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Model Lean Manufacturing With The VSM Method to Reduce Waste In The Production Process Box Electrical Panel at PT.DMI

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Abstract - PT. DMI is a medium-sized company that produces electrical panel boxes. Make-to-order (MTO) is a reference at the start of the production process. The production process includes plate cutting, bending, welding, grinding, powder coating, and part-by-part assembly. Lean Manufacturing started in Japanese manufacturing, to eliminate all waste from the process while pursuing quality improvement in producing finished products. Value stream mapping is an important step in the lean transformation process before entering the waste elimination stage. which can lead to a decrease in the productivity of the company. One of the biggest problems was the lack of bending machines and not having our powder coating machine.

Keywords: Value Stream Mapping, Fishbone diagrams, Flow Process Charts.

1. Introduction

The manufacturing industry is the process of converting raw materials into finished products. This process involves several stages, such as product design, material selection, and production stages or processes. Today, manufacturing involves making products from raw materials through various processes, machines, and operations, all of which are managed in an organized manner through good planning for each activity required.(Supriyanto, 2013).

The electric panel is a container in the form of a rectangular cube box where inside the box, there is a cable connection or electrical panel. The box's existence is very important to protect against leakage of electric current which is dangerous for workers or humans.

One of the problems that will be analyzed is the problem of delays in the production process at PT. DMI. The delay in question is a delay in the production process caused by waste such as downtime, waiting time, or other waste contained in the electric box production line.

2. Literature Review

A. Lean manufacturing

Lean is an approach that aims to improve processes by eliminating activities that do not add value and increase work effectiveness and efficiency. Thus, this method creates faster and optimal performance (Wijaya, 2023).

The main focus of Lean is to identify and eliminate non-value-adding activities in production design (for the manufacturing sector) or operations (for the service sector) as well as supply chain management, which are directly related to customer needs (Gaspersz in Sustainable, 2019).

One method that has been proven effective in quality control and is widely used by large companies around the world is the lean manufacturing method. This lean approach aims to eliminate waste (waste elimination), improve the flow of materials, products, and information, and prioritize process speed to create a smooth flow of products throughout the value stream process (value stream process).

B. Value stream mapping

Value Stream Mapping (VSM) is a method used to describe the physical value stream of a product and identify the root causes of waste.

Value Stream Consists of 2 types according to (Anugrah, 2016) as follows:

a. Mapping the Current Situation Map, aims to find out the flow of the production process and process information from ordering to delivery to consumers.
b. The design of the Future State and Value Stream Map serves as an illustration of the comparison between the current state of the company and the future state of which improvement proposals have been designed to minimize waste and optimize value-added activities.

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C. Waste

Waste (waste) or in Japanese called "muda," is an activity that is highly undesirable in the production system. Youth is an activity that absorbs labor but does not add value to the product(Womack & Jones, 2003).

Table 1. Flow Process

No	Langkah Proses	Waktu (menit)
1	*Cutting, Suplier* melakukan pemotongan lembar plat menjadi beberapa bagian sesuai ukuran dan pola desain	30
2	Menunggu lembar plat yang sudah dipotong untuk masuk *inventory*	1440
3	*Loading* lembaran plat ke mesin *cutting plasma*	5
4	Proses *cutting plasma* memotong bagian-bagian kecil yang terdapat didesain *Box*	20
5	Proses *loading* plat ke mesin *bending*	5
6	Plat di *bending* sesuai pola tekukan	10
7	Koordinasi desain tekukan pada plat	6
8	Proses *loading* plat yang sudah ditekuk ke devisi *welding*	2
9	Proses pengelompokan plat yang sudah dibengkokan	1
10	Proses *welding*	15
11	Proses pengecekan hasil *welding*	5
12	*Loading Box* ke mesin *Grinding*	1
13	Grinding dilakukan ditiap sisi yang terdapat hasil las	10
14	Proses *loading* ke truck	10
15	Proses *powder coatting* dilakukan pada subkon	20
16	Menunggu *Box* selesai di *coating*	1440
17	Proses loading penurunan box dari truk	10
18	Pengambilan aksesoris	5
19	Proses assembly part by part Box	12
	Total waktu	3047

Waste consists of activities that do not add value, but add production costs that are not wanted by consumers (Gopinath & Freiheit, 2012).

