# Quality Control of Defect Sodium Tri Polyphosphate Products Using a Statistical Quality Control Approach at a PT X

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**Abstract.** Quality control is very important for businesses that produce goods and services. The products made by the company will be influenced by effective quality control. Even though the production process is carried out well, sometimes errors still occur which cause the product to not meet standards or experience damage (defects). Quality control can be implemented using the Statistical Quality Control (SQC) method. The SQC method is a method used to control product quality standards at minimum costs so that efficiency arises in a company. The aim of this research is to examine and identify forms of control of defective Sodium Tri polyphosphate products at PT. X. This research uses a qualitative descriptive method. The results of this research are that the type of quality damage below quality is more dominant based on Checksheet calculations, Pareto diagrams and P control charts (P-chart).

**Keywords:** Quality control, Sodium Tri polyphosphate, Statistical Quality Control.

## 1. Introduction

Currently, in the era of globalization, advances in science and technology increase competition in an industry. One of them is a product made by a company, which is at the forefront of the industry and has quality above competitors in the same industry. One of the factors of business success is this product quality strategy, and improving a business's position in the competitive market starts from the organizational environment where employees are involved in implementing this quality strategy.

Quality control is very important for businesses that produce goods and services. With the quality of the goods and services produced, the company expects customer interest and fulfills needs. The products made by the company will be influenced by effective quality control. The products produced by the company have certain different characteristics. Even though the

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production process is carried out well, sometimes errors occur which cause the product to not meet standards or sufferdefects.As a result, companies must implement good quality control [1]. Quality control is necessary because defective products will be detrimental to the company if left untreated. The existence of communication between the company and customers allows them to know and understand needs in accordance with customer desires. Companies can carry out optimal production activities to make customers satisfied by giving a pleasant impression and minimizing bad impressions. As a result, product quality inspection is very important and beneficial for the company.

PT. X is a company engaged in manufacturing Sodium Tripoly Phosphate (STTP) and Phosphoric Acid. The products made are sold widely both domestically and internationally. The products produced include Pure Phosphoric Acid, STPP Technical Grade, STPP Food Grade Powder and Food Grade Coarse, Phosphate Blend, PT. X has a production target of 500 thousand tons per month, so quality is important to maintain consumer loyalty and competitiveness.

Sodium Tri polyphosphate or Sodium Triphosphate with the molecular formula Na5P3O10 is a product derived from phosphate which is widely used as a product component in households and industry. Sodium Triphosphate can also be used as a food quality improver because this substance is an addictive ingredient, besides that it can also be used as a builder in detergent. The many and important uses of sodium triphosphate mean that the need for this substance increases along with the growth of society's needs. The high need for sodium phosphate must be accompanied by large production levels so that the need for this substance can be met.

Every company must have good quality standards for its products, both from the process and the final product that is ready to be sold on the market. PT. X In its business producing STPP Food Grade products, in fact still found the quality of products that are still below quality and company standards. Based on the data obtained by the author, it is known that products that comply with and are below company standards are still somewhat unstable. The following is data on the amount of production of PT. X:

**Table 1**. Data on Number of STPP Food Grade & Technical Grade January 2022 – December 2022

| No | Month | STTP Target (Tons) | Production Amount (Tons) | Total Production On (Tons) | Amount of Off Production (Tons) | Percentage % |
|---|---|---|---|---|---|---|
| 1 | January | 500 | 435,750 | 218,400 | 217,350 | 50% |
| 2 | February | 500 | 633,750 | 417,750 | 216,000 | 34% |
| 3 | March | 500 | 45,000 | 15,500 | 29,500 | 66% |
| 4 | April | 500 | 275,450 | 151,800 | 123,650 | 45% |

| No | Month | STTP Target (Tons) | Production Amount (Tons) | Total Production On (Tons) | Amount of Off Production (Tons) | Percentage % |
|---|---|---|---|---|---|---|
| 5 | May | 500 | 65,400 | 12,000 | 53,400 | 82% |
| 6 | June | 500 | 351,650 | 228,400 | 123,250 | 35% |
| 7 | July | 500 | 474,350 | 347,000 | 127,350 | 27% |
| 8 | August | 500 | 27,000 | 0 | 27,000 | 100% |
| 9 | September | 500 | 238,900 | 0 | 238,900 | 100% |
| 10 | October | 500 | 62,000 | 16,000 | 46,000 | 74% |
| 11 | November | 500 | 447,250 | 74,000 | 373,250 | 83% |
| 12 | December | 500 | 33,750 | 22,750 | 11,000 | 33% |
| | **TOTAL** | **6,000.00** | **3,090,250** | **1,503,600** | **1,586,650** | **51%** |

Based on the table of number of STTP Food Grade & Technical Grade products for the 2022 period above, there are products that do not comply with the company's quality (amount of off production) of 1,586,650 tonnes and (amount of on production) of 1,503,600 tonnes. When comparing products according to company standards, the number of off products is greater than the amount of on production with a percentage of 51%. The following is data related to the number of defects in STTP Food Grade & Technical Grade products:

**Table 2**. Data on Number of Defects for STPP Food Grade & Technical Grade

| Month | Below Standard (Ton) | Clumping (Ton) | Rough Texture/less smooth(ton) | Total |
|---|---|---|---|---|
| January | 108.675 | 18.139,2 | 90.535,8 | 217.350 |
| February | 94.387 | 54.113 | 67.500 | 216.000 |
| March | 15.918,5 | 0 | 13.581,5 | 29.500 |
| April | 75.504,9 | 8.891,1 | 39.254 | 123.650 |
| May | 53.400 | 0 | 0 | 53.400 |
| June | 45.429,7 | 16.214,5 | 61.605,8 | 123.250 |
| July | 61.891 | 39.350 | 26.109 | 127.350 |
| August | 17.167,4 | 9.832,6 | 0 | 27.000 |
| September | 90.172,25 | 88.653,45 | 60.074,3 | 238.900 |
| October | 22.957 | 11.457 | 11.586 | 46.000 |
| November | 224.933,34 | 55.737,48 | 92.579,18 | 373.250 |
| Desember | 3.435,3 | 4.231,7 | 3.333 | 11.000 |
| **Total** | **813.871** | **306.620,03** | **466.158,58** | **1.586.650** |

The table 2 the types of defects in food grade and technical grade sodium tri polyphosphate products in the production process. Defects in sodium tri polyphosphate are divided into three indications of defective products such as below quality, lumpy, and rough or less smooth texture. In January 2022 the total of the three types of defects will be 217,350 tons. In February, the total number of defective products was 216,000 tons. In March, the total number of defective products was 29,500 tons. In April, the total number of defective products was 123,650 tons. May 2022 total defective products will be 53,400 tons. Followed by June, total defects amounted to 123,250 tons. In July 2022, total defects will be 127,350 tons. In August, total defects were 27,000 tons. In September, total defects amounted to 238,900 tons. In October, total defects amounted to 46,000 tons. Followed in November by 373,250 tons. In December, total defects amounted to 11,000 tons.

