Analysis of Production Quality Control in Minimizing Product Defects with the Six Sigma Method
(Case Study at PT. Jaykay Files Indonesia)

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Abstract - PT. JayKay Files Indonesia is a company engaged in the industry that produces files and drills. Where the products have been exported to various countries and the quality is well received by various overseas customers. PT. JayKay Files Indonesia is certified with ISO 9001:2008, OHSAS 18001:2007 and ISO 14001-2004 environmental management system. However, to maintain this quality, the company must control the existing defective products. Then the research was carried out using the Six Sigma DMAIC (Define Measure Analyze Improv Control) stage. And produced 4 (four) types of defects in the Define stage, with the calculation of the sigma value of 3.8 with 3.8% damage at the measure stage, the Analyze which occurs because there are several causes using a fishbone diagram, namely machine, human, method and environmental factors. At the improve stage, there are several recommendations for improvement so that for control, supervision is carried out at the dept. Quality control.

Keywords: Six sigma method, defect, production quality control

I. INTRODUCTION

In this industrial era 4.0, business movements are increasing rapidly. This has an impact on business competition that is getting higher and tighter in both the domestic market and the international market. Every business sector is required to always compete with other companies. One of the efforts to be able to excel in the competition or at least survive in the competition is to pay special attention to the quality of the products produced by the company.

According to Sofyan Assauri (in Hayu Kartika, 2013) control and supervision are activities carried out to ensure that production and operating activities are carried out in accordance with what was planned and if deviations occur, these deviations can be corrected so that what is expected can be achieved.

According to Bakhtiar et al (2013) quality control can be interpreted as "activities carried out to monitor activities and ensure actual performance".

Companies that implement quality control can be sure that the quality of the resulting production can also increase. Quality control can be interpreted as an effort made by the company to be able to reduce defective products in one production (Safrizal & Muhajir, 2016). One of the important criteria that must be considered by consumers in choosing a product is quality. A product is said to have high quality if it can meet the specifications desired by consumers without the slightest defect (Rimantho & Mariani, 2017).

According to Vincent Gasperz (2005:480), quality control is: “Quality control is the operational techniques and activities used to fulfill requirements for quality”.

PT JayKay Files Indonesia is one of the stingy producers that still survives in this 4.0 industrial era. At this time PT JayKay Files Indonesia is faced with the problem of many defective products or there are many defects for slim taper products in the proving division. Until now PT JayKay Files Indonesia does not have the right solution to overcome the problem of defective products that occur. Therefore, PT JayKay Files Indonesia needs to improve quality control with the Six Sigma method, with the theme, “Analysis of Production Quality Control in Minimizing Product Defects with the Six Sigma Method”.

II. RESEARCH METHODS

The implementation time of this practical work is from January to February 2020. The place where this research was carried out was at PT. JayKay Files Indonesia Semarang. The method used in the quality data processing process uses the Six Sigma method using the Six Sigma method (define, measure, analyze, and improve). is the theoretical basis in accordance with this research. The type of data used in this study is quantitative data which is data that can be calculated, namely data in the form of numbers and supporting information in the form of production cost data of PT JayKay Files Indonesia, which is primary data, namely data obtained from companies and interviews. directly with company employees who are considered related to this research.
III. RESULTS AND DISCUSSION

In the production of Slim Taper at PT. JayKay Files Indonesia found the following types of defects:

a. Forging Process (Broken Handle, Muntir Handle, Flat Handle)
b. Grinding (Hollow, Thick, Thin)
c. Cutting (chopping, Crooked, Not deep enough)
d. Proving (Seam/Laps, Broken Tang, Hollow, Size, Edge Damage, chopping, Level Out, Less Weight, Stamp NotVisible, Bend, Soft, Crack, Broken, Knocking, Dirty, Not Taking Prover, Pitting)

The next step is to determine the CTQ (Critical to Quality). The data used is the Quality Control Department data on the proving process which is the final stage before product packaging. Then determined and simplified CTQ in the proving process as Good Production and Reject. After determining the CTQ (Critical to Quality) then data is collected for 27 days in the proving process to determine the number of defects that occur in one day of the production process. Observations for 27 days can be seen in the table below.

