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Product quality control by implementing statistical process control in qobidh cassava chip MSMEs in Tebing Tinggi City

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ABSTRACT

Globalization has become the main driver for the wave of information and technological innovation, stimulating the transformation of consumers to become more sensitive to quality standards and the value of the products offered. This research aims not only to explore how quality control utilizes sophisticated statistical tools in curbing the level of product defects in the corporate environment, but also as an important milestone in understanding the dynamics of change in an increasingly connected era of globalization. This research uses the Statistical Process Chart method. In an effort to control quality, statistical analysis becomes the main weapon, with check sheets and histograms acting as navigation that leads to understanding complex data. The control chart p becomes a sentinel that monitors the traces of defective products, keeping them within the desired statistical control limits. However, it is not enough to simply observe; The next step is to explore the root of the problem, which is depicted through a cause-and-effect diagram that details the factors of materials, labor, machines and production methods as the main determinants of the success or failure of a product. The analysis results show that even within control limits, real challenges arise from factors that are the main triggers for product damage, such as remaining pieces which cause damage of 29,160 grams, followed by damage due to crushing of 2,900 grams. From here, conclusions and recommendations develop, guiding improvement steps to ensure quality standards are maintained, in line with increasingly stringent and diverse global market demands.

Keywords: Defect; quality control; statistical process control

1. INTRODUCTION

Micro, Small and Medium Enterprises (MSMEs) are productive efforts owned by business entities and/or individuals with predetermined standards [1]. Just as Micro, Small and Medium Enterprises (MSMEs) have an important function for economic development and growth in Indonesia. Sourced from data from the Ministry of Cooperatives and MSMEs, the number of MSMEs in Indonesia has increased every year until in 2018 the number of MSMEs was 64,194,057 businesses and has contributed a portion of income to Indonesia's Gross Domestic Product (GDP) with total income now reaching Rp. 5, 7 trillion per year [2]. This shows the importance of the government paying attention to MSMEs to continue to survive.

According to [1], [3]–[5] Micro, Small and Medium Enterprises (MSMEs) have a significant role in the Indonesian economy, this is because the majority of small and medium entrepreneurs come from home or family industries, so consumers also come from the lower middle class. According [6] stated that customers who definitely want the product they want to buy will be able to satisfy the customer's desires and needs so that customers hope that the product will be in good condition and maintained.

Therefore, entrepreneurs need to monitor and protect so that the quality of the goods they produce is maintained and accepted by customers so they can compete in the market.

SPC implementation is done in Industry on Bitter Tannin Tea Tin product to overcome defect rate [7]. SPC is also applied in Manufacturing Industry to improve quality performance [8]. Quality control in companies, both services and manufacturing, is very much needed. The industry itself must also have an orientation to maintain the quality of its goods or services on the market, so that it is able to meet consumers' needs or desires [9]. Quality control must be maintained effectively and optimally because it directly affects the quality of the products produced. Quality standards include raw materials, production processes and finished products [10]–[12]. Referring to this statement, quality control should be carried out from upstream to downstream, which can be done during processing of raw materials, production activities, until the results meet standards. Referring to [13], the quality of an output produced is something that is very dependent on conditions or circumstances. In addition, customers' perspectives depend on their own subjective point of view, where they consider good quality to be that which suits their needs and preferences (suitability for use). Apart from that, an item can be said to be of quality if the item is suitable for the customer [14], [15]. The quality of the goods produced by the company is determined according to the characteristics and measurements that have been determined.

Even though production methods have been implemented well, defects still often occur in the field where the quality of the goods produced does not meet the established standards [16]. An industry can be said to be quality if the company has controlled processes and good production process methods. With quality control, the company is expected to be able to increase effectiveness and supervision to prevent defective production and reduce the effectiveness of waste in terms of materials and labor and ultimately increase production capacity. This supervision becomes very important when a company is carrying out the production process of a product [17]. Therefore, the goods that will be produced will be of good quality if the supervision that must be carried out is also good. Tebing Tinggi, North Sumatra Province, certainly has development opportunities which are definitely a strategic location.

