Lean Manufacturing Applications in the Manufacturing Industry

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Abstract. This research was conducted in manufacturing industry, so this research is based on case study application. This research serves to reduce waste in the industry when making a product. This study categorizes value-added work and which work has no added value. And it is measurable and has value, so it can be evaluated in the future. Later this will be poured or depicted on a map called Value stream mapping. This is a tool from Lean Manufacturing. Lean manufacturing is useful for analysing and reducing non value-added activities, value stream mapping analysis tools, 5L1H process mapping activities, and 5 why tools. From the results of this study obtained the efficiency of the process cycle and total estimation of the improvement of the lead time. This calculation can be an evaluation material for the company.

1 Introduction

Competition nowadays is very rapid in the industrial sector, demanding every company engaged in manufacturing to improve business strategy. This research site is one of the manufacturing companies that produce electronic goods in North Sumatra. The production process that takes place in the company shows the existence of time that is not value added among others the inefficient material transfer in the raw material parts and molding the fan component still using manual way, the length of time waiting for the fan component after the next molding process on the raft at the assembly station. The length of production lead time in the fan production process in the company causes the company can not meet the needs of customers who have been ordered. These problems will adversely affect the company both financially and in partnership and show the lack of productivity of the company in increasing the production capacity of the fan product.

Lean Manufacturing is a set of techniques that when combined and run well will reduce and then eliminate waste [1]. Reducing waste is intended for all activities undertaken on the production floor is an activity that has value added activity, aims to improve competitiveness through the production process effectively and the use of resources efficiently. In this study, the effort made is to define the elements of the manufacturing cycle to reduce waste. The approach used is value stream mapping.

Value stream mapping is a process mapping tool that serves to identify the flow of material and information on the production process from raw material to finished product. Value stream mapping is represented by symbols which representing activity [2]. Activity is grouped into value added and non-value added, so it can be easily known which activity could give added value and those who do not give added value.

The successful application of lean manufacturing by using value stream mapping to reduce total lead time has been proven through scientific research [3]. In his journal that leads on current state maps of 29.43 days can be reduced to the inventory level of the process, which reduces inventory levels to 18.04 days to 15 days. This proves that the use of value stream mapping can reduce total lead time.

2 Research method

The research instrument used in this research is digital stopwatch used in data collection to measure the time of fan production process. Value stream mapping is used in data processing to visualize the real state of the production process and determine the classification of value added activity and non-value added activity. Observations made based on The Maytag Company that is with the provision of 10 times observations for activities that take place in the cycle of about 2 minutes or less while 5 times observation for activities that take place in the cycle time greater than 2 minutes.

3 Result and discussions

3.1 Formation of current state map

Current State Map is a description of the ongoing production process within the company covering material flow and information flow. The current state map consists

Figure 1. Current state map.

of several steps starting from determining the value stream manager to forming the entire plant flow map.

3.1.1 Determination of value stream manager

Value Stream Manager is someone who understands the whole production process that occurs in detail and has an important role in the production process so as to provide complete information and can assist in providing suggestions for improvement of production processes.

3.1.2 Formation of SIPOC diagram

SIPOC diagram used in this study to analyse and describe about how the process can provide services to customers. The formation of this diagram helps in explaining a complex project and its scope is unclear.

The elements used in the diagram are:
1. Supplier : Raw material storage warehouse and additional spare parts
2. Input : Plastic pellets, calcium carbo, colour flour, and additional spare parts
3. Process : Process stages that change from raw materials and spare parts into products.
4. Output : Fan type 1651 KP
5. Customer : Consumer

3.1.3 Overall map formation (current state map)

At this stage each process along the value stream is combined with the flow of material and information into a single stream within the plant. Understanding of the two streams as follows:
1. Material flow
   Material flow describes the movement of the main material in the process of production process along the value stream.
2. Information flow

The flow of information that companies use there are two types, namely:
a. Manual Information Flow
This information flow occurs between the production managers of each process that takes place on the production floor. The schedule given is the daily activity schedule after getting the adjustment of the amount of ingredients entered.
b. Electronic Information Flow
Information delivered using electronic devices. This information flow takes place between the production planning department and the marketing department, raw material suppliers, and between the marketing department and the customers.

Current state map that has been equipped with material flow and information flow and lead time bar can be seen in Figure 1. In making this current state map, the time is divided into two, ie production lead time indicating the existence of non-value added time and process time Cycle in the production process) which is value added time.

3.1.4 Takt Time Calculation

Takt time shows how often a product should be produced to meet consumer demand. Production time available with shift is 8 hours / day on Monday to Saturday. Rest period of 1 hour / day on Monday to Saturday. Within 1 month consists of 4 weeks and within 1 week there are 6 working days. [4]

$$\text{Takt time} = \frac{available\ work\ time\ per\ week}{customer\ demand\ per\ week}$$

Customer demand rate per week
= (1800 units/month) / (4 weeks/month) = 473 unit/weeks

Available time percentage obtained information that the production of fan type 1651 KP reaches 45% compared with other types of products produced in the company. So that available time of 480 minutes working hours per day, for 1651 KP fan is 216 minutes or 12,960 minutes. Takt time calculation is done starting at each work station, and

starting from the last process is on the product gasket until the mixing of raw materials.

