Analysis Quality Control of Carded and Combed Yarns Using Six Sigma Method

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Abstract. The purpose of this study is to conduct a quality control analysis of carded and combed yarn produced using the six sigma method. The approach used in working with the Six Sigma method is DMAIC (define, measure, analyze, improve and control). The results obtained from the carded and combed yarn products are there are 4 types of defects, such as the strength of the thread does not match the standard, contami, bad rolls and tangled thread. The average DPMO value is both threads of 7,786 with an average sig

1. Introduction

In this study, the analysis was carried out on quality control of production for carded and combed products. Analysis is an investigation of an event (essay, deed, etc.) to find out the actual situation (causes, sitting case, etc.) [1]. Quality control is a company entity that controls the quality of the product produced [2]. Quality control that will be analyzed is carded and combed yarn products produced using the Six Sigma method. Six sigma according to Gaspersz (2007) is a benchmark of industrial process performance between the transaction process between suppliers and customers, in addition it is considered as a company strategy to implement improvements and become process controllers. The approach used in the Six Sigma method is DMAIC which means define, measure, analyze, improve and control [3].

Six Sigma is used to examine defects in this case but six sigma has also been used to solve some problem in an industry such as six sigma is used to examine several values influencing the pH values of a plain yogurt company [4]. Lean six sigma has been used to manage scrap [5]. Six sigma has also been used to improve productivity in a fan manufacturing company [6]. Six sigma methodology and DMAIC (define, measure, analyze, improve, control) methodology has also been carried out to reduce defects in a rubber gloves manufacturing process [7]. Six sigma has also been used to control configuration in Intel’s manufacturing RandD environment [8]. Customized six sigma has also been used to enhance productivity at a paper manufacturing company [9]. Six sigma methodology has also been carried out to investigate and streamline the communication and information system within an infrastructure.
support service company [10]. Six sigma methodology has also been used to increase the yarn quality in textile industry [11]. Six sigma methodology has also been used to reduce defects in textile weaving [12]. Lean six sigma framework also can be used to enhance operational performance in an MRO (maintenance, repair and overhaul) facility [13]. However, in this research we used six sigma DMAIC (define, measure, analyse, improve, control) methodology to find out defects that exist in the product.

The aim of the researcher is to analyse the quality control of carded and combed products produced using six sigma methods to find out the types of defects that exist in the product, the root causes of problems and output that researchers can provide to the company. The six sigma method processing is carried out by collecting data obtained from the quality control and production. Data received in the form of production data for 2017, data on the number of defective products or grade B products. In addition, researchers conducted interviews and surveys directly to the production floor to find the root causes of the defects that occurred.

2. Methodology

The research method used in this study is to analyze the data in the form of the number of yarn production with the number of flawed threads that exist. With that data, it can be seen how many percent of defective products are produced in one year. Then the researcher conducted an interview on the quality control section to ascertain what types of defects occurred and requested data on the number of defective products based on the type of defect. The data that has been obtained is used by researchers to get the number of dominant defects, defects per million opportunities values and Sigma levels. Then the researchers conducted interviews and field surveys to find the root causes of product defects using a diagram of the fish bone and 5 why must be given a proposed improvement.

3. Results and discussion

The Six Sigma method uses the DMAIC (define, measure, analyze, approach. This method itself is an abbreviation that defines which means defining the goal of improving the process that is consistent with demand of customer and strategy of company formally [14], measure is a measurement of process performance so that the process can be compared with the target set [14], analyze is an activity for understand why irregularities occur and look for reasons and causes [15], improve is an activity to set a plan to improve the quality of six sigma [15], control is a control of the process carried out continuously [14].

3.1. Define Phase

a. Mapping the production process using SIPOC (Supplier, inputs, process, outputs, customer)

Mapping the production process using SIPOC (Supplier, inputs, process, outputs, customer) can be seen in Figure 1.
Figure 1. SIPOC (Supplier, inputs, process, outputs, customer) of Carded and Combed yarn.

b. Identification of Critical to Quality (CTQ)
Critical to Quality (CTQ) identification table can be seen in Table 1.

| No | Consumer’s standard (Defect type) | Description |
|----|----------------------------------|-------------|
| 1  | Thread Strength Out of Standards | The strength of the standard thread has an average value of 464.34 for Carded threads and 434.1 for Combed threads. |
| 2  | Roll isn’t Good                  | 1 cone of yarn must have a neat shape and direction of the roll |
| 3  | Contami                          | 1 cone of thread must be clean from contaminants |
| 4  | Mixed Thread                     | When looking at the side of the cone the thread must be neat, no threads coming out of the cone spheres |

There are 4 critical to quality, namely the strength of the thread does not match the standard, bad rolls, contami and interfering yarns on both Carded and Combed yarn products.

c. Histogram diagram
The histogram diagram can be seen in Figure 2.
3.2. Measure Phase
a. Pareto Diagram

