Application of lean manufacturing to improve procurement lead time in the case of the steel industry

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Abstract. The steel industry is classified as a strategic industry that supports many industries, due to continuous national development. The steel industry must improve the quality of its production processes in order to increase its competitiveness. One factor that supports the stability of the production process is the procurement process. Delays in the procurement process can disrupt the smooth production process. The purpose of this research is to minimize waste in the steel procurement process by using the value stream mapping method. This research begins by making current state mapping of the actual procurement process, then analyzed the activity categories including value added activity and non-value added activity. In the beginning, the total time value added activity is 7488 minutes and total time non value added activity is 12240 minutes. An improvement was made in terms of the negotiation process, document review, and waiting for an offer, the result of the total value added activity is 7488 minutes and non-value added activity is 2160 minutes, so the procurement process initially 41 days became 21 days.

1. Introduction

The steel industry is a strategic industry that is used as raw material and supporting material for many industries, for infrastructure (road construction, building construction, and bridge construction) transportation equipment, automotive, or weaponry [1]. Indonesia is one of the major steel users and suppliers. Based on data from the Ministry of Industry, Indonesia’s steel consumption reached 12.7 million tons in 2017 and its projected to be 21.4 million tons in 2025 [2]. The Ministry of Industry ensures that the full potential of the steel industry can have a maximum role, because it much needed for national development. The development of the national steel industry is needed to support increased infrastructure development in Indonesia, both by the Government and the private sector which requires large amounts of steel [3].

PT. Krakatau Steel is the one of steel company in Indonesia. To carry out business activities, the company is supported by many functions, the functions are marketing, production and technology, logistics, finance, human resources, and business development. Procurement or logistics is an important function in a company's [4]. Procurement department has an important role for supply the material in the company and responsible to get the quantity and quality of material needed. Timeliness in the procurement process is one of the key factors preventing the disruption of the production process [5]. The current condition of the procurement process in the company is still not optimal. The lead time target for the material procurement process set by the company has not yet been reached.

The purpose of this research is to improve the performance of the procurement process in the case of steel companies using lean manufacturing approach. The value stream mapping method is one of the
well-known and widely adopted lean manufacturing tools to reduce waste in the production process in various industries [6][7][8][9].

2. Literature Review

2.1. Procurement

Procurement is the activity of finding, obtaining, buying materials through a tender process or competitive bidding process. This process is done in order to satisfy the buyer in receiving materials at the best price by considering many aspects, these aspects are quality, quantity, time and distance. Procurement is a comprehensive activity of the purchasing process [10]. Purchasing is an activity to obtain material to meet the needs of the company. The purpose of purchasing is different and narrower than procurement, because of purchasing is part of procurement. Purchasing functions include obtaining goods by fulfilling the following provisions: Right product that is right and in accordance with standards and specifications, Right amount with the amount according to needs or orders, Right Time with delivery time according to user needs, Right Price with competitive prices [10].

2.2. Lean Manufacturing for Procurement

Lean manufacturing for procurement is a production practice that considers all the expenditure of available resources to obtain economic value to the procurement process without any waste, and this waste is the target to be reduced [11]. Implementation of lean manufacturing is one of the characteristics that indicates that the company focuses on customer satisfaction, and product results [12]. Lean always sees the value of a product from the customer's point of view, where the value of a product is defined as something that the customer wants to pay. If the company does not want to bear excessive costs, it must be able to find a number of things to be eliminated to avoid waste. Cases that often occur in daily life and operational activities of a company are a waste of time and energy. Other waste may occur because the use of equipment that is considered not so important for the company or during the production process.

2.3. Value Stream Mapping for Procurement

Value stream mapping is a collection of all activities in which there are activities that provide added value and non-added value activity is needed to complete the Purchase Request process to become a Purchase Order. This activity is part of the procurement process which includes the flow of the procurement process. Value Stream Mapping is one of the ideal tools as a first step in the process of improving the company that is used to help visualize the procurement process as a whole [13].

Value Stream Mapping consists of a sketch that maps the current state and the Future State. Current state sketches describe the process of material and information flow currently in the process. This visualizes the process of being able to identify waste in the system and encouraging users to take a systematic approach to eliminate waste. A sketch of a future state is a chart showing how to make a lean flow.

