Journal of Mathematics Technology and Education Vol. 1, No. 1, 2021 | 77 - 93

Journal of Mathematics Technology and Education

Application of Six Sigma Method for Quality Control of Palm Kernel Oil Production In PT Socfin Indonesia

Novita Sari[1], Mardiningsih[2]

[1]Student of Department of Mathematics, Universitas Sumatera Utara, Medan, 20155, Indonesia
[2]Department of Mathematics, Universitas Sumatera Utara, Medan, 20155, Indonesia

Abstract. Socfin Indonesia is an upstream plantation company with the main products are Crude Palm Oil (CPO), Palm Kernel Oil (PKO), and Karet Alam. The problems that encounter is still found a defective product where the quality of the products produced still not fulfilling the company's quality standards. The purpose of this study was to apply the Six Sigma method in quality control for reducing defects in palm kernel oil (PKO) production at PT. Socfin Indonesia. The company has the characteristics for quality of palm kernel oil (PKO) products that consist of water content, broken core levels and dirt content. Based on the data obtained, the percentage of disability was 31.73% while the company's tolerance limit was 30% for overall production. The method used was Six Sigma with the DMAIC procedure. Based on the results of the study, the company's DPMO value was 105,724 with a company sigma capability value of 2.7496. The ability to produce defective products was about 31.72%. The proposed for improving the quality product of palm kernel oil (PKO) with the Six Sigma method against the company by complying the Standard Operation Procedure (SOP) that has been made to avoid anythings that can interfere the production process.

Keyword: Application, Palm Kernel Oil, Six Sigma Method, Quality Control

Abstrak. *PT. Socfin Indonesia adalah perusahaan perkebunan hulu dengan produk utamanya adalah Crude Palm Oil (CPO), Palm Kernel Oil (PKO), dan Karet Alam. Permasalahan yang dihadapi yaitu masih terdapat produk cacat di mana kualitas produk yang dihasilkan tidak memenuhi standar kualitas perusahaan. Tujuan penelitian ini adalah menerapkan metode Six Sigma untuk mengendalikan kualitas untuk mengurangi kecacatan (defect) pada produksi palm kernel oil (PKO) di PT. Socfin Indonesia. Perusahaan memiliki karakteristik kualitas produk palm kernel oil (PKO) yang terdiri atas kadar air, kadar inti pecah dan kadar kotoran. Berdasarkan data yang diperoleh, persentase kecacatan adalah 31,73% sedangkan batas toleransi perusahaan sebesar 30% untuk keseluruhan produksi. Metode yang digunakan yaitu Six Sigma dengan prosedur DMAIC. Berdasarkan hasil penelitian, nilai DPMO perusahaan sebesar 105.724 dengan nilai kapabilitas sigma perusahaan sebesar 2,7496 . Kemampuan menghasilkan produk cacat sekitar 31,72%. Usulan perbaikan kualitas produk palm kernel oil (PKO) dengan metode Six Sigma terhadap perusahaan yaitu mematuhi Standard Operation Procedure (SOP) yang telah dibuat untuk menghindari hal-hal yang dapat mengganggu jalannya proses produksi.*

Kata Kunci: *Penerapan, Palm Kernel Oil, Metode Six Sigma, Pengendalian Kualitas*

Received 08 Nov 2021 | Revised 11 Nov 2021 | Accepted 15 Nov 2021

---

*Corresponding author at: Jl. Bioteknologi No.1, Padang Bulan, Kec. Medan Baru, Kota Medan, Sumatera Utara 20155 Kampus USU

E-mail address: novita2111.ns@gmail.com

e-ISSN: xxxx-xxxx | DOI: 10.32734/jomte.v1i1.7582
Journal Homepage: https://talenta.usu.ac.id/jomte

1 Introduction

The quality of a product is the ability to deliver performance that matches or even exceeds what the customer wants [1]. Palm kernel oil (PKO) or palm core oil is a vegetable oil that can be consumed, derived from palm oil plants other than crude palm oil (CPO) or palm oil. Palm kernel oil (PKO) is more widely used for the oleochemical industry, such as fatty alcohol, methyl ester (biodiesel), glycerol, and others [2]. PT. Socfin Indonesia is an upstream plantation company with its main products being Crude Palm Oil (CPO), Palm Kernel Oil (PKO), and Natural Rubber (CV60, CV50 and SIR10). According to Derom Bangun (chairman of GAPKI) although the price of crude palm oil (CPO) has increased but it cannot be used as a benchmark for the company's profits. In the palm oil industry, companies take the tungan from the sale of palm kernel oil (PKO).