Before the Pareto diagram, below is Table 2 which is a cumulative table of product defects used to create a Pareto diagram:

| Type of Defect       | Number of Defect | Cumulative Defect | % Defect | % Cumulative Defect | Number of Defect | Cumulative Defect | % Defect | % Cumulative Defect |
|----------------------|------------------|-------------------|----------|---------------------|------------------|-------------------|----------|---------------------|
| Carded               |                  |                   |          |                     |                  |                   |          |                     |
| Thread Strength Out of Standard | 319.91          | 319.91            | 88%      | 88%                 | 52.25            | 52.25             | 89%      | 89%                 |
| Contami              | 23.79            | 343.7             | 7%       | 94%                 | 3.86             | 56.11             | 3%       | 96%                 |
| Roll isn’t Good      | 15.22            | 358.92            | 4%       | 99%                 | 1.56             | 57.67             | 2%       | 98%                 |
| Mixed Thread         | 5.13             | 364.05            | 1%       | 100%                | 0.94             | 58.61             | 1%       | 100%                |
| Total                | 364.05           |                   | 100%     |                      | 58.61            |                   | 100%     |                     |

Below is a pareto diagram based on the type of cumulative defects of Carded and Combed threads can be seen in Figure 3:
There is one type of defect that has the most number, namely the strength of the thread out of standard on Carded yarn as much as 88% with the number of defects as much as 319.91 bale from a total of 364.05 bale of Carded Grade B thread and 89% of Combed yarn with as many defects as 52.25 bale. [14]

b. DPMO and Sigma Level
DPMO values and sigma levels for carded and combed yarn products can be seen in Table 3.

| Product | Product Number | Number of Production | Number of Defect | CTQ | DPMO  | Sigma Level |
|---------|----------------|----------------------|------------------|-----|-------|-------------|
| Carded  | 18             | 118,06               | 1,88             | 4   | 3.982 | 4,15        |
|         | 20             | 1.951,84             | 78,97            | 4   | 10.115| 3,82        |
|         | 22             | 656,55               | 13,81            | 4   | 5.259 | 4,06        |
|         | 24             | 8.268,08             | 200,09           | 4   | 6.051 | 4,01        |
|         | 28             | 1.382,83             | 61,45            | 4   | 11.110| 3,79        |
|         | 3              | 124,99               | 0,44             | 4   | 881   | 4,63        |
|         | 40             | 407,74               | 7,41             | 4   | 4.544 | 4,11        |
|         | 20             | 764,04               | 15,82            | 4   | 5.157 | 4,07        |
|         | 22             | 41,11                | 4,81             | 4   | 29.251| 3,39        |
|         | 24             | 45,09                | 0,35             | 4   | 1.941 | 4,39        |
|         | 30             | 1.278,7              | 37,63            | 4   | 7.358 | 3,94        |
| Combed  |                |                      |                  |     | 7.786 | 4           |

The production of Carded and Combed yarn is good enough because it ranges from 3 and 4 sigma which has exceeded the average sigma level of companies in Indonesia which are still around 2 sigma. 3 sigma which means the probability of flawless products is 93.3% and 4 sigma which means that the flawless product is 99.4. [8][7].

3.3. Analyze Phase
This type of defect identified the cause using fishbone then analyzed the root causes using 5 Why’s as below in Figure 4.
Figure 4. Five why’s the strength is out of the standard

3.4. Improve Phase

Based on the root causes, it found through 5 Why’s, the improvements or proposed improvements that the researcher gave:

a. Monitor and improve the workability of each operator.

b. Conduct regular health checks, ensuring employees are free from alcohol and dangerous drugs.

c. Organize recreation and giving motivation by team leaders to employees.

d. Improve work environment facilities on the production floor for example lighting that must meet the standard of 500 lux.

e. Replace the old machine with a new engine.

f. Make regular machine maintenance scheduling.

g. Utilize a broken machine to take components that can still be used and can be used as spare parts for other machines.

h. Check the engine before production starts.

i. Provide clear sanctions against employees who are negligent of their responsibilities.

j. Motivate employees to be more responsible for their work.

k. Direct supervise by the responsible party in each production room because supervision has not been carried out so far.

l. Replace raw materials from western countries that have a small amount of contaminants.

m. Mix raw materials from eastern countries with western countries, so that raw materials from the west can neutralize the quality of raw materials in the eastern countries.

n. Add air vents.
4. Conclusion
The conclusion of this study that the defective products contained in the carded and combed yarn products consist of 4 types, namely the strength of the thread does not match the standard, contami, bad rolls and interfering threads. The most dominant type of defect is the inappropriate thread strength, which is 88% for carded yarn and 89% for combed yarn. The cause of yarn strength defects that do not match the standards on carded and combed yarn products consists of machine factors which are caused by a machine that dies suddenly and the engine performance is reduced with the root cause of operating fatigue, aging of the machine and not carrying out machine inspection. The material factor is caused by the poor quality of the fiber of cotton yarn with the root cause of cotton fibers originating from the eastern countries. For the man power factor, it is caused by the operator who is not right in managing the process time with the root cause of operator fatigue. The media factor caused by the air cycle is not good with the root cause of air ventilation in the manufacturing area. An improvement can be made to reduce defects in the Carded and Combed yarn products according to the improve phase.

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