FMEA Approach to Analysis Crude Palm Oil Quality Parameters

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Abstract. Palm oil companies are an important part of development in all countries, including in Indonesia. The development of the oil palm plantation business in Indonesia has experienced significant progress. This condition can be seen from many companies set up the Palm Oil Factory (PKS) and the increasing variety of products can be produced from palm oil so that it can increase the selling value of the product. There are many problems faced by the palm oil industry in producing a product, one of them which is a quality problem. In the Crude Palm Oil (CPO) production process, it is known that the products produced are not in CPO quality standards. Products not in this standard result in decreasing product quality and causing major problems for the company. Therefore, it is carried out to overcome problems above, an analysis is carried out by identifying the causes of the decline in the quality of CPO. Based on the results of the study, the highest RPN value of 280 was obtained with the cause of failure, namely the quality of raw materials is not good and is a type of failure which is the top priority for immediate improvement. The recommendation improvement can be done to prevent disability to carry out careful inspection of raw materials.

1. Introduction

Indonesia is one of the largest crude palm oil (CPO) producing countries in the world from palm oil plantations. The development of the oil palm plantation business in Indonesia has experienced significant progress. This can be seen from the many companies set up Palm Oil Factory (PKS) and the increasing variety of products can be produced from palm oil and increases the value sales of the product. The high demand for CPO has an impact on business competition among CPO producers.

One of the efforts made by the company to meet CPO demand is to produce good quality of CPO to increase production utilization and company competitiveness. The quality of the product which is satisfies the users needed may include the different features and enhances the performance of product [1]. The quality of CPO is said to be good if it meets the quality standards. CPO quality standards becomes quality parameters are Free Fatty Acid (FFA), water content and impurities.

The palm oil industry in one of the industries in Medan city has experienced problems with the quality of CPO produced. In the CPO production process, it is known that the products produced are not in CPO quality standards. Products are not in this standard result in decreasing product quality and causing major problems for the company. There are several factors affects these problems both from the engine, work methods, materials used and operators. However, these factors are not yet known specifically which is parts are affect the most product defects. The impact of this problem is the quality of CPO is not homogeneous and gives the disadvantage to the company because the company must
reprocess CPO whose quality exceeds the standards and it causing of considerable waste. Therefore, to overcome the problems above, an analysis is carried out by identifying the causes of decline quality of CPO.

Many methods can be used to analyze these problems, one of them is the Failure Mode and Effect Analysis (FMEA) method. FMEA is a method to identify and analyze potential failures and consequently aimed to plan the production process is steady and can avoid the failure of the process of production and losses desired [2]. FMEA is one method that is often used to measure the reliability of a product or process. It can identify the highest risk so that actions can be determined to prevent these risks. So that it can significantly reduce industry losses in terms of money and time [3,4]. The main purpose of the FMEA method is to identify potential defects or failures in products, processes or designs. Then the next step is to eliminate or reduce the risk associated with the potential for the defect. By consistently applying the FMEA method, it is expected to continue to improve product quality, process and design [5].

Many researches have been done to overcome the causes of quality decline. Amir et.al (2014) conducted research for define point of failure, analyze the effect of implying appropriate corrective actions applying failure modes and the effects analysis method (FMEA). Through FMEA, the risk and analysis are considered as different aspects. In order to reduce and reduce risks and reduce threats, continuous analysis must be carried out within a certain period [6]. Another study has been done by Nurul et.al (2014) by using failure mode effect and criticality analysis method in the automotive parts industry. The purpose in this case study is to analyze and identify the characteristics of product defects based on data rejecting products received on the industrial inspection line [7]. However, this study is more significant to know the main causes of the priority of declining quality of CPO and improves can be done as soon as possible. This study aims to identify the factors that cause problems in CPO quality using Failure Mode and Effect Analysis.

2. Methodology

The research was conducted in one of the palm oil industries with the object of research in the form of the quality of crude palm oil. The research began with direct observation of the palm oil industry to see and observe the conditions of the industry. From the results of observations, it is determined the formulation of the problem in accordance with the conditions of the industry. After the formulation of the problem is determined, then the research objectives are determined for the problems occur. Then data collection is needed in the research. Data collected comes from the results of observations directly and the results of interviews with the company. Based on these data, an analysis of the problems in the quality decline of crude palm oil happened in the company was carried out.