PT. Socfin Indonesia is currently faced with a challenge where consumers ask to further improve the quality of products produced by the company. It can be seen from the existence of defect products where the quality of the products that produced still not fulfilling the company's quality standards. In addition, the pressure of similar companies is also a problem that must be addressed immediately by the company. Therefore, there needs to be improvements to the quality of the products produced.

In using Six Sigma method was restricted in define, measure, analyze dan improve [3]. The result of study showed the largest type of canning defects is knocked down flange (KDF). Sigma value of 3.46, final yield of 97.5%, and process capability (Cp) of 1.15. Recommended improvement alternatives are providing directions and SOP's training for workers, controlling and maintaining machines more rigorously,scheduling machine component replacements, training and supervising machine operators, inspecting canned materials more rigorously, and adding turbine ventilators in production areas.

The proportion of defective products to 2 sigma, it can be stated that the control of the proportion of sigma level 2 is still within the control limit, which is with a proportion of 0.309, but the company is expected to continue to make improvements and improve quality to be able to minimize the value of the proportion of defective products [4].

Based on some previous research, the Six Sigma method is the most effective method to be used in overcoming production defect problems. is a vision of improving quality towards the target of 3.4 DPMO (Defects Per Million Opportunities), for any product or service transaction and is an attempt at perfection. If a product (goods and/or services) is processed at the Six Sigma quality level, the company may expect 3.4 failures per 1 million DPMO opportunities or expect that 99.99966% of what the customer expects will be in that product [5].

2 Theoritical Review

Quality is a measure of how close a good or service is to a certain standard. Standards may relate to time, materials, performance, reliability, or (objective and measurable) characteristics that can be anticipated [6].

Quality control is an integrated activity ranging from the control of material quality standards, production process standards, semi-finished goods, to the standard delivery of final products to consumers, so that goods and / or services produced in accordance with the planned quality specification [7].

2.1 Six Sigma

The term Sigma is a Greek letter σ used for the amount of Standard Deviation or Standard Deviation in statistical science. Standard deviation can be depreciated as the average difference in sample values to the average value of data. Indirectly the Standard Deviation describes the magnitude of the diversity of sample measurement results.

If the product (goods and/or services) is processed at the Six Sigma quality level, the company may expect 3.4 defects per million opportunity (DPMO) or expect that 99.99966% of what customers expect will be in that product.

Define, Measure, Analyze, Improve, and Control (DMAIC) is at the heart of Six Sigma analysis that ensures the voice of customer runs in the entire process so that the resulting product satisfies the customer's wishes.

a. Define The System. Define (identification) is the first operational step in a Six Sigma quality improvement program. Here are the steps taken at the Difine stage, namely:

   1. Project Statement**.** A project statement is a statement that includes several components. The following:

      - Business Case
      - Problem Definition
      - Project Scope
      - Goal Statement
      - Project Timeline.

2. SIPOC Diagram. SIPOC (Supplier-Input-Process-Output-Customer) diagram is one of the most important model diagrams in business operational functions. The explanation of each section on the SIPOC diagram is:

   - Supplier
   - Input
   - Process
   - Customer

b. Measure The Aspects. Measure is the second operational step in the Six Sigma quality improvement program. There are three main things to do in this stage:

   1. Select or define Critical to Quality (CTQ). Critical to Quality (CTQ) is a very important attribute to note because it is directly related to customer needs and satisfaction. It is an element of a product, process, or practice that has a direct impact on customer satisfaction.

