International Journal of Engineering Research and Advanced Technology (IJERAT)

DOI: 10.31695/IJERAT.2020.3622

E-ISSN : 2454-6135

Volume.6, Issue 7
July -2020

Application of Lean Manufacturing to Optimize Working Space by Reducing Lead Time in the Production Department Using the Value Stream Mapping (VSM) Method

Novera Elisa Triana[1] & Sakti Aji Lesmana[2]

[1-2]Industrial Engineering Department

Faculty of Engineering, Universitas Mercu Buana

Jl. Raya Meruya Selatan, Kembangan, Jakarta 11650

Indonesia

ABSTRACT

Every company, especially manufacturing companies are required to make efficiency in each line to increase productivity in order to compete with other companies. With the increasing demand for new products from customers, or usually called a New Project, companies are challenged to utilize the work area as much as possible with the existence of new production lines to meet the customer's demand. To do that, the company should immediately make improvements on all lines so that free space will be obtained which will be used for new projects. To reduce the Lead Time on the line in the production department with the expectation to get an optimal working area which creating space to be used for a New Project. Using the Value Stream Mapping method as a first step to mapping the entire process from upstream to downstream to identify Lead Time and lead to waste in each process. High waste occurs in the inventory lead time. Non-value added activities are mostly found in the inventory part after platting in receiving and finished good parts. It also found in the information flow of the finished good parts. While developing the future state map, it decreased the total lead time by about 5% so that it creating a workspace for the new projects.

Keywords: Workspace, Lead Time, Lean Manufacturing, Value Stream Mapping, Inventory.

1. INTRODUCTION

An Automotive Component Company manufactures seat and door components for four-wheeled vehicles. It has been established for 6 years. Many products have been produced and successfully distributed to several customers of four-wheeled vehicle manufacturers with a project of 2,490 square meters of pedestrian lanes, 2,430.85 square meters of logistic area, 803,5 square meters employee facilities, and only 139 square meters of free space. In its achievement as a manufacturing company managed to become the first stir and second stir company that is trusted by customers. Those refer to the number of projects done each year, it required an optimal working space utilization.

By looking at current conditions, the company does not have enough area to make a new production line and extra space for material storage. The total working space is10,610 square meters with only 139 square meters of free space available. While the area needed for new production lines is 502 square meters. There is also material storage about 288.7 square meters as an additional of used area. The total area needed for a new project is 652 square meters, so the total work area in the upcoming project needed at 11,262 square meters. Projects cannot be implemented if the work area is insufficient.

Lean Manufacturing method known as Value Stream Mapping (VSM) can be used to help describe material flow and as an information of the product goes through the entire business process that creates value from material to delivery to the customer. So that it can identify any waste that exists in the flow of goods and the flow of information that occurs at this time. With goals of having a more efficient work area.

The waste will indirectly affect the length of lead time in the production process itself. Understanding lead time is the average time for the flow of one unit of product throughout the process (from start to finish) including the waiting time (waiting time) between sub-processes [1]. In lean manufacturing, there is one method that is VSM which aims to identify/ know waste and activities that have and do not have added value in this case it is necessary to map the process flow within the company. Value Stream Mapping is a method for visualizing material flow and information flow through the production process. [2] [3]

Some things that will be identified from VSM are excessive inventory buildup in certain processes, high scrap, low uptime, too large batch size, insufficient information flow, too long waiting time, and time efficiency of the overall process business. VSM

requires to validate operational data directly to the field (Gemba), discuss with workers to ensure the actuality of the data. VSM will assist in overall business process improvement and make it more efficient. [4].

2. LITERATURE SURVEY

2.1 Lean Manufacturing Concept

Lean manufacturing or lean production or well known as lean, introduced at the Japanese Toyota Automotive company, became very popular as a process management philosophy in improving production systems. The principle of lean is to focus on eliminating waste and reducing activities that do not provide added value (non-value-added) in a process, while at the same time maximizing value-added activities to the final product under customer demand[5] [6]. The benefit obtained in eliminating waste is the ease of adjusting to fluctuating market demands so that the company able to survive in competition.