Based on the total defective products above, the total number of defective products with products that are below quality, lumpy and have a rough texture is 1,586,650 tons. This shows that the product is defective at PT. Petrocentral for the 2022 period will experience fluctuations. STPP products with substandard quality are caused by poor quality selection of raw materials. This product will later be marketed at a price below products that have reached the company's quality standards and will be labeled as an STPP Food Grade Coarse product.
Meanwhile, STPP products that are lumpy and have a rough or less smooth texture are caused by uneven mixing of raw materials and lack of supervision from production operators. Products that are lumpy with a rough texture will later be reprocessed by the company until they become products that are suitable for sale on the market. This reprocessing process increases the burden of production costs and causes losses to the company because the production costs incurred are excessive and the sales revenue obtained by the company is not optimal.

Quality control is something that must be carried out urgently so that the products produced are comparable to the company's quality standards so that defective products and losses incurred by the company can be minimized. Rusdiana in Lubis Anwar, (2023) explains that quality control is an activity carried out by companies in the production process so that the products processed meet standard quality criteria [4]. The purpose of the need for quality control is to ensure that products that do not meet the company's quality standards can be minimized. Good quality services and goods will create positive memories for customers, especially in meeting customer needs.

Quality control can be implemented using the Statistical Quality Control (SQC) method. The SQC method is a method used to control product quality standards at minimum costs so that efficiency arises in a company (Andespa, 2020) [2]. Quality control using the Statistical Quality Control (SQC) method is needed so that companies can quickly find out the causes of product non-conformity with the standards that have been implemented by the company so that companies will also make quicker and more precise decisions in maintaining product quality so as to minimize the presence of defective products.

Based on the background, the author is interested in researching product quality control, especially food grade sodium tri polyphosphate with the title "Controlling Sodium Tri Polyphosphate Defect Products Using a Statistical Quality Control Approach at PT. X". The author uses the SQC method because this method has never been applied, and the facts in the field show that there is a fairly large percentage of defective products at PT. X so that by implementing this method the company is expected to be able to minimize product defects in sodium tri polyphosphate products.

## 2. Literature Review

**Operational Management**

According to Kumalaningrum, et al (2019; 2-3), operational management is a key process by which a business produces goods and services that its customers need [12]. Any action or series of actions that takes some raw materials or materials, processes them, and then delivers some finished goods or finished goods to some clients is a process.

**Scope of Operational Management**

According to Efendi, et al (2019; 2-3) includes planning and implementation of manufacturing infrastructure. Production system design includes the following things [8]:
a. Select and create items, procedures, and machines.
b. Selecting Locations and Facilities for Manufacturing.
c. Layout design
d. Task and job design.
e. Formulation of production plans and resource allocation.

The operation of the production system includes the following:
a. Create a manufacturing blueprint.
b. Organize and manage the acquisition of necessary resources.
c. Service and maintenance of machines and tools (maintenance).
d. Manage people and other resources.

**Definition of Quality**

The American Society for Quality organization explains that quality is a product characteristic that covers the entire contents of a product which aims to provide satisfaction for the needs of the product or service. This understanding is supported by Irwan and Haryono in Rosid, (2019) who explain that quality is the characteristics of an entire product that has value above other competing products in providing customers' needs and desires [18]. Fahmi in Rosid, (2019) a value in a product that can provide satisfaction for customers if the product meets customer expectations is the definition of quality [18].

## Quality Control

Actions that need to be implemented by the company during the production process to create products that are ready for sale while still paying attention to and achieving the standards set by the company by making quality improvements to products that do not meet the company's standards are the definition of quality control. According to Asasuri in Rosid (2019), the definition of control is a supervisory activity in company operations that is carried out in accordance with company procedures and specifications. If a production error occurs, this will be immediately evaluated so that production continues to produce products in accordance with company expectations [18]. In planning quality control, several steps need to be taken. The first step is to identify points of error or deviation in the production process. The second step is to make a decision on the measurement used at the error point based on the variable. The third step is to make a decision on the number of samples to be used from an output or product. The final step is to determine who will carry out the inspection.

## Quality Control Objectives

Quality control is defined as a company's way of creating quality conformity with applicable operational standards so that the products produced comply with the company's qualifications. Based on this definition, the most important objective of quality control is to ensure that the products that have been produced produce quality conformance with company standards and minimum costs so that they are suitable for sale on the market.

Quality control is directly related to production control, because before a product appears, the product is first in the production phase where the products produced must be monitored in every process in order to produce quality products with minimum production costs, therefore the two are interrelated. . Assauri in Carmelita, (2022) states the meaning of quality control as follows[6]:

a. Achievement of products that comply with production quality standards

b. Minimize production costs so that production efficiency remains.

## Product Defect

A product is a good or service that can be produced by going through a production (manufacturing) process so that it can be sold on the market and is able to meet the needs of consumers so that the company can make a profit from selling products that have been marketed. Every company wants its products to not experience product defects (zero defects) in the production process, this causes losses for the company itself so the company will try as hard as possible to control product quality. Kholmi and Yuningsih in Khoirunnisa, (2019) explained that a defective product is a product that fails during the production process, resulting in a product that is below the company's established quality standards [13]. The essence of a defective product cannot be equated with a product that meets the company's qualifications because the characteristics of the defective product already have differences in quality from products that meet the company's qualifications.

**Understanding Statistical Quality Control (SQC)**

According to one quality expert in Indonesia, Statistical Quality Control is an urgent matter for companies. He explained that SQC is an approach to quality control by collecting data, processing data, and making decisions based on previous processes Ismail & Setiafindari, (2023) [11]. According to Andespa, (2020), an activity process carried out to maintain and control product quality so that it is the same as company standards, supported by a minimum level of production costs and assisted by an analytical tool in order to achieve company efficiency, is an understanding of Statistical Quality Control.ol (SQC) [2]. The aim of this method is to minimize defective products during the production process. Apart from that, SQC also aims to supervise the production process to create products that comply with the company's quality standards. SQC has seven main analytical tools that need to be implemented by companies, namely: checkseet, histogram, paretto diagram, scatter diagram, control chart,fishbone diagram, flow diagram.