   2. Develop a data collection plan. The key Critical to Quality (CTQ) designation or selection in a Six Sigma project is to establish a plan for data collection.

   3. Measure current performance. Measure current performance at the process level, output or outcome to be established as a work baseline at the beginning of a Six Sigma project.

c. Analyze The Data. The third step in the program improves the quality of Six Sigma using Pareto Diagrams. The concept of E siensi Pareto and Pareto's Law states that 80% of defective products are due to 20% of the overall production. Problem solving should focus or prioritize 80% of the majority/dominant cause first. The benefit that will be obtained by using The Pareto Diagram is that an analyst will know the statistical picture of the cause of the problem that will be the initial focus to solve.

d. Improve The Process. Once the sources and root causes of quality problems are identified, it is necessary to establish an action plan to improve six sigma quality. Basically, the action plans will describe the allocation of resources and priorities and / or alternatives carried out in the implementation of the plan. Establish an action plan for six sigma quality improvement [8].

2.2. Normality Test for Data

The principle of the normality test using Kolmogorov-Smirnov is to look for the greatest deviation (D) of the cumulative distribution function of observational (empirical) data to its theoretical cumulative distribution function. The magnitude or smallness of the deviation formed cannot be determined if there is no comparison. Kolmogorov has already determined the comparison amount for the D value that obtained. This magnitude is given the symbol $\boldsymbol{D}_{(\boldsymbol{\alpha};\boldsymbol{n})}$ and its value can be seen in the Kolmogorov-Smirnov Critical Table. The steps required in the Kolmogorov-Smirnov test are:

a. Data from observations are compiled ranging from the smallest observation value to the largest observation value.

b. From the value of these observations will be compiled a cumulative relative frequency distribution calculated using empirical distributions and notated with $F_e(x_i)$ and use the following formula:

$$F_e(x_i) = \frac{f_k}{n} \tag{1}$$

c. Calculate the value of z_i with formula:

$$z_i = \frac{x_i - \mu}{\sigma} \tag{2}$$

Where:

$$\mu = \frac{\sum_{i=1}^{n} x_i}{n} \tag{3}$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \mu)^2}{n}} \tag{4}$$

Note: f_k= Cumulative frequency of data

n = Amount of data

z_i = the value of statistic tester

x_i = Data at-i

μ = Average value

σ = Standard deviation

$(i = 1,2,3, \dots, n)$

d. Calculates the cumulative relative frequency distribution calculated using theoretical distributions based on normal curve areas and denoted by Ft (xi) and using the following formulas:

$$F_t(x_i) = 0{,}5 - P(z_i) \quad (5)$$

Where, $P(z_i)$ is probability value z_i from default normal cumulative table.

e. Calculate the difference between $F_e(x_i)$ and $F_t(x_i)$. And, Take the maximum difference number or largest deviation notated with D.

$$D = max\ |F_e(x_i) - F_t(x_i)| \quad (6)$$

Requirements:

1. Interval or ratio scale of data (quantitative).
2. Single data/ not in the group on the frequency distribution table.
3. It can for n (big or small).

In the test of the approach to normal distribution, using the Kolmogorov-Smirnov method and, the hypothesis applies:

H_0 : The data from the population is normally distributed

H_1 : The data from the population is not normally distributed

The hypothesis will then be tested using the examiner's statistics and the following values:

If $D \leq D_{(\alpha;n)}$, so H_0 accepted and H_1 rejected.

If $D > D_{(\alpha;n)}$, maka H_0 rejected dan H_1 accepted.

The advantages of Kolmogorov-Smirnov are:

1. It don’t need data in group
2. It can be use in small sample
3. It’s not categorical
4. More flexibel, it can use to estimate varian of standard deviation.

2.3. Control Chart

A daily or individual model control map is created for each observation. Therefore, the company will have some limit controlling the proportion of errors for the quality of its production process. The advantage of a daily or individual model control map (individual p-chart) is its determination in deciding whether the sample is within or outside its control limit.

