Performa: Media Ilmiah Teknik Industri
ISSN 1412-8624 (print) | ISSN 2620-6412 (online)
Vol. 24, No. 1, 2025, Page. 59-66
doi.org/ 10.20961/performa.24.1.86438

Independent Mixed Sampling Plans Potato Paste as The Main Raw Material for Biscuits at PT X

Sri Mumpuni Retnaningsih[1*], Muhammad Alifian Nuriman[2], and Rizka Widya Berliana[3]
[1,2,3]Department of Business Statistics, Vocational Faculty, Sepuluh Nopember Institute of Technology (ITS)
Jl. Teknik Kimia Sukolilo, Surabaya, 60111, Indonesia
Email: mumpuni@statistika.its.ac.id[1], alifian.nuriman@its.ac.id[2], rizkawidyab20@gmail.com[3]

Abstract

PT X, a prominent entity in the snack food manufacturing sector, has identified significant quality control challenges in the production of its flagship biscuit product, which utilizes potato paste as a key ingredient. The primary quality attributes under assessment are the color and pH level of the potato paste. Historically, inconsistencies in these attributes have been observed, resulting in substandard dough quality. The existing inspection methodology, characterized by its subjective nature due to the immediacy of processing requirements, has heightened the risk of accepting raw materials that do not meet established standards. To address this issue and enhance the evaluation of current inspection processes, an independent mixed sampling plans method is proposed. This method entails an initial sampling based on variable criteria followed by a secondary sampling based on attribute criteria if the initial sample is rejected. Utilizing the Dodge-Romig Table with a Lot Tolerance Percent Defective (LTPD) of 12% and a consumer risk of 10%, the study determined an Acceptable Quality Level (AQL) of 1.01% and a producer risk of 4%. The proposed sampling plan necessitates 7 samples for variable criteria and 31 samples for attribute criteria, with an acceptance number of one defect. Implementation of this method, based on company data, resulted in a revenue probability of 0.6933, indicating that 69 out of every 100 inspected units of potato paste would conform to quality standards. This proposed method significantly enhances the objectivity and reliability of the inspection process, thereby augmenting overall product quality.

Keywords*: Efficient, Inspection, Plans, Quality*

1. Introduction

Quality is the key to a company's competitive advantage, because good quality can be a strategy to dominate market share (Sutaat, 2023). Superior product quality is obtained by controlling the process from the beginning to the end of the production process, as is also done by PT Siantar Top, Tbk. Since 1972, this company has been known as a pioneer in the snack food industry in East Java and continues to develop to strengthen its position as a frontline company engaged in manufacturing snack foods, such as crackers, noodles, biscuits and wafers. This company is committed and highly dedicated to consumers through various products with the best taste (taste specialist), competitive prices, guaranteed halal quality, and legality (Siantar Top, 2023). Currently, companies are often faced with quite serious challenges due to increasing consumer demands for the quality they produce, as well as competitive pressure from competitors who offer similar products.

In line with the complexity of the challenges faced, the company continues to make improvements to improve product quality, but often faces problems in the biscuit category products due to high demand in the market, which reaches 100,000 cartons per month. One of the superior products (best quality) and market leader in the biscuit category is Deo Go Potato whose main raw material is potato paste (Siantar Top, 2023).

The quality of the raw material for potato paste is very important to maintain the quality of the biscuits produced. The quality characteristics that are considered by the Quality Control (QC) division for potato paste are color, pH and water content. Non-compliance with standards regarding the quality characteristics of raw materials can result in a decrease in the quality of biscuits, because the water content is too high and the pH changes quickly within a few hours, causing the quality of the dough to become softer and affecting the level of maturity and taste of the biscuits. This happens because the company is still based on subjectivity in inspecting raw materials (Siantar Top, 2023).

The potato paste inspection method in the company is carried out by examining the sample based on attribute criteria and if it is rejected, continuing to examine the variable criteria. Potato paste will still pass inspection provided it meets the standards for the most important variable quality characteristics, namely pH. Potato paste samples were taken randomly from containers. The potato paste that comes from each container contains 5 tons or 167 sacks. 10% of the 167 sacks or around 16 sacks were taken. One sack weighs 30 kg and each sack examined takes a sample of 1 kg of potato paste (Siantar

[1*] Sri Mumpuni Retnaningsih

Received 5th June 2024; Received in revised form 25th July 2024; Accepted 19th August 2024

Top, 2023). If the number of defects obtained is more than 12%, the potato pasta will be returned or rejected by the company and if it is less than 12%, the company will ask the supplier for a price conversion.