## 3. Research Methods

**Types of Research**

According to Qualitative methods are research methods that aim to explore the situation of an object, in this case the researcher is the key instrument. Data analysis in qualitative research is inductive with research results that emphasize the meaning of what is researched [22]. This research uses a qualitative descriptive method. The qualitative descriptive research in this study is to describe the Statistical Quality Control (SQC) method to reduce product defects in Sodium Tri PolyPhospate products.

Research conducted at PT. X with the intervention level of this study is very minimum, where researchers only examine the defect product on Sodium Tri Polyphospate (STPP Food Grade). The researcher is not involved in company activities, the researcher only collects information, then the information is analyzed in order to compare company policies using the SQC approach and then provide conclusions to the company so that PT. X can improve quality and reduce product defects in sodium tri polyphosphate products.

**Research Location**

Carrying out research requires a location that is used as an object to obtain data and information. The location chosen as the observation site was chemical manufacturing in gresik region, which is located in East Java.

## Units of Analysis

The units of analysis are things that need to be stated in the place where the social situation will be researched (Sugiyono, 2022) [22]. The unit of analysis in this research is precisely the Production Directorate of PT. X, East Java. The author selected informants using a purposive sampling technique with the following criteria:

1. Employees of PT. X in the production department
2. Length of work more than 10 years.
3. Understand the production process flow for sodium tri polyphosphate products.

## Data Types

The type of data in this research can be the views or experiences of the research subjects, who in this case are informants. The informants who were informants in this research were several employees in the production sector and knew the production process for sodium tri polyphosphate products. The author's hope for informants is that informants can explain the flow and production process of sodium tri polyphosphate products, especially if there are STPP products that do not comply with company standards. This explanation provides the author with an understanding of the product's non-compliance with company standards so that the author can analyze the procedures implemented by the company and propose a method for the company to control defective products.

The type of data in this research comes from the company's sodium tri polyphosphate (STTP Food Grade) production report data which was used as a reference in the writing.

## Data Sources

### Primary Data Source

The data source obtained from primary data is interviews with informants, namely employees of PT. X who knows about how STPP product quality control has been carried out. Some of the questions the author asked the informants included:

1. Is PT. X has a control team to minimize product defects?
2. How and what standards does the company apply to minimize product defects?
3. What steps does the company choose if a defective product is found that is below the company's quality standards?

### Secondary Data Sources

Secondary data sources were obtained from company document archives with the aim of knowing the distribution of production data and product defects for January-December 2022.

**Data Collection Techniques**

Research was conducted at PT. X is located in East Java. This research was conducted within 2 months, namely in November and December 2023. The data used were primary and secondary data, where primary data was obtained using interview, observation and documentation methods. Secondary data was obtained by studying literature related to the problems raised in this research. In data analysis and processing, the method used is the SQC (Statistical Quality Control) method using a descriptive qualitative method approach where in this research 5 stages were carried out, namely: stage 1 (one) examination using an examination sheet or (Check Sheet), stage 2 ( two) namely using a Pareto diagram, stage 3 (three) namely using a Histogram diagram), stage 4 (four) namely using a static calculation analysis tool control chart (P-Chart), and stage 5 (five) problem solving using analysis cause and effect diagram (Cause And Effect Diagram).

**Structured Interview**

According to Sugiyono, (2022;138) Structured interviews are used as a data collection method in research by asking and preparing several lists of questions to informants regarding problems in a study so that researchers obtain information from the interview [22].
Interviews were submitted to the head of production, head of electricity, K3 safety, quality control lab, and production operator employees and researchers are carried out to find out information and search for data about the problem of the Tri Polyphospate Sodium Defect Sodium product and with the topic studied so that it is expected to obtain clearer data.

**Observation**

Observations during this research are called non-participant observations. According to Sugiyono, (2022; 146) non-participant observation is observation carried out by researchers but the researcher is not involved or involved in business activities [22]. Researchers are personal or independent observers.
Researchers conducted direct observations at the company to find out and dig up data related to the defective sodium tri polyphosphate product problem that occurred

## Documentation

According to Sugiyono (2018) in Fairus (2020;35-36) documentation is information collected from various sources such as books, archives, notes, written numbers and photos to complement learning [9].

**Data Analysis Technique**

The research uses the Milles & Hubberman model data analysis technique. Sugiyono (2022) said that in order to guarantee the validity of the data, activities in qualitative data analysis using the Milles & Hubberman interactive model include data reduction, data presentation and data verification [22].

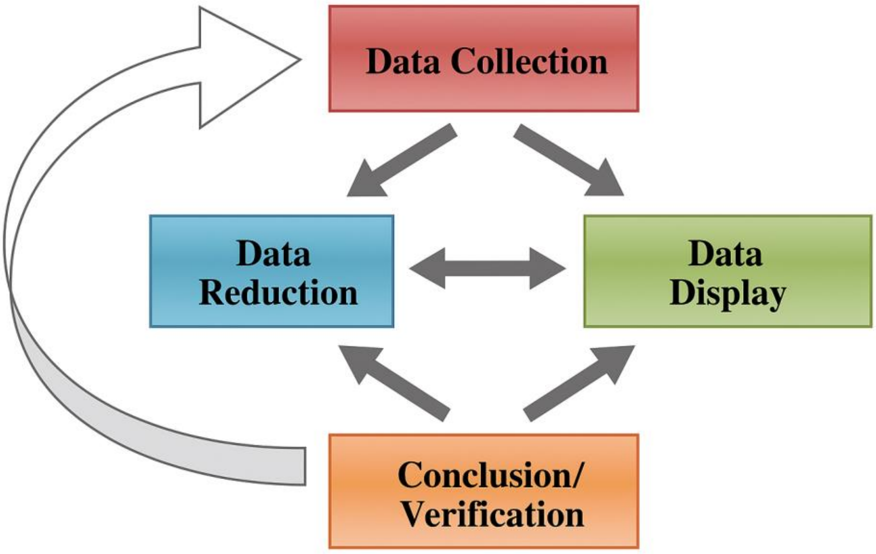


**Figure 1.** Interactive Model Image

**Data Validity Test**

Membercheck is used as a data validity test in research on product defect control at PT. X. According to Pardede & Sinaga (2020) member check is an activity carried out in providing re -confirmation to the informant for the suitability of the information obtained to re -confirm the validity of the information [15].