The determination of the proportion of errors of each sample at each observation is notated as p_i and the formula:

$$p_i = \frac{x_i}{n_i} \tag{7}$$

The determination of central line is notated as CL and the formula:

$$CL = \bar{p} = \frac{\sum_{i=1}^{g} p_i}{g} \tag{8}$$

And, the determination of upper control limit is notated ad UCL and lower control limit is notated as LCL, and the formula:

$$UCL = \bar{p} + 3 \cdot \sqrt{\frac{\bar{p}(1-\bar{p})}{n_i}} \tag{9}$$

$$LCL = \bar{p} - 3 \cdot \sqrt{\frac{\bar{p}(1-\bar{p})}{n_i}} \tag{10}$$

Where: p_i = Proportion of each sample's error at each observation

x_i = The number of defective products per sample at each observation

n_i = the number of samples taken at each observation (variation)

$\bar{p}$ = Average proportion of errors

g = Amount of observation

$(i = 1,2,3,\ldots,g)$.

Process Capability is used to get process capability values for attribute data is with the following formula:

$$Cp = \frac{UCL-LCL}{6\sigma} \tag{11}$$

Where: Cp = The index of capabality process

$\bar{p}$ = Average proportion of errors.

2.4. Sigma Value

Sigma value is used to assess processes that have been underway using indicators of the number of defective products and using sigma value guidelines as a reference for process assessment.

a. Defect per Unit (DPU). This measure reflects the average number of defects of all types to the total number of units of the sampled units.

$$DPU = \frac{Total\ Defective\ (D)}{Total\ Produksi\ (U)} \tag{12}$$

b. Total Opportunities (TOP). Indicates the number of opportunities for defective products and defects in the product.

$$TOP = Total\ Produksi\ (U) \times OP \tag{13}$$

c. Defect per Opportunity (DPO). Shows the proportion of defects in the total number of opportunities in a group/subgroup.

$$DPO = \frac{Total\ Defective(D)}{Total\ Opportunities\ \text{(TOP)}} \tag{14}$$

d. Defect per Million Opportunities (DPMO). Indicates how many defects will appear if there are one million chances.

$$DPMO = DPO \times 1.000.000 \tag{15}$$

e. Sigma Value. The calculation of the conversion of sigma value from DPMO to sigma value is carried out using Microsoft Excel with the calculation formula:

$$= NORMSINV\left(\frac{10^6 - DPMO}{10^6}\right) + 1{,}5 \tag{16}$$

3 Research Methodology

The research was conducted at PT. Socfin Indonesia. The time of the study was conducted in the month June 2020 to November 2020. The object of the study is palm kernel oil (PKO) products produced by PT. Socfin Indonesia. Related data required in the study are the number of Palm Kernel Oil (PKO) production and the number of defects of Palm Kernel Oil (PKO) products.

Based on the purpose of research that is to solve real problems that occur in the company, then the type of research used is applied research. The steps of data analysis are:

a. Conduct literature studies obtained from previous books, journals and research on Palm Oil and the Six Sigma method;

b. Conduct preliminary studies obtained from PT. Socfin Indonesia such as factory conditions, production processes, and supporting information.

c. Collect data. The data used is secondary data obtained from PT. Socfin Indonesia on production data and palm kernel oil (PKO) defective product.

d. Processing data with the Six Sigma methods are :

1. Define
    - Create a project statement.
    - Make SIPOC diagram.
2. Measure
    - Determine the critical to quality.
    - Perform a data normality test with the Kolmogorov-Smirnov Test method using equations 1 – 6.
    - Make p-chart using equations 7-10.
    - Calculate the value of capability process using equations 11.
    - Calculate DPU, TPO, DPO, DPOM, and sigma value using equations 12-16.
3. Analyze
    - Make pareto diagram.
4. Improve
    - 5W+ 1H Method.
5. Control
    - Comply with SOP.
6. Do an analyze and discuss about the result.
7. Make a conclusion and suggestions.

