



Green bottle packaging design for micro, small, and medium enterprises (MSME)

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ABSTRACT

Plastic bottle waste constitutes a significant part of plastic waste. The extensive use of plastic bottles for packaging generates a substantial volume of waste, particularly those made from polyethylene terephthalate polymers, with high carbon chain content, resulting in slow decomposition. UMKM Markisa is among the businesses employing plastic bottles for packaging. This study aims to develop a green manufacturing strategy for MSMEs, focusing on consumer distribution. Employing the Kano and HOQ methods, the study seeks to identify consumer-desired attributes for Passion Fruit Aurora products and prioritize product development. Through 15 questionnaires distributed to 100 consumers, the study identified three attributes with the highest ratings: 16% for the choice of packaging materials, 13% for recyclable packaging, and 9% for redesigning the packaging. The research concludes by recommending the adoption of eco-friendly plastic packaging using PLA material, ensuring easier decomposition and environmental safety due to its plant-based origin. This proposal also suggests incorporating an attractive design, emphasizing the need for all MSMEs to embrace environmentally sustainable packaging.

1. Introduction

In recent years, there has been a growing interest in environmental protection, manifesting in increased demand for eco-friendly products among consumers. The rapid growth of businesses has consequently led to more intricate environmental challenges, driving various protective initiatives amid heightened consumer consciousness. Multiple studies have indicated the shared responsibility of companies and consumers in upholding environmental sustainability. Moreover, plastic waste has emerged as a pressing issue for both Indonesian and global communities. The extensive use of non-biodegradable plastic items has resulted in substantial waste accumulation in urban areas and oceans, leading to contamination and posing severe threats to both human health and the environment. Earlier research has highlighted the lethal impact of such waste on several protected animal species. The discovery of a deceased humpback whale, its stomach filled with plastic waste in Wakatobi, Indonesia, sparked global concern over these pollutants [1].

Innovations in environmentally friendly plastic bottles include biodegradable options made from

natural materials capable of rapid decomposition. Biodegradable plastics, such as Poly Lactic Acid (PLA), derive from natural polymers like starch, cellulose, and fat. Starch and Poly Lactic Acid stand out as the most widely used materials in biodegradable plastic production [2], [3], [4]. PLA emerges as a sustainable substitute for conventional polymers due to the mass production of lactides through the microbial fermentation of agricultural by-products, predominantly carbohydrate-rich substances. Recent advancements have demonstrated the conversion of lactic acid into polylactic acid through two primary routes: the indirect route via lactide and direct polymerization via polycondensation, resulting in PLA. Both end products are generally categorized as PLA [5].

2. Material and method

2.1. Sample determination

In this study, a non-probability technique was used in determining the sample, which does offer each member of the population an opportunity (chance) to be included in the process. Furthermore, accidental sampling was used as a determination method in

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further studies, where the participants were selected based on spontaneous factors. This indicates that anyone who accidentally met with the author and was suitable can be used as a respondent. The inclusion criteria were individuals who are familiar with the product "Aurora Passion Fruit Syrup", and a total of 100 respondents were selected.

2.2. Kano questionnaire preparation

The Kano-QFD questionnaire consisted of functional questions on the conditions or feelings felt by consumers when the attributes were available/fulfilled. Meanwhile, it contained dysfunctional questions when the product attributes were not present. In the Kano questionnaire, the ratings used were 1=like, 2=expect 3=neutral, 4=tolerance, and 5=dislike.

2.3. Validity and reliability test

The validity and reliability test were assessed prior to conducting data processing using SPSS software. The questionnaire was considered valid when r count $>$ r table, where r -table was obtained from the table of Product Moment/correlation coefficient determined from $df = N-2 = 35-2 = 33$ with a 5% error using a two-way test. Meanwhile, the questionnaire was considered reliable when Cronbach's alpha value was $>$ 0.7.

2.4. Kano method

In this stage, the determination of the Kano category and the calculation of consumers' satisfaction coefficient was carried out to determine the attributes of consumer desire and the size of the effect given, using the following steps [6].

- a. Combining functional and dysfunctional answers for each product attribute from 100 respondents based on the results of Kano's evaluation table.
- b. After all the answers from the questions were converted into the form of A, M, O, R, Q, or I, the next step was to count the number of each component of A, M, O, R, Q, and I for each question.
- c. Determining the Kano category for each attribute using Blauth's formula. When the sum of $O + A + M$ was greater than that of $I + R + Q$, the grade obtained is the maximum value of one dimensional, attractive, must-be. (2) When the sum of $O + A + M$ was less than that of $I + R + Q$, the grade obtained is the maximum value of indifferent, reverse, and questionable. (3) When the sum of values $O + A + M$ was equal to that of $I + R + Q$, the grade is the maximum value among all Kano categories, including one-dimensional, attractive, must-be, indifferent, reverse, and questionable.
- d. Based on the sum calculation of each category, customers' satisfaction coefficient can be determined using Equations (1) and (2).

$$Better \text{ (kepuasan)} = \frac{A + O}{A + O + M + I} \tag{1}$$

$$Worse \text{ (ketidakpuasan)} = \frac{A + O}{A + O + M + I} \tag{2}$$

Based on the calculation of "better" and "worse" from the Kano categories, the values obtained can be shown through the Kano quadrant, where "better" was represented as the Y-axis and "worse" as the X-axis, as shown in Fig. 1.

