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Lean Manufacturing Machine using Value Stream Mapping

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Abstract. Production process of mid scale manufacturing in Indonesia commonly using conventional sequential process. There are some wasted process and has already slowing down production lead time and creating more expenses for manufacture. The need of eliminating useless steps in production development for cost cutting lead to Value Stream Mapping (VSM) as mapping tool in it. VSM acceptance itself has already proven in many research studies which use manufacture in many levels as its case study. This paper, aims at using VSM as tool in examining mid scale manufacture production development. It also evaluated how VSM is put into real world practice in mid scale manufacture in Indonesia. Based upon observation and interview, then it can create future state map which eliminate waste from production development and also shorten lead time and propose new production development flow. At least, more than 500 minutes overall which can be eliminated in production process time after remapping it. While at least 141 minutes are being reduced for its VAT. However, it still need non technical effort to ensure company to use available map in their production development. Since that mostly mid scale manufacturing using family business management which still believe traditional process rather than modern one. Thus, future research should include psychological industrial aspect in VSM implementation in Indonesia..

1. Introduction

Production process of mid-scale manufacturing in Indonesia commonly using conventional sequential process. There are some wasted process and has already slowing down production lead time and creating more expenses for manufacture. This research study took place in mid scale manufacture which produce sheller machine for farming post production. While mid scale manufacture in Indonesia commonly focusing in more labor for its production development, it risks unefficient production cost which lead into more expensive product price.

The need of eliminating useless steps in production development for cost cutting lead to Value Stream Mapping (VSM) as mapping tool in it. VSM acceptance itself has already proven in many research studies which use manufacture as its case study [1]–[5]. Thus, it is chosen as mapping tool in order to eliminate wasted process inside sheller machine production.

Wasted process in production development lead into more expensive sales price, therefore, it should be evaluated in order to get better sales price for customer. While VSM is one of great mapping tool which can evaluate process for customer purpose and redraw shorter timeline and production lead time [6], so hopefully it can leverage competitive advantage for mid scale manufacture in marketplace.

On the other hand, the need of efficient manufacture process which leads into lean production process, can reduce material flow inside it. While the actors inside mid scale manufacture in Indonesia are mostly from conventional "old skool" person, drawing diagram using VSM should help simplify their understanding the need of efficient process. Since that VSM offers simple and yet powerful step by step approach, it also should help the actor draw future map for better process in its production development.

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This paper, aims at using VSM as tool in examining mid scale manufacture production development. It also evaluated how VSM is put into real world practice in mid scale manufacture in Indonesia. Since that many Indonesia small-mid scale manufactures merely organized using traditional approach in their production flow. Therefore, VSM in this case study is used to identify and eliminate wasted process and create new future map process for more efficient production development for them.

This research also evaluated VSM real practices effectiveness in Indonesia as en effort for lean production, especially for mid-scale manufacture. Because applied research about VSM in Indonesia is rarely found, thus there are small amount reference for VSM research in Indonesia. While Indonesia as development country, thus this research should also can be as valuable reference for other similar country research using VSM

2. Literature Review

Lean Manufacturing (LM) which originated come from Japan employes some methods such as JIT (Just In Time), TPM (Total Productive Maintenance) and also Kanbans [5]. The aim of LM is decreasing production cost and also create better production timeline toward efficiency for lesser effort [7]–[9] .

One of the LM tool which has already proven theoritically and empirically successful for mid-scale production process is Value Stream Mapping (VSM) [6], [11], [12]. There are some researchers who already prove that VSM can fit in many SME (Small Medium Enterprise) production process (in this paper named as mid-scale manufacture), and its efficiency includes time waste reduction and also defect reduction [12]. Thus, decision of using VSM in this case should also can fulfil research purpose based upon previous background explanation.

VSM consists of five core process which are [6], [13]: (1) selection of product family, (2) draw current state mapping, (3) draw future state mapping, (4) define working plan, and (5) achieving working plan. Other researchers stated that the fifth process is about experimenting what future mapping has been drawn, or simply experimenting what have already drawn [12], [14].

Each process in VSM should be: (1) valuable, (2) capable, (3) available, (4) adequate and (5) flexible, in order to create lean thinking in product development [15]. Therefore, each steps in product development should be evaluated in current state map, and then re-draw into future state map. VSM itself can be applied in many scales manufacture, from big size manufacture [1], [16] through small-mid scale manufacture [11], [15], [17] in effective way. Especially for small-mid scale company which has limited investment, VSM can have potential improvement in it [11]

3. Result and Discussion

Normal time measurement method used in this study continuos time study. Measurements were performed by elemental breakdown in any part of production to obtain activities. Time measurement performed on the activities and sample also test the adequacy of the data. This measurement happened because the length of time the majority of the activity and also the number of existing activities. Having obtained the normal time, the next step is to create the initial map. The initial map is a map of the company's condition before the repair.

