Performance Improvement in Aerospace Production Through Lean Manufacturing Implementation

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Abstract. The high demand in aerospace industry require on going improvement to meet its customer. Prototyping is a form of effort to ensure the quality of airplanes. However, several problems rose in this phase but two of them are significant in disrupting the production system. They are the spare parts tardiness and unnecessary motion leading a high lead time. The objective of this article is to develop lean action plan to reduce lead time in airplane prototyping. The method applied in this paper is divided into three major phases. Firstly, evaluate current system performance using Value Stream Mapping (VSM). Secondly, determine the dominant waste by cooperating waste finding checklist. Finally, develop a lean action plan. Most waste occurred in production activities. Waste of motion is the highest among other waste with the score of 44 followed by waiting with the score of 24. The third highest waste is excess processing with the score of 2. The causes of these wastes are lack of facilities such as machines and tools and inefficient operators in picking and mixing sealant. The lean action plans are to add machines and tools for labelling, adding sealant room and to change the production plant lay out. By doing so, the lead time can be reduced up to 0.25 hours.

1. Introduction
Manufacturing industries involves wide spectrum of parts to its production process. It opens a possibility of occurring wastes which compromised lead times and at the end, the value to its customer. Wastes are all activities requires time, space and resource but did not add any value to the product in customer’s perspective [1]. The purpose of this article is to develop lean action plan to reduce lead time. The object of this study is an airplane industry, particularly the prototyping process. It shows symptoms of waste happened in that process. Therefore, lean manufacturing is the proper approach to address that problems. It can be applied to identify wastes along the production stream. Lean manufacturing is powerful to eliminate those waste, improve quality and reduce lead time [2]. In addition, it can increase the output by eliminating any form of waste in production line [3]). Cooperating VSM in Lean Manufacturing implementation proofed to reduce production cost, shorten the lead time and increasing profit margin [4].

VSM is a proper tool to enhance the quality of information generating such as time, resources and information flows from parts to finish goods [5]. VSM and Value Stream Analysis Tools (VALSAT) manage to reduce waste in furniture industry by properly identify the significant waste which is inventory (19%) and determine the right tool to cooperate which is process activity mapping (PAM) [6]. VSM and Valsat also used in concrete industry [7]. Together VSM and Valsat powerful enough to identify wastes in ship manufacture industry and able to minimize the production time, not to mention improve production efficiency up to 91% [8].
2. Basic theory

2.1. Lean Manufacturing

Lean Manufacturing is an approach to help factory to identify and eliminate production waste, improve product quality and reduce production cost [9]. There are at least seven types of production waste:

- Waste of overproduction. In some occasion, some finished products couldn't make their way to costumer. Those products are called waste of overproduction. One of the reasons this waste occur is earlier production timeline or producing larger amount of product than costumer needs.
- Waste of motion. The movement of employees in working on products is a necessity. However, if there is a movement that does not provide added value to the product, it can be categorized as waste. Those movements include searching, selecting or stacking components, tools and so on.
- Transportation waste. In a well-designed system, workplaces and storage areas are close together so that material transfer is close. The equipment is placed where it is used, and material is transferred to the process as needed.
- Processing waste. Nonvalue added processes must be eliminated. In some cases, changes in product design often cause a reduction in some parts of the final product. Waste of processing can take the form of unnecessary processes or carry out inefficient processing.
- Waste time. This type of waste can be divided into two groups, namely waiting time and queuing time. Waiting time occurs when a part has finished, but other parts that will be assembled with it have not been completed. Queuing time occurs when a part has finished, but cannot continue because the next machine is still doing another job.
- Defective product. This waste arises from producing defective products or components or requires repair. Repairing or reworking, scraping, producing replacement goods, and inspections, means that additional handling, time and effort are considered as waste.
- Unnecessary Inventory. This waste arises from excessive inventory. Expenditures due to waste include warehouse costs, costs due to obsolete products, and damaged products.

2.2. Waste Finding Checklist

Waste finding checklist is used to measure waste production in each production activity [10]. The measurement process is carried out using a form as shown in Figure 1.

![Figure 1. Waste finding checklist form](image)

3. Research method

This article study one of the airplane parts which called elevator and use its 2017 production data. VSM applied to identify inefficiencies within manufacturing industry, specifically in production process [9]. VSM is lean manufacturing tool to analyse the future state of a production process. Beside VSM, this study also applied Waste Finding Checklist (WFC) to identify wastes. After wastes are...
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identified, Fishbone Diagram is applied to find its root cause. Subsequently, lean action plan developed using 5W+1H.

