illustration of the comprison between the current state of the company and the future state of which proposals for improvement have been designed in order to minimize waste and optimize value-added activities

d. Waste

Waste is all activities in the work process that do not provide added value. The sources of waste in a manufacturing industry are as follows:

- Waste on Input: Excess inventory, unused materials (defective, obsolete)
- Process wastage: Scrap and rework, inefficient processes, outdated or obsolete processes, unreliable processes
- Waste of Output: Unsold overproduction, defective products, obsolete or outdated products

3. Methodology

The bottleneck that occurs can result in a lack of productivity from the company. The impact of the bottleneck is that the box panel product is not directly carried out by workers on the same day, so the box is at risk of piling up. In addition, waste can exceed the standard time that should be. To eliminate waste, companies can use lean methods.

One of the tools or tools that can be used to implement lean is Value Stream Mapping (VSM). The whole process is depicted with certain symbols on a piece of paper. The purpose of VSM is to identify the production process so that materials and information can run without interruption, increase productivity and competitiveness, and assist in implementing the system. Therefore, VSM helps in finding waste in the production process.

Identification of value added and non value added activities is an important process in the lean approach. In manufacturing, three types of activities can be categorized according to (Monden, 1993 cited by Isnain, 2016), namely, as follows:

- Value Adding Activity (VA) is an activity that can provide added value from the customer's point of view on a product material that is made or processed.

- Non-Value Adding Activity (NVA) is an activity to make products but does not provide added value for customers.
- Necessary Non Value Adding Activity (NNVA) is an activity that does not provide added value but is required in the existing process procedures.

4. Results and Discussion

The VSM method is referred to as one of the methods that applies a visualization image that is most efficient in describing the current state of a system, and is able to identify a long-term vision and be able to develop a company plan to get the desired goals. Current State Value Stream Mapping is made based on the identification of value added activity and non value added activity in the production process of Appl's electrical panel box.

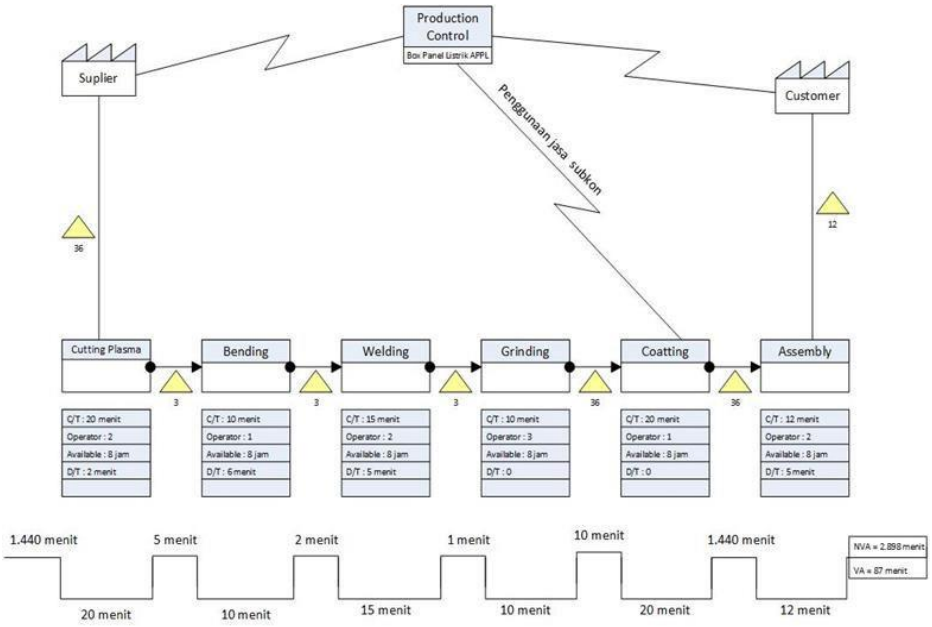

Figure 1. Current State Map
Source: data processing

Table 1. Current State Map

No	Process Step	Time (minute)	Category
1	Cutting, the supplier cuts the plate sheet into several parts according to the size and design pattern	30	VA
2	Waiting for the plate that has been cut to enter the inventory	1440	NVA
3	Loading plate sheet into plasma cutting machine	5	NNVA
4	Plasma cutting process cuts small parts that are designed BOX	20	VA
5	Plate loading process to bending machine	5	NNVA
6	The plate is bent according to the bending pattern	10	VA
7	Bending design coordination on plate	6	NVA
8	Porcess loading plate that has been bent to the welding division	2	NNVA
9	Bent plate grouping process	1	NVA
10	Welding process	15	VA
11	Welding result checking process	5	VA
12	Loading Box into Grinding machine	1	NNVA
13	Grinding is done on each side where there is a weld	10	VA
14	Loading process to truck	10	NNVA
15	powder coating process is carried out on sub contractors	20	VA
16	waiting for the box to finish coating	1440	NVA
17	the process of loading the box drop from the truck	10	VA
18	assembly process part by part Box	12	VA
19	accessories pick up	5	VA
	Total time	3047	