Table 1.
Evaluation table

Customer requirements		Dysfunctional				
		Like	Must be	Neutral	Live with	Dislike
Fuctional	Like	Q	A	A	A	O
	Must be	R	I	I	I	M
	Neutral	R	I	I	I	M
	Live with	R	I	I	I	M
	Dislike	R	R	R	R	Q

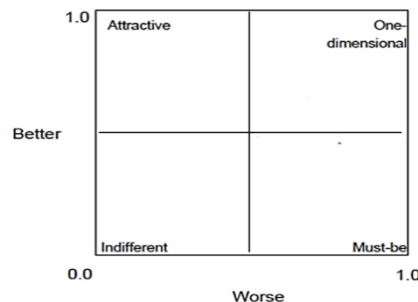


Figure 1. Kano quadrant

2.5. QFD method

The procedure of QFD deployment are as follows [7].

1. Determination of WHAT's Matrix. Determination of customer needs was obtained from the Kano category, namely must-be, one-dimensional, and attractive.
2. Determination of Planning Matrix. The planning matrix consisted of several data, including importance to the customer, which was used to determine the importance level of each consumer's needs and desires, with the following equation.
3. Determination of Technical Respondents. Technical respondents were selected by companies to answer or fulfill consumer desires from the what's matrix. Furthermore, they were obtained from interviews or discussions with the company.
4. Determination of Linkage Matrix. The linkage matrix showed the relationship between attributes to customer needs and technical responses. The relationship in the matrix was categorized as strong, moderate, weak, or with no linkage.
5. Matrix Determination . In this part of the technical matrix, absolute importance was calculated to determine the priority of the technical respondents. This value can be obtained through the following equation.

3. Results and discussions

3.1. Results

From the distribution of the Kano-QFD questionnaire to 100 respondents, a total of 13 technical responses were obtained. The results of the process were used to determine the Kano category with Blauth formula, as shown in the table. Furthermore, the calculation of better and worse values was carried out to determine the magnitude of the attribute effect on consumers' satisfaction or dissatisfaction. Of the total 100 respondents, the comparison of the number of

respondents according to their gender is that there are fewer male customers than female customers. With a percentage of 40% male and 60% female. This shows that most customers are women. From a total of 100 respondents, the percentage of private employees is 16%, students 11%, civil servants 34%, staff 8%, and self-employed 16%. The presentation in the picture above shows civil servants dominating in product purchases.

The one-dimensional quadrant has 2 attributes, namely the 8th and 13th. This quadrant has a high better value of 0.57, where customers' satisfaction increased by 57% assuming the attribute was fulfilled. The attractive category can provide a high level of customer satisfaction. However, supposing customers do not find this attribute in the product, it caused dissatisfaction. The attractive quadrant was located at 6, 7, 14, and 15. The category has a high better value of 0.47-0.65, where customers' satisfaction increased by 65% assuming the attribute was fulfilled. The worse value in this category was low, which was less than the average or only ranged from (-20) to (-0.50).

Customers were dissatisfied when the must-be category was not fulfilled, but their satisfaction increased or became neutral when the criteria was met. There was a total of 6 attributes, such as 2, 4, 5, 9, 10, and 11. The must-be quadrant has a better value, which was below average and ranged from (-60) to (-90), where customers' dissatisfaction reached 60-90% assuming the attribute was not fulfilled.

The indifferent category does not have an impact on customers' satisfaction. There are 2 attributes in the quadrant, namely 1 and 12. In the indifferent quadrant, the better value only ranged from 0.29 to 0.39 and the worse value ranged from 0 to (-40) or less than average. Therefore, attributes in the indifferent category were considered unimportant/not necessary because they have less impact on customers' satisfaction and dissatisfaction.

Table 2 shows Kano category questionnaire Results with Blauth formula whereas Table 3 shows the calculation of better and worse for Kano category.

