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Abstract. The Plywood company in this study was able to produce 6,000m3/ year of plywood, but during 2018 and 2019 this company was only able to provide 2,905.14 m3/year and 1,120.73 m3/year. Production in 2018 and 2019 is far below the production capacity. This research will apply the lean manufacturing concept in the production process of a plywood company. This research uses value stream mapping (VSM), value stream analysis tools (VALSAT), process activity mapping (PAM), Pareto diagrams, and root cause analysis. It is found extreme categories that occur in many processes, namely processing production and inventory. The recommendations given are to reduce employees and provide adequate storage. The future state VSM shows that a change in a lead time of 68%, and the reduction of the production process is 248.18 minutes.

Key Word : Lean Manufacturing, VSM, VALSAT, Root Cause Analysis

1. Introduction

Increased industrial competition in Indonesia makes companies compete to improve company performance. To compete with other companies, the company must be an efficient and minimal waste in its production process. To achieve dynamic company performance and minimal waste, the company apply lean manufacturing methods to maximize value for customers and increase company profitability by eliminating production processes that give no added cost.

The plywood company, which in this research study has not yet maximized production performance. This company has a production capacity of 6,000 m3 / year, but in 2018 and 2019, production capacity is only at 2,905.14 m3 / year and 1,120.73 m3 / year. The production results are not optimal because there is a waste in the production process, which is processing raw materials into finished goods by 50% - 70%, as listed in the following Table 1. :

Table 1. Processing Raw Materials into Finished Goods (m3)

Year	LOG	WIP	Finished Good	%Waste LOG to WIP and Finished Good
2017	14,741.20	5,257.63	242.50	62.69%
2018	7,112.16	2,748.35	156.79	59.15%
2019	4,406.41	969.83	150.89	74.57%

In addition to wastage in the production process, this company also needs to make adjustments to the production of employees' salaries. Table 2. To show salary costs almost the same from 2017 to 2019, even with decreasing production results. The following Table 2. compares product results with full salary costs:

Table 2. Comparison of product results with detailed salary costs for 2017 – 2019

	Unit	2017	2018	2019
WIP + Finished Good	m3	5,500.13	2,905.14	1,120.72
Salary	Rp	4,614,498,505	4,219,566,775	4,887,389,211

So through this research, researchers want to find the causes of waste that occur y examing the flow of the production process, starting from the purchased raw material to the finished products delivered to consumers. Also, this research

will look for the root causes of problems that occur during the production process and provide recommendations for appropriate improvement.

2. Research Method

2.1. Lean Manufacturing

Lean Manufacturing is methodology to reduces or eliminates waste from manufacturing process and also maximizing productivity to increase value added product for customer.

2.2 Value Stream Mapping (VSM)

Values Stream Mapping is a method for mapping value streams details so that waste can be identified and can be found several reasons that cause waste can occur as well provide the right way to eliminate or reduce the waste. Value Stream Mapping focuses on activities that are provide value added (value adding activity), activities that do not provide added value (non value adding activity), as well as activities that does not provide added value but is needed (necessary non value adding activity).

2.3 Value Stream Analysis Tools (VALSAT)

Value Strem Analysis Tools is the approach used for carry out the process of weighting on waste, after doing weighting then the selection of tools using a matrix is done. This method is done to get the right tools in the process mapping.

2.4 Root Cause Analysis

Root Cause Analysis is defined as a collective term that describes a wide range of approaches, tools, and techniques used to uncover causes of problems. Some RCA approaches are geared more toward identifying true root causes than others, some are more general problem-solving techniques, and others simply offer support for the core activity of root cause analysis.

2.5 Cause Effect Diagram

Cause Effect Diagram or Fish Bone Diagram used to identify, sort and display various the cause of a problem. This diagram illustrates the relationship between the problem with all the causal factors that influence the problem.

This study will use data from observations and distribution of questionnaires to production employees. Then draw value stream mapping to describe the problem and uses root cause analysis to find the root cause of the problem and eliminate. The results of this study will reduce non-added value during the production process, suggest improvements to the root causes of problems in the production process and are expected to have further improvements after applying the proposed improvement results.