3. Methodology

This study uses the VSM method as a performance measurement tool for the lean manufacturing approach. VSM can identify activities that have added value or not. The first stage begins with data collection during the production process of the Electrical Panel Box using a stopwatch as a measuring tool.

The following are the steps taken in making VSM (Value Stream Mapping):

a. Identification of Family Products

This identification is intended to focus the mapping process on products that have less efficient processes and simplify it so that data collection can be done more easily and quickly.

b. Creation of Current State Map

Making a map of the current state (current state map) is done by using Value Stream Mapping (VSM) of the company's actual situation which includes consumer orders, the company's operational processes, and the product journey from start to arrival in the hands of consumers.

c. Problems in VSM flow

At this stage, an analysis of existing activities is carried out, which can be classified into three categories, namely activities that provide added value (value-added activities), activities that are necessary but do not provide added value (necessary but non-value-added activities), and activities that do not provide added value (non-value-added activity).

d. Creating a Future State Map

A future state map is a visual picture of the conditions desired by the company in the future, based on improvement proposals taken from the existing current state map.

4. Results and Discussion

A. Flow Process

Flow Processes data that shows the sequence of operations, inspections, transportation, delays, and storage that occur during a process or procedure.

B. Current state map

After making observations, the flow of the production process is obtained in the table**1**, and then a current state map in image 1 from the

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beginning of the manufacturing process to the end of the manufacture of electrical panel boxes.