To eliminate or minimize waste, lean manufacturing system users use a variety of tools, called lean building blocks. What's noteworthy is that it has been proven that successful lean manufacturing system users implementing in the company realize that even though this program can be run as a stand-alone program. It's rarely found a significant improvement in the company when it's stand-alone. While the right way is the implementation of lean manufacturing systems must have an impact on all aspects to the company and implement lean not as its standard might harmed the company[7].

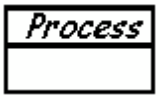
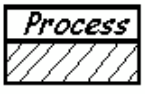
2.2 Value Stream Mapping

VSM is a method used to create a production flow map and information flow obtained by a company to produce quality products. [8]. All operational activities and information obtained will be mapped in a very simple picture. The picture includes the input and output, the process of making goods, and the presence of consumers. VSM is also used to assess and examine the waste that occurs. With this concept, the company can build a sense of urgency that includes several members of an organization and is also used as a communication tool to facilitate the implementation of the Lean. [9][10]

VSM is a quality management tool which able to compile the current state process by opening up opportunities to make improvements and reducing waste. In general, VSM comes from the Lean principle to reducing waste, inventory, and operational costs, improving product quality, increasing productivity, and ensure a more comfortable working environment. [11] [12].

2.2.1 Value Stream Mapping Symbols

Table 1. VSM symbols

No	Name	Symbol	Function
1	*Customer Supplier*		Represent suppliers when placed on the top left, which is a starting point that is commonly used in depicting material flows. While the image will represent the Customer if placed at the top right, usually as the endpoint of material flow.
2	*Dedicated Process*		State the process, operation, machine, or department through which material flows. In particular, to avoid mapping any undesired process steps, this symbol usually represents a department with a continuous internal flow.
3	*Shared Process*		Stating the operation of the process, department, or work station with families that share in the value stream. Estimated number of operators needed in Value Stream mapped.
4	*Databox*		This symbol has symbols in it which state the information/data needed to analyze and observe the system.
5	*Operator*		This symbol represents the operator. This symbol shows the number of operators needed in the process.

DOI : 10.31695/IJERAT.2020.3622

2.2.2 Product Family

The initial step in making Value Stream Mapping is to create or identify a product family in the value stream. A family meant is a group of products that have safety in the steps of the process and the use of equipment [8].

2.2.3 Creating a Current State Map

Creating a value stream from the current state activity to determine the problem faced from the perspective of the organization and customers. The current state mapping is a description of the operating conditions that occur in the current process. The current state is a big picture of the process in the company, and will not tell the process details of each process. The current state map will describe the entire process from beginning to end, so we can understand the general process in production and able to identify improvement initiatives.

2.2.4 Creating a Future State Map

Future state mapping is to determine the ideal mapping for the future. Future state map is part of the optimization phase. Future state mapping can involve future state cell design and implementation plans. The use of future state maps is to reflect loop maps in identifying waste and determining what becomes reality in a short time.

2.2.5 Kaizen Blitz

Kaizen Blitz is a technique used to improve performance quickly. Kaizen comes from the Japanese language which means continuous improvement. While *Blitz* or flash is likened to something that happens very fast. So, Kaizen Blitz is a kaizen approach that is used to provide fast results. Kaizen Blitz, in the form of a short-term project aimed at improving a process.

3. RESEARCH METHODOLOGY

The aim of this research is to reduce lead time by designing the flow of information and materials to obtain optimal working space in production departement and automotive industry, located in Indonesia. To study the objective of the research, the following research methodology was adopted which is depicted in the figure 1.