3. Result and Discussions

3.1. Value Stream Mapping Current State

The following diagram will display the value stream mapping current state which is the production process flow that has been carried out by the company :

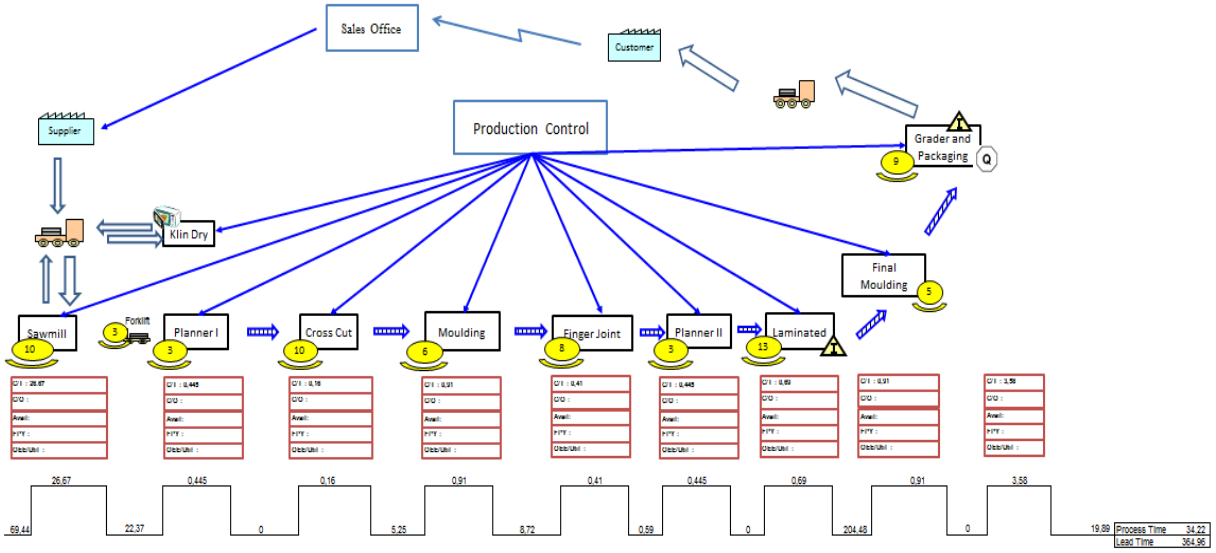

Figure 1. Values Stream Mapping Current State

Figure 1. illustrates the current state of the production process from ordering raw materials to shipping to consumers. There are a number of employees and the time it takes to produce one product for each production activity. Total Process Time for one product is 34.22 minutes and takes a lead time 364.06 minutes every one product. This production process still has several processes that must be eliminated so that the production process can run optimally.

Through the mapped production process flow from Figure 1. a questionnaire was made to ranked seven wastes that could occur during the production process. After the results of the questionnaire have been recapitulated, the results of the questionnaire are used for calculations in the selection of mapping tools. Here are the results of calculating the selection of mapping tools:

Tabel 3. Result of Value Stream Mapping Tools

Waste in Manufacture	PAM	RM	PVF	QFM	DAM	DPA	PS (a) Volume (b) Value
Overproduction	39	117	-	39	117	117	-
Waiting Time	270	270	30	-	90	90	-
Transportation	324	-	-	-	-	-	36
Processing	486	-	162	54	-	54	-
Inventory	147	441	147	-	441	147	49
Motion	333	37	-	-	-	-	-
Defect	20	-	-	180	-	-	-
Jumlah	**1.619**	**865**	**339**	**273**	**648**	**408**	**85**

Based on Table 3. process activity mapping is used to carry out further analysis for the elimination of activities that give no added value to consumers.

