IMPLEMENTATION OF VALUE STREAM MAPPING (VSM) TO INCREASE PRODUCTIVITY OF ASSEMBLY PRODUCTION LINE

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ABSTRACT

As a manufacturing company, PT. ABC has plans to create a new lean production line of product X. They did it to fulfill customer demand and be able to compete with other manufacturing company. Current performance shows that there is an average of 2% products that through a rework process, in which 95% of it can still be reused. In this research, we try to proposed a design of production line by applying Value Stream Mapping (VSM) in the process. Based on the results of data processing that has been carried out, it can be seen that the application of VSM in the production process can identify the process of waste that occurs easily. With its application can provide an average increase in productivity for the assembly line by 92.5% and an increase in productivity about 167% compared to the previous layout.

Keywords: *Value Stream Mapping, Lean, Production, Assembly Line*

INTRODUCTION

In the manual assembly process, many cross-assembly concepts are implemented to increase productivity. Often the assembly process gets a lot of attention, because the inefficiency of an assembly line can cause overall production costs to increase, especially labor costs. However, the machining process also needs attention because it will be related to the supply of inputs for the assembly line.

In this study, an ABC manufacturing company that produces product X plans to build a lean production line on its production floor. This is an effort to fulfil the number of product demands and achieve a competitive advantage so that the company is able to compete in the market. Therefore, it is necessary to analyze the current condition of the company and develop a lean production line design so that it can minimize inventory both in the form of work in process and finished products.

Currently, the demand for product X is about 240 units per day. The manufacturing process can be grouped into two parts. The first part is the component making part while the second part is the assembly and packing part. Process performance shows that so far there is an average of 2% of products that must be rework and about 95% of rework products can be used again. The availability of packaged cartons does not have a significant disturbance, but the casting machine has a high level of product damage about 5%.

According to [1], VSM is a very effective tool for improvement of productivity and to visualize production process in a simple way. In this research we design a new lean production process trajectory on the production floor at ABC manufacturing company so that a production process is formed that is able to meet the number of consumer demands.

LITERATURE REVIEW

Lean Manufacture

The term lean was first introduced by John Krafcik in his research on the International Motor Vehicle Program (IMVP) project. Then this concept was disseminated by Womack, Jones and Ross in a book entitled "The Machine That Changed the World". The lean concept along with its development turned into lean manufacturing where this concept comes from the practice of a Japanese company namely Toyota, which is known as the Toyota Production System.

According to [2] lean manufacturing is a system that helps identify and eliminate waste, improve quality, and reduce production time and costs. This system also makes the company more flexible and more responsive in reducing waste. The House of Lean figure is a great tool for graphical descriptions of Lean initiatives to all employees in the company. This tool can show how the various topics discussed in Lean Manufacturing interact with each other [2].

Lean manufacturing is a process management philosophy originating from the Toyota Production System (TPS), which is well known for its emphasis on eliminating waste with the aim of increasing overall customer satisfaction (Liker, 2006). In achieving this goal, there are several efforts that must be made, including eliminating waste. There are 7 types of waste according to Ohno, namely Overproduction, Waiting, Transportation, Overprocessing, Movement, Inventory, and Defect.

Value Stream Mapping

Value Stream Mapping (VSM) is a technique developed by Toyota and later popularized by the book, “Learning to See (The Lean Enterprise Institute, 1998)”, by Rother and Shook. VSM is used to find waste in the production process of a product. The key advantage of creating a value stream mapping is to focus on the entire value stream to find waste systems and optimize some local situations at the cost of the entire value stream [3].

According to [4] VSM is a collection of all data related to the production process and is able to identify various types of waste that occur. In value stream mapping, there are two mappings that must be described, namely the creation of a current state map and a future state map. The current state map is made to map the actual production floor conditions, where all information contained in each process is included in the mapping. The current state map is used to identify waste and the sources of waste that occur.

After identification of waste is done, it can be described future state map. The future state map is a mapping of the company's condition in the future as a proposed improvement plan from the existing current state map.

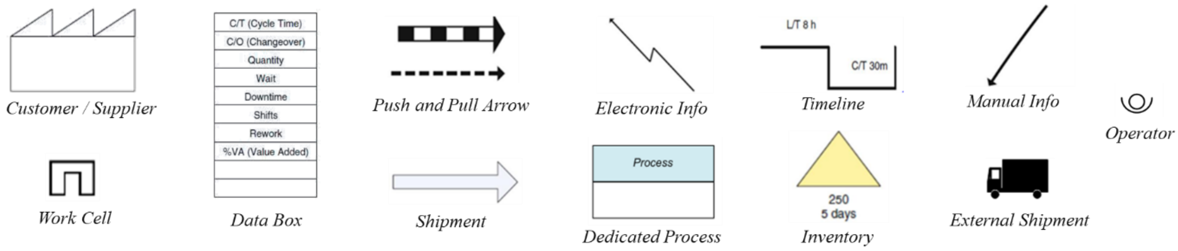

Figure 1 Value Stream Mapping Symbol

III. METHODOLOGY

The methodology of this research are shown in Figure 2.

