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# APPLICATION VALUE STREAM MAPPING TO MINIMIZE WASTE IN AIRCRAFT INDUSTRY

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Abstract. Nowadays, many organizations have already implemented lean manufacturing (LM) in order to be competitive in global market. Many company need Lean Manufacture to reduce wastes or activity that has no added value to increasing efficiency in process production. Currently, PT Xis one of aircraft manufacturing in Indonesia has issues a procurement department. Currently, the big problem of procurement department is delays to make dokument PR and PO in 2014 this cause the long lead time in 2014. Based on historical data, total delay from making PR is very high about 84% and for PO the delay takes 73%. With these facts that procurement department has very high delay in making PR and PO, PT Xwants to solve this problem by identify waste that happen in procurement department, so it will decrease the lead time in procurement department. The first stage in the application of value stream mapping is the Current State Mapping, this stage can illustrates the real condition of procurement department processes along with lead time of any such process. The second stage is analysis current value steam mapping, in this stage all waste is identified and resolved. The final stage is, Future State Mapping in this process produce a new process and a new lead time. Based on current Value Stream Mapping, it is found three category wastes there are over processing, waiting time, and unnecessary movement (motion). The solution provided to reduce the waste are cleaned-up SAP data, standardization of writing material, format Quotation and RFQ, procurement check point and email reminders. Solution that has been given can minimize waste and lead time and will reflect in future state mapping. By making Future state value stream mapping based on the solutions that have been given can reduce the total lead time. Total lead time in procurement department was reduced by 39%. Total lead time can decrease 19 days with average lead time 49 days for the current VSM decrease into 30 days for future VSM.

Keywords: Value Stream Mapping, Waste, Lead time, procurement department, Aircraft Industry

#### Introduction

Nowadays, many organizations have already implemented lean manufacturing (LM) in order to be Some implemented competitive in global market. companies have а few tools/techniques/practices/procedures of Lean Manufacturing, while others have implemented a whole spectrum of LM elements (Gurumurthy and Kodali, 2009). Fundamentally, many companies already realized the benefits of successful Lean implementation such as reducing lead time, cost saving and improved product quality and customers satisfaction. Lean manufacturing principles also can be applied to resolve problems in aircraft industry. PT X can also apply lean manufacturing to resolve problem and improve their performance. Currently, PT X is one of aircraft manufacturing in Indonesia has issues a procurement department. Procurement department is division has responsibility for the procurement of aircraft material. The division also has responsibility begin from material purchase planning until to delivery materilas from supplier, this division make it sure ordered material suitable with internal customer demand that is engineering. This division also negotiating with supplier to get the best price, lead time and payment system which can be make company more

profitable. Currently, the big problem of procurement department is delays to make dokumen PR and PO in 2014 this causing long lead time in 2014. Based on historical data, the big problem from procurement department is delay time in making PR and PO document. From table above, it can be seen that average delay from making PR is very high about 84% and for PO the delay takes 73%. With these facts that procurement department has very high delay in making PR and PO document, PT Xwants to solve this problem by identify waste that happen in procurement department, so it will decrease the lead time in procurement department. One of the common technique use in Lean Manufacturing is VSM (Value Stream Mapping) which aim to mapping process and identify wastes in procurement department, production line etc. By doing VSM the company will be easier to identify waste, design how to reduce waste, and increase efficiency and effectiveness.

## Literature Review

## Lean Manufacturing

The term "lean manufacturing" focuses on producing value-added features while identifying and eliminating non-value-added activities in the production environment. The central focus of value, according to Womack and Jones (1996), should be on providing products with specific capabilities, offered at predetermined prices, through a dialogue with predefined customers.

# Concept and Principles of Lean Manufacturing

Besides that, in the books Lean Thinking, John Womack and Daniel Jones define the five principles of lean. There are:

- a) **A Specify value.** The customer is the definer of value and they are willing to pay for something. Then, if they are not willing to pay, it is called waste.
- b) **Identify the value stream.** After the value is clearly defined, then the value stream is clearly defined. A value stream is the set of all action necessary to bring a product from the raw materials into the hand of the customers.
- c) **Make value flow.** Within the value stream mapping, the one piece flow is applied where possible.
- d) Let customer pull. A pull system is applied where the single piece flow is impossible.
- e) **Pursue perfection**. After using the value stream mapping technique to create a plan to achieve this, process Kaizen is used to reduce waste and continuously improve.

## Waste

According to the various authors (Taj, 2008, Chase et al., 2006 Heizer and Render, 2004; Yandell, 2002), waste can be defined as any activity that does not add value to the finished product. These can be excess inventory, unnecessary operations, scrap, rework or transportation. The core feature of this concept is that by reducing waste activities, more resources are made available to concentrate on those activities that add value to the product or service.