4 Results & Discussions

4.1 Data Collection

The data collection required in the study was the amount of palm kernel oil (PKO) production and the number of palm kernel oil (PKO) product defects.

Table 1 Production Amount of Palm Kernel Oil (PKO) on June 2020- November 2020

Date (2020	TBS in Process (kg)	Production of PKO (%)
2 June	182.510	4,11
3 June	194.370	4,07
4 June	221.930	4,05
5 June	225.870	4,08
6 June	223.720	4,02
⋮	⋮	⋮
30 November	155.050	3,76
Total	20.342.230	483.35

Table 2 Calculation Result of Palm Kernel Oil (PKO) Production on June 2020-November 2020

Date (2020)	TBS in Process (kg)	Production of PKO (%)
2 June	182.510	4,11
3 June	194.370	4,07
4 June	221.930	4,05
5 June	225.870	4,08
6 June	223.720	4,02
⋮	⋮	⋮
30 November	155.050	3,76
Total	20.342.230	483.35

4.2 Problem Assumption

The assumptions that used in this study are: 1) Production process during this study did not change and did not have an interference; 2) Workers at the study time are made can work reasonably, have control the work properly and correctly considered as normal operators and are able to cooperate with researchers; and 3) The machinery and equipment used during the production process are in good condition and there is no maintenance schedule of machinery and equipment during the research.

4.3 Data Processing

Data processing in research uses the Six Sigma method, with five stages namely Define, Measure, Analyze, Improve, and Control (DMAIC). DMAIC is a broadly structured problem-solving procedure used in quality and quality improvement processes.

4.3.1 Define The System

Define is the first operational step in the Six Sigma quality improvement program. Here are the steps taken at the Difine stage, namely:

a. Project statement is a statement that includes several components, such as:

1. Business case. Companies are faced with the challenge of increasing demands for the quality of products produced by companies, while the trend is also reinforced by competition pressures from similar companies.

2. Problem definition. The problem faced by the Company is that there are still defect products where the quality of the products produced does not meet the company's quality standards.

3. Project scope. The scope in the company's problem solving activities is the production of palm kernel oil (PKO) with data from June 2020 to November 2020.

4. Goal statement. The purpose of the study was to apply the Six Sigma method to control the quality of palm kernel oil (PKO) products in the company.

5. Project timeline. The deadline for work is until November 2020.

b. SIPOC Diagram

SIPOC diagram (Supplier-Input-Process-Output-Customer) is one of the most important model diagrams in business operational functions. The explanation of each part of the SIPOC diagram can be seen in Figure 1. As follows:

SUPPLIER	***INPUT***	***PROCESS***	***OUTPUT***	***CUSTOMER***
Farm Fruit Receiver Station	Bunch of Fresh Fruit (TBS)	Fruit reception Sterilizer Stripper Digester and Presser Clarifier Separation between seed and kernel Seed drying Seed separation Seed disintegration Separation between kernel and shell Wet separation	Palm Kernel Oil (PKO)	Palm kernel / crushing plant)

Figure 1 SIPOC Diagram

4.3.2 Measure The Aspects

Measure is an operational step in a Six Sigma quality improvement program.

a. Identification critical to quality (CTQ). Critical to Quality (CTQ) is a product criterion that has been set by the standard as a benchmark for the quality of products produced by the company in order to meet customer needs. Before a product is categorized as a defective product, the criteria for failure or disability must be defined first. In this study the standard palm kernel oil (PKO) product can be seen in Table 3. As follows:

Table 3 *Critical to Quality* (CTQ) The Production *Palm Kernel Oil* (PKO)

CTQ	Criteria	Spesification	Description
CTQ-1	Moisture	< 7%	High levels of water can cause rancid oil and decreasing the quality of the palm kernel oil
CTQ-2	Broken Kernel	< 30%	Broken kernel is very sensistive to fungus and acidification
CTQ-3	Dirt Content	< 7 %	The existence of dirt in kernel can make the result of the rendemen/ oil extraction that produced unoptimal.

b. Normality test for data. The principle of the normality test using Kolmogorov-Smirnov is to look for the greatest deviation (D) of the cumulative distribution function of observational (empirical) data to its theoretical cumulative distribution function.