The problem that occurs with Qobidh Chips UKM, which is one of the UKMs that produces various variants of cassava chips with varying sizes and flavors, is that up to now the production process still has shortcomings that can cause defects in the product so that the product cannot be sold to customers. The damage referred to is the presence of goods that are not created in accordance with established standards [18], [19]. According to consumers, a good quality standard is that goods can function according to consumer needs. If the buyer feels that the item cannot function according to the buyer's needs, the item can be said to be a damaged/defective product [20].

The main objective to be achieved through the implementation of this research is to conduct a more in-depth study and provide a comprehensive picture of how at the Product Quality Control stage at the Qobidh Cassava Chip UKM in Tebing Tinggi City, the Statistical Process Control (SPC) method was applied in an effort to achieve target

2. METHOD

This research will involve a series of methodological steps that have been designed in detail, as outlined below:

In carrying out this research, a descriptive approach was used which was then enriched by the use of quantitative analysis as the main component that supports the research process. The field study was carried out to observe the general condition of the company, especially Product Quality Control at the Qobidh Cassava Chip UKM. The goal is to understand the description of product quality and its control in depth. Literature studies were carried out by formulating theories based on previous scientific publications to develop Statistical Process Control (SPC) analysis methods to handle company problems. This research activity was carried out at Qobidh Cassava Chip UKM in Tebing Tinggi City, located on Jl. Raya Sipis-pis, Serdang Bedagai, Sipis-pis District, North Sumatra. This research began after a comprehensive new change [21]. Primary data obtained from direct interviews with chip business owners and also employees. Meanwhile secondary data obtained from company information and supporting literature and references. Observation, this method involves direct observation at the location with the aim of obtaining information about existing systems. Observations in this research were carried out in order to understand the production process from start to finish

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through to quality control activities. Documentation, involves examining and recording reports and related documents from the company. Interview, using verbal communication to obtain information from sources. Data analysis, in research, data collection was carried out using tools in the Statistical Process Control (SPC) section. The methods used were as follows:

- Record production data and defective products (Chee Sheet) and namely by collecting all production data obtained from the company and then processing it into a structured table. This is done to make it easier to find out the total of each disability.
- Create a histogram so that it can be read or explained with fast data. Then, this information must be presented in the form of a histogram, which is a visual way to display data in the form of a bar graph that depicts the frequency distribution of various types of defects in the production process.
- Create a Control Map using (P-Chart) in analyzing this research data. A control chart (damage proportion control chart) is used as a tool for controlling the statistical process. The use of a p control chart was chosen because the quality control applied refers to attributes, while the data taken as an observation sample is unstable, and damaged products can still be repaired and therefore need to be rejected. The following are the stages in creating a p control chart:

  a. Determine the center line (CL), which is the average value of product damage (p).

$$L = p = \frac{\sum np}{\sum n} \tag{1}$$

Where:
∑np : Total number of damaged items
∑n : Total number checked

b. Calculate the upper control limit (UCL) using the formula

$$UCL = p + 3 = \frac{\sqrt{p(1-n)}}{n} \tag{2}$$

Where:
p : average product damage
n : total group/sample

c.Calculating the lower control limit (LCL).

$$UCL = p - 3 = \frac{\sqrt{p(1-n)}}{n} \tag{3}$$

Where:
p: Average product damage
n : production amount

Note: if LCL < 0 then LCL is considered = 0. If it is seen that the data obtained contains data that is not within the control limits, then the data is not uniform. This shows that the quality control implemented by UKM Qobidh Chips still requires improvement. This can be observed on the p-chart diagram when there are points that fluctuate inconsistently, indicating deviations in this production process. The Control Map really helps us to identify the type of damage to the product produced. The type of damage can certainly occur in the product produced. Look for the most dominant causal factors using a diagram, namely cause and effect. Apart from that, if the problem is known using a histogram, factor analysis can be carried out, namely damage, using a Cause and Effect Diagram to find the causal factors.

