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STATISTICAL QUALITY CONTROL ON BREAD PRODUCTION USING PROCESS CONTROL CHART

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ABSTRACT: *In this study, the researchers analyze quality control of bread using attributes P-chart to meet in quality control statistics. The population of this study consisted of all types of bread created by My-Food bakery industry (chocolate bread, butter bread, and round bread), with a manufacturing capacity of 500 packs each day, resulting in a total population of 15000 packages for 30 days. The sampling strategy used in this study was a withdrawal of bread type samples based on judgment sampling and random sampling. Although My-Food bakery created five varieties of bread, the researchers only took three. We may deduce from the SPSS test normalcy that these three types of bread are still within a company's standard limit. Despite the fact that production is under control, the corporation must investigate the manufacturing machinery in order to avoid further faulty products.*

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INTRODUCTION

Consumers and the finished product cannot be isolated from the manufacturing process. Consumers undoubtedly anticipate that the commodities they purchase will be able to suit their requirements and aspirations, and that these products will be available in proper and assured conditions. As a result, businesses must ensure that the quality of their products is assured and approved by consumers in order to compete in the market. Consumers will trust you if you provide excellent service. Meanwhile, manufacturing must pay greater attention to the quality of the product results, necessitating quality control to determine whether the product faults created are still within acceptable limits. As we all know, quality control is critical in both service and manufacturing businesses. With the quality of services or items supplied, the producer intends to attract consumers and fulfill their wants and wishes.

Correctly performed quality control will have an effect on the final product's quality. The quality of the things manufactured is governed by distinct features. Although the manufacturing procedures have been successfully executed, there are still mistakes that the quality of the product produced does not meet the standard, or in other words, the product is damaged or faulty.

Good quality control is the source of the product's great quality. Many businesses utilize specialized ways to make high-quality goods. As a result, quality control is required to maintain the product created by the appropriate quality standards. The quality standards of a corporation are often determined by raw materials, the manufacturing process, and the completed product (results). As a consequence, quality control operations may be carried out beginning with the selection of materials and continuing through the manufacturing process to the end outcome in the form of goods that are tailored to the company's requirements.

Statistical Process Control (SPC) is a typical process control technique that is used to determine the cause of changes in the control chart as well as the study of process capabilities. In many statistical applications, the control chart is used to assess the "quality" of a product, whether it is under control or not (Lestari, 2015). Dr. Walter Andrew Shewhart of Bell Telephone Laboratories in the United States initially proposed the Control Chart in 1924 with the intention of eliminating abnormal variations by separation of variations generated by specific sources of variation and common causes. This variety implies that the manufacturing process must be stable and capable of producing all goods according to requirements.

Quality necessitates a continuing process of improvement. When the measured values are within the SPC approach's expectations, relevant quality improvement may be implemented. The incompatibility of such qualitative features and net weight of the items will have an effect on the manufacturer or the customer on the one hand. If the quality characteristics surpass the manufacturer's criteria, and if the quality characteristics fall below the customers' specifications, both will be affected. The writer may deduce from the research problem given above that the studies objectives are to assess quality control of bread utilizing characteristics P-chart to fulfill in quality control statistics.

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METHODOLOGY

Quality control is utilized in research at My-Food bakery industry in an attribute, which is the measurement of quality on product attributes that cannot or are difficult to quantify. The attributes at issue include product quality, success, or failure. The P-chart is a method for measuring attribute quality that calculates the proportion of existing flaws. These control charts are used in attribute quality control to regulate the damaged product phase of the manufacturing process and determine if it is still within tolerance.

This study's population consisted of all sorts of bread manufactured (chocolate bread, butter bread, and round bread) by My-Food bakery industry, with a manufacturing capacity of 500 packs per day, resulting in a total population of 15000 packages for 30 days (1 month).

When the My-Food bakery industry developed five sorts of bread, the authors only took three types of bread goods using judgment sampling and random sampling (data report collected in June). The gathered data on production outcomes will be analyzed using Statistical Quality Control (SQC) analysis utilizing the P-charts (P-charts) Diagram technique, which is processed using the Minitab program.