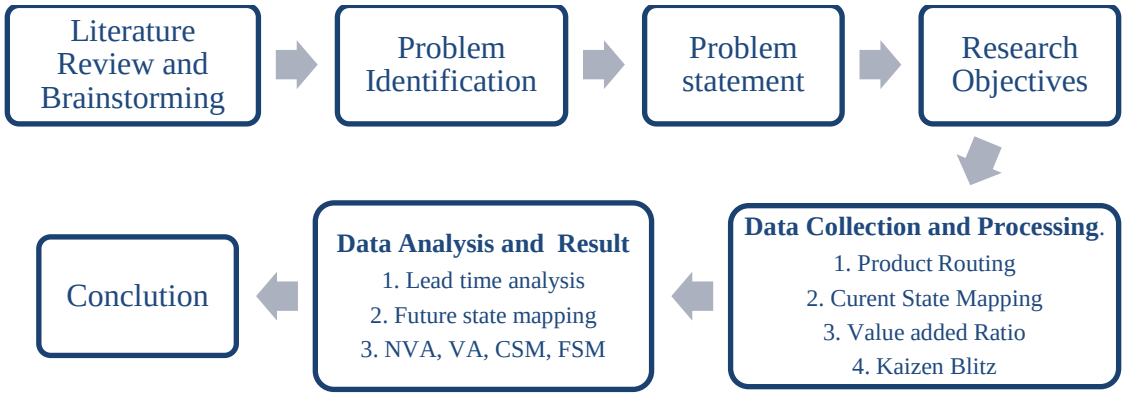


Figure 1. Research Steps Using the VSM Methodology

4. RESULT AND DISCUSSION

4.1 Current State Mapping Establishment

Current State Mapping is an illustration of existing conditions based on the company's actual condition after making observations on the shop floor. The current condition map is made by describing the flow of a process, material, and information from upstream to downstream. Figure 2 is the Current State Mapping of car seats and door products.

DOI : 10.31695/IJERAT.2020.3622

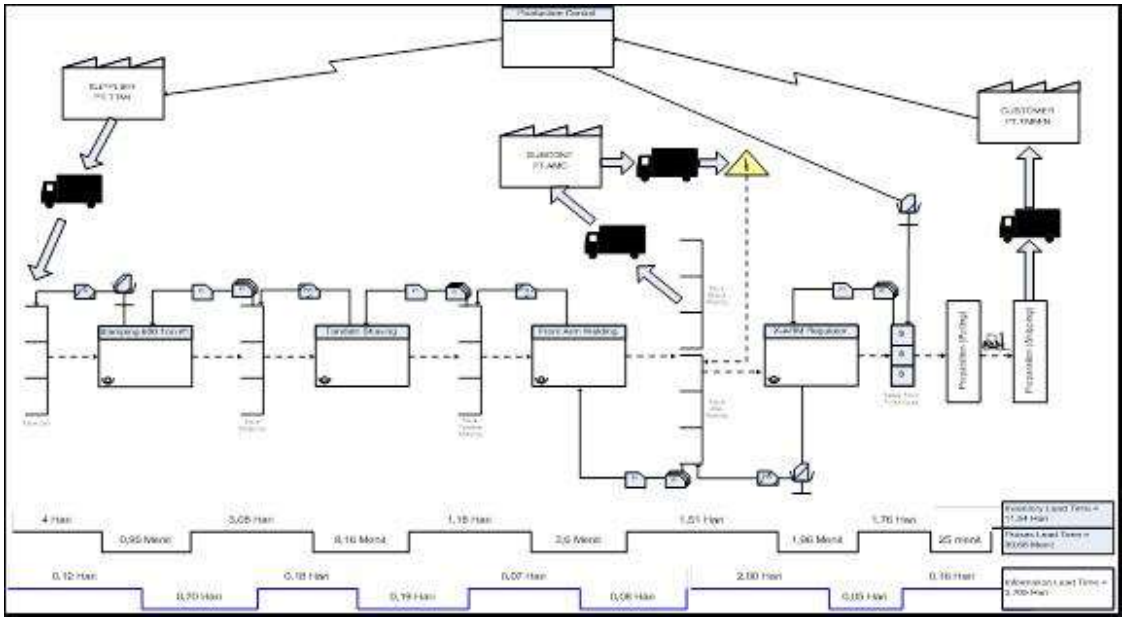


Figure 2. Current State Mapping

Value Added Ratio

Total inventory lead time is:

$$Inventory\ lead\ time\ (Day) = Total\ lt\ WIP + Total\ lt\ safety\ stock$$
$$= 255.14 + 9{,}011.25$$
$$= 9{,}266.39 \text{ Minutes}$$
$$= 11.04 \text{ days}$$