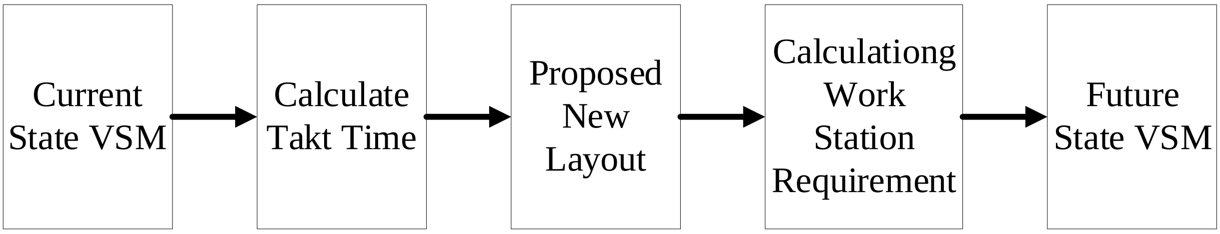

Figure 2 Methodology

The first step in this research is to map the current production process which is then described in the Current State VSM. After that, the research continued by calculating takt time to find out the time available for the production process. After calculating the takt time, the next step is to make a layout proposal based on the results of the analysis of existing conditions. The next step is to determine the number of work stations in the assembly process, where the number is determined based on the takt time that has been determined at the beginning. The last step in this research is to design a production system by making a value stream mapping based on the results of the proposed production system.

RESULT AND ANALYSIS

Data and Demand

Based on the observations, it is known that some data related to problems that need to be analyzed include the demand for product X is 240 units per day. The production floor at ABC company consists of two separate rooms that are next to each other, namely the component manufacturing section and the assembly section. The processes that take place in the component manufacturing section include:

- Aluminum casting with a processing time of 3 hours with a maximum processing capacity of 100 units. This process takes 1 hour to set up including cleaning and heating.
- Machining I process takes 10 minutes per unit component with negligible set up time.
- Machining II process takes 5 minutes per unit component with negligible set up time.

The process that takes place in the assembly section includes 5 stages of assembly, in stages 2 and 3 additional components X1 (stage 2) and X2 (stage 3) are purchased from suppliers with the assembly process time shown in Table 1.

Table 1

Assembly Stage Process Time

Stage	1	2	3	4	5
Time Process (min/unit)	4	5	8	4	4

The process of sending components from the manufacturing section to the assembly section is carried out using a trolley with negligible travel time (side by side). The next process is product inspection using a testing machine for 2 minutes per unit.

If the product does not pass the test, it is returned to the repair department for repair. Furthermore, the product packaging process contains 12 units which takes 2 minutes.

4.2 Current State Value Stream Mapping

From the initial data, the takt time value can be calculated which is the time available to produce an item divided by the number of requests for the item within a certain time.

$$Takt\ time = \frac{720\ minute}{240\ product} = 3\ min/prod$$

Then to analyze the current state of the production process whether it can meet the takt time or not, it is necessary to prepare a current state value stream mapping as can be seen in Figure 3.

The value stream mapping in Figure 3 uses the assumption that each process only uses one machine. Delivery of aluminum raw materials is sent by the supplier every day according to the needs for production in a day. Likewise for additional components X1 and X2 sent by the supplier every day according to the need for production in a day. In this case, it is assumed that the two additional components are purchased from one supplier so that they can be delivered simultaneously. In this initial condition, no inventory is provided as a buffer between each process, so that the machining process 1 can only operate when the casting process has completed one production batch.