4. Result and Discussion

Value Stream Mapping (VSM) is used to determine the company's production floor’s initial conditions. The elevator production process begins with the Tail Unit Assy N219 stage and ends with the final inspection stage as shown in Figure 2. In total there are 37 activities that occur during the elevator production process where the cycle time is 46,040 hours and lead time of 60,918 hours thus creating waiting time for 2 days 12 hours. In addition, the takt time is 14 days/elevator or 89.6 hours. This shows that takt time is below the cycle time so that it can be ascertained that the production is running slow.

Figure 2. Waste in Aerospace Production

The overall processes lead to 2 days and 12 hours of waiting time. In respect to that time, the next step is to group the activities into Value Added (VA), Non-Value Added (NVA) and Necessary Non-Value Added (NNVA). Hence, the cause of waiting times can be identified. The results are as follow; Value Added is 44,520 hours; Non-Value Added is 0,418 hours; and Necessary Non-Value Added is 49,520 hours. Waste Finding Checklist (WFC) is cooperated to find the wastes in the elevator production. A series of discussion with experts are performed to fill the WFC filled. From the WFC the waste of motion has the highest value of 44, then waste of waiting is in the second place with a score of 24. The complete result is shown in Figure 3. Thus, the waste motion will be elaborated on the cause of the problem using fishbone diagram.

Figure 3. Current Value Stream Mapping
After all types of wastes are identified, Fishbone Diagram is applied to determine the root cause of the problem. Waste motion caused by 18 production process activities which caused by lots of unnecessary movements or excess movement which can cause additional time in the production process. Improvement analysis focus on waste of motion in several production process activities. The result is a program to change the layout to make JIG elevator closer. Another program it to add sealant space to the elevator production process location so that the operator does not have to bring the sealant too far from the elevator production process room. The last program is to restrict the operators to take and mix sealant. In addition, the labelling of the machine or tools is done in order to facilitate the operator in working. Based on those improvements’ program, it can reduce cycle time and lead time. Figure 4 shows the Future Value Stream Mapping in accordance to those program.

Figure 4. Future Value Stream Mapping

5. Conclusion
The results of WFC show that the greatest waste is waste of motion with a value of 44, followed by waste waiting with a value of 24. The activities that experience the highest waste and therefore the focus of improvement are activities that have a sealant process. The improvement programs are to add machines and tools, change lay out, add sealant room in production process, and restriction for the operators. It reduces cycle time to 45,040 hours and lead time to 60,668 hours.

References

[1] Charron, R., Harrington, H., Voehl, F., Wiggin, H. 2015 The Lean Management System Handbook. U.S: CRC Press, Taylor & Francis Group.
[2] Abdulmalek, F., Jayant, R. 2007 Analyzing the benefits of lean manufacturing and value stream mapping via simulation: a process sector case study International Journal Production Economic 107 pp 223-236.
[3] Gaspersz, V. Lean Six Sigma For Manufacturing and Service Industries. Jakarta: PT. Gramedia Pustaka Utama, 2011.
[4] Jakfar, A., Setiawan, W., Masudin, I. 2015 Reducing waste dengan menggunakan pendekatan lean manufacturing Spektrum Industri Vol. 13 No. 1 pp. 1-114.
[5] Patel, N., Chauhan, N., Trivedi, P. 2015 Benefits of value stream mapping as a lean tool implementation manufacturing industries: a review IJIRST Vol.1 Issue 8.
[6] H Arif, D., Vanany, I 2016 Implementasi lean manufacturing dengan metode value stream mapping pada PT X.
[7] Setyastuti, Y., Dewi, S., Suharyanto, A. 2017 Peningkatan produktivitas pada proses produksi pracetak dengan penerapan metode lean construction untuk eliminasi waste Rekayasa Sipil, Vol. 11 No. 3.

[8] Tebiary, A., Suastika, I., Ma'ruf, B. 2017 Analisis non value added activity pada proses produksi kapal dengan pendekatan value stream mapping Jurnal Wave Vol. 11 No. 1 pp. 22-23.

[9] Salunke, S., Hebbar 2014 Value stream mapping: a continuous improvement tool for reduction in total lead time. International Journal of Current Engineering Vol.2 pp 931-934.

[10] Gaspersz, V 2007 Lean Six Sigma For Manufacturing And Service Industries Jakarta: PT. Gramedia Pustaka Utama.

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