Customer demand rate per week on fan packing product will be the basis of customer demand rate calculation in previous process, that is assembling process in accordance with push system principle.

Comparison between takt time and cycle time of production obtained from observation can be seen in Table 1.

Tabel 1. Comparison of cycle time and takt time

Activity	Cycle Time	Takt time
Mixing raw materials	21,36	28,51
Molding dop hinge	46,62	27,36
Molding rotary switch	35,11	27,36
Molding dynamo's dwell	51,55	27,36
Molding dynamo's cap	50,15	27,36
Molding plastic nuts	38,42	27,36
Molding fan leaf	49,80	27,36
Molding casing logo	35,73	27,36
Molding hinge fan stand	39,86	27,36
Molding front casing	35,48	27,36
Molding back casing	35,45	27,36
Molding casing button	34,66	27,36
Molding fan tread stand	47,87	27,36
Installation of bottom tread with spare parts	9,20	28,80
Assembly	18,32	28,80
Packing	13,40	28,51

From the table above the time process under takt time indicates the process run faster or can meet the demand. The production process in this state is not very good, but it needs to be analyzed whether there is a surplus of labor that can be reduced to balance the workload of other stations. Process time under takt time is the process of mixing raw materials, molding rotary rotary switch components, molding chasing component logo, front chasing component molding, rear chassis component molding, button chasing component molding, spare part assembly, assembly assembly, and Packing.

Stations with processing time above takt time indicate the process is running slower than it should be. The process is molding component dop hinge, house dynamo component molding, dynamo-housing component molding, molding plastic nuts components, molding fan leaf components, molding fan stand hinges, and molding stand fan footprint components. Improvements that can be made to adjust to takt time are by reducing batch size of production, improving working methods by reducing inefficient activity or increasing labour amount.

3.2 Current state map analysis

3.2.1 Waste identification with PAM

In identifying the existence of non-value added activities for the company, these observations are made directly to the company's production floor. With the observation supported by interviews with employees and supervisors, therefore can be seen whether or not there is waste in the company. In addition, a method that can be used to identify waste is Process Activity Mapping (PAM).

Recapitulation of Process Activity Mapping (PAM) results can be seen in Table 2.

Table 2. Recapitulation of number and time of PAM result of fan production process type 1651 KP

Activity	Numbers	Time (Minutes)
Operation (O)	22	77,74
Transportation (T)	19	72,58
Inspection (I)	5	15,52
Delay (D)	13	581,40

Based on the identification of process activities contained in the production line

3.2.2 VA dan NVA analysis

In this stage will be grouped activities that include value added and non-value added. The value of value added time is obtained from the process time contained in the current state map. While non value added time is the lead time of each process which is also found in current state map. Grouping for value added activity can be seen in Table 3.

Table 3. Value added activity

No	Value Added Activity	Time (Minutes)
1	Raw materials are weighed	1,95
2	The calcium carbo extract is weighed	1,82
3	The colour flour enhancement is weighed	1,19
4	Mixing Raw Materials	12,18
5	Issued from mixing machine	1,59
6	Molding dop hinge	1,17
7	Molding rotary switch	1,22
8	Molding dynamo's dwell	1,23
9	Molding dynamo's cap	1,3
10	Molding plastic nuts	1,17
11	Molding fan leaf	1,38
12	Molding casing logo	1,19
13	Molding hinge fan stand	1,4
14	Molding front casing	1,2
15	Molding back casing	1,17
16	Molding casing button	1,17
17	Molding fan tread stand	1,11
18	Installation of bottom tread with spare parts	1,28
19	Assembly	26,98
20	Packing	16,04
Total		77,74

Grouping for non value added activities can be seen in Table 4.

Table 4. Non value added activity

No	Non Value Added Activity	Time (Minutes)
1	The raw material is brought to the mixing machine	1,32
2	Additional calcium carbo ingredients are brought to the mixing machine	1,28
3	The colour flour enhancer is brought to the mixing machine	1,19
4	Moved to a molding machine	2,56
5	Components stacked waiting in transport	572,58
6	Bring it to the assembly line	61,92
7	Spare parts waiting for the raft	8,82
8	Spare parts are transported to the assembly line	1,21
9	Vane testing	1,96
10	Check the assembly results	7,54
11	Transport to a temporary buildup	3,12