Data normality test showed that $D(0{,}0561) \leq D_{(0{,}05;125)}(0{,}1208)$, so H_0 accepted and H_1 rejected. This means that the total defect data of palm kernel oil (PKO) products comes from the normal distribution population.

c. Control chart. Error proportion control maps (p-charts) are used for a large number of varied samples. The steps to create a p control map (p-chart) are as follows:

1. Calculate the proportion of errors of each sample at each observation of production data and palm kernel oil (PKO) defect data, is:

$$p_1 = \frac{x_1}{n_1} = \frac{2316}{7501} = 0{,}3088$$

2. Calculate the average of proportion is notated with $\bar{p}$, is:

$$\bar{p} = \frac{\sum_{i=1}^{g} p_i}{g} = \frac{39{,}6559}{125} = \mathbf{0,3172}$$

3. Calculate the central line (CL), upper control limit (UCL), and lower control limit (LCL) are as follows:

$$CL = \bar{p} = \frac{\sum_{i=1}^{g} p_i}{g} = \frac{39{,}6559}{125} = \mathbf{0,3172}$$

$$UCL_1 = \bar{p} + 3 \cdot \sqrt{\frac{\bar{p}(1-\bar{p})}{n_1}} = 0{,}3172 + 3 \cdot \sqrt{\frac{0{,}3172(1-0{,}3172)}{7.501}} = \mathbf{0,3333}$$

$$LCL_1 = \bar{p} - 3 \cdot \sqrt{\frac{\bar{p}(1-\bar{p})}{n_1}} = 0{,}3172 - 3 \cdot \sqrt{\frac{0{,}3172(1-0{,}3172)}{7.501}} = \mathbf{0,3011}$$

4. Observing whether the data is in control or out of control can be seen in Table 4, as follows:

Table 4 Calculation of Control Limit p-chart

Num.	PKO Production (kg)	Numb. of Defects (%)	Proportion	CL	UCL	LCL	Information
1	7.501	2.316	0,3088	0,3172	0,3355	0,3011	In control
2	7.911	2.637	0,3333	0,3172	0,3355	0,3015	Out control
3	8.988	3.617	0,4024	0,3172	0,3355	0,3025	Out control
4	9.215	3.817	0,4142	0,3172	0,3355	0,3027	Out control
5	8.994	2.578	0,2866	0,3172	0,3355	0,3025	Out control
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
125	5.830	1.744	0,2991	0,3172	0,3355	0.2989	In control

The p-chart control map for defects in palm kernel oil (PKO) production can be seen in Figure 2. As follows:

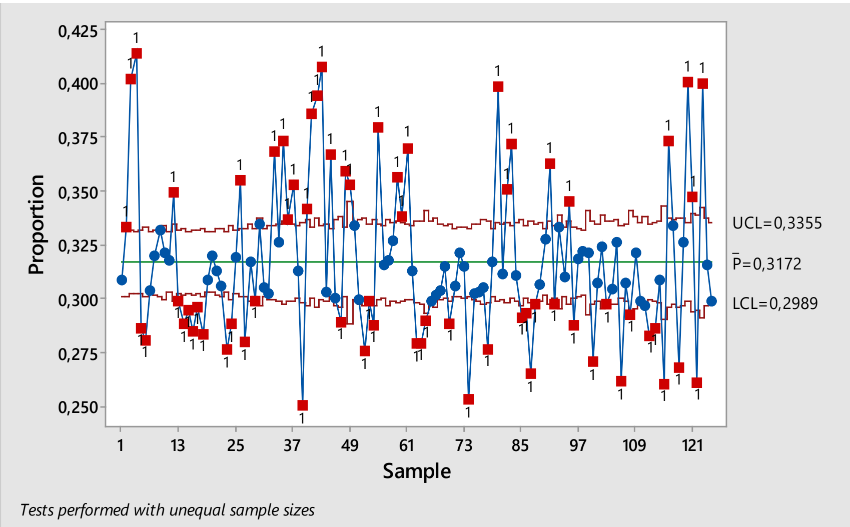

Figure 2 p-chart of Defeated Palm Kernel Oil (PKO) Products

d. Process Capabilities. From the calculation of control limits, the process capability of palm kernel oil (PKO) production to produce products is not defective, namely, as large as:

$$Cp = 1 - \bar{p} = 1 - 0{,}3172 = 0{,}6828 = \mathbf{68{,}28}\ \%$$

e. Calculate The Sigma Value. Sigma value measured based on some initial inputs and parameters.

1. Defect per Unit: $DPU = \frac{Total\ Defective\ (D)}{Total\ Produksi\ (U)} = \frac{250.357}{789.339} = \mathbf{0{,}3172}$

2. Total Opportunities: $TOP = Total\ Produksi\ (U) \times OP = 789.339 \times 3 = \mathbf{2.368.017}$

3. Defect per Opportunity (DPO): $DPO = \frac{Total\ Defective(D)}{Total\ Opportunities\ (\text{TOP})} = \frac{250.357}{2.368.017} = \mathbf{0,1057}$

4. Defect per Million Opportunities (DPMO): $DPMO = DPO \times 1.000.000 = 0{,}1057 \times 1.000.000 = \mathbf{105.724,3255}$

5. Sigma Value : $= NORMSINV\left(\frac{10^6 - DPMO}{10^6}\right) + 1{,}5 = \mathbf{2.7496}$

4.3.3 Analyze The Data

Analyze is the third step in the six sigma quality improving program using pareto diagrams. The calculation of the percentage of defects and the cumulative percentage of each type of palm kernel oil (PKO) production defect can be seen in Table 5. As follows:

Table 5 The Sorting of Defected Palm Kernel Oil Products (PKO)

Num.	Type of Defects	Amount (kg)	Percentage (%)	Cumulative Percentage (%)
1	Broken kernel rate	135.326	54,0532	54,0532
2	Moisture rate	58.942	23,5432	77,5967
3	Dirt Content rate	56.089	22,4036	100
	Total	250.357	100	

Pareto diagram for palm kernel oil (PKO) production defects based on Table 5. It can be seen in Figure 3. As follows:

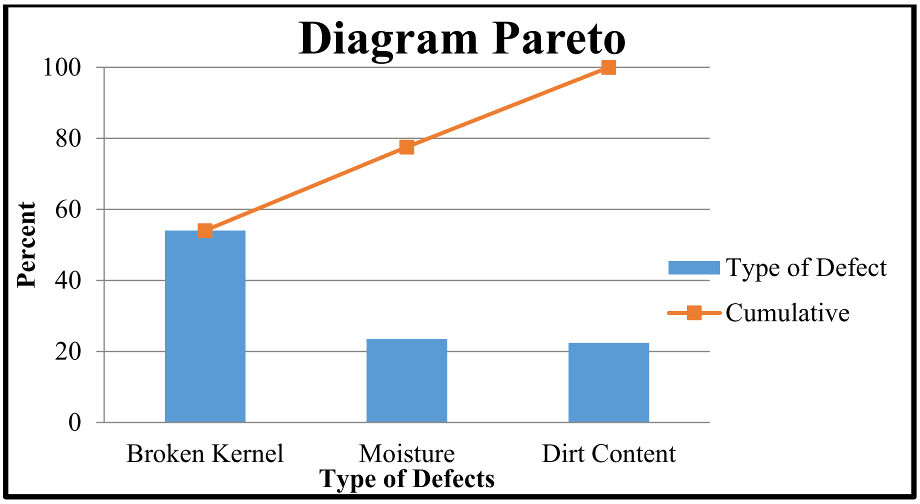

Figure 3 Pareto Diagram of Palm Kernel Oil (PKO) Production Defects

Pareto's law can also mean that 80% of failures are the responsibility of 20% of the cause. The types of defects that reach or approach the cumulative error percentage of 80% are the level of Rupture Core and Water content with a cumulative 77.5967%, so to reduce the number of defective products to the level of 80% is enough to control the type of defect of rupture core levels and moisture content.