Current state map shown as figure 2, which shown product development based upon observation and preeliminary interview. There are 14 processess exclude supply process and product shipment. However, these steps were assumed inefficient, since that product development was stay in warehouse before its shipment. In fact, all of the products are made as customer demand using batch processing, not using continuous product development.

The on demand decision is made because of manufacture can not handle all of the request in its annual product schedule. Thus, it need change in its product development cycle. After examining order process and also finishing statement, it is clearly stated that product development should use batch processing based upon customer order, not using continuous production as current state map shown.

Details of all production development stage shown at table 1. While the real condition shown some of process is not done efficiently, because of lead time from normal time. So, it should be rearranged for better result and shorter time.

Table 1. Normal Time and Standard Time Production

Number of Operations	Work activity	Normal time (minute)	Standard time (minute)
O-1	Making Shaft	126,224	145,157
O-2	Making Stand Shaft	125,733	144,593
O-3	Making Framework	45,482	52,305
O-4	Cutting Home sheller	65,970	75,206
O-5	Cutting Chimney	64,965	74,060
O-6	Perforate Shaft	224,482	271,624
O-7	Welding	117,318	141,995
O-8	Welding Framework	470,552	569,368
O-9	Bending process	130,610	148,895
O-10	Welding Chimney	270,190	326,930
O-11	Assembly and installation of electric motors	69,949	84,639
O-12	Assembly Overall	934,576	1130,837
O-13	Finishing I (Laundering)	134,571	152,065
O-14	Finishing II (Painting)	461,640	521,654
	Total Time Standard:		3839,288

Observation took time for at least two weeks in order to create detail time calculation for each process and also discuss which process is determined as waste and which process is should be extended. This observation process not merely done by researchers, but also includes production manager as the one who really understand what kind of result that company want in order to fulfil customer demand.

At least, there are four major improvements that can be easily shorten production development time. First of all, it can shorten distance for spare parts storage into assembly place which can shorten more than 20 seconds. It also suggested that all spare parts from supplier should not stored in warehouse, because it will be ordered based upon demand for cheaper storage fee. It also can give docking load for spare parts straight through assembly place.

Production development can also give more value added time for more than 100 minutes. This can be done using online sharing electronic data for customer order from customer service (which also take role as marketing) to production division and purchasing division. It also supported by reducing some of welding processes which are also reducing lead time among whole production development.

Table 2. Comparison of the results of the proposed improvement

No	Problem	Before	After
1	The distance was too much to ask for spare parts	67,29 seconds	40,39 seconds
2	Value Added Time	2590,219 minutes	2448,811 minutes
3	Lead Time	7010,953 minutes	6161,773 minutes
4	A long time for spare parts order	28,15 minutes	8,35 minutes

Based on observation, take time owned by the company consumed 1723.2 minutes and all of the production process of Sheller machine still be below the take time. Therefore, the work activity can be modified so that the time may be approaching take time. In the assessment given to the seven kinds of waste in the value stream analysis tools matrix (VALSAT), obtained the selection of the most suitable tool is a process activity mapping (PAM). PAM process, in the beginning found that there are 45 elements NNVA work, 27 VA element, and 19 work elements NVA.

While the proposal PAM was found that there are 46 elements NNVA work, 23 VA element, and 12 work elements NVA. Total number of elements of work reduced from 91 to 81 working elements work elements. In the current state on the initial mapping, value-added time and production lead times each minute is 2590.219 and 7010.953 minutes. In future state mapping, value-added time and production lead times each minute is 2455.94 and 6248.105 minutes. While on mapping the current state of implementation, value added time and production lead times each minute is 2448.811 and

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6161.773 minutes. Increased lead time on the current state of implementation indicates that the production process runs faster.

Process Cycle Efficiency (PEC) on the current state mapping prefix amounted to 0.3695. PEC on the future state mapping is estimated at 0.3931. PEC after implementation amounted to 0.3974. Improved implementation of PEC PEC beginning indicates that the production process has been running more efficiently, ie to minimize and even eliminate work processes that do not add value. Thus, the product can be processed more quickly so that the product quickly into the hands of consumers.

Table 3. Production Standard Time Each Operation

Number of Operations	Work activity	Standard time (minute)
O-1	Making Shaft	132,72
O-2	Making Stand Shaft	140,22
O-3	Making Framework	39,35
O-4	Cutting Home sheller	57,83
O-5	Cutting Chimney	37,74
O-6	Perforate Shaft	224,9
O-7	welding	107,64
O-8	Welding Framework	531,78
O-9	Bending process	147,7
O-10	Welding Chimney	290,79
O-11	Assembly and installation of electric motors	74,69
O-12	Assembly sheller houses and chimney	154,43
O-13	Assembly under the framework and the house	779,69
O-14	Finishing I (Laundering)	151,43
O-15	Finishing II (Painting)	522,79
	Total Time Standard	3393,7

While the mapping process already done, future state map is shown in figure 3. It clearly shown that production development already reduced and also its process. While the production development in future state map has revealed its waste elimination and shorter time, there is still retention from the company.