## Value Stream Mapping

VSM is a significant tool of LM. VSM can serve as a good starting point for any enterprise that wants to be lean. A value stream is all the actions (both value and non-value added) the required to bring a product, or group of products that use many of the same resources in much the same way, through the main flow essential to every product - from raw material to the arms of the customer (Browning, 1998). Hines and Rich (1997) have identified seven VSM tools to identify the wastes present in any system in form of inventory, overproduction, over capacity, wrong processing methods, NVA activities, etc. The "Value Stream" is one of the conception of VSM that had been developed by Rother and Shook in 2009 and it is "all the performance (both value-added and non-value added) presently needed to bring an invention to the mainstream, which is vital for any invention; firstly the invention flow from unprocessed materials into the arms of the consumer and secondly the plan flow from perception to launch. "A value stream is all actions (both value added and non-value added) currently required to bring a product through the main flows essential to every product: (1) the production flow from raw

material into the arms of customer, and (2) the design flow from concept to launch." (Rother and Shook, 1998). Monden (Monden, 1993) introduced three categories classifying operations as non-value adding (NVA), necessary but non-value adding (NNVA) and value adding (VA). Step to make VSM are Current VSM, Analysis VSM, and Future VSM.

# Methodology

In this research, we conduct four steps of research. Firstly, we highlight lead time as the isues that can causes problem in the company. The company has waste in inventory because delay of material. In produce an aircraft needed many materials so if the one material comes delay, the product cannot be produce. Delay material can make the company has higher operating cost and lower customer service level because the delay of material. So, in this study long lead time is critical problem that must be solved. Secondly, we make value stream mapping analysis. It is including business process map, current mapping, analysis current VSM, and identify waste. These first and second steps are conducted by integrating literature study, field observation, historical data collection, and depth interview with one stakeholders on January 2015. Thirdly, we conduct analysis and recommendation. This step can give result in the form of future state mapping. In this step are conducted by depth interview with management for validate the result. Fourthly, we would provide conclusion which answers the problems. The conclusion also proposes recommendation for the company.

# **Result and Discussion**

In this current VSM mapping, the main object to be researched is part of external supply chain process in PT Indonesian Aerospace, start from material planning to procurement process. Financing process, custom and receiving process, material receive (warehouse) are not mapped in this research because it involved the third persons like supplier, government with the regulations. It cannot be controlled. Objective of this research is to improve internal part of PT Xin using VSM, so the area research is only in supply chain area that do not involve the third persons. Data that have been used is lead time data during 2014 and all materials order during 2014. One of the output from this Current VSM mapping is reducing lead time in procurement department by identify waste. Luciana and Lestari/ Journal of Business and Management, Vol.4, No.10, 2015: 1119-1131





Based on the figure above, we can see that the mapping process of procurement department. In this research only focus on process creating PR and PO document. The process begin from coming request by engineering in form MBOM (Manufacture bill of material), then the planner doing three step evaluation before make PR (purchase requisition). The first evaluation is evaluation specification, this purpose of this evaluation is determine the material update or not update. Second evaluation is Evaluation stock, the aim of this process is to checking material it is available in stock or not. The last process evaluation is evaluation alternative, to know the alternative of material if the material can be subtitute with another material that already have in warehouse so the planner not order this material. If the evaluation process is done so the planner do PR creation. Then next step, buyer check in SAP system PR that already create by planner and buyer make evaluate PR, it is aim to checking ordered material suitable with engineering needs or not. If evaluate PR is done, then buyer make RFQ process to searching supplier that can supply engineering needs. If supplier already give quotation, price and lead time so buyer doing evaluate quotation to choose the best supplier to get the best payment system. Next step is buyer create General Purchase Agreement (GPA), in this process buyer must do negotiate with supplier to get the best payment system. Next step is make Purchase Order document based on the result of RFQ process, the last process is create request for payment. The document given to Finance division, in order to finance can do payment to supplier.

In real conditions, Procurement Department has 3 information streams:

> Manual Information Flow

Manual information flow is information stream that happen directly (face to face) between persons who has interest on it. In Procurement Department, information stream happen when material planner make a coordination with user (engineering) to ask material specification. In that time, there is manual changing information happen between planner and engineering. Because there are manual information's it cannot be mapped in Information flow map.

Electronic Information Flow

Electronic information flow is information stream that happen by electronic media, there are SAP system and Email. For SAPsystem, information can be material order from engineering to planner, approval manager. To make PR and PO, procurement department also use SAP information to change information. For media electronic, email is used in RFQ process (Request of Quotation) to share information about RFQ documents.

Push movement

Push movement is mobility of information's by activities from one process to the next process based on process (systematic) that has been made.

According to the known data, then we make the information stream mapping that shown in figure 4.12. The straight arrow show the manual information stream and the arrow with angle show electronic information stream.



