QUALITY CONTROL OF DIRTY CONTENT ON CRUDE PALM OIL USING DEFINE, MEASURE, ANALYZE, IMPROVE, CONTROL METHOD AND GREY FAILURE MODE AND EFFECT ANALYSIS

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Abstract

Indonesia is one of the largest CPO producers with annual growth reaching 6.22%. This makes the demand for Crude Palm Oil (CPO) in Indonesia is quite high. High demand leads to increasingly competitive business competition. PT. UkindoBlankahan Mill is a company engaged in the production of Crude Palm Oil (CPO). In this case, the company is still not able to produce CPO that meets the specification that is seen from dirty content reaching 0.02%. This can affect the quality of the products produced to compete with competing companies. Therefore, this study aims to control the quality of Crude Palm Oil (CPO) by applying DMAIC and Grey FMEA methods. Define stage is done by using tools SIPOC diagram. The measure stage shows that the process is in the state of out of control so it needs to be revised. Measurement capability process dirty content is 0.67. While the measurement of the sigma value of the company is 3.0. Anayze stage is done by using tool cause effect diagram and Grey FMEA. From the result of Grey FMEA obtained the lowest value is Fruit storage place is not good with value 0,4444. The proposed improvements are made to all sources of quality degradation ie to the performance of human, machine, material and method. The control stage is done by applying the control mechanism.

Keywords : Quality Control, DMAIC, Grey FMEA

Introduction

Palm oil (CPO) is one of the export commodities in Indonesia which is expected to experience continuous improvement which of course can increase the country's foreign exchange. CPO production grew rapidly from 27,782,004 tons in 2013 to 35,359,384 tons in 2017 [1]. This is a great opportunity that can make Indonesia as the largest palm oil producing country (CPO). The increasing demand for CPO will lead to business competition between CPO processing industries. Therefore, the quality control of palm oil (CPO) becomes a challenge for the CPO processing industry in the face of business competition.

Quality is one of the parameters that must be considered every company in producing the product. When a consumer feels a certain product is much better quality than a competitor's product, then the consumer will decide to buy a competitor's product. Such demands must be responded by the company. Therefore, companies should apply quality control in the manufacture of palm oil products. [2]. The importance of the role of palm oil is what makes this commodity interesting to be observed, especially from how to control the quality of CPO content to minimize the variations that occur.

PT. XYZ is a company that produces crude palm oil (CPO). CPO quality standards that become parameters of quality are levels of dirtycontent [3]. But in fact, PT. XYZ still produces CPO that does not meet the specified quality standard specification. The non-compliance of quality standard specification produced is caused by several factors such as raw materials, human (operator), machine, and working method. [5]

In connection with the above conditions, it is necessary to perform more comprehensive quality control at PT. XYZ by using the concept of DMAIC (Define-Mesure-Analyze-Improve-Control). Analysis of conformity of product specification can be done by calculating Capability Index (Cp and Cpk). Analysis of problem solving done in this research is by using Grey method FMEA. Grey FMEA is basically the same as FMEA display, but in RPN (Risk Priority Number) calculation using Grey Theory formula. FMEA Grey method in this research is used to improve product quality in production system by applying DMAIC concept.

Research Methods

The research was conducted at PT XYZ in May 2018 until June 2018. The research object observed was Crude Palm Oil. Data dirty content is obtained from laboratory test. Data collected during a certain period. Conducting interviews with production workers who support problem solving.

Results

Data processing is done by using DMAIC method. Stages of DMAIC method used in data processing is Define, Measure, Analyze, Improve and Control.

Define

The define stage is the first step in identifying key priorities that are a priority in improving the quality of products and processes in the company. SIPOC diagram is used to explain the relationship between Supplier, Input, Process, Output, and Customer. This diagram aims to provide an overview of information in general about the business processes undertaken, ranging from suppliers to customers. SIPOC diagram for the production process of Crude Palm Oil (CPO) can be seen in Figure 1.