The company does not set provisions for the number of sacks taken from each side of the container, it is only done randomly and the method of taking samples is based on the inspection officer's estimates, because the material must immediately enter the production process so that production needs are met. The raw material inspection method currently carried out by the company is suspected to have a high risk because it is indicated that there is potato paste which does not comply with the company's criteria, passing the initial (incoming) inspection process. This can cause losses to the company because the potato paste received is of poor quality.

Acceptance sampling is one of the statistical quality control tools in checking the quality of product raw materials in a measurable manner (Russell & Taylor, 2023). The acceptance sampling plans will make it easier for companies to make decisions about whether raw materials or components received from suppliers can be accepted or rejected (Montgomery, 2013). Acceptance sampling methods consist of various types, namely attribute acceptance sampling plans, variable acceptance sampling plans, mixed acceptance sampling plans, and etc (Mitra, 2016). The acceptance sampling method that will be proposed in checking the quality of potato paste is a independent mixed sampling plans.

The independent mixed sampling plans consisted of two stages. Sampling in the first stage was carried out based on variable criteria and in the second stage based on attribute criteria. An independent mixed sampling plans is a sampling plans that is carried out by taking samples based on variable criteria. If the decision is that the lot is accepted then it will be finalized and if it is rejected then an examination of the attribute criteria will be carried out with a different sample. The use of this dual design can reduce the number of samples observed by getting a large chance of acceptance (Schilling & Neubauer, 2017).

So far, the inspection method used by the company is thought to have a high risk because the potato paste received is of poor quality, making it inefficient and affecting product quality. Therefore, an independent mixed sampling plans method is proposed to evaluate the inspection methods currently used by companies. The aim of this research is to design and apply an independent mixed sampling plans, so that companies obtain evaluation results in decision making.

Previous research conducted at PT Siantar Top, Tbk includes Mukarromah (2017) who conducted research related to controlling and improving the quality of Deo Go Potato products at PT Siantar Top, Tbk using the six sigma approach. The method used uses a Multivariate Exponentially Weighted Moving Average (MEWMA) control chart. Then, Widya (2018) related to quality control in the Goriorio biscuit production process at PT Siantar Top, Tbk. The methods used are Multivariate Exponentially Weighted Moving Average (MEWMA) and MEWMV. Previous research that used a mixed acceptance sampling plans method was Herawati (2017) regarding a sampling plans using the dependent mixed sampling plans method for IPA Glyphosate 62%, the raw material for making herbicides at PT. Petrosida Gresik.

Based on previous research, the state of the art of this research is using a different method, namely using acceptance sampling on different raw materials from research that has previously been carried out and the independent mixed sampling plans method has never been applied. In fact, with this method, based on theory, the samples taken are not influenced by the results of previous inspections. This makes it possible to carry out sampling independently from each other. Meanwhile, in dependent mixed sampling plans, the results of previous inspections influence subsequent sampling. This freedom can simplify the inspection process and can be more efficient in terms of the number of samples required to achieve the desired inspection level.

2. Research Method

The data used in this research is secondary data for potato paste raw materials obtained from the biscuit division laboratory of the incoming Quality Control (QC) at PT X. The quality characteristics used in this research are color and pH which are requirements for the quality of potato paste raw materials. X_1 (color) is an organoleptic examination to determine whether the color of the potato paste used as a sample match the light yellow color specifications (Siantar Top, 2023). Meanwhile, X_2 (pH) or acidity level shows an indicator for measuring the acid or base level in potato paste with a specification limit of between 5,5-6,2 (Siantar Top, 2023). The analysis stages carried out in the independent mixed sampling plans research on the raw material for potato paste for biscuit products are as follows.

1) Design independent mixed sampling plans with the following stages.

a. Find the AQL value, producer risk (α), and consumer risk (β) with several experiments using the Dodge-Romig inspection table with the LTPD value used being 12% based on company information shown in Figure 1. Producer risk (α) is the risk due to reject good quality products in lots. The magnitude of α is related to the Acceptance Quality Level (AQL). AQL is the maximum value of the percentage of defects accepted by the manufacturer, so that the lot is accepted with a high probability. Consumer risk (β) is the risk resulting from receiving products of poor quality in lots. The magnitude of β is related to the Lot Tolerance Percent Defective (LTPD). LTPD is the maximum value of the percentage of defects accepted by consumers, so that the lot is accepted with a low probability (Aft, 2018).

