Quality Assessment Using Quality Loss Function Method in PT. QRS

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Abstract. The process of production affects the quality of the products produced. Related to this, good quality control is needed to improve product quality. This quality control can be done by improving methods or production processes that reduce product quality. PT. QRS is one of the companies engaged in the manufacturing of zinc coated steel sheets. The problem in the company is to see if variation from the product can lead to additional cost or loss in the company. Based on these problems, it is necessary to calculate the losses due to variations in the dimensions of the product in which the company must pay to achieve the desired specifications. To find out the initial problem we can analyze with Taguchi’s Quality Loss Function. Based on calculations, it was found that the value of the process capability index for the long dimension obtained was $C_p = 0.5556$. From the calculation of the company's loss data, it was obtained at Rp. 17.111.796/month.

1. Introduction

Quality is a major factor in the success and growth of the company expanding market share. Companies that have the highest quality products will be able to reduce costs. Because of this, a company must have a quality control department that is responsible for product quality problems.

Losses experienced by companies can be caused by many things, both errors caused by humans, machines, raw materials, work methods, and work environment. Therefore we need a method that can support quality improvement with the aim of being able to avoid more losses and produce quality products.

A good production process in the company can improve the quality of the products produced. The better the production process carried out in the company, the resulting product will be in accordance with the specifications set by the company. To achieve the best quality products, companies need to use SNI as a reference in carrying out production activities so that the company produces quality products.

Research conducted on the company which based on discussions with companies that there are variations in the production process that occurs within the company. This problem initiates because the number of products that must be reworked exceeds the company standard of 0.5% of total production per shift. The research objectives is to examine the quality of the production process that can be seen by calculating the loss that occurred in the company because of the variation that happened in the
production. The research objectives initiate because the standard of SNI that the company must producing products according to the specification.

The study of Taguchi’s Quality Loss Function is applied to sugar companies conducted by Nita Marikena where the value of the company is calculated which is influenced by several characteristics namely water content, turbidity, particle size distribution and polarization and calculate the capability of the production process that occurs. The results obtained that for the level of turbidity of the most inconsistent products that do not meet the specifications of GKP 2 so that the losses occur [1].

Another study of Taguchi’s Quality Loss Function applied to the cooking oil factory conducted by Utomo Hadi which is calculated the value of the company loss that is influenced by several characteristics, namely color, odor, acid number and water content and calculate the capability of the production process that occurs. Then give a proposal and calculate the loss of the proposal then compared with the initial state loss. The results obtained are losses occur at IDR 269,319,600 annually. For this reason, it is proposed improvements that can reduce losses to IDR 219,067,200/year. One of the root causes of the problem of varying color characteristics is that the engine temperature of the slurry tank changes [2].

Another study of Taguchi’s Quality Loss Function applied to the track link factory conducted by Khawarita Siregar which is calculated the value of the company loss that is influenced by several characteristics, namely length, hardness index and tensile strength and calculate the capability of the production process that occurs. Then give a proposal and calculate the loss of the proposal then compared with the initial state loss. The results obtained are losses occur at IDR 2,744,308/month. For this reason, it is proposed improvements that can reduce loss to IDR 1,997,341/month [3].

The study on Taguchi’s Quality Loss Function applied to flour companies was conducted by Cristian, it was found that the company’s loss value was influenced by the types of characteristics of flour, namely PH, color, moisture content, and SO₂. The author considered that the quality loss is proportional to the squared manufacturing error (machining) same to the correctly established “target” value, equal to the prescribed average value, but not same to the nominal value [4].

The study of Taguchi’s Quality Loss Function was conducted by Hagos Berhane that analyze the capability of performance of drilling, pressing, and reaming operations carried out for the manufacturing of two major lock components viz. Results of this study indicated that the performance of all the processes are not capable and loss incurred. It is found that the combination of histogram and Taguchi technique helps to evaluate the overall performance of given process [5].

Based on the studies conducted earlier, the method Taguchi’s Quality Loss Function is the most appropriate to settle the problem of the company. This study was conducted to evaluate production activities within the company and provide input for companies in reducing variations in the production process so as to improve the quality of the products produced.

2. Methodology

Quality control is a combination of all the tools and techniques used to control the quality of a product at the lowest possible cost and meet the requirements of the customer. Quality control is an engineering and management activity, by which the characteristics of product quality are measured. The factors that influence quality control include[6]:

- In terms of operators: the skills and expertise of people who handle products.
- In terms of raw materials: raw materials supplied by the seller.
- In terms of machines: the types of machines and machine elements used in the production process.

In any production process, an inherent or natural amount of variability will always exist regardless of how well it is designed and maintained. Natural variability or background noise is a cumulative effect whose basic cause cannot be avoided. In the context of statistical quality control, this natural variability is often called the stable system of chance causes. A process operating with only variation in chance
causes is said to be under statistical control. In other words, chance causes are an inherent part of the process [7].