3.2. Eliminate NVA activities and maximize VA

Through the results of the process activity mapping, we get the time of production activities on operations, transportation, inspection, storage, and delay. Also, this method can determine the time of events that adds value, or that's must be eliminated in the production process. The following Table 4. results from making process activity mapping current state:

Table 4. Results of PAM Recapitulation and Value Added Activity

Activity	Total	Minute
Operation	17	40.55
Transport	3	57.42
Inspeksi	3	24.04
Storage	3	22.60
Delay	2	224.99
Total	28	369.61

Activity	Total	Minute
VA	13	34.23
NNVA	9	82.56
NVA	6	248.18
Total	28	364.96

Based on Table 5., six activities do not provide added value with a time of 248.18 minutes. So by eliminating non-value added activities, the lead time will reduced by 68% in the process of 1 wooden block. The following table shows events that give no added value activity to consumers :

Table 5. Non-Value Added Activity

No	Activity	Type	NVA
1	Waiting for the Kiln Dry process	D	21.60
2	Gather the remaining small pieces of wood blocks	S	5.24
3	Collect molding shavings	S	8.72
4	Choose small pieces of wood that are still good and compose on the machine	O	0.59

5	Laminated wood beams pressed	D	203.39
6	Wrapped Finished goods that are ready to be sent	S	8.64

3.3. Critical waste mapping

Based on the data questionnaries from twenty production employees, they calculate the essential waste. Based on the ranking of seven waste and percentage cumulative waste below 80% (Figure 2.), four critical wastes are prioritized to find the root of the problem. Those four wastes are processing, inventory, overproduction, and motion.

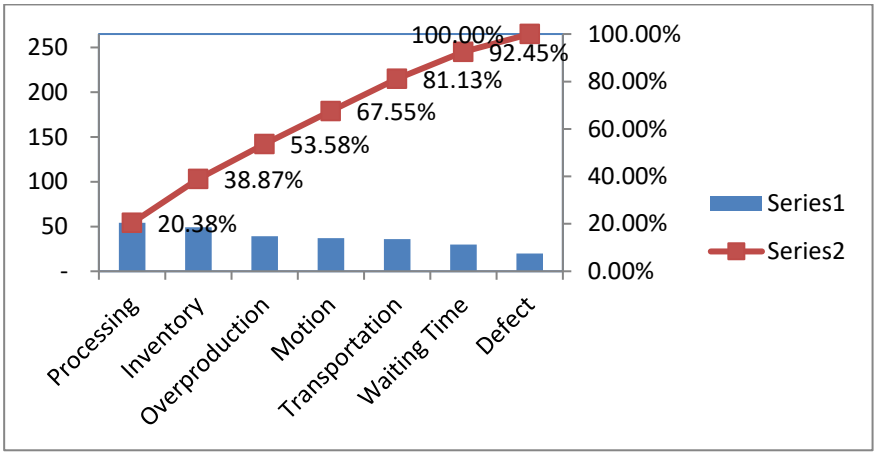

Figure 2. Pareto Diagram

Through waste priority, a mapping of the possibilities and impacts of the problems obtained through root cause analysis is carried out, and seven issues are categorized in extreme areas, namely:

- Lack of supervision
- There is no clarity on the production output that must be produced
- There is a lack of employee overtime
- There is no warehouse for storing goods
- Stockpiling causes the production floor to narrow
- Inventories that accumulate often damaged
- There are several employees in the same work floor which causes inefficiency in work

Concerning the seven problems, there are two proposed improvements given after analyzing the issues, namely:

- Reduction of labor examined through the capacity of engine performance and output results that can be generated during one hour of the production process.

Table 6. Calculation of Employee Reduction

Activity	Block/ Minute	Q Block/ Hour	Q Machine	Block/ Machine	Current Employee	Future Machine	Future Employee
Sawmill A	4,83	12	1	300	4	1	4
Sawmill B	0,54	112	5	560	6	1	2
Planner I	0,89	67	2	134	6	1	2
Cross cut	0,16	378	3	1.134	10	1	2
Moulding	1,82	32	4	128	10	3	6
Finger Joint	1	60	1	60	8	2	4
Laminated	1,78	33	4	132	15	3	6
Grader dan Packing	3,58	16	9	144	9	5	5

Based on Table 6. The number of employees required for production is obtained through proper machine needs. The company only requires the production of the 71 wooden blocks within one-hour of the production process; therefore, a reduction in machinery and employees is made to maximize production performance, the reduction in employees can also reduce the salary that must be paid by the company. One machine just

needed two employees, except sawmill one machine can be handled by four employees and also grader and packing one machine only required one employee to manage the machine.