Member checking is an important thing to do to test the correctness of the data and information obtained by researchers. Membercheck will be given to informants to provide an assessment of whether there are deviations in sentences that have been examined during the interview process or differences in views between the researcher and the informant. With member checking, the research that has been carried out can be proven to be correct because it is based on the informant's point of view anddata from the informants themselves

## 4. Results and Discussion

### Check-sheet Results

As explained in the previous chapter, the first step in the calculation uses the SQC method, namely the Checksheet table. This table is processed by collecting production data on defective products to be studied and then processing the data again into a structured table. The checksheet aims to facilitate the data collection process in analyzing defect product damage data on STPP Food Grade & Technical Grade products. The following is a checksheet table for STPP Food Grade products for the 2022 period:

**Table 3.** Data on production quantities and types of STPP Food Grade product defects

| Month | Production Amount (Tons) | Low Quality (Tons) | Clot (Tons) | Rough/less smooth texture (Tons) | Total | Percentage % |
|---|---|---|---|---|---|---|
| January | 435,750 | 108,675 | 18,139.2 | 90,535.8 | 217,350 | 50% |
| February | 633,750 | 94,387 | 54.113 | 67,500 | 216,000 | 34% |
| March | 45,000 | 15,918.5 | 0 | 13,581.5 | 29,500 | 66% |
| April | 275,450 | 75,504.9 | 8,891.1 | 39,254 | 123,650 | 45% |
| May | 65,400 | 53,400 | 0 | 0 | 53,400 | 82% |
| June | 351,650 | 45,429.7 | 16,214.5 | 61,605.8 | 123,250 | 35% |
| July | 474,350 | 61,891 | 39,350 | 26,109 | 127,350 | 27% |
| August | 27,000 | 17,167.4 | 9,832.6 | 0 | 27,000 | 100% |
| September | 238,900 | 90,172.25 | 88,653.45 | 60,074.3 | 238,900 | 100% |
| October | 62,000 | 22,957 | 11,457 | 11,586 | 46,000 | 74% |
| November | 447,250 | 224,933.34 | 55,737.48 | 92,579.18 | 373,250 | 83% |
| December | 33,750 | 3,435.3 | 4,231.7 | 3,333 | 11,000 | 33% |
| **Total** | **3,090,250** | **813,871.39** | **306,620.03** | **466,158.58** | **1,586,650** | **729%** |

Based on Table 3, it is known that there are 1,586,650 tonnes of products that do not comply with established standards from the total production amount. Three types of defects were found in food grade sodium tri polyphosphate products, namely, below quality products amounting to 813,871 lumpy products 306,620.03 and rough textured products 466,158.58. From total production of around 3,090,250 tons per year 2022

The results of this check sheet show that the non-conformity value of this product can be categorized as high because it reaches 729% of the total production defects in a year.

### Histogram Results

After the check sheet is created, the next step is to create a histogram. This histogram is useful for seeing the types of damage that occur most frequently. The following is a Histogram created based on table 3.

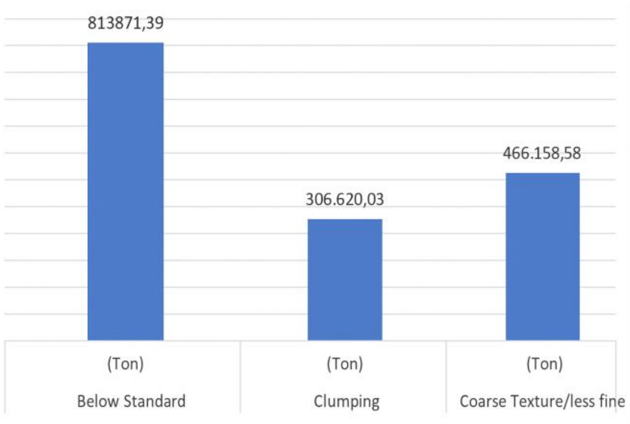


**Figure 2**. Histogram of defective products for the period 2022

Based on Figure 2 above, we can see that the type of damage that most often occurs is substandard quality in sodium tri polyphosphate products, with the highest number of defects at 813,871.39 tons, lumpy products at 306,620.03 tons, and rough textured products at 466,158.58 tons. The results of this check sheet show that the condition of the products with the most defects is in the lower quality category of sodium tri polyphosphate products.

### Pareto Diagram

**Table 4.** Number of Defect Frequencies for the 2022 Period

| No. | Defect Type | Amount (Tons) | Percentage | Cumulative percentage |
|---|---|---|---|---|
| 1. | Below quality | 813,871.39 | 51% | 51% |
| 2. | Rough textured | 466,158.58 | 29% | 81% |
| 3. | Clot | 306,620.03 | 19% | 100% |
| | Total | 1,586,650 | 100.00% | |

Based on the table 4, Pareto diagram is created as follows :