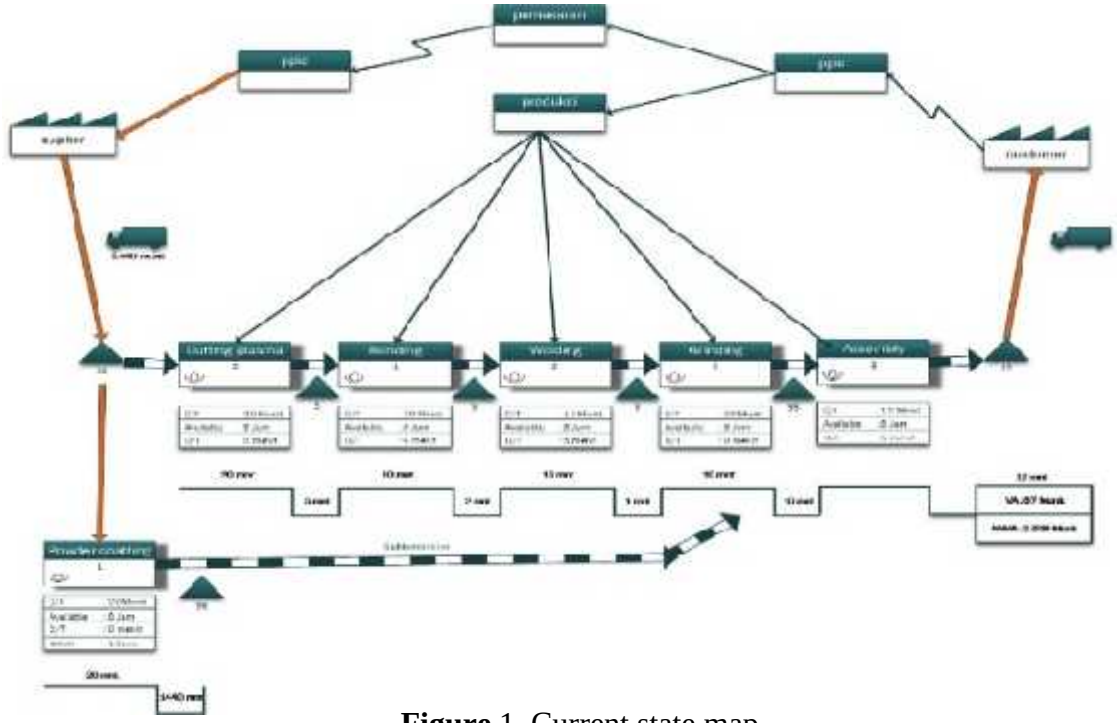

Figure 1. Current state map

C. Fishbone diagrams

Once it is known that the waste that occurs at PT. DMI is waste waiting and processing, then identification of the causal factors for the occurrence of waste is carried out to find out what factors influence the occurrence of waste in companies using the 5 Why, namely humans, methods, machines, and environment.

a. waiting(Powder Coating)

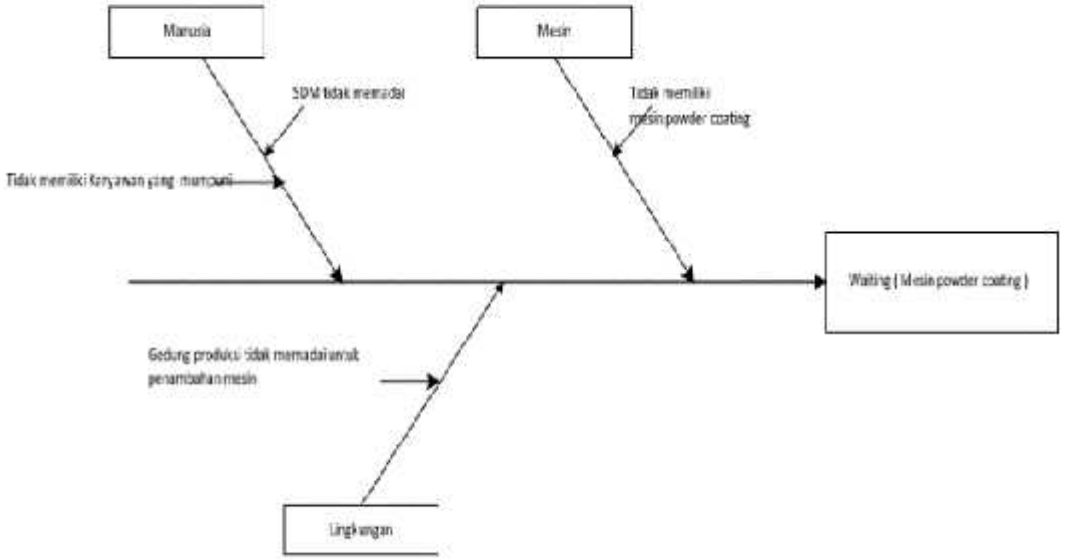

Figure 2. Waiting fishbone diagram

In the picture above are the factors causing the occurrence of wastewater (powder coating), there are 3 factors for the occurrence of waiting which will be described as follows:

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1) Man

Humans are a factor causing waste because the company does not yet have workers who meet the operating standards of powder coating machines.

2) Machine

The machine is a factor causing waste because the company does not have its powder coating machine so it cannot run the process, this requires PT. DMI Indonesia uses the services of a subcontractor for the continuity of the electrical panel box production process.

3) Environment

The environment is a factor that causes waste because the conditions in the production building are inadequate for installing powder coating machines.

b. processing(Bending Process)