Source: data processing

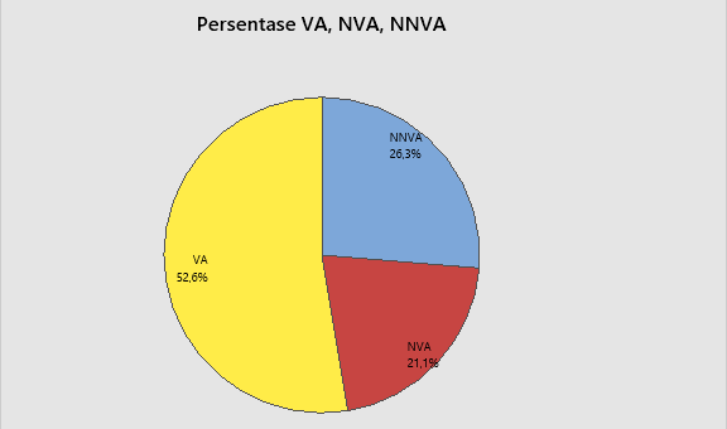

Figure 2. Pie diagram of the percentage values of NV, NVA and NNVA
Source: Data processing

The time required for the production process of APPL Box is 3047 minutes if converted in days is 2.1 days. This procurement process experienced a delay of 1 day from the target set by the company. In this process, it shows that the percentage of value added time is 52.6%, non value added time is 21.1% with details necessary but non value added is 26.3%. Value added time is an activity that provides added value for the company, non value added time is an activity that does not provide added value for the company while necessary but non value added time is an activity that does not provide added value for the company.

Process Cycle Efficiency Measurement

This measurement begins by classifying value-added activities and non-value-added activities.

Process Cycle Efficiency

$$= \frac{Value\ added\ time}{Total\ lead\ time} x\ 100\%$$

$$= \frac{87}{2.898}\ x\ 100\%$$

$$= 33{,}31\%$$

Waste generation analysis

At this stage, an analysis is carried out using a fishbone diagram to find out the causes of potential waste that is carried out by brainstorming with the company.

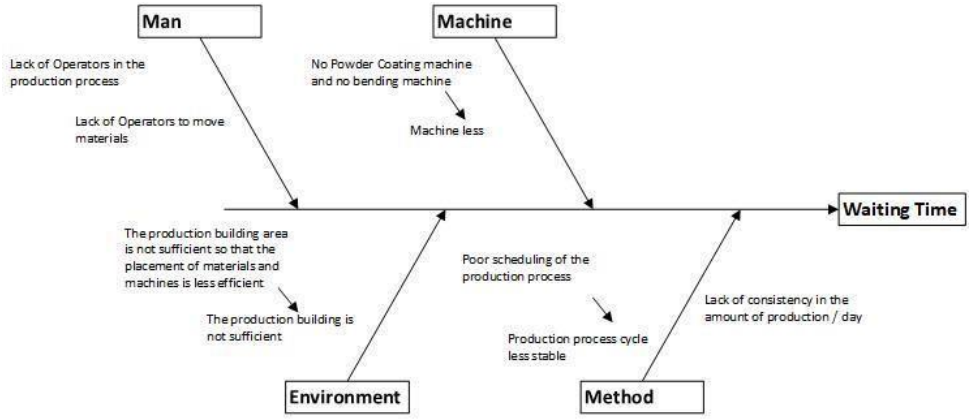

Figure 3. Fishbone Diagram
Source: Data processing

The most potential causes of the above diagram data include:

- The company does not have its own Powder Coating machine.
- Insufficient number of operators.
- Lack of bending machines compared to other machines, where in the production process the company only uses 1 unit of bending machine.

Repair recommendations

Recommendations for improvement are given to the three types of waste with the highest value. Repairs that can be provided include:

- The company adds space in the production line which will later be used for the placement of the powder coating machine, this is necessary because one of the bottlenecks is in the powder coating process where the company is still using the services of a sub-contractor to paint the APPL electrical panel box with a period of approx. 1,440 minutes. Which should be trimmed to 20 minutes per 50 pcs boxes which will be painted using a powder coating machine with a capacity of 50 pcs per 1 round.
- Increasing the number of operators and helpers in each machine with the aim of accelerating the process of loading and unloading materials to the next process, this can be seen from the number of operators in each production machine such as bending machines with 1 operator and 1 operator assembly. This causes delays and results in wastage.
- The addition of a bending machine, there is already 1 unit of bending machine operating and 1 more unit is needed to speed up the plate bending process, this can be seen from the downtime in the bending process getting the highest value, which is 6 minutes per process, where this is used by the operator to setting the machine and reading the design which results in delays and waste.