Whereas for lead time information includes the amount of kanban flow cycle, subcontract process, customer information to planning control, etc. The total lead time is 3,705 days or 3,297.13 minutes. So to get an NVA value, namely:

$$\text{NVA} = Inventory\ lead\ time + Information\ lead\ time$$
$$= 9{,}266.39 + 3{,}297.13$$
$$= 12{,}563.52 \text{ minutes}$$

So total lead time calculation would be:

$$Total\ lead\ time = \text{NVA} + \text{VA}$$
$$= 12{,}563.52 + 39.68$$
$$= 12{,}603.20 \text{ Minute}$$
$$= 14.78 \text{ Hari}$$

Than value added ratio calculation as follows:

$$Value\ added\ ratio\ (\text{VAR}) = 100\ \% - \frac{Total\ lead\ time - VA}{Total\ lead\ time}\ \text{X}\ 100\%$$
$$= 100\% - \frac{12{,}603.20 - 39.68}{12{,}603.20}\ \text{X}\ 100\%$$
$$= 100\% - 99{,}68 = 0{,}32\ \%$$

4.2 Future State Mapping Establishment

Based on the analysis of the current state mapping, the future state mapping design is obtained as a solution to improve company performance. There are decreases in inventory amount, changes in inventory tools, and changes in inventory transfer method to the next process. Those would be reducing the number of lead times and generating more space for a new project. The future state mapping relatively giving no significant changes from the current state mapping such as information flow, because the system has already applying kanban system. Figure 3 is the draft of the future state mapping:

DOI : 10.31695/IJERAT.2020.3622

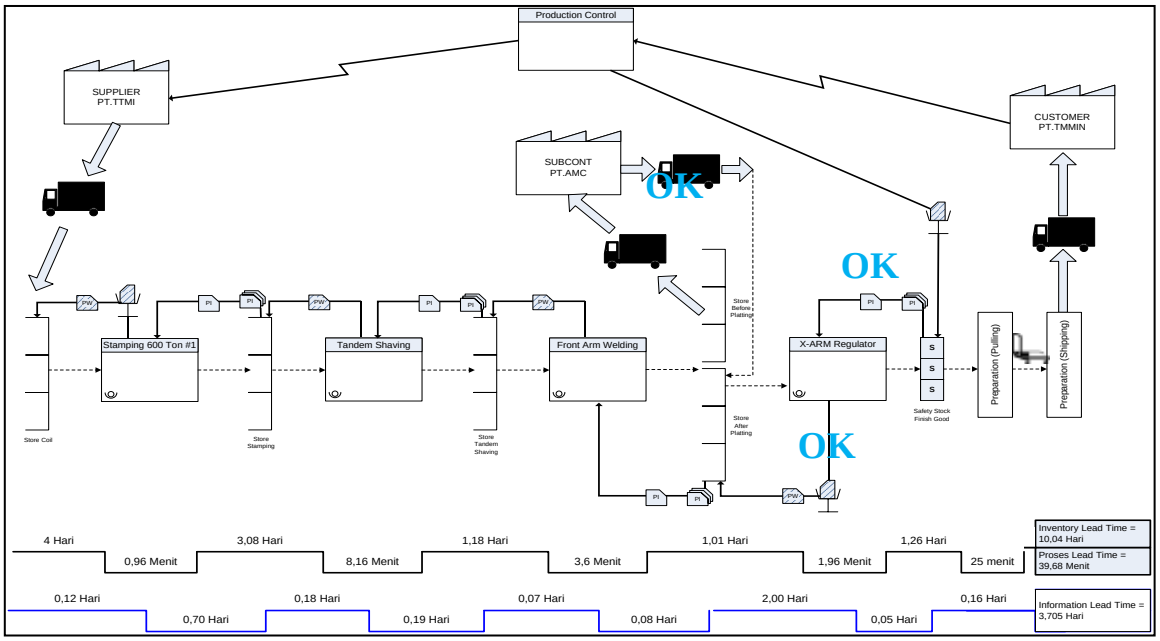


Figure 3. Future State Map

4.3 Eliminating Amount of Inventory

Inventory after the platting process in the receiving area is removed to creating less cumulation in the area. After the semi-finished product results from the "Fr arm gear process", it is delivered to the subcontractor factory (PT.AMC) using a truck as transportation to the platting process. After sending back together with inventory in the receiving area, there is no need to be stored in that area. The receiving workers immediately supply the material to the "after platting storage" area following loading and unloading material processes from the truck.