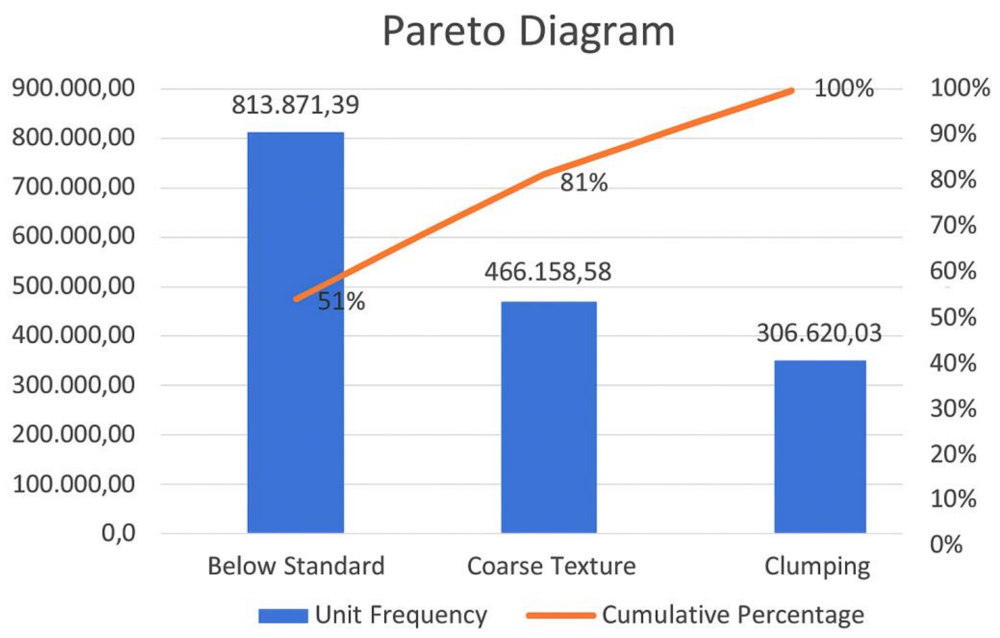


**Figure 3**. Pareto Chart

From the results of the Pareto diagram above, it can be seen that defective products in the production of STPP Food Grade & Technical Grade products for the 2022 period are dominated by products with standards below quality with a percentage of 51%. And the cumulative percentage is 51%, then the product with a rough texture is 29%, and the cumulative percentage is 81%, and the lumpy product is 19% and the cumulative percentage is 100.00%.

The results of this Pareto diagram show the cumulative percentage of the three types of defects, namely substandard quality, rough textured products, and lumps caused by the quality of raw materials and uneven mixing of raw materials and lack of supervision from production operators. Therefore, this analysis focuses on substandard products with the highest percentage of defects, where if this happens it can cause losses. These losses are caused by defective products that are below quality and will be sold at prices below the company's market.

## Control Chart Results

Control charts are intended as a static calculation analysis tool. The steps for calculating the P control chart are as follows:

Calculation of damage percentage, with formula below

$$P = \frac{np}{n}$$

Note:
np : Number of failures in sub group
n : Number checked in sub group
Sub group: 3rd month

So the calculation is as follows:
Sub group 1: $P = \frac{np}{n} = = 0.249397 \frac{108.675}{435.750}$
Sub group 2: $P = \frac{np}{n} = = 0.148934 \frac{94.387}{633.750}$
Sub group 3: $P = \frac{np}{n} = = 0.35374 \frac{15.918,5}{45.000}$
Sub group 4: $P = \frac{np}{n} = = 0.274114 \frac{75.504,9}{275.450}$
Sub group 5: $P = \frac{np}{n} = = 0.816513 \frac{53.400}{65.400}$
Sub group 6: $P = \frac{np}{n} = = 0.129190 \frac{45.429,7}{351.650}$
Sub group 7: $P = \frac{np}{n} = = 0.130475 \frac{61.891}{474.350}$
Sub group 8: $P = \frac{np}{n} = = 0.635829 \frac{17.167,4}{27.000}$
Sub group 9: $P = \frac{np}{n} = = 0.377447 \frac{90.172,25}{238.900}$
Sub group 10: $P = \frac{np}{n} = = 0.370274 \frac{22.957}{62.000}$
Sub group 11: $P = \frac{np}{n} = = 0.502925 \frac{224.933,34}{447.250}$
Sub group 12: $P = \frac{np}{n} = = 0.101786 \frac{3.435,3}{33.750}$

Calculating the center line (CL)
The center line is the average product damage. With formula below
$CL = \bar{p} = \frac{\sum np}{\sum n}$

Note :
$\sum$ np: Total number of defects
$\sum$ n: Total number checked

So the calculation is:
$CL = \bar{p} = \frac{\sum np}{\sum n} = \frac{813.871,39}{3.090.250} = 0.26336$

Calculating the Upper Control Limit (UCL)
To calculate the upper control limit or UCL, use the formula:
$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

Note:

$\bar{p}$: average product nonconformity
n : production quantity

The calculation is:

UCL = $\bar{p} + 3\sqrt{\frac{\bar{p}\,(1-\bar{p}\,)}{n}}$=0.26336+3 = $\sqrt{\frac{0,26336(1-0,26336)}{3.090.250}}$0.264112

Calculating the upper control limit or Lower Control Limit (LCL)
To calculate the upper control limit or LCL, use the formula:

UCL = $\bar{p} + 3\sqrt{\frac{\bar{p}\,(1-\bar{p}\,)}{n}}$

Note:
$\bar{p}$: average product nonconformity
n : production quantity

So the calculation is:

LCL = $\bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p}\,)}{n}}$=0.26336-3 = $\sqrt{\frac{0,26336(1-0,26336)}{3.090.250}}$0.262608

The calculation results with the P control chart are as follows:

**Table 5.** Calculation of Control Limits for the 2022 Period

| Month | Production quantity | Number of defects | Proportion of defects (P) | CL | UCL | LCL |
|---|---|---|---|---|---|---|
| January | 435,750 | 108,675 | 0.249397 | 0.26336 | 0.264112 | 0.262608 |
| February | 633,750 | 94,387 | 0.148934 | 0.26336 | 0.264112 | 0.262608 |
| March | 45,000 | 15,918.5 | 0.35374 | 0.26336 | 0.264112 | 0.262608 |
| April | 275,450 | 75,504.9 | 0.274114 | 0.26336 | 0.264112 | 0.262608 |
| May | 65,400 | 53,400 | 0.816513 | 0.26336 | 0.264112 | 0.262608 |
| June | 351,650 | 45,429.7 | 0.129190 | 0.26336 | 0.264112 | 0.262608 |
| July | 474,350 | 61,891 | 0.130475 | 0.26336 | 0.264112 | 0.262608 |
| August | 27,000 | 17,167.4 | 0.635829 | 0.26336 | 0.264112 | 0.262608 |
| September | 238,900 | 90,172.25 | 0.377447 | 0.26336 | 0.264112 | 0.262608 |

| Month | Production quantity | Number of defects | Proportion of defects (P) | CL | UCL | LCL |
|---|---|---|---|---|---|---|
| October | 62,000 | 22,957 | 0.370274 | 0.26336 | 0.264112 | 0.262608 |
| November | 447,250 | 224,933.34 | 0.502925 | 0.26336 | 0.264112 | 0.262608 |
| December | 33,750 | 3,435.3 | 0.101786 | 0.26336 | 0.264112 | 0.262608 |
| **Total** | **3,090,250** | **813,871.39** | | | | |

Because P (proportion of defects) is more between the UCL and LCL, the process capability is running well, so it can explain that the process capability is able to meet the desired tolerance limit specifications but requires strict control because there are several samples that are above the UCL.