Future State

Future State Value Stream Mapping is a proposed improvement of current state value stream mapping by eliminating activities that are considered waste. Future State Value Stream Mapping is made based on the proposed improvements that have been made.

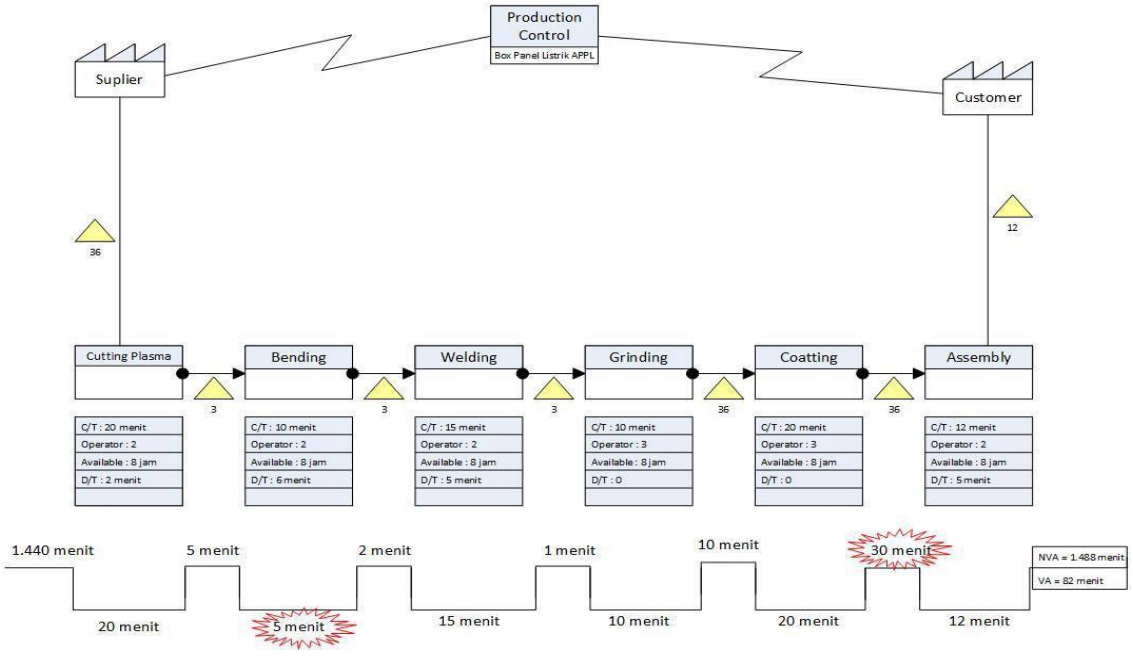

Figure 4. Future state map
Source: data processing

The coating process no longer uses the services of subcontractors so that it can reduce waiting time after the coating process goes to the assembly process. This is done because looking at the processing results which show the high waiting time from the coating process to the assembly process which was previously 1,440 minutes after adding a powder coating machine to the company, it can cut the time by 1,410 minutes so that the waiting process becomes only 30 minutes.

Furthermore, in the bending process, 1 additional operator was added, which previously only had 1 operator, now there are 2 operators, this is done to speed up the bending process itself which previously took 10 minutes to 5 minutes. This is clearly advantageous because it can reduce the waste in the bending process. The time required for the APPL Box production process is 1.488 minutes if converted in days is 1.3 days. This procurement process has increased for 1 day from the previous total production time.

Process Cycle Efficiency Measurement

This measurement begins by classifying value-added activities and non-value-added activities.

Process Cycle Efficiency

$$= \frac{Value\ added\ time}{Total\ lead\ time} x\ 100\%$$

$$= \frac{82}{1.488}\ x\ 100\%$$

$$= 18{,}14\ \%$$

5. Conclusion

There are two types of waste identified, namely waiting time and lack of powder coating machines. The factors that influence the existence of the two types of waste identified are waiting time and powder coating machines because both are closely related and caused by powder coating machine units that are not owned by the company, thus requiring PT. X uses the services of a sub-contractor as a service provider for powder coating products. The lack of a powder coating machine causes a buildup of products resulting in a long waiting time. Recommendations for improvement that the addition of a powder coating machine so that it does not take a long time and avoids the buildup of boxes which can lead to waste. Adding 1 unit of bending machine with the aim of accelerating the bending process on the plate so as to minimize downtime in the process and minimize waste. The addition of employees to speed up the loading and unloading process in each existing machining process, this is done with the aim of reducing the number of waste in each box transfer to the next process.

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