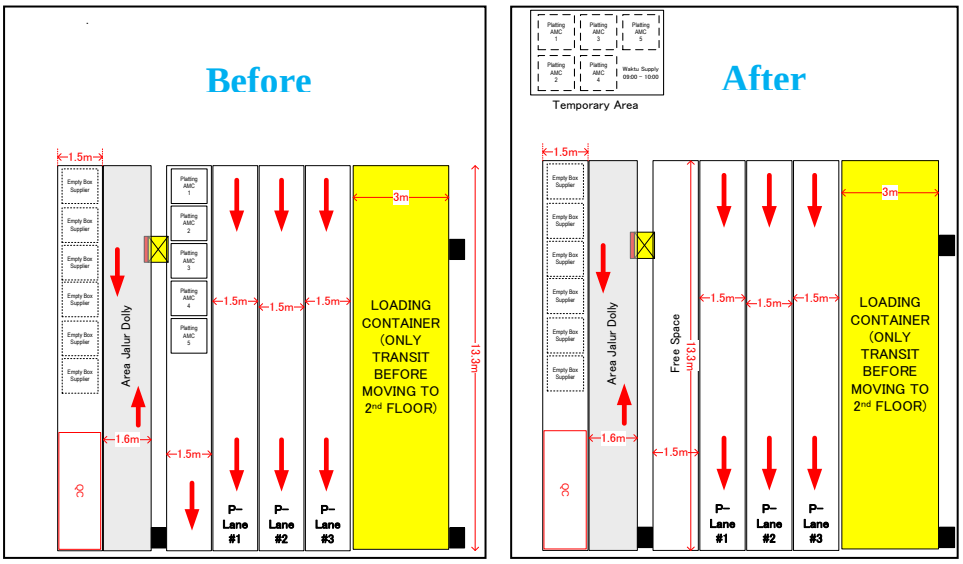


Figure 4. Layout Before - After (Receiving)

Actual conditions in the receiving area are 5 pallets of inventory required 1.5-meter x 13.2-meter area for storage area. Using the future state mapping design, in Figure 4 after platting material immediately transfer by the workers to eliminate storage area requirement. But it would require a temporary area for transit which will be directly supplied by workers at 09:00 - 10:00. Those would free up 1.5 meters X 13.2 meters in the working area.

4.4 *Reducing Safety Stock and Lot Size*

In finished goods warehouse or safety stock used on the "x-arm line regulator' is 1 day and lot size is 70-72 pcs. The amount is quite large and requires 20 lines of roller. Referring to forecast data (forecast) for April - December 2019 period, the demand trend has decreased every month. In July the number of monthly requests increased but was not enough if compared with working days available in a month, while the other months were seen to be less than in April. This becomes a reference point for the amount of finished product inventory (safety good) or safety stock and lot size by kanban will be reduced to 50%. Table 2 is a calculation result:

DOI : 10.31695/IJERAT.2020.3622

Table 2. Stock Safety Data and Lot Size

Part Name	Part ID	Lot Size (Kanban)	Stock (Shift)	Safety Stock (Kanban)	MIN Stock	MAX Stock	Need Roller	Kapasitas Roller (Box)
F/P Reg Assy	A051	7	0,5	3	3	10	1,00	30
F/P Reg Assy	A052	7	0,5	1	1	8	1,00	30
F/P Reg Assy	A053	6	0,5	3	3	9	1,00	30
F/P RH JAM-PRO	A061	9	0,5	2	2	11	1,00	30
F/P RH	A062	5	0,5	2	2	7	1,00	30
F/P LH	A063	5	0,5	1	1	6	1,00	30
F/PLH JAM-PRO	A064	9	0,5	4	4	13	1,00	30
Fr. Pwr. REG Jam-pro RH	A031	9	0,5	9	9	18	1,00	30
Fr. Pwr. REG Jam-pro LH	A032	9	0,5	17	17	26	1,00	30
Fr. Pwr. REG RH	A041	6	0,5	12	12	18	1,00	30
Fr. Pwr. REG Jam-pro RH	A045	9	0,5	23	23	32	2,00	30
Fr. Pwr. REG LH	A042	6	0,5	14	14	20	1,00	30
Fr. Pwr. REG Jam-pro LH	A046	9	0,5	12	12	21	1,00	30