Figure 2 Information Stream Mapping In Procurement Department

Based on Figure above, we can see information stream mapping that happen in procurement department. The information in Procurement department using electronic information flow there are email for communication with supplier in process RFQ and using SAP system in process making request/order, PR, and PO.

After Current VSM complete with information stream, last step in making current VSM need to be completed with lead time from every activities in Procurement Department. Lead time is defined as a period of time between start of activity until finish that activity. In this case, the lead time data is obtained from historical data of PT Xand complete with interview data from Purchaser and Planner. Based on calculation from historical data, there is the average lead time per division :

## Table 1. Average Lead Time Division

| No | Division          | Average Lead Time<br>(Day) |
|----|-------------------|----------------------------|
| 1  | Material Planning | 33                         |
| 2  | Purchasing        | 16                         |

To know the lead time from every activities/process that happen in that division, it needs an interview with other parties to obtain the percentage, so it will be easy to distribute the lead time that has been calculated based on historical data in 2014. After obtained the percentage from every process, then find the lead time with these method is lead time per division multiplying with percentage.

| Division        | Process                                    | Percentage | Lead Time (Day) |
|-----------------|--|------------|-----------------|
| Material        | Evaluation Specification                   | 13%        | 4,29            |
| Planning        | Evaluation Stock                           | 5%         | 1,65            |
|                 | Evaluation Alternative                     | 20%        | 6,6             |
|                 | Purchase Requisition (PR)<br>Creation      | 62%        | 20,46           |
| Purchasing      | Evaluate PR                                | 12%        | 1,92            |
|                 | Create RFQ                                 | 6%         | 0,96            |
|                 | Evaluate Quotation                         | 22%        | 3,52            |
|                 | Create General Purchase<br>Agreement (GPA) | 46%        | 7,36            |
|                 | Create Purchase Order                      | 8%         | 1,28            |
|                 | Create Request for Payment                 | 6%         | 0,96            |
| Total Lead Time |  |            | 49              |

## Table 2. Lead Time per Process

\*Asumption 1 day = 8 hour

After completed all the data, next step is to involve the data to Current VSM, so it can be seen where the highest lead time, the point to make improvement.



Figure 3 Current Vsm Procurement Department

Based on figure above, we can see Current VSM procurement. This figure can describe the real condition of Procurement Department PT X. Total lead time process procurement begin from evaluation specification until create request for payment is 49 days.

For material planning division, researcher found some wastes there are :

1. Waiting Time

One of the activities that cause the long time to maka PR is waiting time is too long. It is can be seen when the planner doing evaluation specification and evaluation alternative, they should be coordinated with engineering (internal customer), usually when the material requested by the engineering is not update material, so planner must be coordinate with engineering to replace the specification of material with update material. This activity that causes long waiting times. This activityy takes a long time because communication between planner and engineering usually use email, so planner has long time to wait reply email from engineering.

2. Motion

In process evaluation stock usually do by system SAP because SAP system provide the data of stock material. But, often planner should go to the warehouse to ask the actual stock because in system also provide quantiy of material not also a cut of material. For some material like raw material metal (RMM) such as alumunium sheet that can be cut into several size according to the needs of engineering. So planner should do checking of these pieces so if the engineering requested material is not too much, they can use the pieces of cut material that orde to supplier. It was categorize as waste motion because of this activity, time to make PR can be getting longer.

3. Overprocessing

The next waste that occur in material planning division is over processing. Much of data ini the SAP system were needed but is still already in the system. It is happen because diference writing materials, the one material can have 2-6 diference writing material but it is same material. It is inhibits the planner's work in during evaluation process because planner must be checking all of the diference writing materials to get result of evaluation.

For the purchasing division researcher found some waste there are:

1. Overprocessing

Waste over processing that occur in purchasing division when the buyer must make a resume quotation and price after getting the result of supplier RFQ. It is happen because every supplier participating in the RFQ process provide quotation documents with diference format because PT X not have standarization to format Quotation. So, buyer must be repeat all document quotation from supllier into a new document, it takes a long time because minimal 3 supplier who participate in the RFQ process and offrered material by supplier more than one depend on demand of engineering.

2. Waiting Time

When PO ready, the next step is the PO should checked and approved by some manager. In fact, PO release often late because waiting time during the approval process manager, managers often forget to open SAP or the manager is busy so they no have time to open SAP.