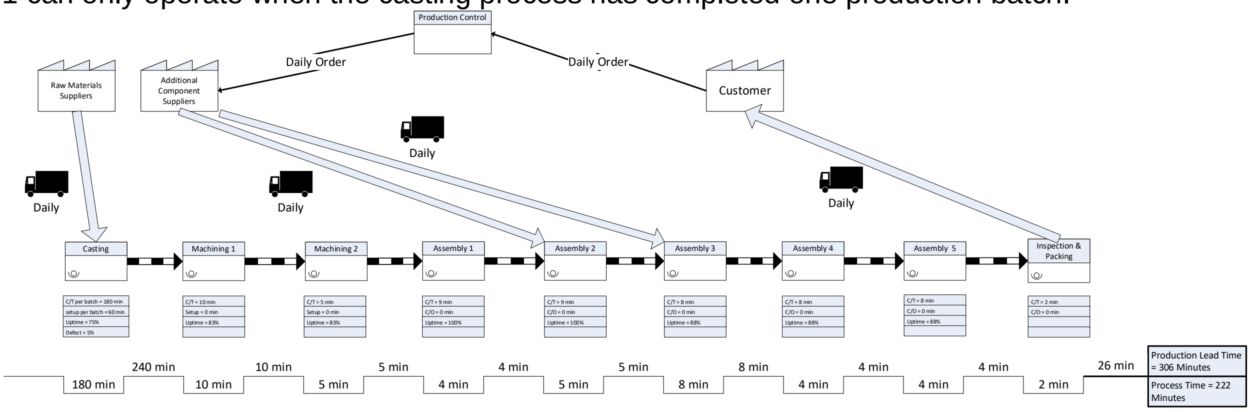

Figure 3 Current State VSM

In this initial condition, the casting process is assumed to use a maximum capacity of 100 units per process. The process of sending product X to customers is carried out every day with a fixed number of requests 240 units per day.

Based on the value stream mapping, it is known that only the casting process and the inspection & packing process have fulfilled the takt time, where the value of cycle time or processing time of each component unit is the takt time value. Meanwhile, all other processes have cycle time > takt time.

Therefore, it is necessary to make line balancing in the production process and determine the number of machines that must be provided in each process so that the production target/demand can be met. The lead time of this process for a pack of 12 units is 306 minutes with a process time of 222 minutes. The difference between lead time and process time is due to the setup time in the casting process and the product waiting time at the time of packing due to the inspection of each component unit.

4.3 Takt Time

The first step in designing a production system to make product X is to determine the takt time. Determination of takt time is needed to find out the time available to produce product X in the available time.

$$Takt\ Time = \frac{720\ minute}{240\ product} = 3\ min/prod$$

The total working hours owned by the company is 12 hours per day or equal to 720 minutes per day. The total working hours is obtained with the condition of the company having 2 work shifts per day, where each shift lasts for 6 hours. The calculation results show that the takt time of product x is 3 minutes, it means that every 3 minutes the production system must produce 1 unit.

4.4 Proposed Layout

Based on the analysis of existing conditions, it can be seen that the existing production processes have not met the number of consumer demands. The process of designing a new production system needs to be made to meet consumer demand for 240 units of product per day. The new layout takes into account the number of machines used, the available working time, and the number of customer requests.

To speed up the production process and reduce waiting time from the assembly process, the production lot to be used in the production process is 1 unit per lot for the entire process except for the casting process. The casting process uses a batch production system, where in 1 batch there are 84 units of casting products which are then sent to the next process.

Table 2

Production Lot Calculation 1st Day

Process	Number of Machine	Minute	Ouput	Number of Process per day	Output/ day	Inventory	Work Hour/day	Description
Casting	1	240	100	3	300	60	12	Prod Day 1
Machining 1	2	10	1	240	240		20	
Machining 2	3	5	1	240	240		20	

Table 3

Production Lot Calculation of 2nd Day etc

Process	Number of Machine	Minute	Ouput	Number of Process per day	Output/ day	Inventory	Work Hour/day	Description
Casting	1	240	84	3	312	96	12	Prod Day 2 etc
Machining 1	4	10	1	240	240		20	
Machining 2	2	5	1	240	240		20	

Based on the above calculation results, the number of machines needed for the casting process is 1 unit, 4 units machining process 1, and 2 units machining process 2. The calculation of the number of machines aims to balance the casting process to machining 2 or parts of the component manufacturing process.

Table 4

Assembly Process Work Station Division

Process	Time	Work Station	Total Time	Number of Machine	Number of Output per Machine
Assembly 1	4	WS 1	9	3	0.333
Assembly 2	5				
Assembly 3	8	WS 2	8	3	0.375
Assembly 4	4	WS 3	8	3	0.375
Assembly 5	4				

The next step is to determine the number of work stations in the assembly process, the number is determined based on the takt time that has been determined at the beginning where the takt time generated is 3 minutes/unit. To fulfill this number, the assembly processes 1 & 2 are combined into 1 work station, and the assembly processes 4 & 5 are combined into 1 work station. The result of the combination makes the processing time for work station 1 is 9 minutes, work station 2 is 8 minutes, and work station 3 is 8 minutes. To meet the number of requests, each work station needs 3 machines so that the takt time generated in the assembly process is 3 minutes per unit. The division of assembly stages into 3 work stations is carried out so that cross-assembly balance occurs so that the idle time of each operator is minimized.

In the proposed layout of Figure 3, the production system is divided into 2 parts, namely the manufacture of components/products and assembly. Based on the results of calculations using the above layout, the number of consumer requests of 240 units per day can be met.