- Eliminate inventory buildup that occurs in every corner of the factory by making a storage rack and facilitate the process of taking finished goods. The following is a display rack that will be used as a storage place for finished products:

Figure 3. Finished goods storage rack

The shelves will consist of five stacks, each stack will have 100 wooden blocks and 25 shelves will be needed for storage due to 12,500 wooden blocks required for a month. Although the costs incurred for the purchase of shelves are quite expensive, the existence of storage shelves will benefit the company. The benefit is the working space of the factory is wider so that it smoothens the production process, the collection of goods becomes more comfortable and there is no accumulation of goods that get damaged.

3.4. Value Stream Mapping Future State

Based on the proposed improvements in the NVA elimination process and root cause analysis, the lead time in the production process is reduced by 248.18 minutes, and the reduction of employees in the production process. The following Figure 4. will display the future state value stream mapping :

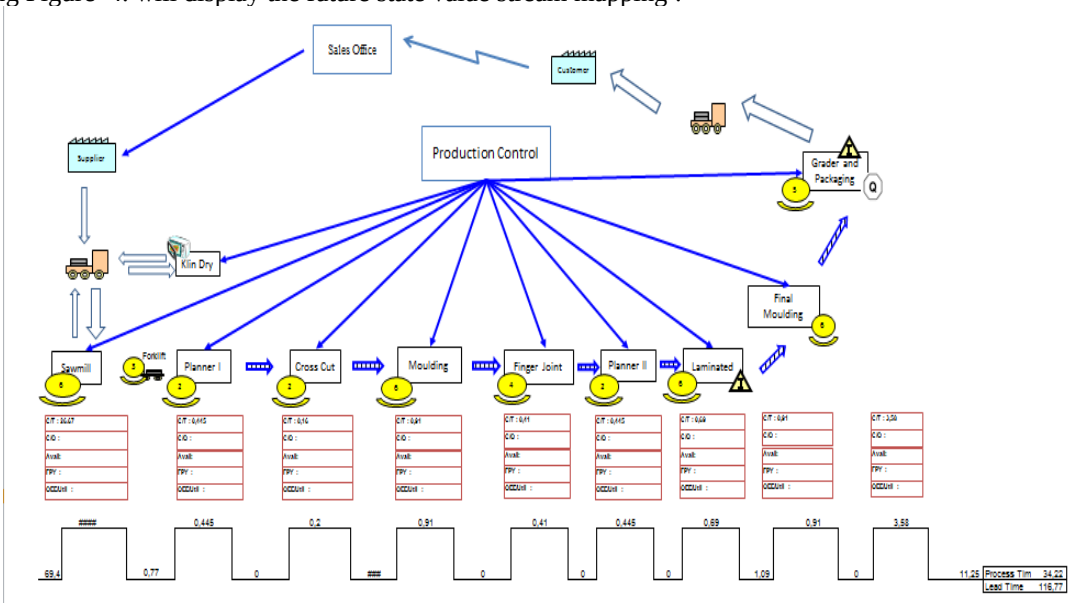

Figure 4. Value Stream Mapping Future State

4. Conclusion

The results of this study are proposed improvements to reduce the number of employees by 37 people, from the reduction of the employee salary costs can also be reduced by Rp 129,500,000/ month. Also, the making of a storage rack is a proposed improvement so that factory working space becomes more comfortable and the storage area tidier to facilitate the movement of the forklift. Through the process of eliminating non-value added, the lead time is reduced by 68% for the future state map. So the production process was reduced to 248.18 minutes.

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