Crude Palm Oil Product Quality Control Using Seven Tools (case study: XYZ Company)

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Abstract. Competition in the palm oil processing industry in Indonesia is very competitive. One of the factors that influence the good name of the company is the quality of the product produced. PT. XYZ is a palm oil processing factory with export and domestic market share. In order for the company to be able to compete with other companies engaged in similar industries, the company is required to need to carry out strict checks on product quality. PT. XYZ faces several obstacles to meet the quality standards of its main products namely Crude Palm Oil (CPO). The problem that is often found related to quality in CPO is the quality of CPO that does not meet consumer standards even though the company has implemented quality control in CPO production. This can reduce consumer confidence in the products sold by the company. CPO product quality standards set are free fatty acid levels (FFA) (<5%), water content (<0.15%) and impurities content (<0.02%). This study aims to determine what types of defect affect the quality of CPO and what causes the defect. This research uses seven tools method consisting of stratification, check sheet, histogram, pareto diagram, scatter diagram, control chart and cause and effect diagram. From the results of the Pareto diagram analysis it appears that the dominant defect that occurs in CPO is high free fatty acid levels with a percentage of 39.3%, then followed by defect with high impurities content of 35.4% and high water content of 25.3%. By using the Pareto 80/20 principle, the defect factor which is further analyzed is the defect of high free fatty acids and high levels of impurities. Through scatter diagrams and correlation analysis, the value of $r = 0.5$, where the value indicates that high free fatty acid defects and high impurities have a positive effect on the number of defects. By using a causal diagram analysis (fishbone diagram) it was found that the factors causing the high level of damage to this palm oil product are influenced by 3 main factors, namely raw materials, humans, and machinery.

1. Introduction
In the midst of globalization and free competition at this time it is very necessary for the ability of companies to compete in the midst of uncertain economic conditions. Companies must determine the right direction and policies in order to maintain economic stability in the company. The increasing competition between companies, encourage each company to increase efficiency and quality standards precisely in all fields. Only companies that have high competitiveness can survive one of them is to prioritize quality improvement.

Quality control is a system of verification and maintenance of a level or degree of quality of the product or process desired by careful planning, use of appropriate equipment, continuous inspection and corrective actions when needed, so quality control is not just an inspection activity or determine whether the product is good (accept) or bad (reject).
XYZ company is a palm oil processing factory with export and domestic market share. Companies are required to produce high quality products so that the company is able to compete with other companies engaged in similar industries. In meeting the needs of consumers, companies still find obstacles from within the company, namely regarding product quality, where the products produced still have a high level of defects. Where the quality standards of the factory consist of free fatty acid levels (<5%), impurities levels (<0.15%) and water content (<0.02%) where the factory production capacity is ± 60 tons / hour. Based on the above conditions, it is necessary to analyze the company using seven tools consisting of stratification, check sheets, histograms, pareto diagrams, scatter diagrams, control charts and cause and effect diagrams (fishbone), where the purpose of this study is to determine what types of defect affect the quality of CPO and what causes the defect using fishbone diagrams.[1].

2. Theoretical Background

The study was conducted at PT. XYZ, where the data taken are free fatty acid levels (FFA), impurities and water content contained in CPO. The study uses seven tools in Statistical Process Control (SPC). The function of the seven control devices is to improve process improvement, so that it will be obtained[2]:

a. Increased competitiveness.
b. Decreasing cost of quality and increasing price flexibility.
c. Increase resource productivity.

Data can be obtained from two main sources namely primary sources and secondary sources. data obtained from primary sources is called primary data, that is data obtained by searching / digging directly from the source by the relevant researcher. Secondary data is data that has been collected and processed by other parties so that it does not need to be explored / sought by the relevant researcher but only to quote or retrieve[3].

