Reducing Waste in Spare Part Production Process with Lean Manufacturing Approach

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Abstract. In the current era of globalization, competition in the industrial world is increasingly competitive, and then the manufacturing industry must be able to optimize its ability to compete.

PT. ABC is a battery production manufacturing company that also produces engine parts for use on the company's production floor. The inability to meet the punch needs to be used on the battery production floor is one of the problems faced by the company. In the punch production process, some activities are not needed such as operators looking for irregularly located support devices and operators repeatedly measuring the results of object feeding in the manual turning process because there is no standard measurement, which causes the grace period to belong. This study aims to reduce waste in a series of production processes or not valuable adding activities and shortening the total waiting time using the Value Stream Mapping tool. To identify waste, you must first know which activities are of added value and not value added. One method proposed to fix this problem is Lean Manufacturing. The result of using the Lean Manufacturing method is the proposed improvement is to eliminate activities that are less efficient and can reduce production time by 2897 seconds and reduce production activities with 17 events so that the production process is more efficient than before. It can be concluded that the waste that occurs is over processing and movement caused by work methods and machinery.

1. Introduction

In the current era of globalization, competition in the industrial world is increasingly competitive. Therefore, the manufacturing industry must be able to compete. Competition in the industry both service industry and manufacturing industry is currently very fast at all, so it requires the company to improve the quality of products made. Improving the quality of the product will provide a guarantee to consumers that the company provides the best services to meet consumer demand at competitive prices in the market.

In the aircraft industry, generally 75% of the material used to make an aircraft component will be garbage, so we need a system efficiency of production on the other side. The efficiency of production systems that run very influential on the performance of the company. Thus, elimination or minimization of waste that occurs is one solution. The approach can be used to eliminate or minimize waste in a production system is lean manufacturing company. Lean manufacturing is a systematic approach to identify and find the cause of the waste and then minimizing or even eliminating it. This study aims to minimize waste in the production process RIB AT STN WFX000 part name in the area of medium prismatic machine 2. The results of the analysis of waste relationship matrix obtained two types of waste that is inventory and waiting, each of which has a weight 7,143 and 6,28 with detailed mapping tools
are chosen process mapping activity with the score 198,286 and supply chain response matrix with a score of 139,429.

To increase productivity, companies must know what activities can increase added (value added), reduce various waste (waste), and shorten lead times.

**Table 1.** Comparison between the Number of Needs Punch on the Battery Production Floor and the Number of production Results Punch at the Workshop in 2016

| Month | Production | Requests |
|-------|------------|----------|
| 1     | 25         | 29       |
| 2     | 28         | 30       |
| 3     | 55         | 56       |
| 4     | 120        | 123      |
| 5     | 15         | 17       |
| 6     | 30         | 31       |
| 7     | 15         | 15       |
| 8     | 45         | 48       |
| 9     | 40         | 43       |
| 10    | 41         | 42       |
| 11    | 15         | 16       |
| 12    | 42         | 43       |

From Table 1. It can be seen that the problem faced by companies is the lack of need punch on the production floor every month. Therefore, the company must make improvements by eliminating activities that are not needed in the production process. Thus, improvement by reducing and eliminating activities that do not have added value (not value-added activity) in the production process can improve the quality of the product. The approach that can be used to reduce and eliminate activities that do not have added value is Lean Manufacturing.

2. **Research Method**

The study was conducted at a battery production plant located in Medan City, North Sumatra. The research was conducted since February 2017

The stages of this research are as follows:
1. Data collection. The data used are two types, namely primary and secondary. The primary data is the real condition on the production floor and the secondary data, namely: The data collected are:
   a. Cycle time data for the making process punch.
   b. Actual work procedures.
2. Data Processing The steps for processing data are as follows:
   a. Establishment of the current state map.
   b. Analyze the current state map.
   c. Formation Future state map.

3. **Results and Discussion**

3.1. **Test of Uniformity and Adequacy of Data**

Test of data uniformity is used to determine whether there is data that is outside the control limit. To test the consistency of the data used the statistical method and the level of confidence and the level of accuracy desired by the gauge is a 95% confidence level and an accuracy rate of 5%.
Data adequacy tests were carried out to find out whether the data are taken already represented the population to be studied. This data adequacy test is carried out for each process. Calculation of test data adequacy for cutting objects can be seen in Table 2.