Table 2.
Questionnaire results

No.	Attribute	Number of Answer						Total
		A	M	O	I	R	Q	
1.	The packaging used for Passion Fruit Syrup has the right size	17	33	12	28	0	0	100
2.	Passion Fruit Syrup packaging has an affordable price	25	27	25	23	0	0	100
3.	Passion Fruit Syrup packaging can be reused	29	29	22	20	0	0	100
4.	The packaging used for Passion Fruit Syrup has a low environmental impact	31	32	17	23	0	0	100
5.	The packaging used for passion fruit syrup has an attractive packaging	27	29	21	22	0	0	100
6.	Passion fruit syrup packaging uses a small amount of new plastic	29	24	23	24	0	0	100
7.	Passion Fruit Syrup packaging has a thinner texture	39	23	26	12	0	0	100
8.	Passion fruit syrup packaging has a lighter plastic weight	26	29	31	14	0	0	100
9.	The raw material for packaging for Passion Fruit Syrup comes from materials that can be recycled	24	30	20	26	0	0	100
10.	The packaging used for passion fruit syrup has properties that are easily decomposed	17	32	22	29	0	0	100
11.	The packaging used passion fruit syrup can reduce contamination	24	34	20	22	0	0	100
12.	The packaging used for passion fruit syrup comes from nature	18	28	35	25	0	0	100
13.	Passion Fruit Syrup packaging contains product information that is safe for consumption	22	18	35	25	0	0	100
14.	The packaging used in Passion Fruit Syrup is safe for consumption	34	32	15	19	0	0	100
15.	The packaging used in Passion Fruit Syrup is environmentally friendly	30	24	17	29	0	0	100

Table 3.
Calculation of better and worse for Kano Category

No.	Description	Kano Category	Kano Kategori Value
1.	The packaging used for Passion Fruit Syrup has the right size	I	0
2.	Passion Fruit Syrup packaging has an affordable price	M	1
3.	Passion Fruit Syrup packaging can be reused	A	4
4.	The packaging used for Passion Fruit Syrup has a low environmental impact	M	1
5.	The packaging used for passion fruit syrup has an attractive packaging	M	1
6.	Passion fruit syrup packaging uses a small amount of new plastic	A	4
7.	Passion Fruit Syrup packaging has a thinner texture	A	4
7.	Passion fruit syrup packaging has a lighter plastic weight	A	4
8.	The raw material for packaging for Passion Fruit Syrup comes from materials that can be recycled	O	2
9.	The packaging used for passion fruit syrup has properties that are easily decomposed	M	1
10.	The packaging used passion fruit syrup can reduce contamination	M	1
11.	The packaging used for passion fruit syrup comes from nature	M	1
12.	Passion Fruit Syrup packaging contains product information that is safe for consumption	I	0
13.	The packaging used in Passion Fruit Syrup is safe for consumption	O	2
14.	The packaging used in Passion Fruit Syrup is environmentally friendly	A	4
15.	Passion Fruit Syrup packaging has a thinner texture	A	4

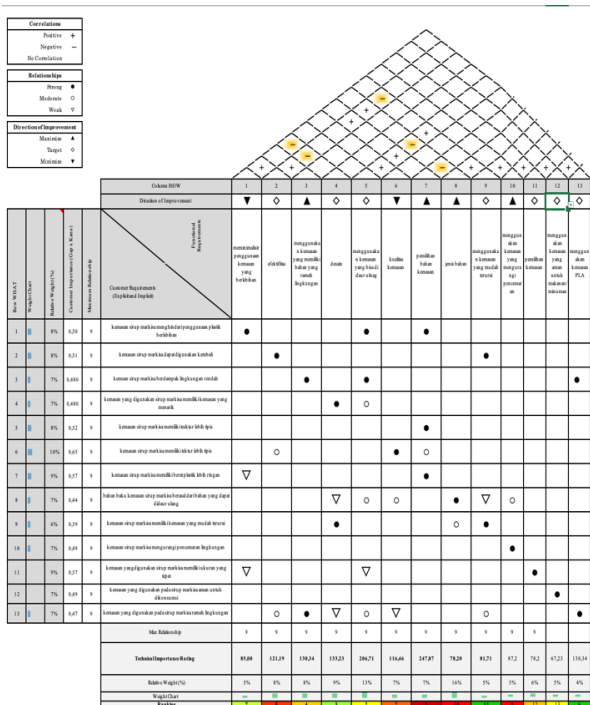


Figure 2. House of Quality

3.2. Formation of the House of Quality

1. WHAT's Matrix (customers' needs)

Attributes that belonged to the must-be, one-dimensional, and attractive categories were considered as customers' needs in the house of quality (QFD) because the indifferent category does not have a significant impact on customer satisfaction. Therefore, it is easy to prioritize quality improvement based on attributes that have a significant impact on satisfaction and dissatisfaction [8].