Control Chart Attributes (p-chart)

One attribute manage Chart used to manage faulty product components from manufacturing is the P Control Chart (error proportion control). The error percentage control (p-chart) method is used to determine if the product faults produced are still within acceptable limits. It may alternatively be defined as a comparison of the number of mistakes with all observations, namely each product that is classed as "accepted" or "rejected" (the number of faulty items).

If the sample taken for each observation is the same number, we can use the error proportion control chart (p-chart) or the number of errors (np-chart). However, if the sample taken varies for each time, the observations change in, or indeed the production will do 100% inspection, we must use an error proportion control chart (p-chart).

If the amount of sample collected for each observation is always the same or constant, then the methods to manually build a P control chart are as follows: The first step is to select a sufficiently big sample size/subgroup (n > 30). Gather the number of subgroups (k) from at least 20 to 25 subgroups. Using the formula: calculate the fraction of faulty units for each subgroup: $p = \frac{x}{n}$ where p is the proportion of errors in each sample, x becomes the number of products that are wrong in each sample, and n is the number of samples taken in the inspection, Calculate the average value of p with formula(1)

$$p = \frac{Total\ defect\ product}{Total\ product\ inspected} \quad \ldots\ldots(1)$$

Calculate Upper Control Limit, Control Limit, and Lower Control Limit, with formula (2)

$$UCL = \underline{P} + 3\sqrt{\frac{\underline{p}\,(1-\underline{p})}{n}} \quad \ldots\ldots (2)$$

$$LCL = \underline{P} - 3\sqrt{\frac{\underline{p}\,(1-\underline{p})}{n}}$$

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Test of normality

In statistics, normality tests are used to determine if a data set is well-modeled by a normal distribution and to compute how likely it is for a random variable underlying the data set to be normally distributed. The most popular techniques to check the normality of the data are the Shapiro-Wilk test and the Kolmogorov-Smirnov test, which are both well-known tests of normality.

The Shapiro–Wilk test is a test of normality. It was published in 1965 by Samuel Sanford Shapiro and Martin Wilk. it tests the null hypothesis that a sample x_1, ..., x_n came from a normally distributed population.

The test statistic is

$$w = \frac{\left(\sum_{i=1}^{n} ai\ x_{(i)}\right)^2}{\sum_{i=1}^{n} \left(x - \underline{x}\right)^2}$$

Where

$x_{(i)}$ With parentheses enclosing the subscript index *i* is the *i*th order statistic, i.e., the *i*th-smallest number in the sample

$\underline{x} = \frac{(x1+x2+x3+\cdots xn)}{n}$ is the sample mean

The coefficients a_i are given by

$(a1, \ldots, an) = \frac{m^T V^{-1}}{C}$

Where *C* is a vector norm

$C = \|v^{-1}m\| = (m^T)^{\frac{1}{2}}$

And the vector *m*

$M = (m1, \ldots, mn)^T$

The Kolmogorov-Smirnov test is a nonparametric test of normality

The test statistic is

D= $maximum\ |F_O(X) - F_r(X)|$

Where $F_O(X) =$ Observed cumulative frequency distribution of a random sample of n observations. And $F_O(X) = \frac{k}{n}$ = (No. of observations ≤ X)/ (Total no. of observations).

$F_r(X)$ = The theoretical frequency distribution.

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RESULT AND DISCUSSION

Quality control on the final result is an action that examines the final product to ensure that it meets the company's quality standards. In this scenario, the corporation assesses if the product is fit for consumer sale and meets company criteria. The first step in statistically analyzing quality control is to create a table (check sheet) detailing the quantity of production and items damaged or failing to meet quality requirements. This Check sheet is intended to streamline the data collecting and analysis process. The production statistics and quality control of the process and outcomes are shown in the table below for June 2023