The total number of rollers needed is only 14 lines. In the store, there is an old project (810A Fr Regulator) that has no requests from December 2018. The old project requires 6 lines. The finished product will be removed so that the total number of empty roller lanes will be 12. By reducing the amount of finished goods inventory, the total lead time is reduced.

Figure 5 is finished goods inventory reducing plan layout.

Figure 5. Layout Before - After (finished goods)

4.5 Transfer Method Changes (Forklift Less)

To reduce forklifts utilization as lifting equipment or forklift less transportation, it would need several stages to apply. The first would be replacing forklift with Dolly. Dolly is specialized to transfer the finished goods along with pallets as a base simultaneously. The second would be facilitating and shorten handling by modifying the roller so it can accommodate the pallet. And the third is to advance finished goods roller to reachable by the workers during transferring finished goods roller to the pallet. Forklift less can reduce the shipping process lead time by 5 minutes and free up an area of 11.1 meters X 2.3 meters.

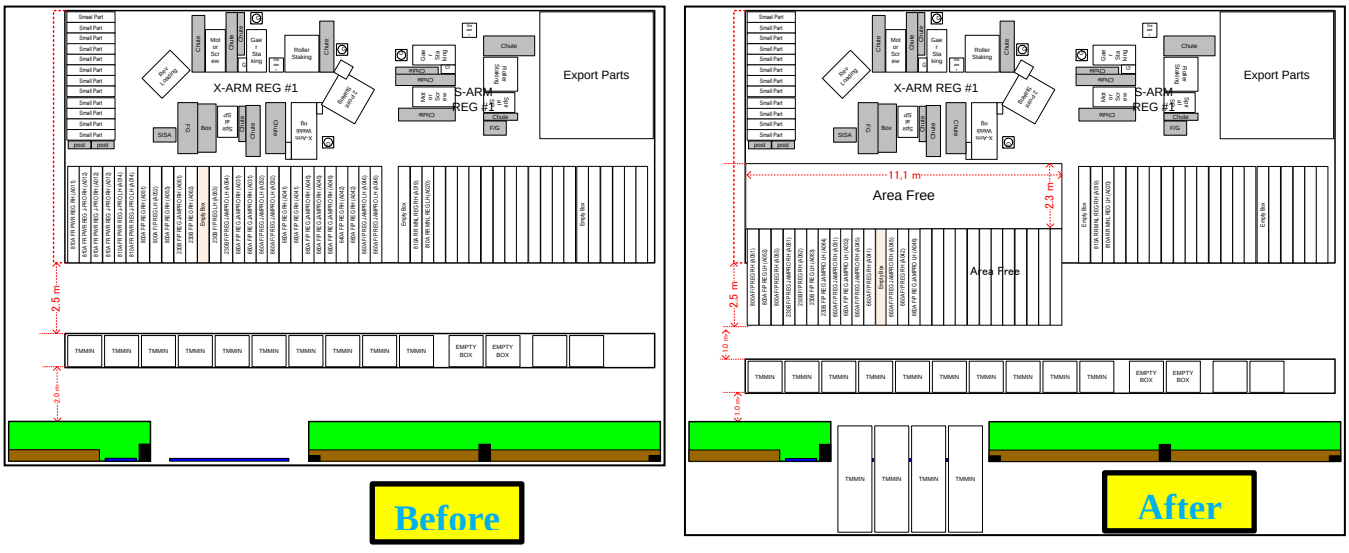


Figure 6. Layout Before - After (forklift less)

4.6 Layout Changes (Re-layout)

From the existing layout conditions, there is room for improving the layout to get better flow and space. From reducing safety stock and lot size arrangement, there are only 12 rollers for finished goods that would be utilized. And from forklift less

DOI : 10.31695/IJERAT.2020.3622

proposition, there are 11.1 meters X 2.3 meters area subside. Judging from the surrounding conditions there is a YHA X-Arm line that only requires 10 finish good rollers and 2 empty boxes. Whereas the line condition is not much different from the X-Arm Regulator line condition had been analyzed. Then the idea is to move the YHA X-Arm line next to the X-Arm Regulator line. From those schemes, there would be build up 7.9 meters X 9.2 meters spaces. From optimizing the space there would be room for a new project to be done. Figure 7 would describe about Re-layout plan.