The purpose of this mapping is to identify all types of waste along the value stream and to take steps in an effort to eliminate the waste. Taking steps in terms of the value stream means working in a large scope, and improving the entire flow rather than just optimizing the flow in piecemeal. This gives rise to a language that is commonly used in the process of procurement of goods, thus will be able to facilitate more mature decisions in improving the value stream. Value Stream Mapping can provide an optimal turning point for the company. The two main steps in VSM mapping are:

1. Making Current State Map to map the current procurement conditions, so that it can identify any waste that occurs. Current State Map Our starting point is to look at the current process flow before improvements are made.
2. The making of the Future State Map as a proposed design for the improvement of the current state map is a description of the process and information after the information after the improvement is made.

3. Research Method
The steps used in this research intended to solve problems in the procurement process, the steps consist of identification problem, data collection and processing the data, value stream mapping (VSM) analysis, and make the fish bone diagram.

For the data collection stage, it is done by direct observation, taking the procurement history data from SAP, study literature, and interview or discussion with expert. The type of data used is qualitative data that is the lead time of procurement from and the data sources used is primary data obtained directly from the SAP.

For the data processing done with two method, there are value stream mapping methods and fishbone methods. Value stream mapping methods is used for identification waste time in procurement process. Current state value stream mapping shows the current conditions of the procurement process so can identify existing waste time, while the future state value stream mapping show the condition of procurement after improvement [14]. Fishbone methods done by making fishbone diagram for identification the causative factor has not been reach the target time for procurement. Diagrams are made based on the results of discussions and interviews with employees who are experts in the procurement field.

4. Result and Discussion

4.1. Current State Value Stream Mapping
According to [15] making current state value stream mapping intended for recognize and know the existing process. Besides that, current state value state mapping also used to determine the flow of information during the process. Value Stream Mapping (VSM) method is one method that applies efficiently visualization picture to describe the current state of, and can identification the long term vision and can develop the planning of the company for reach the target. Current state mapping made base on the identification of value added activity and non-value added activity in the process of procurement in one of the steel company in Indonesia

| No | Flow process of procurement in PT. Krakatau Steel                                                                 | Time (min) | Category |
|----|------------------------------------------------------------------------------------------------------------------|------------|----------|
| 1  | The user prepares an approved Purchase Requisition complete with supporting document (materials catalog)           | 3360       | VA       |
| 2  | Waiting for review                                                                                                | 1488       | NVA      |
| 3  | Purchaser receives the Purchase Requisition (PR) file from the User and evaluates the completeness of the PR documents | 1200       | NNVA     |
| 4  | Purchaser consult the document to user if it is not complete                                                    | 2880       | NNVA     |
| 5  | Purchaser chooses a list of bidders who are competent and have good performance in the supply of goods needed by the user | 480        | VA       |
| 6  | Purchaser make Request for Quotation (RFQ) based on PR that has been made by the User                            | 1440       | VA       |
| 7  | Purchaser sends RFQ to the List of Tender Participants (DPT) via e-mail                                          | 240        | NNVA     |
| 8  | Purchaser is waiting for an offer from the vendor                                                                | 3360       | NNVA     |
| 9  | Purchaser makes a comparisons of Quotation based on offers sent by vendors according to deadlines                  | 240        | NNVA     |
| 10 | Purchaser make, send, and negotiates to vendor who was appointed as a potential winner until the Minutes of Negotiation are signed and endorsed by the Material Procurement Manager | 2832       | NNVA     |
The average time needed in the procurement process at PT. Krakatau Steel is 19.728 minutes, if converted in days is 41.1 days. The process of procurement has been delayed for 20 days from the standard procurement process targeted by the company and listed in the Work instruction (WI). At this stage of the process shows that percentage of value added time is 38% and non-value added time is 62% with detail necessary but non-value added time is 54% and non-value added is 8%. Total value added time in procurement process is 7.488 minutes, while the total non-value added time is 12.240 minutes. Value added time is an activity that provides added value to the company, non-value added time is an activity that does not provide added value to the company while necessary but non-value added time activities are needed but do not provide added value to the company.