3. RESULT AND DISCUSSION

Cassava chip production process at UKM Qobidh Cracker

The process of producing cassava chips from sweet potatoes involves selecting quality raw materials, including mixtures such as salt, chilies and spices for flavor variations. The goal is to produce high quality cassava chips products that satisfy customers with a distinctive taste. This process greatly determines the final quality of the product, which is expected to be accepted in various market sectors. The complete manufacturing stages can be seen in the following Figure *1*.

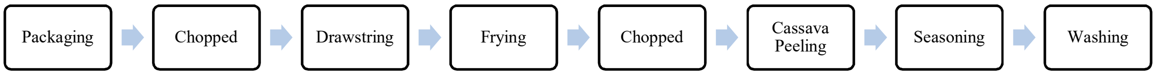

Figure 1. Cassava chips production process

In general, the process of making cassava chips products "Qobidh Cracker" can be explained as follows peeling cassava is an initial process that must be carried out before the next process, as well as a process carried out to remove the skin first. Peeling the skin is an important process to reduce the possibility of contamination by chemical substances that are harmful to the body. Apart from that, stripping can be done in an efficient manner if the small amount of loss of a commodity is acceptable. It is important to pay attention to this process because it prevents fruit flesh from being wasted, which can result in a decrease in quality during the production process. Overall, the peeling process is carried out to remove the outer parts of the fruit that are unwanted or not needed in the production process. Washing the cassava that has been followed is washed with water until all the dirt is clean. After that, the cassava is washed with clean water to ensure that the dirt attached to the surface is completely removed. Draining is a method for removing or removing some of the water from a material by leaving it for 1 minute. The cassava that has been washed is then sliced thinly using a knife or cutting tool to produce slices of uniform thickness. You can then fry the chopped cassava, but the cooking oil must be really hot (± 160-200°). Fry until the sliced cassava is yellow or for 10 minutes. Currently, the models of cassava chips vary in various flavors, and if the chips are produced like that, then the condition of the chips before being removed from the fryer will affect the quality, so you need to pay closer attention. After frying the cassava chips, then process them for a few minutes using a spinner. This seasoning is done after slicing the cassava chips, then after that they are mixed with the available spices, in this seasoning process they must be combined and even. Before packaging, the cassava chips are left to cool. Then put them in plastic with a thickness of 12, cassava chips weighing 100 grams can be packaged in plastic measuring 20x25cm, while those measuring 200 grams can be packaged in plastic of a different size.

Check sheet

The check sheet itself can be the first step that must be taken to statistically quantify our quality control process. This check sheet is a tool that can facilitate the data collection process to the analysis process at the end. Besides that. Analysis using check sheets is also useful for showing problems in detail and based on the frequency of whether or not the cause of the problem occurs, so that decisions can be taken. In the production process, damage is certainly not limited to one type, but can be of various types. So therefore. The check sheet can show the types of damage that often occur in the production process, where the dominant damage can be identified. The data results from the check sheet that have been carried out can be seen in the following Table *1*.

Table 1. Data results via check sheet

Date	Production Amount (gr)	Damage Amount		Total Damage Amount (gr)
		Crumble (gr)	The remaining pieces (gr)	
1	**0**	**0**	**0**	**0**
2	10000	110	1140	1250
3	10000	130	1060	1190
4	12000	130	1430	1560
5	10000	130	1150	1280
6	10000	120	1010	1130
7	10000	120	1110	1230
8	**0**	**0**	**0**	**0**
9	12000	120	1310	1430
10	10000	100	1080	1180
11	10000	90	1040	1130
12	12000	150	1400	1550
13	10000	100	1100	1200
14	10000	130	1170	1300