Table 1: Sample Data on Three Different Kinds of Bread

Days	Sample	Defective Chocolate bread	Defective Butter bread	Defective Round bread
1	250	20	17	21
2	250	19	9	28
3	250	28	21	21
4	250	32	27	17
5	250	34	15	21
6	250	27	18	26
7	250	28	12	17
8	250	24	23	16
9	250	28	11	29
10	250	27	27	25
11	250	18	31	18
12	250	15	22	29
13	250	15	27	22
14	250	18	18	28
15	250	27	14	17
16	250	12	24	21
17	250	24	18	18
18	250	26	21	11
19	250	29	22	23
20	250	21	19	10
21	250	23	21	17
22	250	24	15	27
23	250	19	11	24
24	250	19	29	28
25	250	18	12	19
26	250	25	27	13
27	250	32	14	16
28	250	23	19	12
29	250	12	22	18
30	250	18	27	21
Total	7500	699	593	678

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In Table 1 above, we can calculate the total defect of three kinds of bread (Chocolate bread, Butter bread, and Round bread) which gives a total of 1970 breads that failed to sell in a month. In carrying out production quality control activities, the company places supervisors to oversee the actions in the production process and the final results. The supervisors include workers appointed by the leadership. Quality control of the bread products is using statistical quality control (SQC) applying the p-charts method which is processed through the Minitab. Discussion of each type of bread product produced at My-Food bakery industry as follows:

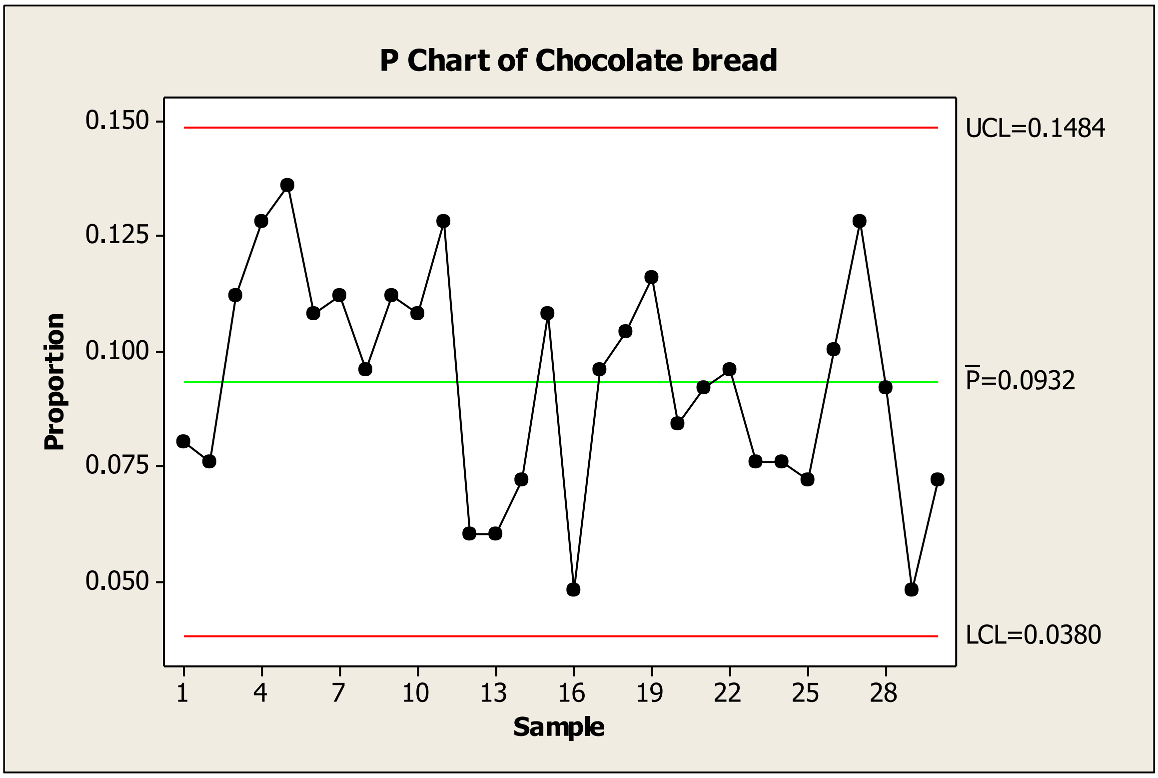

Figure 1: P-Chart for proportion defect chocolate bread

The value of the central line for chocolate bread is 0.0932 or 9.32%, and the upper control limit value (UCL) is 0.1484 or 14.84%, indicating that if the defective or damaged product reaches or exceeds the upper control limit (UCL), the chocolate bread production is ineffective. Similarly, the faulty or damaged product is at the lower control limit (LCL), showing a value of 0.038 or 3.80% suggesting that the chocolate type bread production method is ineffective.