Table 1. Production Results for January

| Day | Production Quantity | Good condition | Reject Condition |
|-----|---------------------|----------------|-----------------|
|     |                     | Amount (Pcs)   | %              | Amount (Pcs) | %              |
| 1   | 20270               | 13058          | 64%            | 7212        | 36%            |
| 2   | 25721               | 21408          | 83%            | 4313        | 17%            |
| 3   | 17460               | 13951          | 80%            | 3509        | 20%            |
| 4   | 24436               | 21143          | 87%            | 3293        | 13%            |
| 5   | 23611               | 19481          | 83%            | 4130        | 17%            |
| 6   | 19776               | 15232          | 77%            | 4544        | 23%            |
| 7   | 21278               | 15843          | 74%            | 5435        | 26%            |
| 8   | 34221               | 29159          | 85%            | 5062        | 15%            |
| 9   | 37514               | 30433          | 81%            | 7081        | 19%            |
| 10  | 19878               | 15767          | 79%            | 4111        | 21%            |
| 11  | 25509               | 21455          | 84%            | 4054        | 16%            |
| 12  | 24698               | 20976          | 85%            | 3722        | 15%            |
| 13  | 33541               | 27862          | 83%            | 5679        | 17%            |
| 14  | 23101               | 18408          | 80%            | 4693        | 20%            |
| 15  | 19321               | 14934          | 77%            | 4387        | 23%            |
| 16  | 14532               | 12231          | 84%            | 2301        | 16%            |
| 17  | 12893               | 7314           | 57%            | 5579        | 43%            |
| 18  | 21440               | 16803          | 78%            | 4637        | 22%            |
| 19  | 36164               | 29843          | 83%            | 6321        | 17%            |

Table 2. Calculation of Control Limit P for January 2020 Period

| Day | Production Quantity | Number of Defects | Percentage of Defects | CL | UCL | LCL |
|-----|---------------------|-------------------|-----------------------|----|-----|-----|
| 1   | 20270               | 7212              | 0,3558                | 0,1909 | 0,1998 | 0,1832 |
| 2   | 25721               | 4313              | 0,1677                | 0,1909 | 0,1998 | 0,1841 |
| 3   | 17460               | 3509              | 0,2007                | 0,1909 | 0,2004 | 0,1825 |

Source: Data Proving Slim Taper for January

Measure

At this stage, calculations are carried out to determine the value of DPMO and Sigma. Before that, a control chart is made by calculating the percentage of defects, CL (Control Limit), UCL (Upper Control Limit) and LCL (Lower Control Limit) using a p control chart.

P control chart has the benefit to help control the quality of production and can provide information about when and where the company should make quality improvements.

The steps for making the p control chart are:

a. Calculating Damage Percentage
   Description:
   np: the number of defects in the subgroup
   n: number of production in subgroup
   Subgroup: Day-
   Then the calculation of the data is as follows:
   Subgroup-1:
   Subgroup-2:
   Subgroup-3:
   Subgroup-4:
   Subgroup-5:
   Subgroup-6:
   And so on until the subgroup or day 27

b. Calculating the center line (CL)

c. Calculating the Upper Control Limit (UCL)

d. Calculating the Lower Control Limit (LCL)

The complete p control chart calculation results can be seen in the following table:

Table 2. Calculation of Control Limit P for January 2020 Period
Based on the picture of the control chart p above, it can be seen that the data obtained are not entirely within the control limits that have been set, even many are out of the control limits, only 1 (one) point is within the control limits, so it can be said that the process is not under control. In the picture above, it can be seen that the 27 samples taken fall into the control limits. The highest value is on the 17th day and the lowest is on the 22nd day. This indicates that there is a high deviation. It states that quality control at PT. JayKay Files Indonesia needs improvement. Because there are very high and irregular fluctuating points which indicate that the production process is still experiencing deviations.