15	**0**	**0**	**0**	**0**
16	10000	90	1210	1300
17	10000	110	1170	1280
18	12000	120	1320	1440
19	10000	130	1110	1240
20	10000	100	1030	1130
21	10000	130	1040	1170
22			**0**	**0**
23	10000	90	1040	1130
24	10000	100	1050	1150
25	12000	130	1400	1530
26	10000	130	1060	1190
27	10000	100	1190	1290
28	10000	110	1150	1260
29	**0**	**0**	**0**	**0**
30	12000	130	1390	1520
Total	262000	2900	29160	32060

Based on Table *1* the production volume for 30 days was 262,000 pcs and the reject rate was 32,060 pcs. This means that the percentage for the defect rate is 12 percent. This exceeds the company's defect target limit. Improvement is needed to reduce the defect rate.

3.3. Histogram Chart

The histogram is the next step to find out again what damage is dominant. Damaged products can be presented in graphic form in the following Figure *2*.

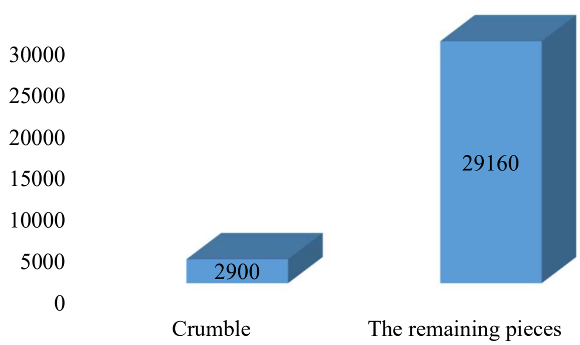

Figure 2. Diagram of damaged products

Through the Histogram Graph, it can be seen that there is damage or product defects that occur, namely damage due to remaining pieces amounting to 29,160 (Grams), then damage due to crushing amounting to 2900 (Grams).

Control chart p (P-Chart)

Next, it will be analyzed again to find out the extent of the damage that occurred after it was controlled (P-Chart). P Control Chart (P-Chart) is very useful in controlling the quality of the production process and provides an indication of when quality improvements must be made by management. As previously explained, the first step in creating a control chart is as follows:

- Calculate the damage percentage
- Calculate the center line of the Control Line (C L)
- Calculation of the upper control limit, or UCL (Upper Control Limit)

The complete results of the calculations based on the steps above are presented as Table 2.

Table 2. Control Map p (P-Chart)

Date	Production (gr)	Defect	Percentage of Defect (%)	CL	UCL	LCL
2	10000	1250	0.125	0.12237	0.13220	0.11254
3	10000	1190	0.119	0.12237	0.13220	0.11254
4	12000	1560	0.130	0.12237	0.13134	0.11339
5	10000	1280	0.128	0.12237	0.13220	0.11254
6	10000	1130	0.113	0.12237	0.13220	0.11254
7	10000	1230	0.123	0.12237	0.13220	0.11254
9	12000	1430	0.119	0.12237	0.13134	0.11339
10	10000	1180	0.118	0.12237	0.13220	0.11254
1 1	10000	1130	0.113	0.12237	0.13220	0.11254
12	12000	1550	0.129	0.12237	0.13134	0.11339
13	10000	1200	0.120	0.12237	0.13220	0.11254
14	10000	1300	0.130	0.12237	0.13220	0.11254
16	10000	1300	0.130	0.12237	0.13220	0.11254
17	10000	1280	0.128	0.12237	0.13220	0.11254
18	12000	1440	0.120	0.12237	0.13134	0.11339
19	10000	1240	0.124	0.12237	0.13220	0.11254
20	10000	1130	0.113	0.12237	0.13220	0.11254
21	10000	1170	0.117	0.12237	0.13220	0.11254
23	10000	1130	0.113	0.12237	0.13220	0.11254
24	10000	1150	0.115	0.12237	0.13220	0.11254
25	12000	1530	0.128	0.12237	0.13134	0.11339
26	10000	1190	0.119	0.12237	0.13220	0.11254
27	10000	1290	0.129	0.12237	0.13220	0.11254
28	10000	1260	0.126	0.12237	0.13220	0.11254
30	12000	1520	0.127	0.12237	0.13134	0.11339
Total	262000	32060				