All of waste that is found must be to have a solution. Therefore, it would be given solutions to mitigate or even eliminate waste. The main waste that has been found is overprocesing, this waste become a root cause that led to the division material planning and purchasing experience lead time that exceeds from the target lead time. The solutions provided for reducing waste over processing are the following:

# 1. Clean up SAP data and the standardization of writing material

For a big problem in material planning will be given solution Clean up SAP data and standardize of writing material. This clean up all SAP data solution means that clean up data material having a similar material but in different writing. After all the data writing double

omitted in the system then the solution subsequently made standardization of writing so that if in the future there is a new material and have not been entered into the SAP system is given writing with a predetermined format. The following proposed format for writing material:

#### Material Code- Spec material- Dimension / Size Material

Filled with a material code to program what material was used. Spec material filled with a material specification that is usually derived from the engineering. Dimension / size of the contents of the material in the material size ordered and also included with the material dimension. After the standardization of writing, researcher expected that all the employees understand this standardization that does not happen again double the writing material with their own definition. With this solution, researcher expected the big problem in material planning division can be resolved and can facilitate the work of planners in the evaluation process.

#### 2. Quotation and RFQ Format

To resolve the big problems that occur in the purchasing division, researcher suggested a solution to make the format document for the RFQ and quotation so that buyers can just give a both of format document to the supplier so the supplier had to fill out all the bids in the same document. The purpose of it solution in order to make easier the buyer to conduct an evaluation of the quotation provided by the supplier. Actually, PT X himself had once had a RFQ document, but now it is no longer used as the format most RFQ done manually by email. With this solution is expected to accelerate and facilitate the buyer to perform his duties.

Then, no also the main waste given solution, there are the additional solution also given to Minimize waste waiting time and motion as follows:

#### 1. Procurement Check Point

To Minimize waste waiting time and motion, researcher provide a solution is Procurement Checkpoint. Procurement check point is a useful media for facilitating communication between internal procurement. Procurement check point is a meeting between all the internal procurement before making the purchase requsition of materials. With the Check Point Procurement expected waiting time and motion can be reduced because of internal communication media here all procurement can share information ranging from distributing or share the results of the tender, evaluate the material specification that is not updated, and share information about the actual stock.

#### 2. Email Reminder

This solution is given to resolve problems is waiting time manager approval process that take a long time. To overcome the problem of waiting time manager will be named Email Reminder. Email reminder is otomatic email if the manager late to give approval. This solution is expected to be able to reduce or even eliminate the approval time can be faster.

The future VSM making derived from solutions which have been given above. In the future state value stream mapping all of procurement department processes in place but there are additional processes. It is procuremet check point process. This process will be added to the planner after receiving requests with aim to facilitate the planner in the process of evaluating material and stock. Here is the new lead time simulation when all the solutions provided by the company:

| Division | Process                         | Lead Time (Day) |
|----------|---------------------------------|-----------------|
| Material | <b>Evaluation Specification</b> | 2,34            |
| Planning | Evaluation Stock                | 0,9             |
|          | <b>Evaluation Alternative</b>   | 3,6             |

#### Table 3. New Lead Time Procurement Department

|                 |            | Purchase Requisition (PR)<br>Creation      | 11,16 |
|-----------------|------------|--|-------|
|                 | Purchasing | Evaluate PR                                | 1,44  |
|                 |            | Create RFQ                                 | 0,72  |
|                 |            | Evaluate Quotation                         | 2,64  |
|                 |            | Create General Purchase<br>Agreement (GPA) | 5,52  |
|                 |            | Create Purchase Order                      | 0,96  |
|                 |            | Create Request for<br>Payment              | 0,72  |
| Total Lead Time |            | 30   |       |

By doing all of the above alternative solution so accordance with the calculation and the target lead time of planner and buyer, the lead time can be reduced by 39% from the current VSM.

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#### Figure 4 Future VSM

Based on future state value stream mapping has been created, it can be seen that there is a time difference. Of all the solutions provided, it can be seen that the difference in the time to 30 days sooner or save time by 19 days from the current VSM.

## **Conclusion and Recommendation**

Based on current value stream mapping, researcher found three wastes there are overprocessing, motion dan waiting time. Waste over processing is a major waste as seen from the historical data, the results of interviews with relevant parties and the results of analysis of the researcher. Thus concluded that the waste is most urgent to be resolved because it affects the lead time of a process that is in material planning and purchasing divisions. The solution that given by researcher to minimize waste are clean up data , , standardization of writing material, format Quotation and RFQ, procurement check point and email reminders. By making Future state value stream mapping based on the solutions that have been given can reduce the total lead time. Total lead time in procurement department was reduced by 39%. With an average lead time of 49 days for the current VSM decrease into 30 days for future VSM.

The company is expected to apply all the proposed solutions of the researcher so waste that occurs in the Procurement department now can Minimize immediately and can create a better work performance. Especially the proposed solution to the main waste in the form of clean up data and the standardization of writing material and quotation format and RFQ. Make the announcement about the format standardization writing material so that all the employees understand the standardization of writing material double. For additional suggestions, researcher suggest PT X using system in RFQ process. So process RFQ can faster and internal procurement could see and know where the material that has been done RFQ. So that the RFQ can also be accessed openly by the system.

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