The next calculation is the measurement of sigma performance with the aim of knowing the current level of work (performance baseline). Performance baseline as a unit of measurement in Defect Per Million Opportunities (DPMO) or sigma capability level (Defrianto & Farida). The calculation stages start from DPO, DPMO, and Sigma Value. Defect Per Opportunities (DPO) is a measure of failure calculated in a six sigma quality improvement program which shows the number of defects or failures per opportunity.

\[
\text{Subgrup -1: } DPO = \frac{7212}{20270} = 0.022237
\]

\[
\text{Subgrup -2: } DPO = \frac{4313}{25721} = 0.010480
\]

\[
\text{Subgrup -3: } DPO = \frac{3809}{17460} = 0.012561
\]

\[
\text{Subgrup -4: } DPO = \frac{3293}{24436} = 0.008423
\]

\[
\text{Subgrup -5: } DPO = \frac{443}{23631} = 0.010932
\]

\[
\text{Subgrup - : } DPO = \frac{4544}{19776} = 0.014361
\]
And so on until the 27th subgroup

Usually this DPO when associated with a constant of 1,000,000 will become DPMO (Defect Per Million Opportunities) with the formula:

$$DPMO = DPO \times 1,000,000$$

The DPMO value is converted to a sigma value using Microsoft excel with the calculation formula:

$$\text{DPMO Value Conversion} = \text{NORMSINV}((1,000,000-DPMO)/1,000,000)+1.5$$

The following is a table of the results of the calculation of DPO, DPMO and Sigma Value:

| No | Production Quantity | Number of Defects | Probability of Disability (p) | DPO | DPMO | Sigma Value |
|----|---------------------|-------------------|-------------------------------|-----|------|-------------|
| 1  | 20270               | 7212              | 0.3558                        | 0.022237 | 22237 | 3.5         |
| 2  | 25721               | 4313              | 0.1677                        | 0.010480 | 10480 | 3.8         |
| 3  | 17460               | 3509              | 0.2010                        | 0.012561 | 12561 | 3.7         |
| 4  | 24436               | 3293              | 0.1348                        | 0.008423 | 8423  | 3.9         |
| 5  | 23611               | 4130              | 0.1749                        | 0.010932 | 10932 | 3.8         |
| 6  | 19776               | 4544              | 0.2298                        | 0.014361 | 14361 | 3.7         |
| 7  | 21278               | 5435              | 0.2554                        | 0.015964 | 15964 | 3.6         |
| 8  | 34221               | 5062              | 0.1479                        | 0.009245 | 9245  | 3.9         |
| 9  | 37514               | 7081              | 0.1888                        | 0.011797 | 11797 | 3.8         |
| 10 | 19878               | 4111              | 0.2068                        | 0.012926 | 12926 | 3.7         |
| 11 | 25509               | 4054              | 0.1589                        | 0.009333 | 9933  | 3.8         |
| 12 | 24698               | 3722              | 0.1507                        | 0.009419 | 9419  | 3.8         |
| 13 | 33541               | 5679              | 0.1693                        | 0.010582 | 10582 | 3.8         |
| 14 | 23101               | 4693              | 0.2032                        | 0.012697 | 12697 | 3.7         |
| 15 | 19321               | 4387              | 0.2271                        | 0.014191 | 14191 | 3.7         |
| 16 | 14532               | 2301              | 0.1583                        | 0.009896 | 9896  | 3.8         |
| 17 | 12893               | 5579              | 0.4327                        | 0.027045 | 27045 | 3.4         |
| 18 | 21440               | 4637              | 0.2163                        | 0.013517 | 13517 | 3.7         |
| 19 | 36164               | 6321              | 0.1748                        | 0.010924 | 10924 | 3.8         |
| 20 | 36195               | 7192              | 0.1987                        | 0.012419 | 12419 | 3.7         |
| 21 | 22496               | 3670              | 0.1631                        | 0.010196 | 10196 | 3.8         |
| 22 | 4266                | 295               | 0.0692                        | 0.004322 | 4322  | 4.1         |
| 23 | 31044               | 5424              | 0.1747                        | 0.010920 | 10920 | 3.8         |
| 24 | 34687               | 5468              | 0.1576                        | 0.009852 | 9852  | 3.8         |
| 25 | 38296               | 9427              | 0.2462                        | 0.015385 | 15385 | 3.7         |