2. Planning Matrix

This planning matrix consisted of several calculations, including importance to the customer, where this value aimed to prioritize desires. The weighting started from the most important attribute with a value of 5 to the least important with a value of 1. The higher the level of importance to customers, the more important the presence of an attribute [9]. The

calculation of importance to the customer can be seen in the 4 customers' satisfaction performances due to evaluation using Aurora Passion Fruit Syrup. The overall calculation results are shown in Fig. 2. The large value obtained indicated that customers were satisfied with the presence of an attribute, and vice versa. The weighting started from the very satisfied attribute with a value of 5 to the dissatisfied with a value of 1.

3. Linkage Matrix

The main purpose of a linkage matrix was to establish a relationship between customers' product requirements and performance measures, which were designed to enhance the product. The first step in creating this matrix was to gather customers' feedback on their wants and needs from a specific product. Furthermore, this perspective was taken from the planning matrix and placed on the left side of the linkage matrix. The company can then begin to develop strategies to improve its product using the customers' outlook. In this process, the strengths and weaknesses of the company were weighed against customers' priorities to determine the aspects that need to be changed to surpass or align with the competition. It was also used to determine the aspects that must remain unchanged. Knowing the need to be improved helps in the creation of a list of performance measures, which were displayed at the top of the linkage matrix [10]. Terninko stated that performance measures were technical measures used to evaluate high-quality product performance [11]. This indicated that businesses must translate customer voices into engineering terms. Every quality request must have at least one performance measure in the matrix.

4. Technical Property and Target

Specific items in the technical property matrix were used to record priorities set for technical requirements. It also provided information on the technical performance of the competitor product and the difficulty level in developing each requirement. Furthermore, the outcome of the matrix was a set of target values for each technical requirement that must be fulfilled by the new design. An organization might

not make the most optimal design in some cases due to cost, technology, or other factors.



Figure 3. Old packaging & new packaging

5. Influence of Design Target and Benchmark

Quality characteristics distributed the customer requirements throughout the linkage. It also provided the organization with prioritized quality characteristics. High-priority quality parameters typically indicate that addressing this technical issue can provide significant value to customers. Furthermore, the high-quality characteristics weight showed a strong linkage with the demand for high-priority quality goods.

On high-priority quality characteristics, the organization's current product can technically refer to the competitor's product. In many cases, the organization must not be surprised that its competitors are superior in specific tasks or characteristics.

QFD helped the organization identify and develop technical areas where it can achieve the most cost-effective customer satisfaction. The organization can then examine the Customer Context for usage problems that need to be addressed.

Fig. 2 explains that from these priorities, suggestions are given in efforts to design green packaging for UKM Markisa Aurora, including making environmentally friendly packaging, carrying out new designs and using PLA green packaging for UKM Markisa Aurora with the highest rating, namely "Selection of raw materials in packaging" with a value The most Technical Importance Rating is 247.87%, and the percentage is 16%. And this will be the priority in solving green packaging problems

which will affect consumer interest in the Passion Fruit Aurora UMKM.

6. Quality Improvement Proposal

Based on these priorities, a proposal has been made in efforts to design green packaging for Aurora Passion Fruit (UMKM), including creating an environmentally friendly packaging proposal, redesigning, and using PLA. Among all the How's attributes, the attribute that was the focus of green packaging design for Aurora Passion Fruit MSME with the highest rating was "Selection of raw materials for packaging", which had the highest Technical Importance Rating of 247.87% and a percentage of 16%. This was the priority in solving green packaging problems affecting consumer interest in Aurora Passion Fruit (UMKM).

Fig. 3 shows the old packaging from UMKM Markisa plastic that is not used environmentally friendly plastic and still has an ordinary packaging design, while the picture and the picture on the right is the new packaging that is proposed to be used by UMKM Markisa packaging, the packaging is made of PLA and the design new packaging.

4. Conclusions

The Kano method can determine the attributes that have a significant impact on customers' satisfaction, namely those included in the must-be, one-dimensional, and attractive categories. Furthermore, the formation of the House of Quality (QFD) provided priorities in efforts to improve the quality of the Aurora Passion Fruit product based on customers' desires, where 14 technical responses can be improved/upgraded by the company.

Further research is suggested to replace the ready-to-drink glass packaging with environmentally friendly plastic. The owner of Markisa Aurora Passion Fruit MSME needs to improve the product based on the results of the attributes in the improvement process. Furthermore, there is a need for awareness among MSME actors regarding environmentally friendly packaging.

Declaration statement

Musdalifah: **Conceptualization, Methodology, Writing-Original Draft.** Sapta Asmal: **Design, Creating product prototypes.** Syarifuddin M. Parenreng: **Resources, Validation, Formal analysis. Resources, Visualization, Investigation. Writing-Review & Editing.**

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Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article or its supplementary materials.

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