Design of production process main shaft process with lean manufacturing to improve productivity

I Siregar¹, A A Nasution², U Andayani³, Anizar¹, K Syahputri¹

¹Department of Industrial Engineering, Universitas Sumatera Utara, Medan 20155, Sumatera, Indonesia.
²Department of Accounting, Universitas Sumatera Utara, Medan 20155, Sumatera, Indonesia.
³Department of Information Technology, Universitas Sumatera Utara, Medan 20155, Sumatera, Indonesia.

¹E-mail: ikhsan.siregar@usu.ac.id

Abstract. This object research is one of manufacturing companies that produce oil palm machinery parts. In the production process there is delay in the completion of the Main shaft order. Delays in the completion of the order indicate the low productivity of the company in terms of resource utilization. This study aimed to obtain a draft improvement of production processes that can improve productivity by identifying and eliminating activities that do not add value (non-value added activity). One approach that can be used to reduce and eliminate non-value added activity is Lean Manufacturing. This study focuses on the identification of non-value added activity with value stream mapping analysis tools, while the elimination of non-value added activity is done with tools 5 whys and implementation of pull demand system. Based on the research known that non-value added activity on the production process of the main shaft is 9,509.51 minutes of total lead time 10,804.59 minutes. This shows the level of efficiency (Process Cycle Efficiency) in the production process of the main shaft is still very low by 11.89%. Estimation results of improvement showed a decrease in total lead time became 4,355.08 minutes and greater process cycle efficiency that is equal to 29.73%, which indicates that the process was nearing the concept of lean production.

1. Introduction
This research was conducted on a palm oil processing machine spare parts manufacturing company in North Sumatra. The products produced are Main Shaft, Cone, Intermediate Gear, Protect Nut, Pulley, Flexible Couple, Press Cage, Screw Press and Digestor. The production system used is make to order where the product will be made if the order has been received from the consumer with the order rules that have arrived first, will be served first (First Come First Serve).

The company experienced problems in carrying out its production. The Company has delayed the settlement of orders that are not in accordance with the agreement when the order is received. Delay in order completion occurs repeatedly with quite large number of delays. Company data shows that the largest number of delays occurred in Main Shaft products with a delay in August of 24 units, September at 12 units and in October 40 units. Delays in product completion will have a chain effect on subsequent product settlements and will inhibit production flow.
Delays in product completion indicate the low productivity of the company in terms of resource utilization. Efforts to increase productivity can be done by increasing the efficiency of resource use. A job will be said to be resolved efficiently if its completion time is shortest [1]. One way to reduce lead time according to Wilson [2] is to eliminate unnecessary activities in the production process. Thus, improvements by reducing and eliminating non value added activity in the production process can improve efficiency. For that the company must know the activities that provide added value (value added activity) and activities that do not provide added value (non-value added activity). One approach that can be used to reduce and eliminate non-value added activity is Lean Manufacturing.

Lean manufacturing is a set of techniques that when combined and run well will reduce and then eliminate waste. Previous research has found that the elimination of non-value added activity by the Lean Manufacturing approach can decrease the production time from 6900 seconds and the time after recommendation of improvement turns to 4645 seconds. This means that the production required process time is reduced 32.68% (2255 seconds) before [3]. Another study also found that Lead Time in paper production amounted to 162 minutes, after the proposed improvement was achieved Lead Time reduction of 72 minutes. So Lead Time obtained for 90 minutes, by reducing the waiting time on arrival of raw material until the production floor process [4]. The research got the same result that is decreasing Lead Time through waste elimination. Elimination of waste is intended for all activities undertaken on the floor of production is an activity that provides added value (value added activity), resulting in increased productivity and competitiveness through increasing the effectiveness of production processes and the efficiency of the use of resources (resources).

2. Research Method

Based on the method used, this research includes action research because this research aims to get a model of company production process design that can increase productivity. Judging from the level of explanation, this research includes descriptive research, because this research describes the systematic, factual and accurate about the facts and the properties of a particular object [5]. The object of this research is the activity done in the main shaft production process itself.

The research instrument used in this research is a Seiko brand digital stopwatch in data collection which used is to measure the time of Main Shaft production process. Present state maps are used in data processing whose function is to visualize the real state of the production process and determine the classification of value added activity and non-value added activity.