4.3.4 Improve The Process

Improvement (improvement) is done after the sources and root causes of quality problems are identified, it is necessary to establish an action plan to improve the quality of SixSigma. The improvement plan uses matrix methods based on the principles of 5W (What, Where, When, Who, andWhy) and 1H (How). This method is done by brainstorming techniques to explore various appropriate alternatives for problem solving. This repair plan is assisted by several employees from the company.

But the improvements made are only limited to recommendations, not applied directly to the company because of the limited time, cost, opportunity, situation and conditions that occurred at the time of this study was conducted.

4.3.5 Control Chart

At this stage of control the results of quality improvement are documented and disseminated, successful best practices in improving the process are standardized and disseminated, procedures are documented and used as standard work guidelines, and ownership or responsibility is transferred from the Six Sigma team to the owner or person in charge of the process. Actions that need to be taken as follows:

a. Perform DPMO calculations and sigma values regularly each period to determine the process's ability to produce products without defects per one million opportunities.

b. Comply with the Standard Operation Procedure (SOP) that has been created to avoid things that can interfere with the course of the production process.

5 Conclusion

Based on the results of data processing on palm kernel oil (PKO) production in PT. Soc n Indonesia by using the Six Sigma method for quality control, obtained some conclusions as follows:

a. The capability value was obtained at 68.28%, indicating that the process of producing defective products was approximately 31.72%. With this level of capability the process is still not able to produce quality products that are defective-free or zero defect.

b. The company's DPMO value of 105,724.3255, indicates that for every 1,000,000 times production the probability of disability is 105,724 times production. While the value of the company's sigma capability amounted to 2,7496σ where it can be said that the company's ability to meet the specific limit of the production process specified to produce the product has not met the target of the minimum sigma value limit of 3.4 or 6σ.

c. With pareto diagrams of the three types of Critical to Quality (CTQ) in palm kernel oil (PKO) production that achieve or approach the cumulative error percentage of 80% are the Rupture Core rate and the Water content with a cumulative 77.5967%.

REFERENCES

[1] Mansur. 2016. Plastic Injection Quality Controlling Using the Lean Six Sigma and FMEA Method. Universitas Islam Indonesia.

[2] Pahan, Iyung. 2006. *Panduan Lengkap Kelapa Sawit Manajemen Agribisnis dari Hulu hingga Hilir*. Penebar Swadaya.

[3] Sucipto, Devita Prima Sulistyowati, Sakunda Anggraini. 2017. *Pengendalian Kualitas Pengalengan Jamur dengan Metode Six Sigma di PT. Y Pasuruan, Jawa Timur*. Jurnal Teknologi dan Manajemen Agroindustri Volume 6 Nomor 1: 1-7. Universitas Brawijaya, Malang.

[4] Agustiono, Galih. 2019. *Analisis Pengendalian Kualitas Cacat Produk di PT. MNO dengan menggunakan Pendekatan Metode Six sigma.* Jurnal Teknik Industri Vol. 1, TI. 98 – TI.106. Universitas Maarif Hasyim Latif, Sidoarjo.

[5] Gasperz, Vincent, 2002, *Total Quality Management*. Jakarta: PT. Gramedia Pustaka Umum.

[6] Marimin. 2005. *Teknik dan Aplikasi : Pengambilan Keputusan Kriteria Majemuk*. Jakarta : PT. Grasindo.

[7] Prawirosentono, Suyadi. 2002. *Manajemen Sumber Daya Manusia: Kebijakan KinerjaKaryawan.* Edisi 1. BPFE. Yogyakarta.

[8] Montgomery, Douglas C. 2009. *Introduction to Statistical Quality Control 7th Edition*.United States : Jhon Wiley and Sons, Inc.