LOT SIZE	PROCESS AVERAGE (%)																	
	0.00 - 0.05			0.06 - 0.50			0.51 - 1.00			1.01 - 1.50			1.51 - 2.00			2.01 - 2.50		
	n	*c*	LQL (%)	*n*	*c*	LQL (%)	*n*	*c*	LQL (%)	*n*	*c*	LQL (%)	*n*	*c*	LQL (%)	*n*	*c*	LQL (%)
1 - 10	All	0	-	All	0	-	All	0	-	All	0	-	All	0	-	All	0	-
11 - 50	11	0	17.6	11	0	17.6	11	0	17.6	11	0	17.6	11	0	17.6	11	0	17.6
51 - 100	13	0	15.3	13	0	15.3	13	0	15.3	13	0	15.3	13	0	15.3	13	0	15.3
101 - 200	14	0	14.7	14	0	14.7	14	0	14.7	29	1	12.9	29	1	12.9	29	1	12.9
201 - 300	14	0	14.9	14	0	14.9	30	1	12.7	30	1	12.7	30	1	12.7	30	1	12.7
301 - 400	14	0	15.0	14	0	15.0	31	1	12.3	31	1	12.3	31	1	12.3	48	2	10.7
401 - 500	14	0	15.0	14	0	15.0	32	1	12.0	32	1	12.0	49	2	10.6	49	2	10.6
501 - 600	14	0	15.1	32	1	12.0	32	1	12.0	50	2	10.4	50	2	10.4	70	3	9.3
601 - 800	14	0	15.1	32	1	12.0	32	1	12.0	50	2	10.5	50	2	10.5	70	3	9.4
801 - 1000	15	0	14.2	33	1	11.7	33	1	11.7	50	2	10.6	70	3	9.4	90	4	8.5
1001 - 2000	15	0	14.2	33	1	11.7	55	2	9.3	75	3	8.8	95	4	8.0	120	5	7.6
2001 - 3000	15	0	14.2	33	1	11.8	55	2	9.4	75	3	8.8	120	5	7.6	145	6	7.2
3001 - 4000	15	0	14.3	33	1	11.8	55	2	9.5	100	4	7.9	125	5	7.4	195	8	6.6
4001 - 5000	15	0	14.3	33	1	11.8	75	3	8.9	100	4	7.9	150	6	7.0	225	9	6.3
5001 - 7000	33	1	11.8	55	2	9.7	75	3	8.9	125	5	7.4	175	7	6.7	250	10	6.1
7001 - 10000	34	1	11.4	55	2	9.7	75	3	8.9	125	5	7.4	200	8	6.4	310	12	5.8
10001 - 20000	34	1	11.4	55	2	9.7	100	4	8.0	150	6	7.0	260	10	6.0	425	16	5.3
20001 - 50000	34	1	11.4	55	2	9.7	100	4	8.0	180	7	6.7	345	13	5.55	640	23	4.8
50001 - 100000	34	1	11.4	80	3	8.4	125	5	7.4	235	9	6.1	435	16	5.2	800	28	4.5

n : size of sample; entry of "All" indicates that each piece in lot is to be inspected.
c : acceptance number for sample.
LQL : limiting quality level corresponding to a consumer's risk (β) = 0.10.

Figure 1. Dodge-Romig Table (Banks, 1989)

b. Determine the most efficient AQL value, producer risk (α), and consumer risk (β) using the Operating Characteristics (KO) curve. When designing an acceptance sampling plans, the general approach is to determine the two points through which the KO curve must pass, namely determining the producer risk value which has a relationship with AQL (p_1), while the consumer risk has a relationship with LTPD (p_2). To get the sample size (n_2) and acceptance number (c), it can be calculated using equations (1) and (2) where d is the number of defects in the sample (Montgomery, 2013).

$$1 - \alpha = \sum_{d=0}^{c} \frac{n!}{d!\,(n-d)!} {p_1}^d (1 - p_1)^{n-d} \tag{1}$$

$$\beta = \sum_{d=0}^{c} \frac{n!}{d!\,(n-d)!} {p_2}^d (1 - p_2)^{n-d} \tag{2}$$

c. Obtain the values n_2 (sample size) and c (acceptance number) for checking the attribute criteria obtained from step 1b.

d. Calculate the standard normal distribution value of AQL (Z_{p1}) and LTPD (Z_{p2}).