**Table 2. Test of Sufficiency of Activity Data Cutting Objects**

| No. | Time (sec) | $X^2$ |
|-----|------------|-------|
| 1   | 667        | 444 889 |
| 2   | 2668       | 446 224 |
| 3   | 3666       | 443 556 |
| 4   | 4667       | 444 889 |
| 5   | 5666       | 443 556 |
| 6   | 6668       | 446 224 |
| 7   | 7667       | 444 889 |
| 8   | 8667       | 444 889 |
| 9   | 9668       | 446 224 |
| 10  | 669        | 447 561 |
|     | Total      | 6673 4,452,901 |

$$N' = \frac{40\sqrt{10(4452901) - (6673)^2}}{6673} = 2.4$$

Value $N' > 2.4$ so it is concluded that the data when cutting objects was sufficient.

3.2. Calculation of Production Process Standard Time

Estimation of standard time is obtained by using cycle time data. Standard time is obtained by calculating the average time first. Summary of standard time calculation of production processes can be seen in Table 3.

**Table 3. Summary of Production Processes Standard Time Calculation**

| Station  | Standard Time |
|----------|---------------|
|          | Seconds | Minutes  |
| Cutting  | 928.54   | 15:48    |
| Lathe    | 338.06   | 5.63     |
| CNC      | 1251.47  | 20.86    |
| Galvanizing | 587.89 | 35273.34 |
### 3.3. Making Current State Map

These elements are drawn in the SIPOC diagram which can be seen in Figure 2.

| Supplier | Input | Process | Output | Customer |
|----------|-------|---------|--------|----------|
| Raw Material Storage | Steel Bar | Cutting | Punch | Productivity Floor |
| | | Lathing | | |
| | | CNC | | |
| | | Galvanizing | | |
| | | Test Strength | | |
| | | Finishing | | |

#### Figure 2. SIPOC Diagram

**Table 4. Information for Mapping**

| Process     | Operator (Osang) | Uptime (%) | C/O (Menit) | CT (Menit) | Available time (Jam) | Scrap (%) |
|-------------|------------------|------------|-------------|------------|----------------------|----------|
| Pemotongan  | 1                | 100        | 15.48       | 15.48      | 8                    | 0        |
| Pembubutan  | 1                | 100        | 5.63        | 5.63       | 8                    | 1        |
| CNC         | 1                | 100        | 20.86       | 20.86      | 8                    | 4        |
| Penyeplukan | 1                | 100        | 587.89      | 587.89     | 8                    | 0        |
| Uji Kekuatan| 1                | 100        | 1.94        | 1.94       | 8                    | 0        |
| Finishing   | 1                | 100        | 48.53       | 48.53      | 8                    | 1        |

#### Figure 3. Current State Map

### 3.4. Selection tool

Value stream mapping with the largest total score according to VALSAT results will be used as the mapping to be able to identify waste in detail. This selection is based on the value stream mapping with
the largest value that is most suitable for identifying waste in the value stream. Complete filling results of VALSAT can be seen in the following table.

Table 5. Recapitulation of Calculations VALSAT

| Waste          | Process Activity Mapping | Supply Chain Response Matrix | Production Variety Funnel | Quality Filter Mapping | Demand Amplification Mapping | Decision Point Analysis | Physical Structure |
|----------------|--------------------------|------------------------------|---------------------------|------------------------|------------------------------|------------------------|--------------------|
| Overproduction | 0 6e3                    | 0 6e3                        | 0 6e3                     | 0 6e3                  | 0 6e3                        | 0 6e3                  | 0 6e3              |
| Waiting        | 28 3e6                   | 28 3e6                       | 3 1e6                     | 0 1e6                  | 9 3e3                        | 9 3e3                  | 0 3e0              |
| Transport      | 9 1e6                    | 0 1e6                        | 0 1e6                     | 0 1e6                  | 0 7e0                        | 0 7e0                  | 1 1e1              |
| Inappropriate  | 9 1e6                    | 0 1e6                        | 3 1e6                     | 1 1e1                  | 0 1e6                        | 1 1e1                  | 0 2e0              |
| Processing     | 3 1e3                    | 9 1e6                        | 3 1e3                     | 0 1e6                  | 9 3e9                        | 3 3e3                  | 1 1e1              |
| Unnecessary    | 9 1e6                    | 1 1e1                        | 0 1e6                     | 0 2e0                  | 0 1e6                        | 0 2e0                  | 0 2e0              |
| Inventory      | 1 1e1                    | 0 1e6                        | 0 1e6                     | 9 1e9                  | 0 1e6                        | 0 1e6                  | 0 1e0              |
| Motion         |                          |                              |                           |                        |                              |                        |                    |
| Defects        |                          |                              |                           |                        |                              |                        |                    |
| Total          | 58                       | 37                           | 9                         | 10                     | 18                           | 14                     | 2                  |
| Ranking        | 1                        | 2                            | 6                         | 5                      | 3                            | 4                      | 7                  |

3.5 Process Activity Mapping

In identifying activities non-value added for the company, observations are carried out directly into the company. With observations supported by interviews with workers and supervisors, it can be seen whether or not there is a waste in the company. Besides, it can be a used tool that can identify the presence of waste, namely Process Activity Mapping (PAM). The recapitulation of Process Activity Mapping (PAM) for punch can be seen in Table 6.