Stages in the implementation of research that is:

1. Analysis of delay in order completion.
2. Analysis of non-value added activity with value stream mapping analysis tools and classification of activity. Calculation of Process Cycle Efficiency is done based on value added time and total lead time resulted from activity classification which become indicator in lean manufacturing approach.
3. Elimination of non-value added activity with the 5 Whys tool and application of pull demand system.
4. Preparation of Future State Value Stream Mapping and estimation of improvement results.
5. Conclusion.

3. Results and Discussions

3.1. Order delay analysis

The delay in order completion occurs repeatedly with a small number of delays as shown in table 1.

| Table 1. Main Shaft Completion Delay |
|-------------------------------------|
| Spare part  | Bulan | Amount (Unit) | Delay (Days) |
|-------------|-------|---------------|--------------|
| Main Shaft  | August| 24            | 14           |

2
Company data show that the largest number of delays occurred in Main Shaft products with a delay in August of 24 units, September at 12 units and in October 40 units.

3.2. Non value added activity analysis
Non value-added activity analysis that occurs in main shaft production process is done with value stream mapping analysis tools and classification of activity.

3.2.1. Value stream mapping
Value stream mapping is an analysis tool in lean manufacturing that represents where waste occurs although it does not directly give effect to the production process. Creating a map of each process category (Door-to-Door Flow) requires production process information to be recapitulated in one process box. For that we need to understand the order of main shaft production process. The order of main shaft production process is:

1. Measurement and cutting process
2. Rolling ring plate process
3. Welding process
4. The process of lathe
5. Milling process
6. Painting process
7. Packing process.

The information collected from each work station is included in the process box. The Present state map illustrates the real condition of the entire process that takes place on the production floor in the process box and the inventory and work in process images that are waiting for each process. Present state map can be seen in figure 1.

3.2.2. Determination of activity classification
Based on the Present state map in Figure 1, the production floor activity will be classified into value added activity and non-value added activity. Activities that are classified into value added activity are activities to convert raw materials into products according to consumer demand. While the activity that is classified non value added activity is activity that does not give change to raw material become product according to consumer demand. Classification of activities can be seen in table 2. The classification indicates that Value added activity based on consumer point of view is 1,295,08 minutes. While non-value added activity amounted to 9,509,51 minutes. Non value added activity that occurs is very significant and is a waste that needs to be reduced and eliminated.

|                | September | October |
|----------------|-----------|---------|
| Cone           | 12        | 3       |
| Cone Guide     | 16        | 3       |
| Hidrolrik      | 8         | 2       |
| Intermediate   | 16        | 4       |
| gear           | 12        | 4       |
|                | 31        | 3       |
3.2.2. Calculation of Process Cycle Efficiency

George (2002) says that a company is said to have implemented the concept of Lean Manufacturing if it has a value of process cycle efficiency of 30% which means that the value-added activity reaches 30% of the activity time as a whole. From table 2 above, it can be seen that the large Value added time

The classification indicates that Value added activity based on consumer point of view is 1,295,08 minutes. While non-value added activity amounted to 9,509,51 minutes. Non value added activity that occurs is very significant and is a waste that needs to be reduced and eliminated.
based on consumer point of view of 1.295.08 minutes. While non-value added time of 9,509.51 minutes. The calculation of process cycle efficiency is as follows:

\[
\text{Process Cycle Efficiency} = \frac{\text{Value added time x 100}}{\text{Total lead time}}
\]

\[= 11.98\%\]

Where:
Total Lead Time = Sum of the value added time with the non-value added time.

### 3.3. Elimination of Non Value Added Activity

Lean manufacturing approach used to reduce and eliminate non value added activity is 5 whys tool to find root of problem and arrangement of alternative corrective action and application of pull demand system.