Since that mostly small-mid manufacture in Indonesia is being held as family business and it means that elder generation opinion still become great matter in every decision making. Thus, it still need greater effort to ensure company management to use this map as their production flow. It means that all of the numbers and diagrams should also being presented using simple explantion for them. While observation ended, there are some data which can be shown under VSM process. There are value added and its following detail which shown how many activities has been analyzed. Data is shown in following table 4.

Table 4. Number of VA, NVA, and NNVA activities

Category	O	T	I	S	D	Amount
VA	27	-	-	-	-	27
NVA	-	19	-	-	-	19
NNVA	15	16		12		45

Information: O = Operation, T = Transportation, I = Inspection, S = Storage, and D = Delay

Where : VA = (Value Added) → Shows activity
NVA = (Not Value Added) → Shows activities that do not add value

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NNVA = (Neces sory but Not Value Added) ⟶ Shows which activity should be Done but did not provide added value

4. Conclusion and Future Research

Based upon result and discussion, it can be concluded that there some processes which can be shorten for its normal and standard time. The help from simple technology for small-mid manufacture such as online sharing data for customer order and also purchasing order, really help in reducing production development time.

It also clearly shown that minimizing the temporary spare part storage distance with the assembly process also can eliminate waste. While some welding processing can also be modified so it might approach below take time. Even though there is one additional process, whole product development time still better than previous one.

Using VSM result, it can ensure the product manager that efficiency really matter for them. That whole process really does create value added for customer order and increase customer satisfaction in the end. While some steps need big improvement, others merely need small improvement that really can reduce waste among production development.

However, whole mapping result still need great commitment from management, since that small-mid manufacture in Indonesia commonly as family business. Thus, implementing improvement such lean concept in their production development usually having retention by elder generation. Even though it already proven as better and more efficient in its process.

Thus, future research for VSM in small-mid manufacture should be also includes managerial point of view in implementing and ensuring company to use it. This managerial point of view will not only creating efficiency number, but it should include how to create standard operational procedure and also focus group discussion with high management level in company. Therefore, it should also include industry phsychology expert inside the team in future research.