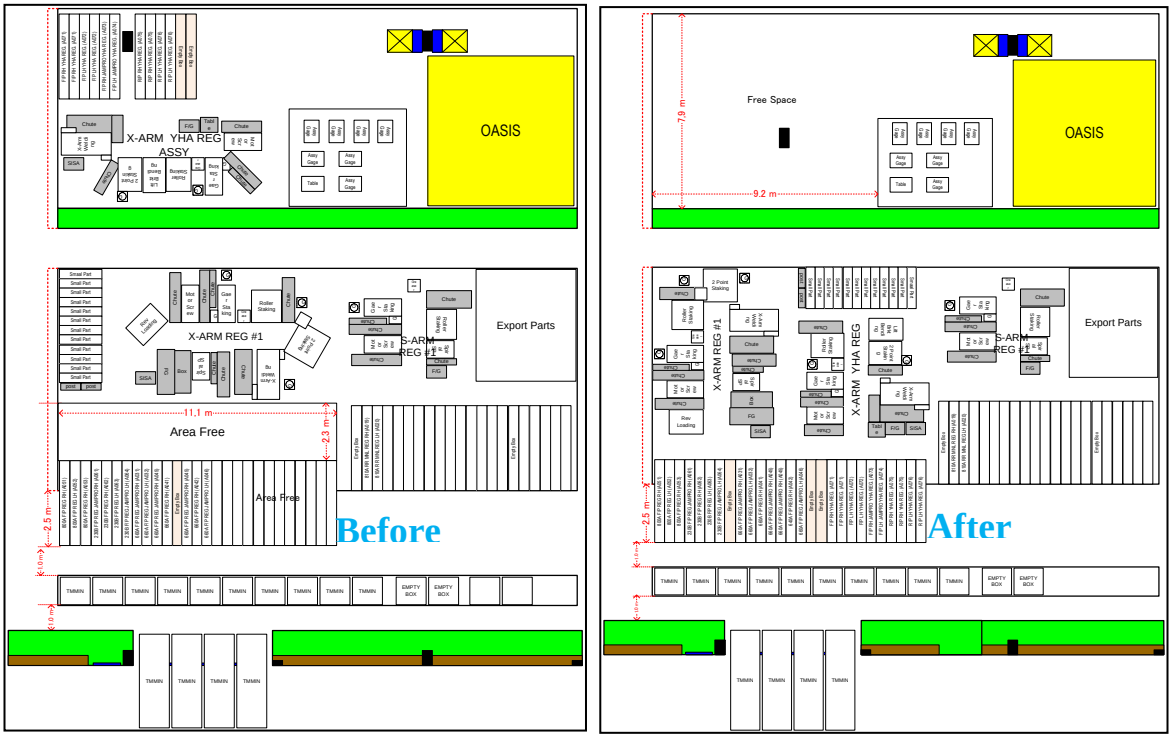


Figure 7. Layout Before - After (Re-layout)

4.7 Comparison of Current State Map and Future State Map

Table 3 would exhibit a comparison of total lead time reduction between current state mapping and the future state mapping. The reduction could happen from the kaizen blitz which facilitates and identify waste found in the current state mapping. In the future state mapping, innital total lead time 12,603.2 minutes fall off 5% (667.5 minutes) to 11,935.7 minutes total lead time.

Table 3. Comparison of NVA & VA

Ratio	*Current state map (Minutes)*	*Future state map (Minutes)*
Value added time	12,563.52	11,896.02
Non-value added time	39.68	39.68
Total	**12,603.2**	**11,935.7**

Table 4 describing a comparison of inventory level, scheme, and information flow between current state mapping and future state mapping.