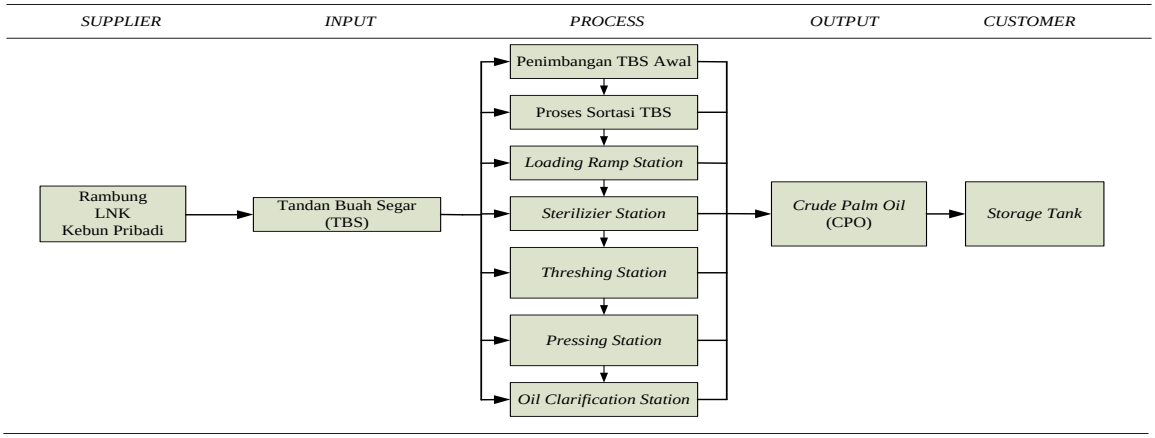

Figure 1. SIPOC Diagram Crude Palm Oil Production Process (CPO)

Measure

Xbar-R Control Map.

A control chart is created to determine whether the process is within the control limits for continuously monitoring process variations. Maps X and R illustrate the variations that occur in the CPO production process. Control charts are made for dirty content. Results of Map $\bar{X}$ and R dirty content can be seen in Figure 2.

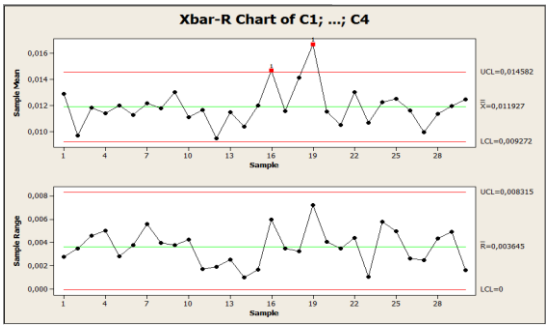

Figure 2.Map X bar- R Dirty Content

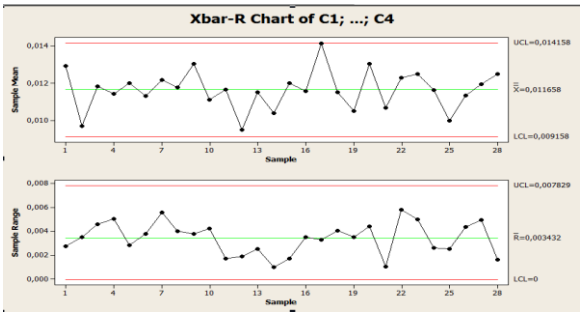

Figure 3.Revision Map X bar- R Dirty Content

Can be seen on the map that there are three data that are outside the control limit (out of control) is the data number 16 and 19. This is because of a common cause that results in data outside the system boundary. Therefore, it is necessary to revise to eliminate the data of numbers 6 and 19 caused by uncontrollable factors. The revised results are shown in Figure 3. It can be seen that the process can still be categorized uncontrollably where further action is needed to reduce the variation. This is indicated by the fact that there are still 5 points below and above the center line in sequence and there are significant changes suddenly.

Capability Process

Process capability is a calculation through comparison between product output and design specifications. If the equipment has the ability to consistently meet the limits of expected quality range, then the quality and cost of production can be optimal.The result of Capability Process measurement of dirtycontent is seen in Figure 4.