Based on the calculation results from the table above, the next step is to create a control chart p which is available in the following Figure 3

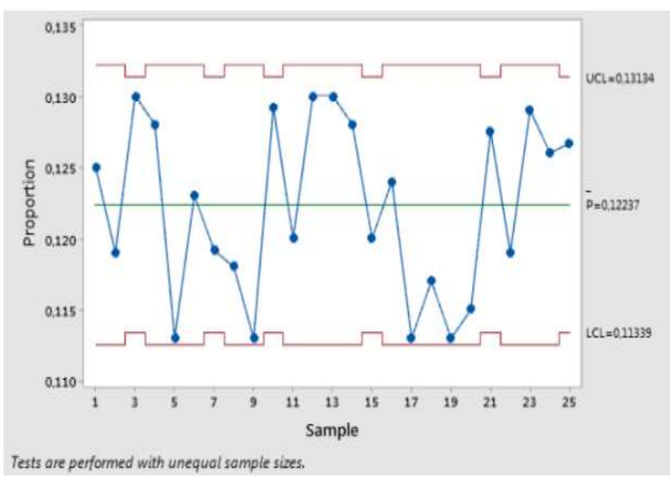

Figure 3. Control Map p

The results of processing using the p control chart show that the defective products produced during November 2020 did not exceed the specified process limits. Thus, it can be concluded that the process performance is within control limits, controlled and stable. Based on the control chart in the picture above, it was found that the product with a crushing defect was the lowest, while the residual defective product was 29,160 (grams) within 1 month. However, the overall product data is defective and goes beyond the established control limits. Obtained based on calculations, CL (Control Limit) is 0.12237, UCL (Upper Control Limit) is 0.13134 and LCL (Lower Control Limit) is 0.11339.

Cause and effect diagram (fishbone diagram)

The Fishbone Diagram or Cause and Effect Diagram is intended as an analysis tool for the factors that cause product damage, namely, there are several groups of factors, namely the causes of product damage in general, which include:

a. People are the parties who drive the production process.
b. Raw Materials (Materials), are elements or components in the process of producing finished products.
c. Machine (Machine), is a tool that functions as automation in the entire production chain.
d. Method, which is 1 step that needs to be considered in detail and applied in the production process.
e. Environment, namely the surrounding production area which can basically influence the process, directly or indirectly.

If we refer to the Histogram Diagram in Figure 2, there are two general types of damage that occur, namely the remaining pieces of the fruit, and the resulting chips that become crushed. Cause and Effect Diagrams can be used to trace these two types of damage. The following is a use of cause and effect diagram for crushed chips and scraps.

a. Crumble chips

Crushed chips are one type of defect that occurs in chips. This defect is a condition of chips that are destroyed, thus decreasing customer satisfaction. Some causes of this defect can be seen in Figure *4*.