e. Calculate the standard normal distribution value of producer risk (Z_α) and consumer risk (Z_β).

f. Calculate the k (critical value) and n_1 (sample size) values for checking variable criteria using equations (3) and (4).

$$k = \frac{Z_{p_2} Z_\alpha + Z_{p_1} Z_\beta}{Z_\alpha + Z_\beta} \tag{3}$$

$$n = \left(\frac{Z_\alpha + Z_\beta}{Z_{p_1} - Z_{p_2}} \right)^2 \tag{4}$$

2) Implement an independent mixed sampling plans based on the company's past data with the following steps.

a. Carry out the first sample (n_1) based on variable acceptance criteria.
   i. A lot is accepted if the sample meets variable acceptance criteria (A). Where the acceptance limit (A) is obtained from BSA - $k\sigma$ for the upper specification limit or BSB + $k\sigma$ for the lower specification limit.
   ii. If the sample does not meet the variable acceptance criteria (A), then a second sample is taken based on the attribute criteria.

b. Carry out a second sampling (n_2) based on attribute acceptance criteria.
   i. The lot is rejected if the number of defects in the sample exceeds the acceptance number ($d > c$).
   ii. A lot is accepted if the number of defects in the sample does not exceed the acceptance number ($d \leq c$).

c. Calculate the probability of acceptance (${P_a}^I$) for sampling stage 1 (variable) using the standard normal distribution from equation (5).

$$\bar{Z}_A = \sqrt{n} Z_A = \sqrt{n} \left(\frac{BSA - \bar{X}}{\sigma} - k \right) \tag{5}$$

Information:

$\bar{Z}_A$: Standard normal deviate for the distribution of individual measurements corresponding to proportion nonconforming in the upper tail
ZA : Standard normal deviate for the distribution of individual measurements corresponding to the acceptance limit A
n : Number of variable samples
$\bar{X}$: Average of variable quality characteristics
BSA : Upper specification limit
σ : Standard deviation
k : Critical value/acceptance

d. Calculate the probability of acceptance (${P_a}^{II}$) for sampling stage 2 (attribute) using equation (6).

$${P_a}^{II} = P(d \leq c) = \sum_{d=0}^{c} \frac{n!}{d!\,(n-d)!} p^d (1-p) \tag{6}$$

e. Calculate the probability of acceptance (P_a) based on an independent mixed sampling plans using equation (7).

$$P_a = {P_a}^I + (1 - {P_a}^I) {P_a}^{II} \tag{7}$$

3) Draw conclusions and suggestions based on the results of the sampling plans analysis that has been created.

3. Result and Discussion

3.1 Characteristics of Potato Paste Quality

Characteristics are used to ascertain whether the pH of the potato paste has met the specification limits. The results of the quality characteristics of potato potato paste pH are shown in Table 1.

Table 1. Variable Quality Characteristics of Potato Paste

Variable	N	Mean	Max.	Min.	Specification Limits
pH (X_2)	167	5,910	6,430	5,080	5,5-6,2

Table 1 shows that the pH of potato paste is not within the specification limit between 5,5-6,2, meaning that there is a pH that is outside the specification limit of 24,55%.

The results of potato pasta characteristics by color are presented visually using the pie chart shown in Figure 2.

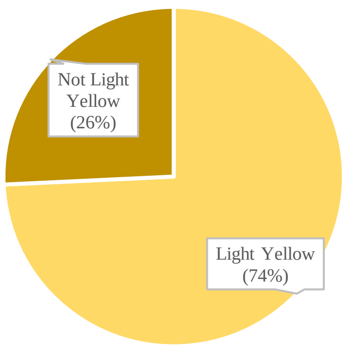

Figure 2. *Pie Chart* Potato Pasta Color

Figure 2 shows that 26% of potato pasta is not light yellow while 74% of potato paste is light yellow (the color it should be).

3.2 Independent Mixed Sampling Plans of Potato Paste Quality

Before making an independent mixed sampling plans of potato paste quality characteristics, it is necessary to first determine the Acceptance Quality Level (AQL) and Lot Tolerance Percent Defective (LTPD) values. The company has set a maximum allowable defect tolerance limit or LTPD of 12%, but the company has not set an AQL value. To design independent mixed sampling, starting from a variable sampling plans, but in calculating the number of samples needed, AQL values, consumer risk (β), and producer risk (α) are required. The three values will be sought using multiple experiments based on a Dodge-Romig single-sampling lot inspection table with an LTPD value of 12% and a consumer risk (β) of 10%. Based on the table, it was found that the AQL value was between 1,01% to 1,5%. The results of several experiments to obtain AQL values and the risks of these producers are shown in Table 2.