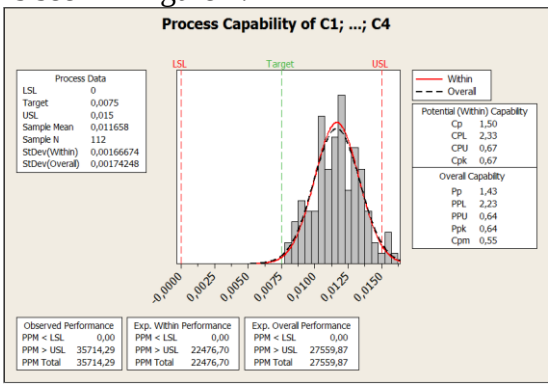

Figure 4. Process Capability (c) Dirty Content

Cp value > 1.33 means indicating that the production process in accordance with that has been set. The use of Cp in assessing process capability is based on the assumption that the process average is right in the middle of the specification limit. In reality, this is not achieved. To correct the above weakness, the Cpk ratio is used, which states the average position of the process compared to the specification limit. The Cpk value between 0 and 1 means indicating that the process average lies within the specification limit but some parts of the process variation lie beyond the specification limit.Cpk value greater than one indicates that all process variations are within the specification limit.

Measurement of sigma value (σ)

DPMO calculation is a good measure for product quality and process, because it is directly related to the cost and time wasted [5]. DPMO value measurements are shown in Table 1.

Table 1. DPMO Value Measurement

	Kadar Kotoran
PPM *Within Performance*	22800
PPM *Overall Performance*	27400
DPMO	50200

Sigma Value [6],

$$\text{Normsinv}\left(\frac{10^6 - \text{DPMO}}{10^6}\right) + 1{,}5 \qquad (1)$$

The company is actually only able to produce a sigma value of 3.14. This certainly makes the company must work to improve product quality to be able to produce sigma of 6.0. The sigma value of three indicates that the firm must incur a larger cost of about 25-40% of the sales due to lower quality and increased waste.

Analyze

In the stage of analyzes made cause and effect diagram and Grey Failure Mode and Effect Analysis (FMEA) which serve as a tool to analyze further.

Identify Problems with Cause and Effect Diagram.

Based on the observations on the production floor of the crude palm oil (CPO) production process, there are several main factors causing the decreasing quality of CPO made in Fish Bone Diagram [8].

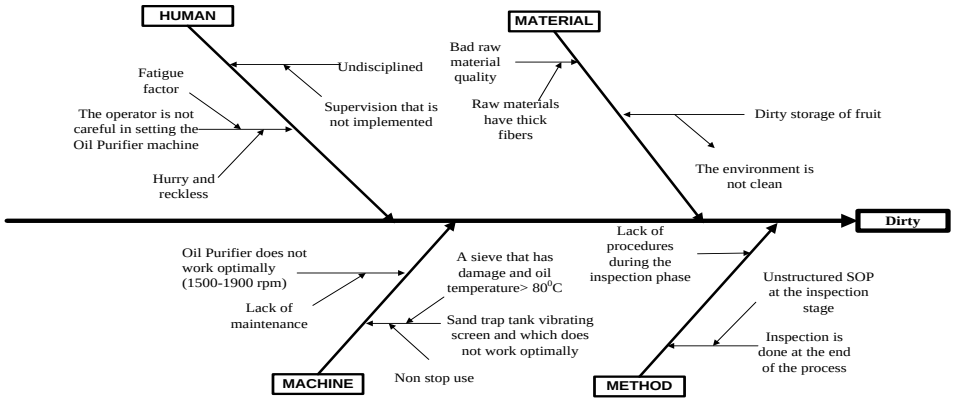

Figure 5. Cause and Effect DiagramDirty Content

Grey Failure Mode Effect and Analysis (FMEA).