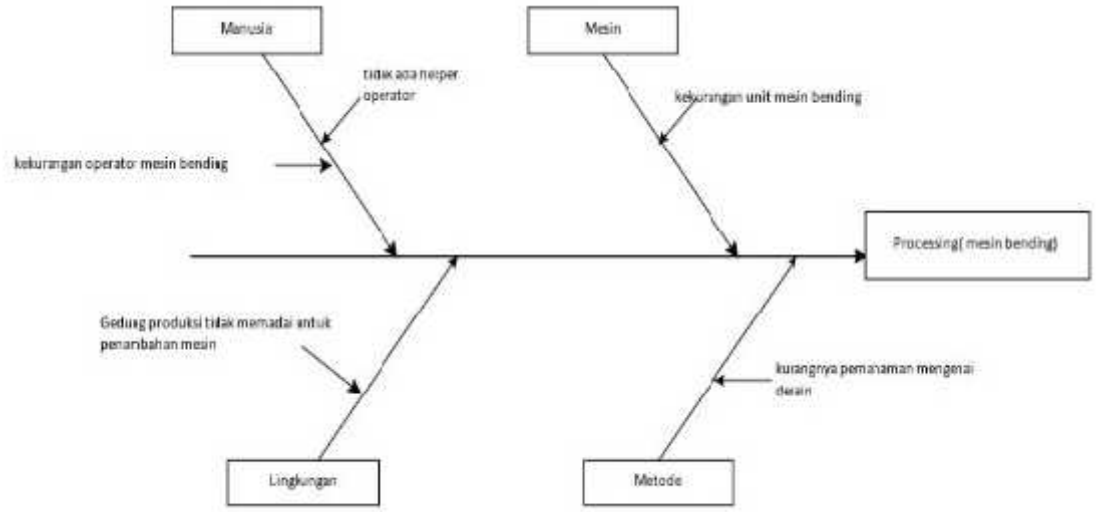

Figure 3. Fishbone diagram processing

Picture 3 shows the factors that cause waste processing (bending machines), 4 factors cause waste processing which will be described as follows:

1) Man

Human or humans become a factor causing waste processing due to the lack of operators in the bending process and the lack of additional workers as operator assistants.

2) Machine

Machines are the cause of waste because the number of bending machine units owned is only 1 unit. This triggers waste in the cycle time of the electrical panel box production process.

3) Environment

The environment is the cause of waste because the bending machine area does not have sufficient space to place the raw materials to be worked on.

4) Method

The working method is also the cause of waste in the production line, especially in the bending process section because during work the workers spend several times consulting regarding the design of the plate to be bent.

D. Improvement recommendations

Based on the current state map of the VSM that was made previously, to reduce waste in the electrical panel box production line at PT. DMI.

1. The first recommendation is to increase the number of operators and helpers in each machine to speed up the process of loading and unloading material to the next process.

   The addition of employees to the bending machine section, which originally numbered 1 person, was added with 1 more person as assistant operator 1 in operating the machine.
2. The second recommendation is that the company adds a bending machine, there is already 1 unit of bending machine operating, and 1 more unit is needed to speed up the

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plate bending process, this can be seen from the downtime in the bending process which gets the highest value of 6 minutes per process, where this is used by the operator to set up the machine and read the design which results in delays and waste. The company added a bending machine which previously only had 1 unit of bending machine plus 1 more unit so that it has 2 units of bending machine.

3. The third recommendation is that the company adds space to the production line which will later be used for placing powder coating machines, this is necessary because one of the obstacles is in the powder coating process where the company still uses sub-contractor services to carry out the process of painting electrical panel boxes with a period of 1,440 minutes. Which should be trimmed to 20 minutes per 50 pcs boxes to be painted using a powder coating machine with a capacity of 50 pcs per 1 round.

E. Future state map

Based on the recommendations for improvements above that have been discussed with the company's experts, improvements to the production process are made using the VSM Future state map in the image as follows:

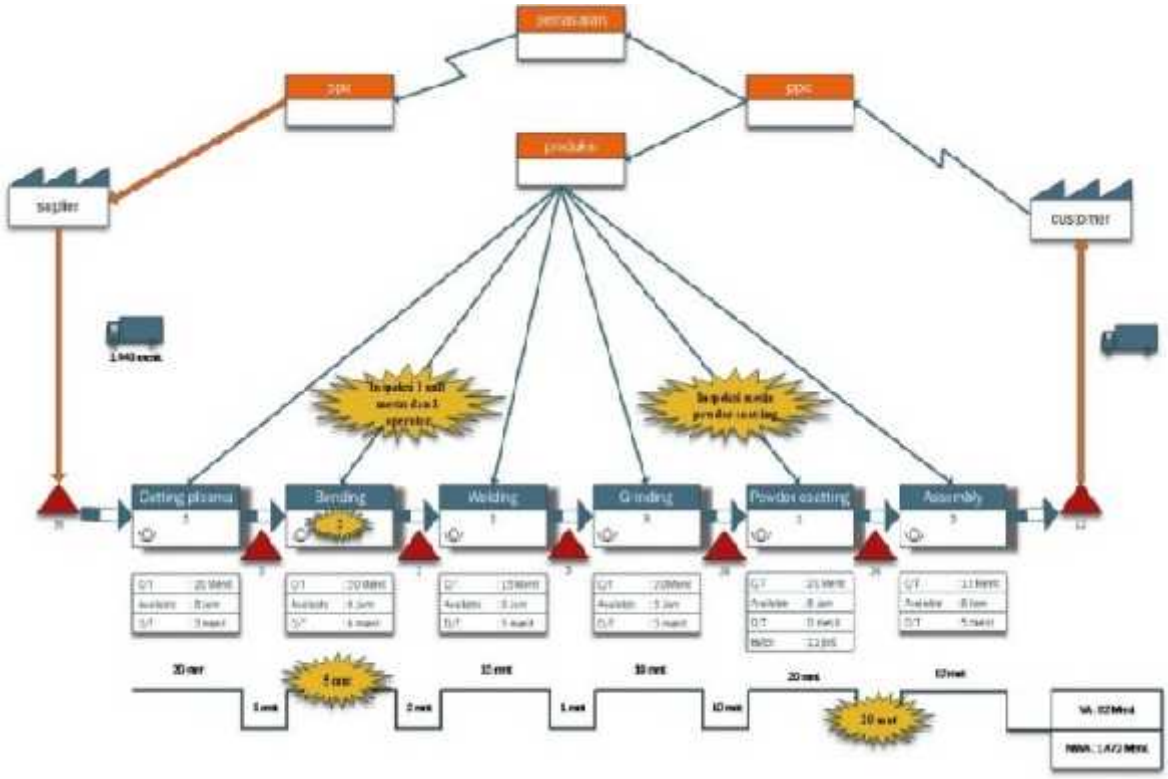

Figure 4. Future State Map

Based on the results of improvements using the future state map, it can be seen that it is effective and by the research objectives, namely lean manufacturing analysis with the vsm method to reduce waste in the electrical panel box production process at PT. DMI.

The first improvement is due to the waste of waiting (powder coatingting) with the addition of a powder coating machine that can minimize waste in the production process, especially eliminating the waiting time for the painting process and reducing company waste. The second improvement is by adding operators to the bending section, which was originally 1 operator to 2 operators. As an assistant to the main operator, this is done because the bending process takes a long time and creates waste if it is only done with 1 operator. It can be seen from

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the current state map that the VA value is 10 minutes. 5 minutes.

The coating process no longer uses subcontractor services to reduce waiting time after the coating process enters the assembly process. This was done because looking at the processing results which showed the high waiting time from the coating process to the assembly process which was previously 1,440 minutes after the addition of a powder coating machine at the company could cut the time by 1,410 minutes so that the waiting time became longer. process to only 30 minutes.

Furthermore, in the bending process, 1 additional operator was added, which previously only had 1 operator, now it has 2 operators, this is done to speed up the bending process itself which previously took 10 minutes to 5 minutes. This is beneficial because it can reduce waste in the bending process.

The time needed for the production process of the electric panel box is 1.488 minutes if converted into days is 1.3 days. This procurement process has increased by 1 day from the previous total production time.