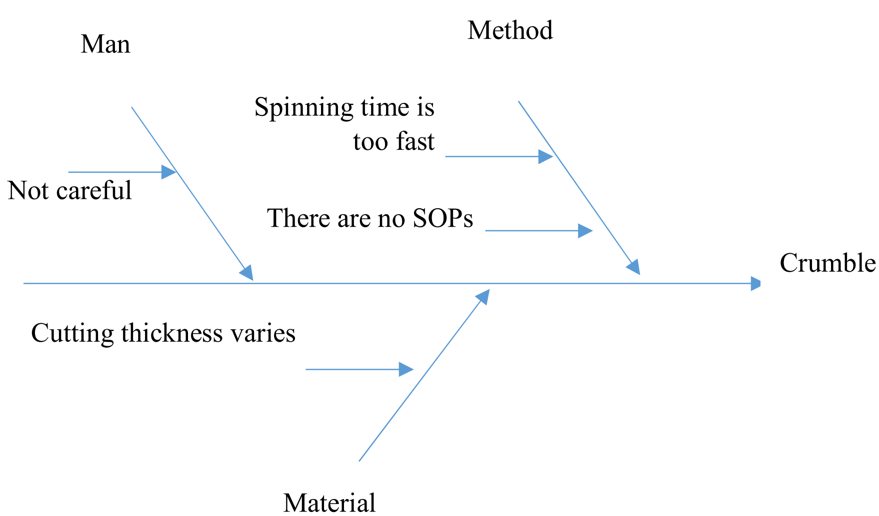

Figure 4. Fishbone diagram of causes and effects of crushed chips

Damage to chip production, such as cracked chips, is caused by the carelessness of workers who are sometimes distracted by other activities, thereby extending the spinning process time. On the other hand, uneven thickness of the pieces is also a cause of production failure. Apart from that, in the production process, UKM Qobidh Cracker also does not have an SOP.

b. Damage to residual pieces

Residual Pieces is one type of defect that occurs in chips. This defect is a condition of poor chip pieces that reduce customer satisfaction. Some causes of this defect can be seen in Figure 5.

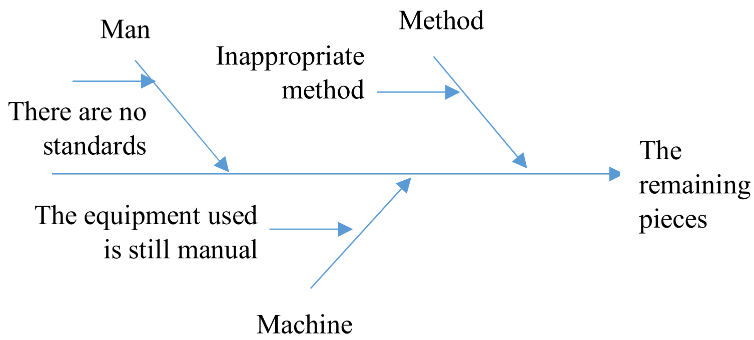

Figure 5. Fishbone diagram cause and effect of remaining pieces

A lot of leftover pieces of cassava are caused by workers who do not have standards in cutting and lack of supervision from business owners. On the other hand, cutting tools that are still manual are also the reasons for leftover pieces.

Factors that cause product damage/defects

There are four factors that can cause damage or defects to products produced by UKM Qobidh Crackers, namely methods, labor, raw materials and equipment. Damage in chip production, such as crumbling chips, is caused by several factors. One of them is the unevenness of the cutting results and the lack of focus of workers who are sometimes distracted by other activities, causing the spinning process to take too long. Apart from that, the lack of implementation of SOPs (Standard Operating Procedures) in the production process at UKM Qobidh Cracker is also the cause. Other damage, such as residual cuts, is caused by the use of manual cutting tools and the lack of standards applied by workers in carrying out cuts. Apart from that, lack of supervision from business owners also contributes to damage in production.

4. CONCLUSION

This research reveals that the application of the Statistical Process Control (SPC) method in Product Quality Control in Qobidh Cassava Chip UKM from the results of the p control chart (P-Chart) can be seen that product quality is still within the upper and lower control limits. These signs are reflected in the control chart graph, where each point remains within the established process limits. So it can be said that the performance of the production process is within control, controlled and stable limits. According to the histogram diagram data created, the level of product damage or defects that occurs most often is damage due to remaining pieces amounting to 29,160 (Grams), next is damage due to crushing amounting to 2,900 (Grams). Meanwhile, the total damage was 32,060 (grams) out of total production of 262,000 (grams) during November 2020. Based on the results of the cause and effect diagram analysis, the factors that cause damage to the production process can be identified, namely material/raw materials, workers, machines and methods. Researchers suggest conducting research using statistical tools for recent or previous years to compare the level of damage.

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