The steps of problem analysis can be done in several steps. The first step is identifying the causes of product quality decline. In this case, the identified factor is the type of content contained in crude palm oil which the content does not meet the standard included in the category of one of the causes in product decline quality. Furthermore, analysis of the causal factors is carried out. This analysis is done using Why-Why Analysis Table. After the cause of the quality decline of crude palm oil is known, then determine the value of the risk priority number (RPN) using the FMEA method. FMEA is a structured procedure to identify and prevent as many as possible modes of failure (failure mode) [8]. FMEA is used to identify the sources and root causes of quality problems [9]. The use of FMEA is based on the value of the RPN obtained. The value of RPN is obtained by multiplying the rating severity, occurrence, and detection [10]. RPN calculations can be done using formulas.

\[ SS = S \times O \times D \]  
\[ \text{................. (1)} \]

The largest RPN value obtained will be a reference to determine the cause of the quality decline of the products are major at risk and will be a top priority in making improvements later.
3. Result and Discussion

3.1. Identification of Causes Factor
Analysis of the causes of declining quality of crude palm oil is done by using the Why-Why Analysis Table. This table is useful for analyzing and finding factors that have a significant influence in determining the quality characteristics of work output. In addition, this diagram is useful for finding the real causes of a problem. The Why-Why Analysis Table for the three types of content causing the decline in the quality of crude palm oil can be seen in Table 1, Table 2, and Table 3.

3.2. Analysis of Causes Factor
Analysis of the causes in declining quality of crude palm oil is done by using cause and effect diagrams. This diagram is useful for analyzing and finding factors that have a significant influence in determining the characteristics of the quality in work output. In addition, this diagram is useful for finding the real causes of a problem. The causal diagram for the three types of content causing the quality decline of crude palm oil can be seen in figure 1, figure 2, and figure 3.

Table 1. Why-Why Analysis for Free Fatty Acid (FFA)

| Decreasing of CPO Quality | Variation of Free Fatty Acid (FFA) | Why | Why | Why | Why |
|---------------------------|-----------------------------------|-----|-----|-----|-----|
| Man                       |                                   | 1.  | The operator is not careful in sorting fruit | 1.  | Fatigue factor |
|                           |                                   | 2.  | No discipline in maintaining the boiling time | 2.  | Supervision is not implemented |
| Material                  |                                   | 1.  | The quality of raw materials is inappropriate | 1.  | There are crude palm oil fractions 5 to 6 |
|                           |                                   | 2.  | High rest fruit | 2.  | Late fruit transportation |
|                           |                                   | 3.  | Broken seed | 3.  | Seed crushed by the truck |
| Machine                   |                                   | 1.  | Temperature of Crude Oil Tank (COT), Temperature of Crude Stelling Tank (CST) are inappropriate | 1.  | Machine unmaintenance |
|                           |                                   | 2.  | Overheat engine | 2.  | Usage of non-stop machine |
| Method                    | Lack of procedures at the inspection stage | Unstructured at SOP at the Inspection Stage |
Based on the text above shows that the causes of quality decline of CPO include humans, materials, machinery and methods. Each of these causes has a different solution.

3.3. Analysis with Failure Mode and Effect Analysis
This analysis is carried out by using the failure mode and effect analysis method to identify the main causes of the declining quality in crude palm oil products produced in the palm oil industry. The purpose of implementing FMEA is to prevent problems occurring in processes and products. Analysis using FMEA is done by calculating the risk priority number. The value of the risk priority number (RPN) obtained by determination first of the values in severity, occurrence, and detection. The value of RPN is obtained by multiplying the rating severity, occurrence, and detection. The results of RPN calculations can be seen in Table 4.