Based on the calculations above, a control chart p can then be created which can look like the following image:

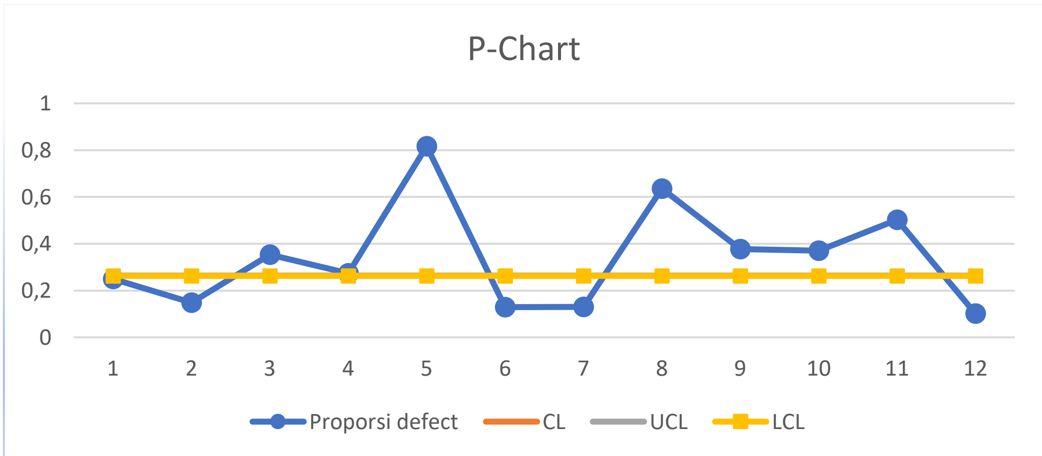


**Figure 4.** Control Map P Proportion of Product Defects for the period 2022

Based on Figure 5 above, the "P" line has seven period points which are located above the UCL (Out of Control) which is shown by the blue line passing through the gray line and the "P" line has four period points which are located above the LCL ( The Lower Control Limit line is yellow, so the defect must be controlled immediately because it is not within the tolerance limit.

## Fishbone Diagram

A cause and effect diagram shows the relationship between the problem faced and the factors that influence it and the possible causes. Common causes of product failure can be classified into the following categories:

a. Man
   The workers who are involved in the production process.
b. Material
   Everything used by the company as a component of the product to be produced consists of main raw materials and auxiliary raw materials.
c. Machine
   Machines and various equipment used in the production process.
d. Method
   Work instructions or work orders that must be followed in the production process.
e. Environment
   Circumstances surrounding the company that directly or indirectly affect the company in general and affect the production process in particular.

Fishbone diagrams aim to analyze problems that cause failure during production and make improvements if necessary. The results of observations made at PT. X found the cause of product failure can be seen in figure 5, 6, and 7