Table 6. Amount and Time of PAM Results for Making Punch

| Activities  | Amount of | Time (seconds) | Percentage (%) |
|-------------|-----------|----------------|----------------|
| Operation (O) | 36         | 28025.9        | 95.49          |
| Transportation (T) | 14         | 555            | 1.89           |
| Inspection (I)  | 6          | 77.9           | 0.27           |
| Storage (S)     | 0          | 0              | 0              |
| Delay (D)       | 2          | 689.4          | 2.35           |

3.6 Proposed Improvement Results

Proposed improvements made can reduce the waste that occurs in the making process punch and reduces the time and number of activities so that the production process runs more efficiently. Based on the comparison of the current state map and future state map, there are changes in production process time and production process activities which can be seen in Figure 4 and Table 7.
Figure 4. Based on a reduction in production process time amounted to 29348.2 seconds - 26451.2 seconds = 2897 seconds. This means that there is a time-saving in the production process of 2897 seconds. Reduction of time taken can help companies meet demand by improving production process time.

Table 7. Comparison of Before and After Repair

| No. | Station       | Time (Seconds) |
|-----|---------------|----------------|
| 1   | Cutting       | 15:48          |
| 2   | lathe         | 5.63           |
| 3   | CNC           | 20.86          |
| 4   | Gilding       | 587.89         |
| 5   | Strength Test | 1.94           |
| 6   | Finishing     | 48.53          |

Table 8. Production Process Activities After Repairing

| No. | Activity                                             |
|-----|------------------------------------------------------|
| 1   | The raw material is brought to cutting machine       |
| 2   | The raw material is inserted into the cutting tool   |
|     | and cutting size adjustment                          |
| 3   | Tightens workpiece holder and measures to            |
|     | adjust blade location                                |
| 4   | Cut object                                           |
| 5   | Turns off machine and releases objects from          |
|     | retaining                                            |
| 6   | Brought objects into the lathe                       |
| 7   | Associated objects to chuck                          |
| 8   | smoothed the front end of the workpiece              |
| 9   | Measured workpiece                                   |
| 10  | Released objects from the chuck and reassembled      |
| 11  | smoothed the rear end of the workpiece               |
| 12  | Measured workpiece                                   |
| 13  | Released from chuck                                  |
| 14  | Brought to CNC                                       |
| 15  | Measured workpiece                                   |
| 16  | Conducted setup for the formation process            |
| 17  | The inserted workpiece in the chuck                  |
18 Conducted formation
19 Conducted setup for CNC finishing
20 Performed finishing on an object
21 Removed object from the chuck and taken to gilding station
22 Bonded object with wire
23 Inserting sand into the container
24 The object is put in the container
25 the container is inserted into the kitchen about
26 Turning on the engine and setting up temperature
27 Performing the plating process
28 The machine is turned off
29 The container is removed from the kitchen sepuh
30 The coolant
31 The object is transferred to the storage not removed
32 The wire is on the object
33 The object is smoothed
34 The object is brought to the CNC machine to test its strength (HRC test)
35 Conducted setup test machine HRC
36 Mounted objects on HRC test machine hook
37 Performed strength test
38 Objects released from the hook
39 Objects have taken to CNC machine
40 Performed finishing using the CNC machine
41 Punch brought to GSP

Figure 5. Future State Map

4. Conclusion

Based on results, we can conclude that:
1. Waste that occurs is over processing and motion that is caused by work methods and machinery and also there is no value-creating time at CNC stations and gilding stations in the form of operators just waiting for the machine to operate.
2. The result of reducing waste in the process of making a punch is a reduction in time by 2897 seconds, from 29348.2 seconds to 26451.2 seconds and a reduction in production activities from 58 to 41 activities.

3. Proposed improvements for the manufacturing process, Punch namely eliminating the activity of taking tools from outside the work area, neatly arranging the tools that will be used so that they are easy to find and work on finishing not manually.

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