Table 2. Experimental Results of AQL Value and Producer Risk

Experiment	α = 0,04		
	AQL	*n*	*c*
1	0,0101	31	1
2	0,0102	31	1
3	0,0103	43	2
4	0,0104	43	2
5	0,0105	43	2
6	0,0106	43	2
7	0,0107	43	2
8	0,0108	43	2
9	0,0109	43	2
10	0,011	43	2
11	0,012	43	2
12	0,013	43	2
13	0,014	43	2
14	0,015	43	2
	α = 0,05		
15	0,0101	31	1
16	0,0102	31	1
17	0,0103	31	1
18	0,0104	31	1
19	0,0105	31	1
20	0,0106	31	1
21	0,0107	31	1
22	0,0108	31	1

Table 2. Experimental Results of AQL Value and Producer Risk (Continued)

Experiment	α = 0,04		
	AQL	*n*	*c*
23	0,0109	31	1
24	0,011	31	1
25	0,012	43	2
26	0,013	43	2
27	0,014	43	2
28	0,015	43	2

*Tables colored green indicate selected

Table 2 shows the AQL and producer risk (α) values in all experiments resulting in a sample number and a receipt number that are not much different so that the most efficient is obtained compared to using the visual KO curve shown in Figure 3.

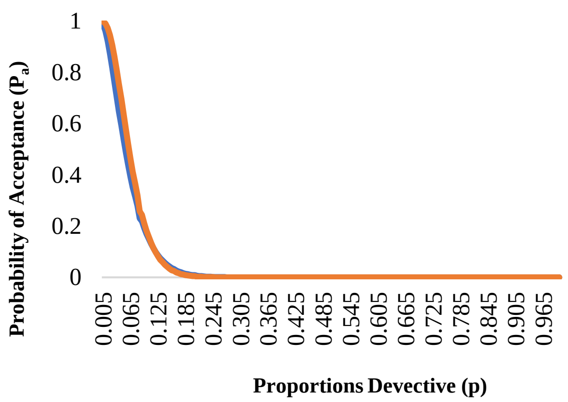

Figure 3. Comparison of KO Curves of Different Sample Counts and Acceptance Numbers

Figure 3 shows a comparison of the KO curve with a blue line with a sample number of 31 and an acceptance number of 1 while the orange one with a sample number of 43 and an acceptance number of 2. The selected AQL value provides information that the selected AQL value is 0,0101 with producer risk (α) 0,04 where the number of samples is 31 and the number of receipts is 1 because when viewed from the blue-striped KO curve has a shape close to the ideal KO curve so it tends to be more efficient with less risk. An AQL value of 0,0101 (1,01%) means that the potato paste sent by the supplier that does not meet the specifications is 1,01%. The LTPD value that the company has used is 0,12 (12%), which means that the company provides a tolerance for potato paste that does not meet specifications of 12% of the total potato paste sent by the supplier.

For the sample size and number of acceptance of the second phase attribute sampling plans based on Table 2, it was obtained through equations (1) and (2) with AQL value (p_1) = 0,0101, LTPD value (p_2) = 0,12; producer risk (α) = 0,04 and consumer risk (β) = 0,1.

$$1 - \alpha = \sum_{d=0}^{c} \frac{n!}{d!\,(n-d)!} {p_1}^{d} (1 - p_1)^{n-d}$$

$$1 - 0{,}04 = \sum_{d=0}^{c} \frac{n!}{d!\,(n-d)!} 0{,}0101^{d} (1 - 0{,}0101)^{n-d}$$

$$\beta = \sum_{d=0}^{c} \frac{n!}{d!\,(n-d)!} {p_2}^{d} (1-p_2)^{n-d}$$

$$0{,}1 = \sum_{d=0}^{c} \frac{n!}{d!\,(n-d)!} 0{,}12^{d} (1-0{,}12)^{n-d}$$

The two equations with several experiments were substituted with the appropriate sample size and number of acceptances. A sample size (n_2) of 31 was obtained with an acceptance number (c) of 1. This means that out of as many as 31 potato paste color checks, if there is more than 1 inspection that results in a defective decision, the lot will be rejected. In addition to the substitution method, it is also proven by using the help of software that the number of samples and acceptance number are the same as the substitution, which is shown visually in Figure 4.