#### 3.3.1. Whys Methods

Classification of activities indicates a major waste of this company is the waste of waiting time. This is supported by the results of discussions with production heads that indicate a waste of waiting time. Waiting time is caused because the main shaft production process runs step by step and does not flow. This problem will look for the root cause with the help of the 5 Whys tool.

| No. | Roots of Problems                                      | Alternative Improvement                                                                 |
|-----|--------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 1   | Supplier stacked orders for a week                     | Communicate to suppliers to make written cooperation contracts                           |
| 2   | The main shaft line production is out of balance       | Modify the chuck on the available lathe in order to be able to do the main shaft        |
| 3   | The number of cranes is limited to serve the needs of all stations | Performing crane addition as the main material handling tool on the production floor       |
| 4   | The main shaft is temporarily stored at the lathe station | Provide work instruction sheet to create work standardization                           |
| 5   | Avoid to turn the engine on and off repeatedly         | Consider the amount of lead time of the main shaft production process compared to the setup of the milling machine |
| 6   | Transportation equipment is unable to service delivery of the product | Performing additional product delivery vehicles                                         |

Having known the root of the problem that causes the high value of non-value added time, then further will be prepared for improvement efforts to reduce non value added time based on the root cause of waste. Alternative improvements that can be made to minimize and eliminate non value added activity in the form of waiting time can be seen in table 3.

Recall Kanban is a kanban card containing the information, quantity, and type of product to be taken from the previous process. The withdrawal kanban is designed uniformly for the whole process of main shaft production, withdrawal kanban can be seen in figure 2.
Recall Kanban is a kanban card containing the information, quantity, and type of product to be taken from the previous process. The withdrawal kanban is designed uniformly for the whole process of main shaft production, withdrawal kanban can be seen in figure 2.

Kanban production orders are kanban cards containing information, quantities, and types of products to be made in the previous process. Production order orders are made in the same format to be used throughout the production process of making the shaft. The format of the kanban card production design commands that will be used in the production process of making the main shaft can be seen in figure 3.

3.3.2. Pull Demand System Implementation
To apply lean concept, production control is cultivated as pull system. The application of pull demand system in the lean concept is done by using Kanban cards. Kanban is a tool to achieve just in time production. With the achievement of just in time production system, the waste of time waiting for main shaft production process can be eliminated.

Kanban to be designed in this research is Kanban withdrawal (recall kanban) and kanban production orders (production kanban).

Application of pull demand system with Kanban tools there are some rules that must be understood and followed by all operators.

3.4. Future state value stream mapping
Preparation of value stream mapping after improvement is drawn in the future state map and calculated the lead time of the proposed improvement. The time change included is a time change that can be observed or estimated from the current state. Value stream mapping in the form of future state maps can be seen in figure 4.
Future state map improvement results showed a decrease in total lead time to 4,355.08 minutes. Total lead time has a direct effect on the process cycle efficiency, to see how much improvement of process cycle efficiency after estimation is done as follows:

\[
\text{Process Cycle Efficiency} = \frac{\text{Value added time} \times 100\%}{\text{Total lead time}}
\]

\[= 29.73\%\]

The process cycle efficiency after estimation has a higher value compared to process cycle efficiency before the improvement of 29.73%. Process cycle efficiency of main shaft production process increased by 17.84% from 11.89%. Improved process cycle efficiency shows significant savings on employees' working hours. Lead time main shaft production process of 10,804.59 minutes down to 4,355.08 minutes.

4. Conclusion

Based on the theoretical basis, the results of research and analysis have been done then it can be concluded that there are very significant non-value added activity at present state map there are six activities with total time of 9,509.51 minutes of total lead time of 10804.59 minutes. Through estimation of improvement results obtained Total lead time in the future state map of 4.355.08 minutes. Value stream mapping showed a decrease in total lead time of 6,449.51 minutes. The saving of working hours will directly increase the production capacity of the main shaft without having to increase the input used in the production process resulting in increased productivity.

References

[1] Sritomo W 2000 Ergonomic: study of moving and time I [in Indonesia: Studi Gerak dan Waktu I] (Surabaya: Guna Widya)

[2] Lonnie W 2010 How to Implement Lean Manufacturing (USA: McGraw-Hill Company)
[3] Devis Z 2011 Penerapan Lean Manufacturing guna Meminimasi Waste pada Lantai Produksi di PT Kharisma Esa Ardi Surabaya [implement lean manufacturing for reducing waste on the production floor] (Surabaya: UPN “VETERAN”)

[4] Zaenal F, Laksono S M 2011 Implementasi Lean Manufacturing untuk Peningkatan Produktivitas Nasional seminar proceeding Teknologi Manajemen XIII (Surabaya: ITS)

[5] Sukaria S 2012 Research Method [in Indonesia: Metode Penelitian] (Medan: USU Press)