Failure Mode Effect and Analysis (FMEA) is a method used to identify sources and root causes of a quality problem. The FMEA method is suitable for Grey Theory application. The main advantage of applying Grey Theory to FMEA is the ability to determine different weights for each factor and does not require any form of utility functionality [9]. The application of Grey Theory in FMEA method is done by first looking for the effect of failure failure (S), chance of failure (O), and failure detection (D), and RPN value (Risk Priority Number). Grey Risk Levels are shown in Table 2.

Table 2. Risk Of Level Grey Failure Mode and Effect Analysis

Failure Mode	Process Function	Γ_{0i}
Dirty	Fruit storage place is not good	0,4444
	Oil Purifier machine that does not work optimally	0,5556
	The operator is not careful in setting up the Oil Purifier engine	0,6111
	Sand trap tanks and vibrating screendan that do not work optimally	0,6667

Improve

Once the dominant cause is known, the next step is to plan improvements and set targets. Improvement plans are structured by brainstorming techniques to find the right alternative plan for problem solving. The preparation of this improvement plan is assisted by several people from the company [7].The proposed improvement is shown Table 3.

Table 3. Recommended Corrective Action

Failure Mode	Cause	Recommended
Dirty	The operator is not careful in setting up the Oil Purifier engine	1. Supervise oil purifier operators 2. Perform regular machine maintenance 3. Conducting screening / mesh 4. Keep the oil temperature at ± 80^0C
	Oil Purifier machine that does not work optimally	
	Fruit storage place is not good	Cleaning station sorting
	The level of inspection (inspection) is lacking	Conduct periodic checks every hour

Control

At this stage control of the improvements that have been made so that no more process failure that can cause defective products [4], [8]. It takes a standardization, documentation and dissemination of corrective actions so that the ever-present failure does not happen again. Control Mechanism can be seen in Table 4.

Table 4**.** Process Control Mechanism of Crude Palm Oil Processing

Aspect	**Improvement**	**Control Mechanism**
Tools/Machine	Checking Tools and Machine Before Process	Provide a special time to ensure that the machine is in good condition to avoid process errors that can result in damage to the product or work accident
	Machine Use Procedures	Provide training to each operator about the use of tools / machines appropriately
		Arrange rules of the working steps of using each tool / machine
		Provide written information in the form of instructions on the steps of the use of tools and placed in a location that allows operators to know and implement such steps and

Aspect	Improvement	Control Mechanism
		procedures, especially in the engine temperature setting.
	Maintanance	Make guide about the stages of treatment level as well as the schedule of maintenance process implementation
Fruit Material	Fruit Selection	Quality of raw materials of course very influential product quality, therefore the selection of appropriate raw materials should be done starting at the time of procurement, as well as at the time of storage materials.
		Knowledge of materials management needs to be improved especially for operators, this can be done by providing specific training on the supply of materials at the beginning of the production phase.
	Fruit Handling	Raw materials should be placed in closed fields, away from the effects of weather conditions (rain and heat).
Human Factor	Coaching and Training Improving the Quality of Human Resources	Management needs to prepare the training plans both in terms of materials, as well as in terms of implementation time that can improve the insight and skills of operators in work.
	Increased Work Motivation	Occupational routines can sometimes lead to a decrease in concentration and the employee's participation in carrying out activities. Therefore, the management needs to take a little time to motivate workers to increase again.
		Provide compensation in accordance with the workload provided
		The existence of specialization in the work, so that the mastery of tasks become more leverage.
Method	Improved inspection	Perform periodic sample checks once every hour

Conclusion

Based on the results of data processing at the define stage, Critiqal to Quality (CTQ) of crude palm oil is dirty conten less than 0.015%. Level measure obtained by average value of sigma value is 3,00, from result of variable control map (map X and R) obtained data is outside system boundary so need revision, from result of capability process still have value of Cpk which is under one showing not yet able company to produce product according to specification. Analytical phase is obtained the main factor causing the decreasing quality of CPO which will be analyzed by Grey FMEA. From the result of Grey FMEA obtained the lowest value Fruit storage place is not good with value 0,4028. Proposed improvement of product quality by making improvements to all sources that make some improvements, so the potential that causes disability can be prevented. While the controls do the results of quality improvement by controlling mechanisms.

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