In the table above, it can be seen that the production of Slim Taper at PT. JayKay Files Indonesia has an average production rate of 25617 pcs per day with an average defect or damage rate of 4905 Slim Tapers per day or a probability of 0.1960. The DPMO value is 12252, which means that the probability of damage per 1 million units is 12252. For the sigma value, the result is 3.8, which means that in each production process there will be no defects or damage of more than 3.8%. Based on these results it can be seen that PT. JayKay Files Indonesia needs to improve the production process so that the level of defects or damage can be minimized. The following is a table of the level of achievement of the sigma value:

| Sigma Achievement Level | DPMO     |
|-------------------------|----------|
| 1-Sigma                 | 691.462  |
| 2-Sigma                 | 308.538  |
| 3-Sigma                 | 66.807   |
| 4-Sigma                 | 6.210    |
| 5-Sigma                 | 233      |
| 6-Sigma                 | 3.4      |

Table 4. Level of Achievement of Sigma Nilai Value

**Analyze**

This stage is carried out by analyzing Pareto diagrams based on data that has been processed to determine the percentage of types of defective products and the order of types of damage that occur from the lowest to the highest in the Slim Taper production process at PT. JayKay Files Indonesia. The following is a table for calculating the percentage of types of defects:

| Jenis Cacat | Frekuensi | Presentase | Akumulasi |
|-------------|-----------|------------|------------|
| Broken Tang | B         | 5934       | 4.48%      | 4.52%      |

Table 5. Calculation of the Percentage of Types of Defects
From the Pareto diagram above, it can be seen that the type of defect L (Crack) is the type of defect with the highest percentage of 21.15%, the second is K (Soft) with a percentage of 13.59% and the third is E (Edging Damage) with a percentage of 12.91% and so on as in the table above. After knowing the type of defect, the next step is to identify the cause of the type of defect using a fishbone.

Improving at the improve stage, recommendations for improvement of each cause of defects that have been made through fishbone diagrams are given. The following are recommendations for improvements that can be made by PT. JayKay Files Indonesia in an effort to improve the quality of Slim Taper products:

| Causes of Defects | Recommendations Repair |
|-------------------|------------------------|
| Lack of training  | Hold training activities or workshops related to the work to be carried out |
| SOP Error         | Conduct regular evaluations if necessary changes or adjustments to SOPs |
| Fatigue           | Optimal work and rest time planning |
| Less Skilled      | Setting worker acceptance standards Do more intensive training |
| Lack of experience| Carry out routine checks regarding machine effectiveness |
| Machine Life      | Schedule maintenance on a regular basis |
| Noise             | Using lighting standards according to the regulation of the Minister of Manpower No. 5 of 2018 concerning Occupational Safety and Health in the Work Environment |
| vibration         | |

Control
The last stage is controlling the improvement recommendations that have been given. Supervision needs to be carried out to see if there are differences in the quality of Slim Taper before and after the implementation of several recommendations. PT. JayKay Files Indonesia, especially the Quality Control Department, tries to implement some of the
recommendations given so that the increase in sigma value can be achieved so that the quality of Slim Taper products at PT. JayKay Files Indonesia has increased and the percentage of defective products can be reduced.

IV. CONCLUSIONS AND SUGGESTIONS

Conclusion
1. The results of the calculation of the quality control of Slim Taper products at PT. JayKay Files Indonesia with the Six Sigma method:
   a. Based on the processed data, the results of the DPMO calculation are 12252, which means that there is a probability of a defective product of 12252 out of one million possibilities and a sigma value of 3.8 is obtained which means that in each production process there will be no defects or damage of more than 3.8%.
   b. The types of damage or defects that often occur in the production of Slim Taper PT. JayKay Files Indonesia is caused by Crack as much as 21.15%, the second is Soft with a percentage of 13.59% and the third is Edging Damage with a percentage of 12.91%.
2. The application of the six sigma method in calculating the quality control of Slim Taper products produces complete, precise and accurate data according to the data needs of the Quality Control department.

Suggestions
1. Companies need to use the six sigma method to be able to find out the types of damage that often occur and the factors that cause it. Thus the company can immediately take preventive action to reduce the occurrence of product defects.
2. Based on the analysis using the six sigma method that has been carried out, the company can make quality improvements by focusing on repairs to types of damage that have a large or dominant number in production, which are caused by factors such as; people, machines, methods, and the environment.

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