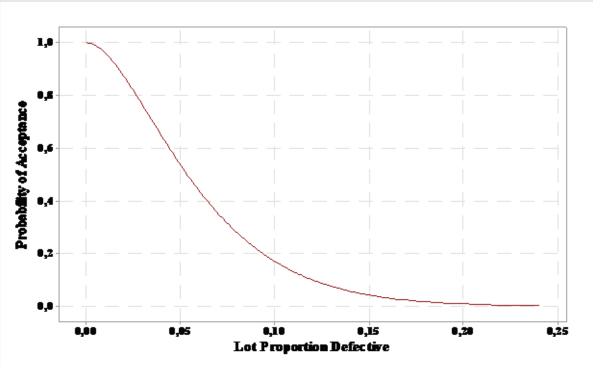

Figure 4. Number of Samples (31) and Number of Attribute Acceptance (1)

After obtaining the AQL, LTPD, producer risk (α), and consumer risk (β), calculations can be carried out to obtain the sample size (n_1) and critical value (k) for the first stage variable sampling plans. The sample size was obtained using equation (4) with AQL value (p_1) = 0,0101; LTPD value (p_2) = 0,12; producer risk (α) = 0,04 and consumer risk (β) = 0,1.

$$n = \left(\frac{Z_\alpha + Z_\beta}{Z_{p_1} - Z_{p_2}}\right)^2 = \left(\frac{1{,}751+1{,}282}{2{,}323-1{,}175}\right)^2 = 6{,}98 \approx 7$$

After obtaining the sample size, the critical value obtained can be calculated using equation (3) with AQL value (p_1) = 0,0101, LTPD value (p_2) = 0,12; producer risk (α) = 0,04 and consumer risk (β) = 0,1.

$$k = \frac{Z_{p_2} Z_\alpha + Z_{p_1} Z_\beta}{Z_\alpha + Z_\beta} = \frac{1{,}175(1{,}751) + 2{,}323(1{,}282)}{1{,}751 + 1{,}282}$$

$$k = 1{,}660$$

The sample size (n_1) was 7 and the critical value (k) was 1,66 mean that the examination of the variable criteria should be taken 7 times to obtain a consumer risk of 10% and a producer risk of 4% and potato paste will be rejected if it is less than the acceptance criteria is 1,66.

3.3 Application of Independent Mixed Sampling Plans on Potato Paste Quality

Based on company data with a sample of 167 using Simple Random Sampling (SAS) with random numbers, potato paste that is not light yellow is obtained as many as 43 (25,75%) and light yellow as many as 124 (74,25%). As a simulation of application in the company, the number of samples in the stage 1 variable sampling plans for potato paste that must be taken is 7, while in the stage 2 attribute sampling, 31 are taken.

From the variable sampling data in stage 1, an average ($\bar{X}$) pH of 5,966 was obtained, then compared to the acceptance limit (A) of 4,54, it turned out that the average pH was greater than the acceptance limit, so it had to be continued to take samples again based on attribute criteria with different samples to get the opportunity to accept the independent mixed sampling plans.

The results of the attribute sampling plans in stage 2 using the Dodge-Romig Table obtained the number of samples (n_2) as many as 31 and the number of receipts (c) as much as 1 which refers to the results of Table 2. It was found that the color of potato paste that did not match the standard (d) or the color was not light yellow as much as 8 turned out to be greater than the acceptance number (c) so the decision was rejected lot.

After obtaining the sample size (n_1) and critical value (k) in the variable sampling design in stage 1 based on the results of sub chapter 3.2, then the calculation will be carried out for the chance of receiving lots from the value of the defect proportion (p). The calculation step to obtain the probability value of variable sampling acceptance in stage 1 is first to find the normal deviation value of the standard defect proportion at the upper specification limit (Z_U) for the pH variable. Based on this value, the standard normal deviation value is then calculated in accordance with the proportion of defects in the acceptance limit (Z_A) which will be used to calculate the average distribution value of the acceptance limit sample ($\bar{Z}_A$) with equation (5) to obtain the probability of acceptance of the variable sampling plans at stage 1, the results are shown in Table 3.