The data processing steps taken are as follows [4]:

a. Stratification, namely the Division and Grouping of Data into smaller categories and have the same characteristics.
b. Check Sheets is a chart for collecting data. Clearly and regularly designed check sheets will help to collect accurate and related data and allow data to be read and used easily
c. A histogram is a portrait of product variations or the results of a process. The histogram displays the frequency distribution of various measurements. The measured variables are along the horizontal x-axis and are grouped into various measurements. The frequency at which each measurement occurs is arranged along the vertical y axis
d. Pareto diagrams can be used to display problem categories graphically so that they can be prioritized correctly. Pareto charts or diagrams show which problems must be dealt with first by showing the proportion of the total problems, each of which consists of smaller problems.
e. Scatter plot diagrams are used to uncover possible causal relationships. it is constructed by plotting two variables against each other on a pair of axes. scatter plots cannot prove that one variable cause another, but it shows how a pair of variables are related and the strength of the relationship.
f. Control charts usually display limits that can be explained by statistical variability as usual. if your process is performing within these limits, it is said to be in control, if not, it's out of control.
g. Cause and effect diagrams (fishbone diagrams) organize and display relationships between different causes for the effect being examined. This chart helps organize the brainstorming process. the main cause categories are placed on the main branches which are connected back to the backbone, and various sub-causes are attached to the branches.

3. Research Methodology

This study was conducted at XYZ company on CPO products. The data used in this study is secondary data while the data is obtained indirectly which can form file documents, archives or company records. XYZ Company itself collects defect data by taking samples 12 times a day by using an
erlenmeyer bottle, after which it is tested for free fatty acid levels, air levels and impurities in the laboratory.

This study uses seven tools in data processing, of which seven tools consist of
a. Stratification
b. Check Sheets
c. Histogram
d. Pareto
e. Scatter Plot Diagram
f. Control Charts
g. Cause and Effect Diagram.

4. Result

After all the necessary information has been collected, an analysis is carried out using seven tools. The initial data collected can be seen in Table 1.

| No | Number of Samples examined (n) | Number of High Fatty Acids | Number of High Impurities | Number of High Water Content | Total Defects/Day |
|----|-------------------------------|-----------------------------|---------------------------|-----------------------------|-------------------|
| 1  | 12                            | 3                           | 8                         | 6                           | 17                |
| 2  | 12                            | 11                          | 7                         | 1                           | 19                |
| 3  | 12                            | 9                           | 8                         | 1                           | 18                |
| 4  | 12                            | 6                           | 8                         | 2                           | 16                |
| 5  | 12                            | 9                           | 5                         | 5                           | 19                |
| 6  | 12                            | 4                           | 7                         | 4                           | 15                |
| 7  | 12                            | 7                           | 5                         | 3                           | 15                |
| 8  | 12                            | 6                           | 5                         | 3                           | 14                |
| 9  | 12                            | 5                           | 4                         | 3                           | 12                |
| 10 | 12                            | 7                           | 9                         | 9                           | 25                |
| 11 | 12                            | 12                          | 9                         | 2                           | 23                |
| 12 | 12                            | 12                          | 7                         | 3                           | 22                |
| 13 | 12                            | 11                          | 2                         | 8                           | 21                |
| 14 | 12                            | 7                           | 8                         | 1                           | 16                |
| 15 | 12                            | 9                           | 6                         | 5                           | 20                |
| 16 | 12                            | 8                           | 5                         | 9                           | 22                |
| 17 | 12                            | 5                           | 7                         | 8                           | 20                |
| 18 | 12                            | 5                           | 3                         | 4                           | 12                |
| 19 | 12                            | 3                           | 5                         | 7                           | 15                |
| 20 | 12                            | 9                           | 5                         | 5                           | 19                |
| 21 | 12                            | 3                           | 6                         | 5                           | 14                |
| 22 | 12                            | 3                           | 10                        | 7                           | 20                |
| 23 | 12                            | 7                           | 9                         | 3                           | 19                |
| 24 | 12                            | 3                           | 3                         | 6                           | 12                |
| 25 | 12                            | 12                          | 8                         | 4                           | 24                |
| 26 | 12                            | 6                           | 5                         | 3                           | 14                |

Table 1. shows that the dominant defect is high FFA levels with 182 defects in 1 month, followed by impurities and water content with 164 and 117 defects respectively. The steps to identify defect using the seven tools are as follows.

a. Stratification

Stratification of types of defects in CPO production include:
- High levels of Free Fatty Acid (FFA)
- High levels of impurities
- High levels of water content

b. Check Sheet
CPO defects check sheet can be seen in table 2.

| No. | Type of Defects                  | Average defects of CPO |
|-----|----------------------------------|------------------------|
| 1   | High levels of Free Fatty Acid   | 182                    |
| 2   | High levels of impurities        | 164                    |
| 3   | High water content               | 117                    |
|     | **Total**                       | **463**                |

c. Histogram
The histogram is used to describe the spread of defects. The histogram can be seen in Figure 1.