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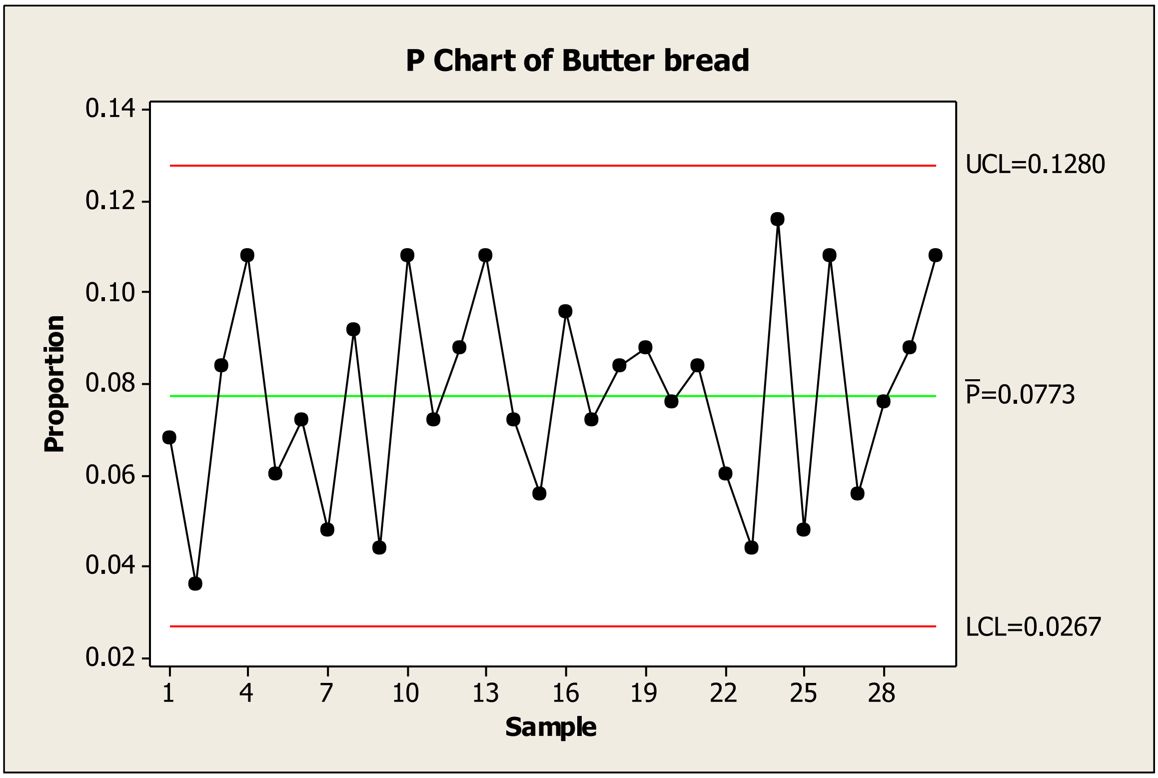

Figure 2: P-Chart for proportion defect Butter bread

According to data processing results for the butter bread type, the central line's value is 0.0773, or 7.73%, and the upper control limit value (UCL), which is 0.128, or 12.80%, renders the production of cheese bread ineffective if the defective or damaged product reaches or exceeds the UCL. Similar to the above, the manufacture of butter type bread is not efficient enough if the faulty or damaged product is at the lower control limit (LCL), which indicates a value of 0.0267 or 2.67%.