Comparison between value added (VA) and non-value added (NVA) can be clearly seen in Figure 2.
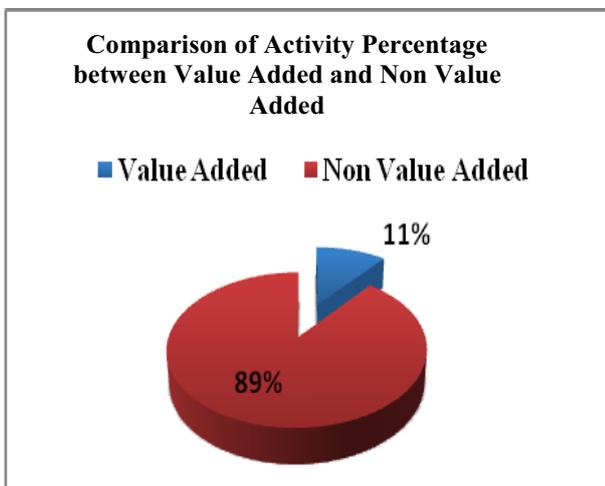
Figure 2. Comparison between value added and non value added.

3.2.3 Cycle time analysis

The cycle time of each process that is a value added time sometimes has non value added elements in it called non value creating time. Overly long cycle times in the processing of a process can also lead to non-value creating time. For example, in parts molding components, long cycle time causes workers on the molding component is often idle so that this activity is classified as waste. Analysis of improvements made to reduce cycle time that will be explained in the proposed further improvement given.

3.2.4 PAM analysis by using 5W1H method

Based on the results of the identification of process activities contained in the production line will be eliminated or reduce activities that are considered not have added value. In addition, it will also consider improvements in activities that can minimize production process time to be shorter. There are some non-value-added and evaluable activities totalling 17, among others, 2, 4, 6, 11, 15, 18, 21, 24, 27, 30, 33, 36, 39, 42, 45, 47 and 59 This is based on direct observation and discussion result due to excessive activity and production process and not added value so it will affect to lead time.

3.2.5 Waste analysis in process

Waste in waiting time that often occurs in the production process at the factory, after that sought the cause by using tools 5 why that can be seen in Table 5.

Table 5. Use of the 5 whys method in troubleshooting

No	Problem: There is a long lead time production in the form of waiting time	
1.	*Why*	The flow of the production process is gradual or not flowing
2.	*Why*	The product components accumulate a long time to perform the next stage of the production process.
3.	*Why*	The old product component is transported to the assembly line
4.	*Why*	Material transportation is repeated using manual method
5.	*Why*	Limited number of material handling available and irregular workplace

From the table above can be concluded that the root of the problem of the occurrence of waste of waiting time due to the limited number of material handling and the number of workers for some long production process that takes a long time to workmanship requires more time. In addition to analyse the waste that occurred, also conducted an analysis of the results of calculation take time lower than cycle time that occurs in some processes.

3.3 Formation of future state map

3.3.1 Preparation of improvement efforts

After it is known that the cause of the waste occurring that causes the high value of non-value added time, then further effort will be made to reduce the non-value added time based on the root cause analysis of the waste that has been explained previously. Based on the root of the problem described above, it can be made a corrective action plan to minimize waste in the form of waiting time. The root of the problem shows the limited number of material handling and the number of workers and the irregularity of the work area on the production floor so that it needs to be repaired. Alternative possible improvements are made to each production activity to reduce waste in the form of waiting

time, irregularity of the workplace, and the number of operators waiting. The alternatives can be seen in Table 6.

Table 6. Alternative improvements for each production activity

No	Roots of Problems	Alternatives Improvement
1.	Raw materials and auxiliary materials in the raw material warehouses await the stages of the process before mixing the raw materials.	Adds the number of workers and job arrangements to the mixing of raw materials
2.	Manual removal resulting in repetitive transfers	Adding semi-automatic material handling to make it easier for employees to do material handling.
3.	The length of waiting time for the product components from the result of molding machine	Improved working procedures in work procedures and operator expertise in using molding machines
4.	The existence of waiting products assembled on assembly lines between assemblers one with other assemblers	Improve working procedures and also train operators to balance during assembly process.
5	Irregularity of the breaking of the components coming from the molding machine to assembly section	Adding the container as a place to lay WIP components so as not to scatter.

3.3.2 Depiction of future state map

Improvements made are drawn in the future state map and calculated lead time result proposed improvement. The time change included is a time change that can be observed or estimated from the current state. The picture of the proposed future state map can be seen in Figure 3. The implementation of the 5 whys strategy and the analysis using PAM (process activity mapping) on the fan production process will be able to reduce the product components that accumulate and reduce the waiting time that occurs. So it can reduce waste (waste) in the process of fan production.

4 Conclusion

Based on the theoretical basis, the results of research and analysis have been done then it can be concluded that there is several non-value added activities which in a very significant amount at present state map with total time of 647.94 minutes of total lead time of 725.68 minutes. Through estimation of improvement result obtained Total lead time in future state map is 250,80 minutes. Value stream mapping showed a decrease in total lead time of 340.9 minutes. The saving of working hours will directly increase the fan production capacity without having to increase the input used in the production process resulting in increased productivity.

References

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