| Types of Defects | Number of Defects | Percentage (%) | Cumulative Percentage (%) |
|------------------|-------------------|----------------|---------------------------|
| High Level of Free Fatty Acid | 182              | 39.3           | 39.3                      |
| High Level of Impurities | 164              | 35.4           | 74.7                      |
| High Level of Water Content | 117              | 25.3           | 100                       |

The concept of the pareto diagram used is 80/20, where 80% of disabilities are caused by 20% of the causes of defect. From the pareto diagram the highest percentage of defects is High levels of Free Fatty Acid with a percentage of 39.3%, followed by high levels of impurities (35.4%) and high water content levels (25.3%).

Pareto diagram can be seen in Figure 2.
e. Scatter Diagram

The first analysis was performed with two variables between the amount of high FFA levels as an independent variable and the number of disabilities as the dependent variable. The regression equation obtained after calculating the parameter values a and b is:

\[ Y = 11.97 + 0.83x \]

After that, scatter diagrams are made with the equation that has been obtained using SPSS software. Furthermore, the correlation values of the two variables were calculated and the value of \( r = 0.665 \) was obtained, where the value of 0.665 indicates that high FFA has a strong positive influence on the number of defects [6].

The second analysis is carried out between the variable amount of high impurities and the number of defects, where the regression equation obtained can be seen as follows.
Y = 11.97 + 0.83x

After that, scatter diagrams are made with the equation that has been obtained using SPSS software.

![Normal P-P Plot of Regression Standardized Residual](image1)

**Figure 4.** Scatter Regression Diagram of High Impurities Level with Total Defects

Furthermore, correlation analysis is performed to see the relationship between the 2 variables. The correlation values of the two variables were calculated and the value of $r = 0.5$, where the value of 0.5 indicates that high FFA and high impurities gives a positive enough influence on the number of defects [7].

f. Control Chart

The control chart aims to ensure that a process is in control and continuously monitors variations of the process. The type of control chart that will be used is a map c. The first test is carried out on high FFA data levels, where the test results show that all data are within control limits. Mapping data into a control chart can be seen in Figure 5.

![Control Chart C: High Levels of FFA](image2)

**Figure 5.** Control Chart C High Fatty Acid Levels of CPO Products
The second test was carried out on high impurities data. The results of tests conducted on high dirt content data indicate the data are within control limits so there is no need for revisions. Control chart chart of high impurities data on CPO can be seen in Figure 6.

![Control Chart C: High levels of Impurities](image)

**Figure 6.** Control Chart C High Levels of Impurities

g. Cause and Effect Diagram

The settlement method using this diagram is used to analyze and determine the factors that cause high FFA levels and high impurities in CPO oil. A causal diagram of high FFA levels in CPO can be seen in Figure 7.

![Cause and Effect Diagram (Fishbone) Causes of High FFA Levels in CPO Oil](image)

**Figure 7.** Cause and Effect Diagram (Fishbone) Causes of High FFA Levels in CPO Oil

Aspects that affect high levels of impurities in CPO can be seen in Figure 8.
5. Discussion
The results of the analysis show that high FFA levels and high impurities are the dominant defects that occur in CPO obtained using the Pareto 80/20 principle, where the two defect factors have a strong positive influence on the number of defects. By using a fishbone diagram it is found that the main causes of defect consist of 3 main factors, namely humans, machines and materials.

6. Conclusion
Based on the analysis of the discussion that has been done, it can be concluded that the defects contained in CPO are high FFA levels, high impurities and high water content, where the dominant disabilities occur in CPO are high FFA levels and high impurities identified by using the principle Pareto 80/20, the cumulative percentage of both defect reached 74.7%. The results of scatter diagram analysis showed high FFA levels and high impurities have a strong positive influence on the number of defects. Thus an analysis of the causes of defect is carried out using a causal diagram and it is found that the dominant cause of defect is high levels of FFA in terms of material (such as low quality raw materials), humans (for example: operators who are not careful in sorting fruit) and machines (like the age of an old machine). The dominant cause of defect for high levels of impurities also consists of 3 factors, namely humans, machines and materials.

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