Table 4. Comparison of CSM & FSM

The object	Ratio	
	Current state map	***Future state map***
Inventory Flow	Precipitating the inventory at receiving when part after platting is sent from the subcontract (PT.AMC) and requires an area for placement	The part after platting is directly supplied by the operator upon arrival at the reception, requiring only a temporary area for temporary laying

DOI : 10.31695/IJERAT.2020.3622

Inventory Level	A large enough inventory at the store finish is good. With 1-day safety stock and 72 pcs of lot size	More inventory at the store finished goods. With a safety stock of 0.5 days dal lot size totaling 36 pcs. 50% down
Information Flow	The process of moving part finish is good from preparation (pulling) to preparation (shipping) using a forklift. Unsafe condition and requires a large area	The process of moving part finish is good from preparation (pulling) to preparation (shipping) using a dolly (forklift less). Safe condition and only requires a small area

5. CONCLUSION

After analyzing the results and discussion, it can be concluded that based on the company's actual conditions using value stream mapping, the cause of long lead time is inventory waste with 9,266.39 minutes lead time, information flow with 3,297.13 minutes lead time and processes with 39.68 minutes lead time. Non-value added activities are mostly found in the inventory level contained in part after platting at the receiving area and finished good part area, also in finish good transfer part information flow. Future state mapping could reduce 5% of total lead time, which is 667.5 minutes, from 12,603.2 minutes to 11,935.7 minutes. Reducing 1.5 meters X 13.3 meters working space in the receiving area and 7.9 meters X 9. 2 meters in the X-Arm Regulator line. Lean principle could free up working space and reducing inventory level coincide with lead time reduction.

6. ACKNOWLEDGMENT

Mercu Buana University Research Center funded this research. We are grateful for all the experts who are willing to be research partners, with no mention of the company name.

REFERENCES

1. Gaspers, V. 2007. Lean Six Sigma for Manufacturing and Service Industries. Jakarta: PT. Gramedia Main Library.
2. Kadam, JS, Shende, N., & Kamble, DP 2012. Value Stream Mapping Tools for Waste Identification in the Assembly of Tractor Manufacturing. International Conference on Emerging Frontiers in Technology for Missile Areas. Nagpur, India: Yeshwantro Chavan College.
3. Kholil, M., & Mulya, R. 2014. Waste Minimization and Proposed Enhancement of MCB (Mini Circuit Breaker) Production Efficiency with Lean Manufacturing System Approach at PT. Schneider Electric Indonesia. Journal of PASTI Volume VIII No. 1, 44-70
4. Liker, KJ, & Meier, D. 2006. The Toyota Way Fieldbook A Practical Guide *For Implementing Toyota's 4Ps*. New York: Mc Graw-Hill
5. Womack, PJ & Jones, TD 1996. Lean thinks banish waste and create wealth in your corporation. New York: Simon & Schuster Rockefeller Center.
6. Shodiq, M., Khannan, A., & Haryono. 2015. Analysis of the Application of Lean Manufacturing to Eliminate Waste in PT Adi Satria Abadi's Production Line. Journal of Industrial Systems Engineering Vol. 4, No. 1
7. Womack., Jim., & Jones. 2003. Seeing The Whole Mapping The Extended Value Stream, USA: Brookline, Mashacussets.
8. Ohno., & Taiichi. 1988. Toyota Production System: Beyond Large Scale Production. Massachusetts: Productivity Press inc.
9. Rother, M. & Shook, J. 2004. Learning To See: Value Stream Mapping to Create Value and Eliminate Young version 1.4. Cambridge: Lean Enterprise Institute
10. Santosh, B., Dighe., & Kakirde, A. 2014. Lean Manufacturing Implementation Using Value Stream Mapping: A Case study of Pumps Manufacturing Company. International Journal of Science and Research (IJSR).
11. Nash., Mark, A., & Polling, S. 2008. Mapping The Total Value Stream. New York: A productivity Press Book
12. Ramassubu, M. 2018. Creating value stream mapping to identify areas of improvement and improving the USC mailing process. International Journal of Advanced Research, Ideas, and Innovations in Technology.

DOI : 10.31695/IJERAT.2020.3622