**Figure 1.** The percentage comparison of VA and NVA value of procurement processes.

**Figure 2.** Current State Value Stream Mapping in procurement process.
Figure 2 shows the entire flow both in terms of the process and information contained in the process of procurement in PT. Krakatau Steel starting from the user process by creating a PR based on the notification of the need for goods in the field which is equipped with supporting files in the form of materials catalogue, bill of materials, as well as drawings, PR made after procurement planning check the stock of goods in the warehouse. Then the PR file is continued to the Material Procurement division, and the PR file will be processed by the purchaser. Next the Purchaser evaluates the completeness of the PR file, if the file is complete and complies with the procurement requirements, then the purchaser chooses a list of bidders who are competent and have good performance in the supply of goods needed by the user according to the commodity. After that, purchaser make a RFQ, RFQ is requests for price quotes to vendors or suppliers of goods. The next process the vendor sent by RFQ makes a Quotation containing the price offered at the time of procurement of goods at a specified deadline. After the vendor sends a price quote letter, the purchaser opens the offer with the bid opening team and make Minutes of opening of bids which are signed by the team and approved by the manager of the Procurement Materials Division. After the minutes of opening the offer are signed by the manager, a Comparison of Quotation (COQ) is made by Purchaser so the prospective tender winner was chosen. After that negotiations are carried out by the purchaser to prospective tender winners until the Minutes of Negotiation are signed and endorsed by the Material Procurement Manager. Next, the Purchaser creates a PO and validates the PO based on PR data and negotiation results, and submit it to the vendor so that the vendor sends the goods within the specified time.

After the allotted time, the vendor sends the goods according to the criteria and requirements on the PO. When the goods are received, a conformity inspection is carried out by the Inspector in the Warehouse Management Department. If the items match, then proceed to the Warehouse Management storage area, however, if the item has a discrepancy, the item is rejected and returned to the vendor. Furthermore, goods that have been stored in the warehouse can be taken by the user who ordered the goods by making a reservation for the collection of goods.

4.2. Waste identification in procurement

According to [11] waste is all activities that cannot add value in the process of transforming inputs into outputs along the value stream. Waste identification is obtained through interviews with employees in the vendor management services and internal experts in the procurement department.

Through the results of measuring the time of the observation process carried out, there is some waste that results in a long time in the process of making a Purchase Order (PO). The impact of making a Purchase Order (PO) that is too long is resulting in requests for user goods to arrive late from the specified time. Based on observations and lead time calculations, there are various kinds of waste found in the existing processes. Waste that exists are:

1) **Over Processing.** That is because there is a process that requires procurement in replying to requests from Users via file. The response is given when confirming the continuation of the PR process, whether it is a request to complete supporting PR documents or unclear PR specifications.

2) **The second Waste** is negotiation process by Purchaser, where the negotiation process is included in the necessary non value added activity, because the negotiation process is still done manually that is face to face, so that the determination of the negotiation schedule can be delayed because of the busyness of both the supplier and purchaser.

3) **The third Waste** is waiting for offers from vendors, where the process is waiting for offers from vendors in the category of necessary non value added activity, where the standard is waiting for the offer is 7 days and shipping the offer, and some vendors still send them manually via hard copy of the offer delivered to the procurement department.

From the causes of waste procurement can be analyse with a fishbone diagram, where the fishbone diagram is a tool to identify various kinds of potential causes that occur in a problem and analyse the problem [16]. The fishbone diagram was developed from the results of discussions and interviews with procurement and vendor management employees. Here is a fishbone to describe the flow of the causes of the waste that occurred in the procurement process.
1. Evaluation process of request documents conducted by Purchaser

![Diagram](image)

**Figure 3** Fishbone causes the length of document review.

2. Negotiation Process By Purchaser

![Diagram](image)

**Figure 4**. Fishbone causes the length of the negotiation process by the Purchaser.
3. Waiting for Offer from Vendor

![Fishbone diagram](image)

**Figure 5.** Fishbone causes the duration of the offer from the Vendor.

**Table 2.** Identify Value Added Time and Non-Value-Added Time procurement

| No | Waste                                                                 | Proposed Improvement |
|----|-----------------------------------------------------------------------|----------------------|
| 1  | The Purchase Request Document Review Process by Purchaser             | Provide training to users so that users are not wrong in completing documents, and checklist forms can be made so that no documents are missed. Creating an e-negotiation system using either WEB or other online applications to facilitate time control of the negotiation process, as well as giving notifications to vendors when negotiation time is almost reached the limit. |
| 2  | Negotiation Process                                                   | The follow-up process uses the tender deadline reminder notification via e-mail. |
| 3  | Awaiting Offers from Vendors                                         |                      |