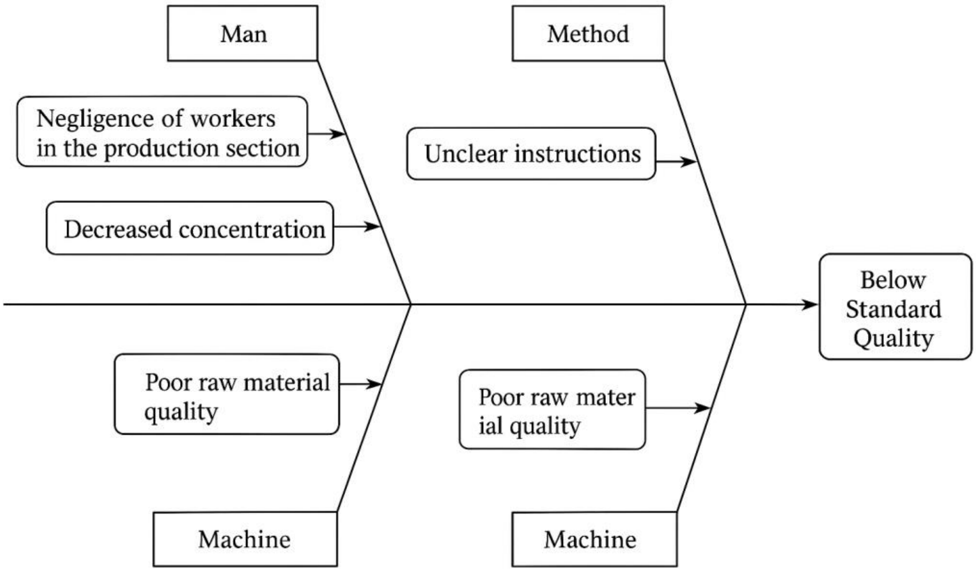


**Figure 5.** Fishbone diagram of causes of substandard quality

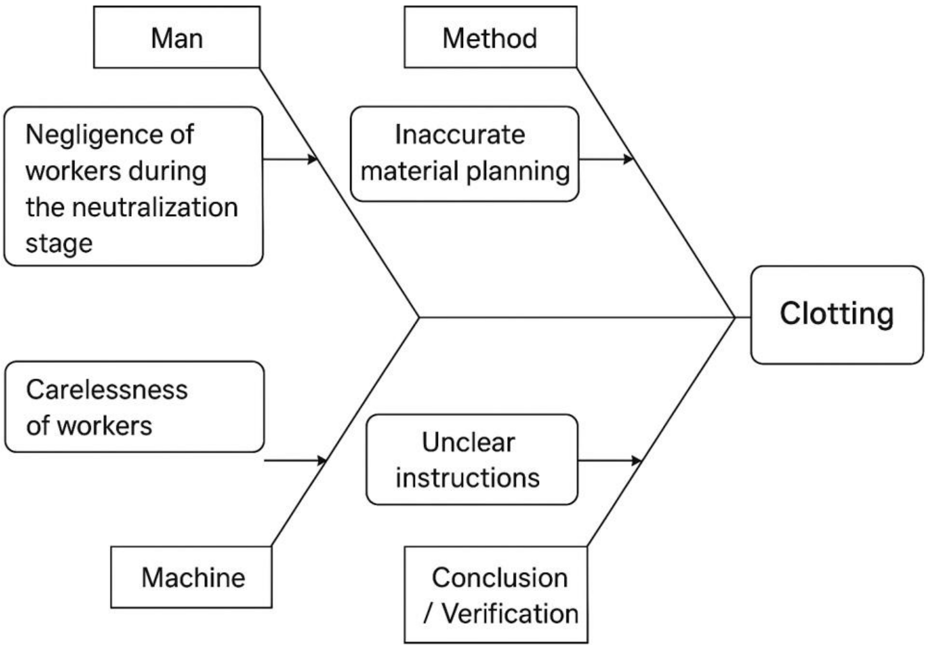


**Figure 6.** Fishbone diagram of lumpy products

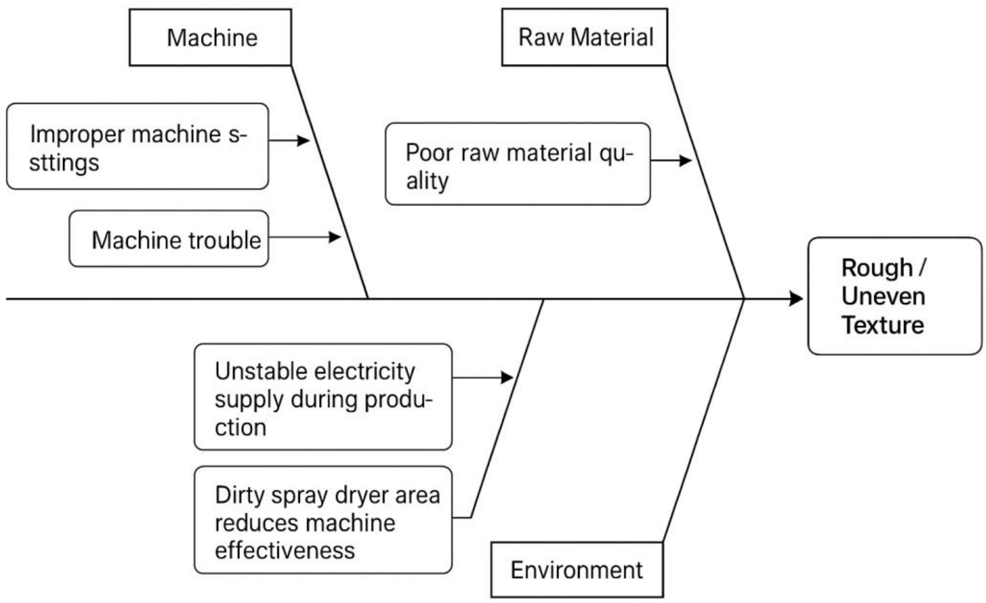


**Figure 7.** Fishbone diagram for products with a rough/less smooth texture

Figure 5 shows that 51% of defective products caused by substandard quality in the 2022 period have become the dominant cause of sodium tri polyphosphate products at PT. X. Therefore, it is worthy of special attention to overcome further losses from the non-examination of operators at work and some environmental factors and tools that help the defect.

This lumpy product defect (figure 6) is the result of a product that is not shaped like powder. There are lumps at the end of the process so it is not suitable for sale. This defect is not the responsibility of the production division, however checking and adding the right raw materials is very helpful in reducing the possibility of defective products. Products that clot in the 2022 period are 19%. Various external to internal factors are involved, starting from people whose job rotation causes negligence at work to poor machines and inappropriate work methods which trigger employee performance to become less focused which can damage production results.

Product defects that have a rough or less smooth texture (figure 7) are the result of an imperfect process that makes the product rough. Products with a rough texture in the 2022 period are 29%. The main factor causing this defect is the machine, which is less than optimal and the lack of a supporting environment causes the product produced to be less than optimal during the production process.

Based on observing the fishbone diagram image above, product defects are mainly caused by machines, employees, raw materials, methods and the environment. Machines and raw materials most influence the occurrence of less than optimal final products and less thorough employee performance. These factors are the main causes that influence weaknesses in the production process, giving rise to product defects in sodium tri polyphosphate products.

**Table 6.** Proposed Improvements for Reducing Quality Defects below Quality

| No. | Source of Cause | Causative factor | Suggestions/ Recommendations |
|---|---|---|---|
| 1. | Man | 1. Negligence of production workers.<br>2. Decreased concentration. | 1. Providing stricter supervision in the production section.<br>2. Provide direction to production workers about the importance of quality.<br>3. Give warnings to workers if they make mistakes. |
| 2. | Raw material | 1. The quality of raw materials is not good. | 1. Buying raw materials must be more careful and thorough.<br>2. Evaluate supplier performance |
| 3. | Machine | 1. The machine settings are not quite right.<br>2. Machine jammed. | 1. Carrying out regular maintenance on production machines.<br>2. Provide regular lubrication without waiting for the engine to jam<br>3. Repairing machines whose settings are incorrect |
| 4. | Method | 1. Instructions not clear | 1. Provide clear direction regarding SOPs, which apply to avoid errors.<br>2. Provide sanctions to careless workers |

**Table 7.** Proposed Improvements for Reducing Lumpy Defects

| No | Source of cause | Causative factor | Suggestions/Recommendations |
|---|---|---|---|
| 1. | Man | 1. Worker negligence during the neutralization stage.<br>2. Worker carelessness. | 1. Provide guidance during the neutralization stage so that it remains maintained and avoids clumping.<br>2. Provide motivation and bonuses for workers who work well.<br>3. Provide sanctions or warnings if repeated mistakes are made. |
| 2. | Method | 1. Instructions not clear.<br>2. Inaccurate raw material planning. | 1. When giving instructions, they must be clear and according to SOP, and easy for workers to understand. |

| No | Source of cause | Causative factor | Suggestions/Recommendations |
|---|---|---|---|
| 3. | Machine | 1. The machine settings are not quite right.<br>2. Machine trouble | 1. Carrying out regular maintenance on production machines.<br>2. Provide regular lubrication without waiting for the engine to jam.<br>3. Repairing machines whose settings are incorrect. |

**Table 8.** Proposed Improvements for Reducing Defects in Rough/Less Smooth Textured Products

| No | Source of Cause | Causative factor | Suggestions/Recommendations |
|---|---|---|---|
| 1. | Machine | 1. The machine settings are not quite right.<br>2. Machine trouble | 1. Carrying out regular maintenance on production machines.<br>2. Provide regular lubrication without waiting for the engine to jam.<br>3. Repairing machines whose settings are incorrect. |
| 2. | Raw material | 1. The quality of raw materials is not good. | 1. Buying raw materials must be more careful and thorough.<br>2. Evaluate supplier performance |

## 5. Conclusion

Based on the data that has been analyzed along with the discussion described in the previous chapter, the author draws the following conclusions :