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Additional Figures

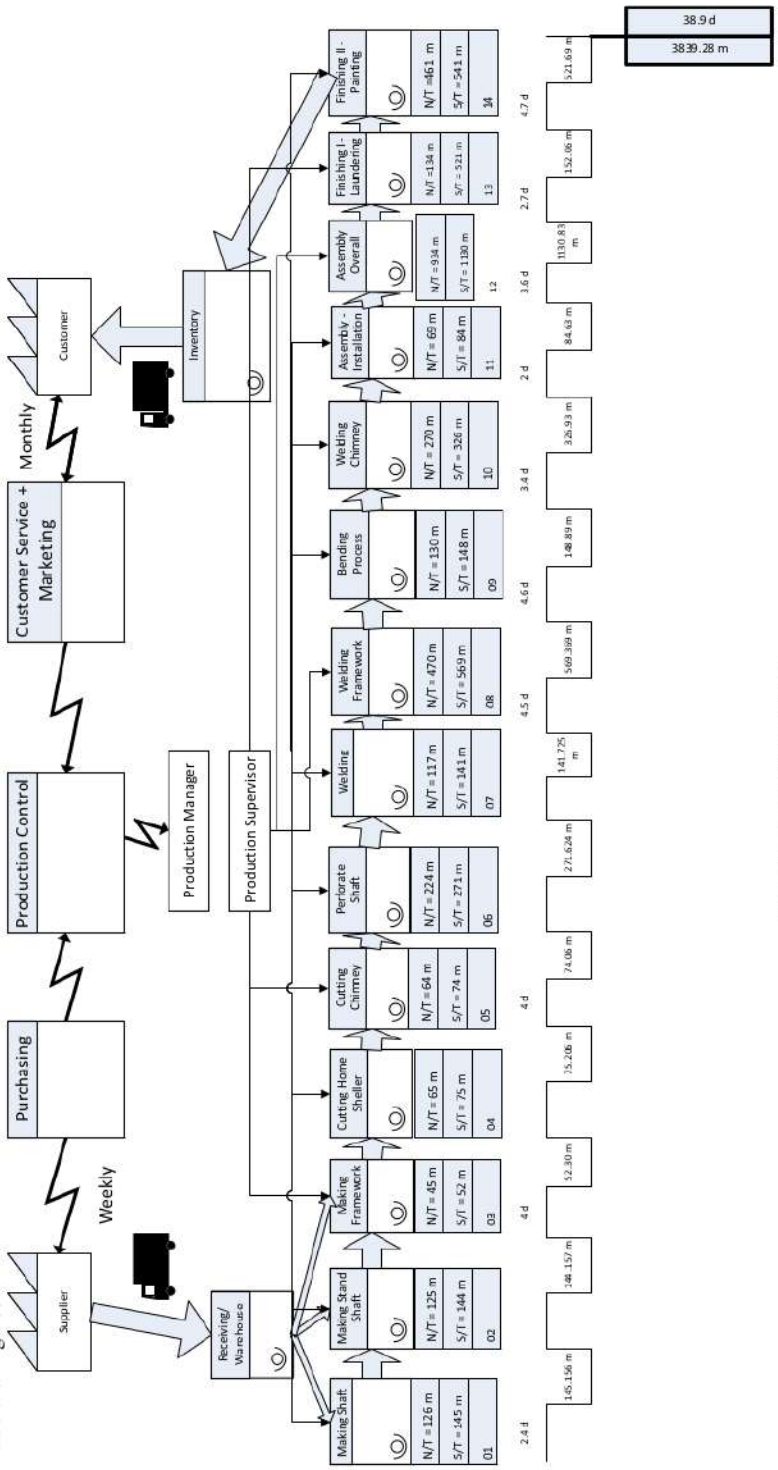

Figure 1. Current State Map

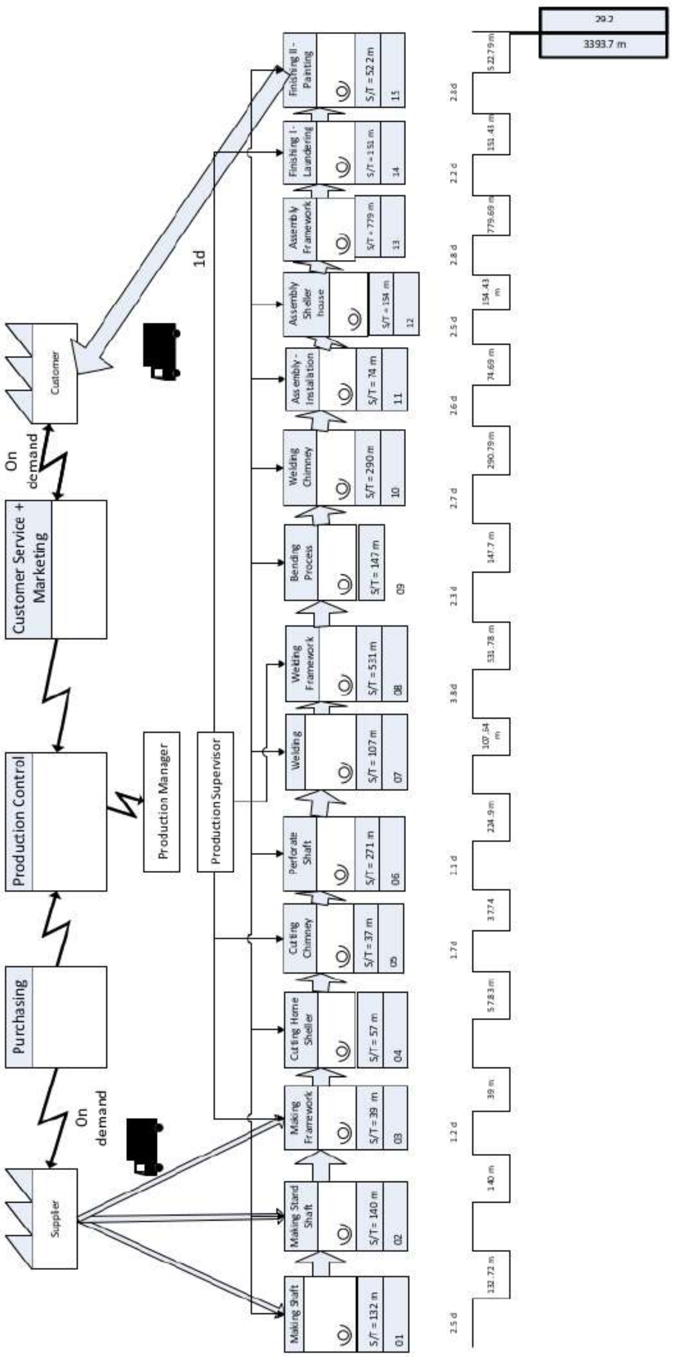

Figure 2. Map Implementation

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