4.3. Proposed Improvement

This section explains the proposed improvements to be able to reduce or even eliminate the waste that is used as the basis for making future state value stream mapping procurement. This proposed improvement was obtained from the results of identification with fishbone.
4.4. Future State Value Stream Mapping

Future State Value Stream Mapping is a proposal and suggestion for improvement of current state value stream mapping by minimizing or eliminating waste. Future State VSM made based on the proposed improvements that have been made. The process of procurement starts from the user making a PR until the issuance of a PO. Waste elimination in the Future State VSM is done at the Evaluation stage of the document from the user, where by eliminating the time Evaluation of documents from the user can eliminate waste as much as 5568 minutes both in terms of reviewing documents, evaluating documents, and returning documents, this can be done by providing information to the user regarding the completeness of supporting files that must be sent to the procurement department. The next elimination of waste is in the process of waiting for offers from vendors, which originally took 3360 minutes, can be reduced to 1440 minutes, This can be done by providing reminders and following-up of vendors who take part in tenders and offer prices. The next eliminating waste is reducing negotiation time, which originally took 2832 minutes, can be reduced to 240 minutes with notes that negotiations are conducted online without having to face to face. The total time shown in Figure 6 is 9648 minutes or 20.1 days, half a day faster than the company's target of 21 days. And faster than the total time at the VSM Current State which is 41.1 days.

Figure 6. Future state value stream mapping of Procurement.

Figure 7. Percentage of VA and NVA values in future state value stream mapping.
In the Future State VSM conditions show that the total percentage of value added time in the procurement process is 78%, while the percentage of total non-value added time is 22%, with details of non-value added time of 0% and necessary non value added time of 22%, with a total value added time of 7488 minutes, while the total non-value added time is 2160 minutes. Value added time can be interpreted as activities that can provide added value to the company, non-value added time is an activity that does not provide added value to the company, while necessary but non-value added time is an activity that does not provide added value to the company.

4.5. Comparison of Current State VSM with Future State VSM in the procurement process
This section explains the differences between current state value stream mapping and future state value stream mapping in the procurement process which includes the percentage of value added time the percentage of non-value added time, total value added time and total non-value added time

| Table 3. Comparisons of Current State Value Stream Mapping with Future State Value Stream Mapping in steel procurement process |
|---------------------------------------------------------------|
| **Current State VSM** | **Future State VSM** |
| Percentage value added time | 38 % | 78 % |
| Percentage non-value added time | 62 % | 22 % |
| Total value added time | 7488 minutes | 7488 minutes |
| Total non-value added time | 12240 minutes | 2160 minutes |

The total percentage of value added time in the Future State Value Stream Mapping has increased from the Current State Value Stream Mapping, from 38% to 78%, an increase of 40% with a fixed time of 7488 minutes, time at value added time remains the same because value added activity is an activity that can provide added value to the activity, so there is no need to make changes.

The total percentage of non-value added time when the condition of the Future State Value Stream Mapping has decreased from the condition of the Current State Value Stream Mapping i.e. from 62% to 22% decreased by 40% with a total time on the condition of Current State Value Stream Mapping of 12240 minutes to Future State Value Stream Mapping of 2160 minutes so that it decreased by 10080 minutes.

5. Conclusions
The implementation of the value stream mapping method in the procurement process in steel industry can reduce procurement lead time from 41 days to 21 days or decrease in procurement lead time by 50 percent. In the initial state, the percentage of activities that were classified as non-value added time was 62 percent and value added time was 38 percent. The waste activities or non-value added activities identified in the steel procurement process are the process of evaluating PR documents, the process of waiting for offers from vendors, and the negotiation process. The solution provided to anticipate the waste are provide training to users and make checklist forms, create an e-negotiation system using a web system to reduce face to face, and provide notification to the vendor when the offer deadline is near. After the improvement process, the percentage of non-value added activities decreased to 22 percent and value added activities increased to 78 percent.

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