1. Based on the cheek sheet and Pareto diagram, it can be concluded that the types of damage that often occur in the sodium tri polyphosphate production process at PT. X is a type of quality damage below quality with a total damage of 813,871.39 tons or 51%damage, coarse -textured damage of 466,158.58 tons or 29%, lumpy damage amounted to 306,620.03 or 19%.
2. Based on control chart P, implementation of quality control at PT. X has 3 stages of control, namely control in the first stage of pre-purification, the second stage of purification, and the third stage of neutralization. The use of statistical tools with P control charts in product quality control can identify that product quality is outside control limits or the production process is still in deviation. This means that special cause variations do not exist, then the remaining variations are solely caused by general cause variations.
3. Factors that cause defective products are old machines, employee performance, monitoring methods, and cotton raw materials. The main causal factor is the machine, meaning the machine most influences the final product. Then followed by employee factors, method

factors and raw material factors as other causes that form the final product. So the older the machine used, the more defective products it produces and vice versa. The worse the employee's performance, the more defective products there are, and vice versa. The weaker the monitoring methods carried out by company management, the more product defects there will be. If the company is less careful in selecting raw materials, it will cause more defective products.

## References


[1] Akbar, DC (2018). Analysis of Sugar Product Quality Control Using Statistical Quality Control (SQC) at PT. Pathbe Agronik Indonesia, Cilacap, Central Java. Journal of the Islamic University of Indonesia.

[2] Andespa, I. (2020). Quality Control Analysis Using Statistical Quality Control (SQC) at Pt. Pratama Abadi Industri (JX) Sukabumi. Udayana University E-Journal of Economics and Business, 129. https://doi.org/10.24843/EEB.2020.v09.i02.p02

[3] Ardiansyah, R., Rizqi, AW, & Kurniawan, Moh. D. (2022). Quality Control Using Statistical Quality Control (SQC) Approach On Bag Products of UD. FGH. MOTIVECTION: Journal of Mechanical, Electrical and Industrial Engineering, 4(2), 129–140. https://doi.org/10.46574/motivection.v4i2.118

[4] Anwar, MK (2023). Analysis of Stick Production Quality Using the SQC (Statistical Quality Control) Method. Mabisya Journal, 4(1), 49-58.

[5] Cresswell, & John W. (2019). Qualitative Research & Research Design Choosing Among Five Approaches. Yogyakarta: Learning Library.

[6] Carmelita, F. (2022) Quality Control Analysis of Aluminum Spatula Products in Pekanbaru (Case Study of Yansen Business), Riau Thesis, Riau Islamic University.

[7] Darmawan, MR, Rizqi, AW, & Kurniawan, MD (2022). Analysis of Tempe Product Quality Control Using the Statistical Quality Control (SQC) Method at CV. Aderina. 19(22).

[8] Efendi, Suryono, Djoko Pratiknyo, & Edi Sugiono. (2019). Operational Management. Jakarta: LPU-UNAS.

[9] Fairus. (2020). Analysis of Internal Control Over Payroll Systems and Procedures in Efforts to Support Labor Cost Efficiency at PT Pancaran Samudera Transport, Jakarta. Thesis, STIE Indonesia. Url: http://repository.stei.ac.id/2172/. (Accessed December 20, 2023).

[10] Fauzi, Ahmad, et al. (2022). Research methodology. Banyumas: CV Pena Persada.

[11] Ismail, N., & Setiafindari, W. (2023). Proposed Quality Improvement of Lotus Golf Gloves Using Statistical Quality Control and 5W+1H Methods. Scientific Journal of Mechanical, Electrical and Computer Engineering, 3(2), 215–228. https://doi.org/10.51903/juritek.v3i2.1714

[12] Kumalaningrum, Maria Pampa, Heni Kusumawati, & Rahmat Purbandono. (2010). Operation management. Yogyakarta: YKPN College of Economics.

[13] Khoirunnisa, AA (2019) Quality Control Analysis in Efforts to Minimize Product Defects Using the Six Sigma Method in Printing and Screen Printing Companies, Ponorogo Thesis, Muhammadiyah University Ponorogo.

[14] Nugroho, BWD, Jakti, NJK, Rochman, MAN, & Nugroho, J. (2023). Analysis of Sugar Product Quality Control and Quality Costs in Supporting Production Effectiveness (Case Study: PT Madu Baru Pg Madukismo). 2(2).

[15] Pardede, PS, & Sinaga, CJS (2020). Analysis of Coffee Quality Control in Ksu Pom Humbang Cooperative Production Using Statistical Quality Control Methods. Journal of Creative Industries (JIK), 4(01), 79–88. https://doi.org/10.36352/jik.v4i01.24

[16] Prawirosentono, Suyadi. (2002). New Philosophy of Integrated Quality Management in the 21st Century Case Study and Analysis. Jakarta: Bumi Literacy. Jakarta.

[17] Rucitra, AL, & Fadiah, S. (2019). Application of Statistical Quality Control (Sqc) in Telon Oil Quality Control (Case Study at PT. Agrointek, 13(1), 72. https://doi.org/10.21107/agrointek.v13i1.4920

[18] Rosid, HA (2019). Analysis of Product Quality Control Using the Statistical Processing Control (SPC) Method at the Company PT. TMMIN. Bekasi. Thesis, Pelita Bangsa University Bekasi.

[19] Saputra, D., & Reinjauli, R. (2019). Cement Product Quality Control Through the Statistical Quality Control (SQC) Approach (Case Study at PT. Semen Baturaja). Integration: Scientific Journal of Industrial Engineering, 4(1), 24. https://doi.org/10.32502/js.v4i1.2095

[20] Sari, IGAAH, & Sudiartha, GM (2019). Quality Control of the Arabica Coffee Production Process at UD. Cipta Lestari in Pujungan Village. Udayana University Management E-Journal, 8(4), 2495. https://doi.org/10.24843/EJMUNUD.2019.v08.i04.p22

[21] Sinaga, STD, Putri, SH, & Pujianto, T. (2023). Analysis of Quality Control in the Black Tea Production Process Using Statistical Quality Control Methods. TEKNOTAN, 17(2), 153. https://doi.org/10.24198/jt.vol17n2.10

[22] Sugiyono. (2022). Qualitative Research Methods and R&D. Bandung: Alphabeta.

[23] Sahara, L., Lestari, SP, & Barlian, B. (2023). Analysis of Product Quality Control Using the Statistical Quality Control (SQC) Method at the Aldina Bakery Bread Company, Tasikmalaya City. PPIMAN: Center for Management Science Publications, 1(4), 214-231.