F. Process flow analysis

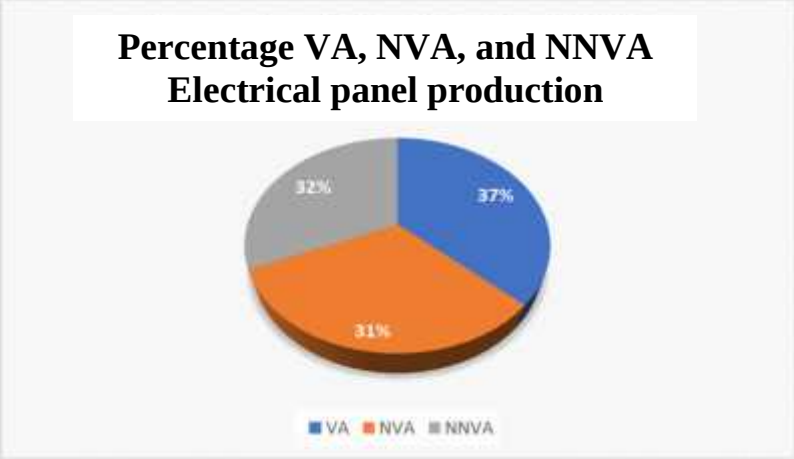

Figure 5. FPC analysis pie chart before repair

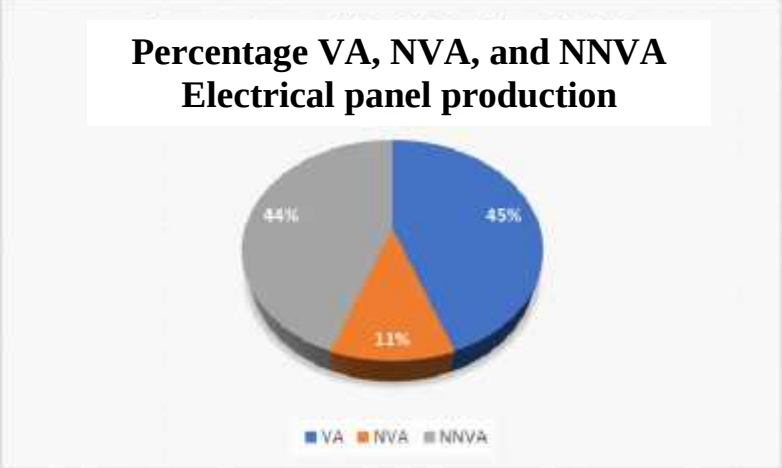

Figure 6. FPC analysis pie chart after repair

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After making improvements, it can be seen that in the previous FPC, the value for VA classification or production, operation, and storage processes was 37%. After the repair was done, the VA value increased to 45%. This was due to the addition of a powder coating machine, the addition of 1 bending machine unit, and 1 operator which made the production process time faster. In addition, the weighing process has also been changed to an operational process.

Furthermore, for the NNVA classification or production, transportation, and inspection processes, the value at the previous FPC was 32%. After the repairs were made, the NNVA value increased to 44%. This is due to the elimination of the long time-consuming transportation process from subcontractors so that transportation time can be reduced.

Finally, the NVA classification or waiting production process on the previous FPC has a value of 31%. After the repairs were made, the NVA value became 11%. This happens because delays only occur in the process of procuring raw materials from suppliers.

5. Conclusion

Based on the results of observing and processing data on the production process of the electric panel box, the following conclusions can be drawn:

1. There are 2 types of waste identified, namely waiting time and shortage of powder coating machines.
2. The factors that influence the existence of the two identified types of waste are waiting for time and powder coating machines because both are closely related and are caused by powder coating machine units that are not owned by the company so PT. DMI uses subcontractor services as service providers for powder coating products. The lack of powder coating machines causes product buildup which results in waste.
3. Recommendations for improvement that can be given include:

G. The addition of a powder coating machine so that it does not take long and avoids the accumulation of boxes which can result in waste.

H. The addition of 1 bending machine unit to speed up the bending process on the plate to minimize downtime in the process and minimize waste.

I. The addition of employees to speed up the loading and unloading process in each existing machining process, is done to reduce the amount of waste in each box that is transferred to the next process.

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