**Table 4. Recapitulation of Calculation in Risk Priority Number at FMEA Table**

| Failure Mode          | Failure Effect                                      | S | Failure Causes                                      | O | Detection Method                  | D | RPN |
|-----------------------|-----------------------------------------------------|---|----------------------------------------------------|---|-----------------------------------|---|-----|
| Variation of FFA Level| Causes low quality of oil quality which is damage human health | 8 | The operator does not carefully sort the fruit | 6 | Do intensive supervision       | 5 | 240 |
|                       |                                                     |   | The quality of raw materials is not suitable     | 7 | inspection of raw materials carefully | 5 | 280 |
|                       |                                                     |   | The temperature of COT and CST is not suitable   | 3 | Periodic temperature checks       | 5 | 120 |
|                       |                                                     |   | Lack of procedures at the inspection stage       | 3 | Create a new SOP                | 4 | 96  |
| Variation of Water Level| Causes hydrolysis in the rancid taste and oil smell | 6 | Operators whom are not disciplined operate the procedure | 5 | Do supervision                  | 4 | 120 |
|                       |                                                     |   | Improper quality of raw materials                | 7 | Do inspection of harvesting time  | 4 | 168 |
|                       |                                                     |   | Sterilizer, vacuum dryer and oil purifier machines doesn’t work optimally | 5 | Supervision of Engine Settings   | 4 | 120 |
|                       |                                                     |   | Lack of procedures at the inspection stage       | 4 | Create a new SOP                | 6 | 144 |
| Variation of Impurities Level| Activates microbes and enzymes that react and produce free fatty acids and discoloration in oil | 7 | The operator does not concentrate | 5 | Do supervision                  | 4 | 140 |
|                       |                                                     |   | Raw material quality is unappropriate            | 7 | Do maintenance of the storage area | 3 | 147 |
|                       |                                                     |   | Sterilizer, vacuum dryer and oil purifier machines doesn’t work optimally | 4 | Inspection of each machine       | 6 | 210 |
|                       |                                                     |   | Inspection is not comprehensive                  | 4 | Inspection at each process whether it is in good condition or not | 5 | 140 |
Based on the table above, the highest RPN value of 280 is obtained with the cause of failure, namely the quality of raw materials are not good and is a type of failure which is the top priority for immediate improvement. The recommendation improvement can be done to prevent defects is to carry out careful inspection of raw materials.

4. Conclusion
By using FMEA, it can be seen that the cause of failure is the quality of raw materials are not good with an RPN value of 280. This failure is a type of failure mode which is the top priority for immediate improvement. The recommendation improvement can be done to prevent defects is to carry out careful inspection of raw materials.

References
[1] Asma S, Abdul G, Muhammad I, Muhammad Y, and Naveed A 2015 Global Journal of Management and Business Research: EMarketing 15
[2] Khawarita S and Syahrul F S 2017 The 2nd Annual Applied Science and Engineering Conference (AASEC) 288 (2017), pp. 1-6
[3] Ambekar S, Edlabadkar A and Shrouty V 2013 Int. J. Of Eng. And Innovative Tech. (IJEIT) 1
[4] Parsana T S and Patel M T 2014 Int. J. Of Industrial Eng. and Mgt Sc 4 (3), pp. 145-152
[5] Patrycja H and Michal M 2017 6th International Conference on Operations Research and Enterprise Systems (ICORES)
[6] Amir A N, Danial Z, Idin Z K, and Mona T 2014 International Journal of Poultry Science 13 (12), pp. 718-728
[7] Nurul A A, Rosmaini A, Shaza S, and Noorhafiza M 2014 8th MUCET (Melaka Malaysia, 10-11 November 2014)
[8] Helia V N and Wijaya W N 2017 IOP Conf. Series: Materials Science and Engineering 215 (2017), pp.1-10
[9] Khalida S, Jelly L, Rahmi M S, Indah R, Ikhsan S, and Mangara M T 2018 MATEC Web of Conferences 197 (2018), pp.1-4
[10] Foster S 2010 Managing Quality (Integrating The Supply Chain, 4th Edition) (New Jersey: Pearson Education, Inc)

Acknowledgement
Author would like to thank to Universitas Sumatera Utara for funding the financial support to publish this paper and the meubel company which are willing to be the object of research. We appreciate the efforts of all those who have cooperated in conducting this study.