Variation is defined as the non-uniformity of the product or service produced. Variation can also be defined as the product or service produced does not meet the specified standard specifications [8]. In any production process, some variations in product quality are unavoidable. These variations, which in general are attributed due to chance causes or assignable causes, may result in an unacceptable level of process mean, process variance or both. Variations due to chance causes are random in nature. Their occurrence is not predictable and they do not occur in repetitive cycles. The resulting variations in raw materials, slight vibration of machine, lack of operator perfection in reading measurements and setting controls [9].

Process capability describes the process's ability to produce or deliver output in accordance with customer expectations and needs. Process capability is often expressed by the process capability index, which is a critical performance measure that describes the relationship between process variability and the specification's spread boundary. The process capability index $C_p$, is an illustration equation of the price of the specification spread ratio or the process spread to 6 standard deviations ($6\sigma$) [10].

The purpose of the quality loss function is a quantitative evaluation of the losses caused by product variations that occur. The essence of quality control is the percentage of disabilities and countermeasures. If a defective product is shipped it will cause quality problems. If the defective product is not shipped it will cause a loss for the company. To avoid damage to the company's reputation, it is very important to estimate the quality of the product before sending. When products are delivered according to specifications, forecasting the quality level of non-defective products is required. To fulfill this purpose a process capability index is used. This index is calculated based on the distribution of tolerance by $6\sigma$ [11].

This study was conducted from February 2020 to April 2020. The research object is observed zinc coated steel sheets. The variables contained in this research are:

- The independent variable in this study is the product dimension variation.
- The dependent variable in this study is the loss of the production process.

This research steps can be seen as follows:

- Collecting the data.
- Mapping product dimension values using X bar-S Chart.
- Calculating the process capability.
- Calculating loss in the production process.

3. Results and Discussion

Initially all the data collected was tested with a control map. Control chart is a tool used to see whether a process is in accordance with specifications and monitor the process to remain stable and only contain variations of common causes. In this study, the control chart used is the $\bar{X}$ – S control map. The $\bar{X}$ – S control map for length and width can be seen at Figure 1 below.
From Figure 1, it can be seen that the data that has been collected was in control. When all data is in control, then the process capability index is calculated to measure the ability of a process to produce a product in accordance with the expected specifications. The process capability index for length can be seen at Figure 2 below.

From Figure 2, it can be seen that the result of the calculation of the process capability is 0.5556. Based on the result it can be concluded that the process is not capable. An incapable production can be
caused by many factors such as man, machine, method and etc. After getting the $C_p$ value, then calculate the loss incurred by the company. The following is a summary of the loss incurred can be seen at Table 1.

| No. | Loss                        | Loss/piece |
|-----|-----------------------------|------------|
| 1.  | Direct labor                | IDR 437,50 |
| 2.  | Material loss               | IDR 32,54  |
| 3.  | Company’s overhead          | IDR 221,95 |
|     | Total                       | IDR 691,99 |

From table 1, it can be seen that the company loss was IDR 691,99/pieces. The loss that incurred caused by the variation of the product that have been produced. After obtaining the total loss incurred by the company, then performed calculations to see the curve of Taguchi’s Quality Loss Function for length dimension. The curve of Taguchi’s Quality Loss Function for length dimension that can be seen at Figure 3.

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\[
A = \text{Rp. 691,99} \\
\text{Tolerance} = 7,5 \text{ mm} \\
k = \frac{A}{(\text{Tolerance})^2} \\
k = \frac{691,99}{(7,5)^2} = 12,3020 \\
L = 12,3020(y-2141,5)^2
\]

![Figure 3. Taguchi’s quality loss function for length](image)

The calculation of loss of quality can be calculated with the following formula.

\[
L = \frac{A}{9C_p^2}
\]

A = IDR 691,99

$C_p = 0.5556$

The calculation of loss of quality that happened in the company per unit of production can be seen from the calculation.

\[
L = \frac{691,99}{9(0,5556)^2} = \text{IDR 249,08}
\]
The company produced 68,700 pieces every months. The total of loss of quality in the company is 68,700 x IDR 249.08 = IDR 17,111,796 /month. It is very important for the company to reduce the losses that occur by analyzing the process in the production.

4. Conclusion
Based on the results and discussion conducted above, it can be concluded that dimension the product variations that are already in control in statistical control and stable over time. Even though the control map has been in control, the upper and lower limit values obtained are still not in accordance with SNI standards so it is necessary to improve the production process to obtain the desired upper and lower limit values. Based on the calculation, it is found that the value of the process capability index for the long dimension is obtained \( Cp = 0.5556 \). Based on the result it can be concluded that the process is not capable. An incapable production can be caused by many factors such as man, machine, method and etc. The value of the company’s loss of quality arising from the dimensional variation of the product using the Taguchi Loss Function method is IDR 17,111,796 / month. The value obtained does not include social losses that may occur due to poor performance when shipping the product to the customer. To prevent greater losses for the company, it is very important for the company to reduce the losses that occur by reducing the variety of products produced.

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