Table 3. Probability of Acceptance of Stage 1 Variable Sampling Plans

p	Z_U	k	n	Z_A	$\bar{Z}_A$	P_a^I
0,407	0,234	1,66	7	-1,426	-3,772	0,000081

Table 3 shows the probability value of acceptance obtained based on the proportion devective (p) from variable sampling at stage 1. It appears that the proportion of defective potato paste is 0,407 with the normal deviation of the standard of defect proportion at the upper specification limit (Z_U) for the pH variable of 0,234 at the critical value (k) is 1,66 and the sample size (n) is 7. Based on this value, a standard normal deviation value was obtained that was in accordance with the proportion of defects in the acceptance limit (Z_A) of -1,426 with the average distribution value of the admission limit sample ($\bar{Z}_A$) of -3,772 so that the probability of accepting variable sampling at stage 1 (P_a^I) is 0,000081.

The calculation of the probability of acceptance of attribute sampling in stage 2 is known that the sample size (n) is 31 and the acceptance number (c) is 1 (see Table 2) with the proportion devective (p) of non-light yellow potato paste is 0,0359, so the probability of acceptance of the attribute sampling plans in stage 2 ($P_a{}^{II}$) can be calculated using equation (6).

$P_a{}^{II} = P(d \leq c) = \sum_{d=0}^{c} \frac{n!}{d!(n-d)!} p^d (1-p)^{n-d}$ $P_a{}^{II} = P(d \leq 1) = \frac{31!}{0!(31-0)!} 0{,}0359^0 (1-0{,}0359)^{31} + \frac{31!}{1!(31-1)!} 0{,}0359^1 (1-0{,}0359)^{30}$

$P_a{}^{II} = 0{,}6933$

Based on the value of the acceptance probability value obtained in the sampling of variables in stage 1 ($P_a{}^{I}$) of 0,000081 and attribute sampling in stage 2 ($P_a{}^{II}$) of 0,6933. The acceptance probability for independent mixed sampling (P_a) based on equation (7) is obtained as follows.

$P_a = P_a{}^{I} + (1 - P_a{}^{I}) P_a{}^{II}$

$P_a = 0{,}000081 + (1 - 0{,}000081)0{,}6933$

$P_a = 0{,}6933$

The calculation results show that the probability of acceptance for independent mixed sampling (P_a) is 0,6933 with the proportion devective in stage 1 ($P_a{}^{I}$), namely variable sampling plans of 0,000081 and the proportion devective in stage 2 ($P_a{}^{II}$), namely attribute sampling plans of 0,6933. This means that if an examination is carried out on 100 potato paste, 69 of them are not defective. If this happens in the field, then the decision of the lot must be rejected or returned to the supplier. Rejecting lots that do not match quality standards helps the company maintain its product reputation and can ensure that the final product made from the potato paste is of consistent quality and meets customer expectations.

3.4 Comparison of the Result of the Proposed Method with Previous Research

The following are the results of a comparison of the proposed method with similar previous research using an acceptance sampling plans shown in Table 4.

Table 4. Comparison of Parameters of the Proposed Sampling Design Results with Related Previous Research

Source	AQL	LTPD	α	β	Variable		Attribute	
					n	k	n	c
Researcher (2024)	1,01%.	12%	4%	10%	7	1,66	31	1
Faridah (2017)	17,8%	51,8%	5%	10%	10	0,38	16	6
Herawati (2017)	11,05%	25%	5%	10%	28	0,91	64	11

Table 4 shows the results of the comparison of AQL, LTPD, producer risk (α), consumer risk (β), number of variable samples and attributes (n), critical value (k), and acceptance number (c). The researcher (2024) used the independent mixed sampling plans method on potato paste, Faridah (2017) used independent mixed sampling plans on sidafur, and Herawati (2017) used dependent mixed sampling plans on glyphosate. It can be seen that each type of raw material has different characteristics from each study. However, when viewed from the AQL, LTPD, consumer and producer risks used, the researcher (2024) has better results in determining the number of samples, critical values, and acceptance numbers. This is because the parameters used have a small risk so that they tend to be stricter and more efficient in producing the number of samples to be inspected.

4. Conclusion

Based on the independent mixed sampling plans using LTPD 12%, AQL 1,01%, consumer risk 10%, and producer risk 4%, the results of variable sampling in stage 1 were obtained with a sample size (n_1) of 7 and an critical value (k) of 1,66. Meanwhile, the sampling of attributes in stage 2 was obtained with a sample size (n_2) of 31 and the acceptance number (c) of 1. The results of the application of independent mixed sampling plans applied to PT X potato paste raw materials had an acceptance probability of 0,6933. This means that out of 100 units of potato paste inspected, there will be 69 units that are not defective. It can be said that the quality of the potato paste that the company receives is poor.