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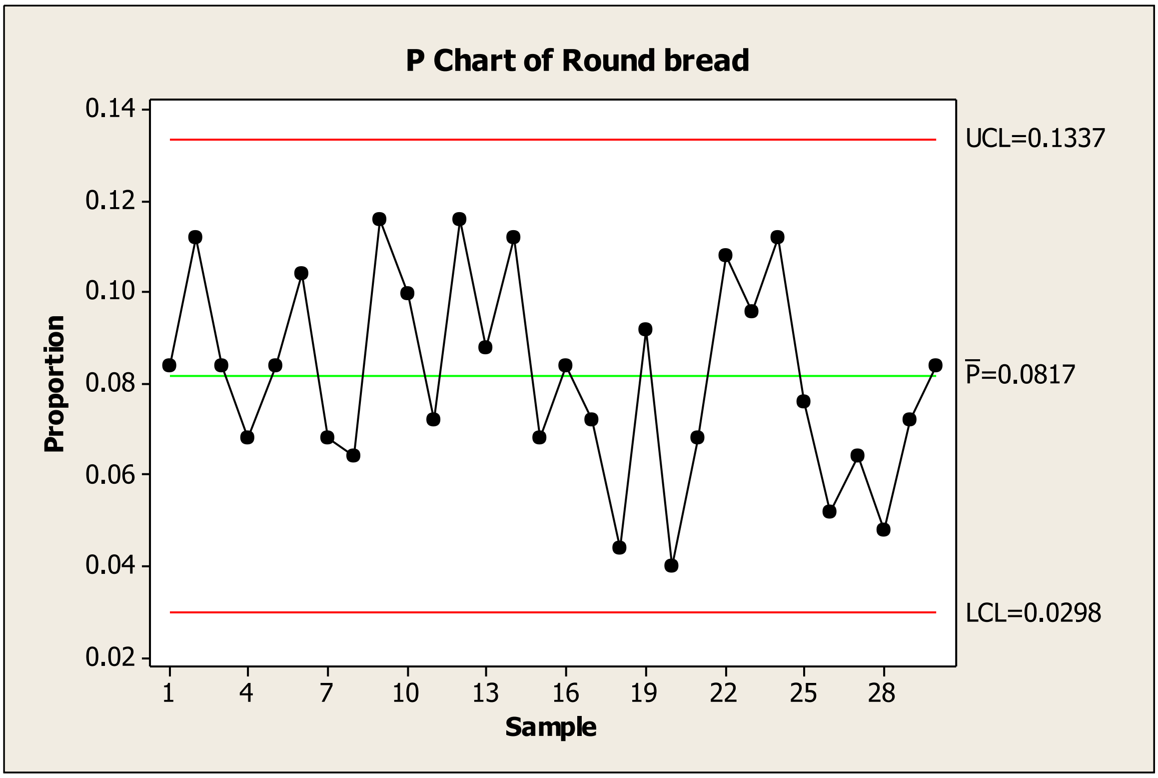

Figure 3: P-Chart for proportion defect Round bread

Round bread type, from the results of data processing on Figure 3, shows the value of the central line is 0.0817 or 8.17%, the upper control limit value (UCL) is 0.1337 or 13.37% which means if the defective or damaged product reaches or above the upper control limit (UCL) the Round bread production is ineffective. Similarly, the defective or damaged product is at the lower control limit (LCL) indicating a value of 0.0298 or 2.98% means that the production process of cheese type bread is not effective enough.

Table 2: Test of Normality for Three Different Kinds of Bread

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Chocolate bread	.111	30	.200*	.971	30	.556
Butter bread	.120	30	.200*	.965	30	.417
Round bread	.105	30	.200*	.955	30	.227

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

The table 2 above is the resulting test of normality for three samples of bread. The Kolmogorov-Smirnov[a] test and Shapiro-Wilk, shows that the probabilities ($P < 0.05$) is less than 0.05 which indicates that the samples bread at My-Food bakery industry are in control data and the data are normal.

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CONCLUSION

The researchers may deduce from the research problem given above that the goals of the study are to assess quality control of bread using attribute P-chart to satisfy quality control statistics. In this study, the researchers used a technique to determine if the manufacturing process of My-Food bakery is under control or not, and as previously said, the production of My-Food bakery is under control. If we add up the total flaw of the three types of bread seen by the researchers, we get 1970 bread that did not sell. Despite the fact that production is under control, the corporation must investigate the manufacturing machinery in order to avoid further faulty products.

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