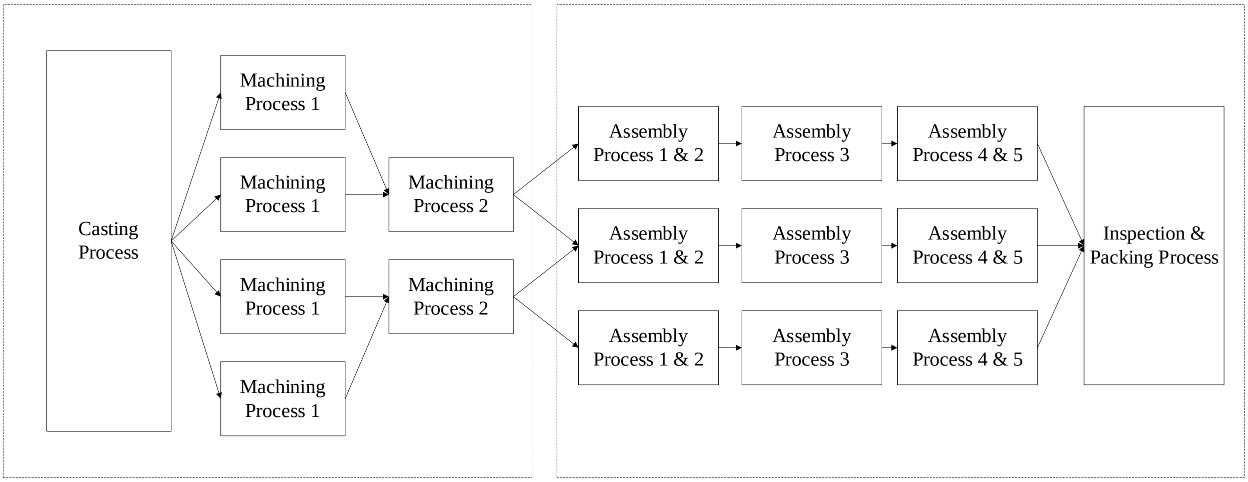

Figure 4 Production System Proposal Layout

The final step in the production system design process is to create a value stream mapping based on the results of the proposed production system as shown in Figure 5.

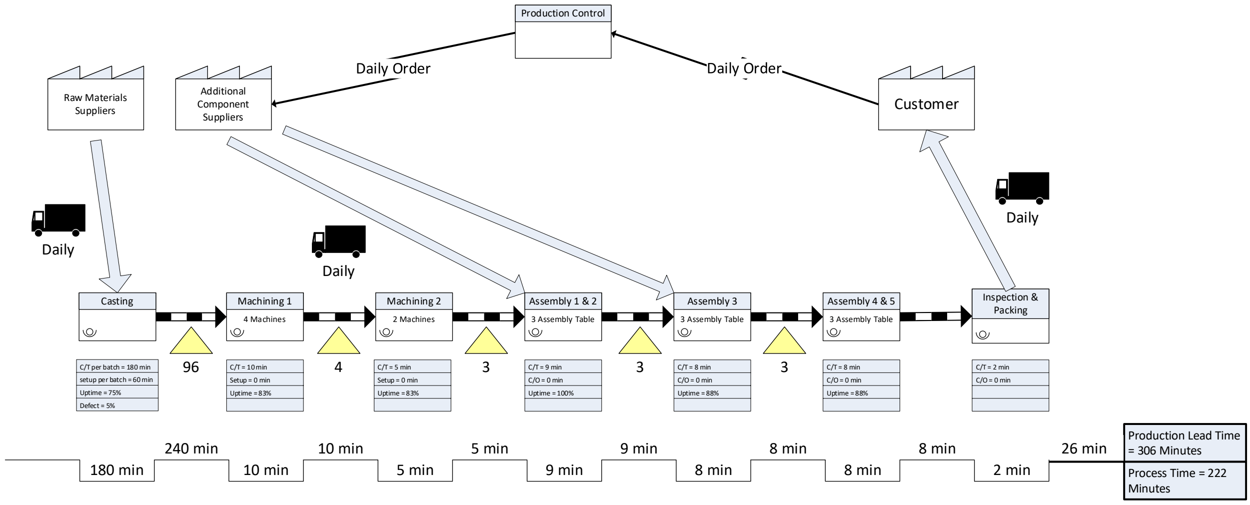

Figure 5 Future State VSM

V. CONCLUSION

Based on the results of data processing that has been carried out, it can be seen that the application of VSM in the production process can facilitate the identification process of waste that occurs. The use of the proposed layout will result in idle time for assembly 1 & 2 of 0 minutes, assembly 3 of 1 minute, and assembly of 4 & 5 of 1 minute. The productivity level of operators at assembly work stations 1 & 2 is 100%, while for assembly work stations 3 and 4 & 5 is 87.5%, so the average productivity for assembly lines is 92.5%. There is an increase in productivity compared to the previous layout by 167%.

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