Suggestions for researchers can then use other types of sampling plans and quality characteristics so that the results are more diverse and comparable. The advice for companies is to be able to make agreements with suppliers regarding the AQL value, so that suppliers can set clear standards regarding the proportion of defects allowed. This can minimize the risk of receiving defective product quality from each lot coming from the supplier. In addition, it is recommended to use independent mixed sampling plans to examine potato paste if you want a sampling design that can combine variable criteria and attributes because it is stricter in decision-making regarding the acceptance or rejection of lots.

Acknowledgment

The author would like to thank the Department of Business Statistics for providing support in the preparation of the paper and PT X for helping to provide research data.

References

Aft, L. S. (2018). *Fundamentals of Industrial Quality Control* (3 ed.). New York: CRC Press.

Banks, J. (1989). *Principles of Quality Control*. New York: John Wiley & Sons.

Faridah, N. (2017). Rancangan Sampling Penerimaan Untuk Pasir Vulkanik Sebagai Bahan Baku Utama Sidafur di PT. Petrosida Gresik. Tugas Akhir. Surabaya: Institut Teknologi Sepuluh Nopember (ITS)

Herawati, A. R. (2017). Rancangan Sampling dengan Metode Dependent Mixed Sampling Plans pada IPA Glyphosate 62%, Bahan Baku Pembuatan Herbisida di PT Petrosida Gresik. Tugas Akhir. Surabaya: Institut Teknologi Sepuluh Nopember (ITS)

Mitra, A. (2016). *Fundamentals of Quality Control and Improvement* (4 ed.). Canada: John Wiley & Sons, Inc.

Montgomery, D. C. (2013). *Introduction to Statistical Quality Control* (4 ed.). United States: John Wiley & Sons, Inc.

Mukarromah, L. (2017). Pengendalian dan Peningkatan Kualitas Produk Deo Go Potato Menggunakan Metode Six Sigma Di PT Siantar Top, Tbk. Tugas Akhir. Surabaya: Institut Teknologi Sepuluh Nopember (ITS).

Russell, R. S., & Taylor, B. W. (2023). *Operations & Supply Chain Management* (11 ed.). United States: John Wiley & Sons.

Schilling, E. G., & Neubauer, D. V. (2017). *Acceptance Sampling in Quality Control* (3 ed.). Boca Raton: CRC Press Taylor & Francis Group.

Siantar Top. (2023, June 28). *Siantar Top*. https://siantartop.co.id/

Sutaat. (2023). *Manajemen Operasional Bisnis* (1 ed.). Banyumas: Amerta Media.

Widya, D. (2018). Pengendalian Kualitas Pada Proses Produksi Biskuit GO! RIORIO di PT Siantar Top, Tbk. Tugas Akhir. Surabaya: Institut Teknologi Sepuluh Nopember (ITS).

Performa: Media Ilmiah Teknik Industri
ISSN 1412-8624 (print) | ISSN 2620-6412 (online)
Vol. 24, No. 1, 2025, Page. 59-66 doi.org/ 10.20961/performa.24.1.86438

AUTHORS METADATA

I. **First Author*:**

1. First Name : Sri
2. Middle Name : Mumpuni
3. Last Name : Retnaningsih
4. E-mail : mumpuni@statistika.its.ac.id
5. Orcid ID :
6. Orcid URL :
7. Affiliation : Sepuluh Nopember Institute of Technology
8. Country : Indonesia
9. Bio Statement : Department of Business Statistics, Vocational Faculty
10. Phone Number :

II. **Second Author:**

1. First Name : Muhammad
2. Middle Name : Alifian
3. Last Name : Nuriman
4. E-mail : alifian.nuriman@its.ac.id
5. Orcid ID :
6. Orcid URL :
7. Affiliation : Sepuluh Nopember Institute of Technology
8. Country : Indonesia
9. Bio Statement : Department of Business Statistics, Vocational Faculty
10. Phone Number :

III. **Third Author:**

1. First Name : Rizka
2. Middle Name : Widya
3. Last Name : Berliana
4. E-mail : rizkawidyab20@gmail.com
5. Orcid ID :
6. Orcid URL :
7. Affiliation : Sepuluh Nopember Institute of Technology
8. Country : Indonesia
9. Bio Statement : Department of Business Statistics, Vocational Faculty
10. Phone Number :