Designing Eco-Friendly *Kambuik* Shopping Bags: A Quality Function Deployment Approach

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ABSTRACT

The proliferation of plastic shopping bags has raised concerns regarding environmental sustainability. To address this issue, technological advancements have enabled the development of eco-friendly shopping bags. These bags can be returned, contributing to a more eco-conscious shopping experience. However, aligning these bags with customer preferences and needs presents a significant challenge. To overcome this, we propose the use of the Quality Function Deployment (QFD) method. Applying the QFD method, we have identified the technical characteristics of eco-friendly shopping bags, utilizing woven *Mansiang* leaf material. The resulting bags measure 55 cm in length, 35 cm in height, and 8 cm in thickness. Furthermore, we present innovative designs, including bags, wallets, and flower holders. The inherent strength of the woven *Kambuik* material allows for efficient carrying capacity, offering a viable alternative to plastic shopping bags. Notably, *Kambuik* is derived from plants and has minimal environmental impact. Our research confirms the feasibility of designing safe and eco-friendly *Mansiang* leaf shopping bags, aligning with sustainable practices.

1. INTRODUCTION

Rapid population growth and the rise of informal settlements, particularly urban slums, in developing countries are projected to result in increased plastic consumption by 2050 if no action is taken [1]. Improper disposal of plastic bags has caused significant environmental problems worldwide, prompting various levels of government to take action [2].

Plastic bags have become an indispensable part of daily life, serving multiple purposes such as carrying groceries and packaging various items. Their practicality and versatility make them challenging to replace [3]. However, the environmental impact of plastic bags is undeniable. They contribute to flooding by obstructing waterways and embankments, and in extreme cases, they can damage reservoir turbines. Plastic bags are also a major driver of climate change, as their life cycle—from production to disposal—generates greenhouse gas emissions. Approximately 12 million barrels of oil and 14 million trees are consumed annually in plastic production [4]. Even during the disposal stage in landfills, plastic waste continues to emit greenhouse gases [5].

Remarkably, Indonesia ranks second globally in terms of plastic waste dumped into the sea [6]. To address the issue, Regulation No. 32/2009, focusing on the "Protection and Management of the Environment," aims to comprehensively preserve environmental functions, prevent contamination, and minimize environmental damage. The regulation encompasses planning, utilization, control, maintenance, supervision, and law enforcement to safeguard the Indonesian Republic's territory.

Regulation No. 32/2009 provides a legal framework for the Padang City Government to take specific actions in combating plastic waste and promoting environmentally friendly alternatives within its jurisdiction. The effective implementation of policies and practical measures is crucial for achieving environmental protection goals outlined in these regulations.

Environmental management is a crucial responsibility of local governments, encompassing fundamental services that each region must independently manage and protect [7, 8]. The Office of Environmental Padang City - West Sumatra, Indonesia, has reported that the landfill in Air Dingin, Padang City, accumulated approximately 40.5 tons of plastic waste as of October 2019. In response, the Padang City government enacted Mayor Regulation No. 36/2018, "Controlling the Use of Plastic Shopping Bags," to reduce plastic waste. Nevertheless, the use of plastic bags remains prevalent in both traditional and modern markets.

The eco-friendly green shopping bag movement has emerged as a government strategy to address the excessive use of plastic bags [9]. In addition to banning single-use plastics, including plastic bags, cups, and food containers, environmentally friendly initiatives are being promoted. These initiatives involve encouraging the use of reusable shopping bags and recyclable packaging materials, as well as implementing more efficient waste management systems and constructing waste processing facilities.

In this context, researchers aim to offer an alternative to plastic bags to reduce their consumption [10]. Woven *Mansiang* leaf shopping bags are proposed as a viable

solution due to the strength and durability of *Mansiang* stems used for weaving. West Sumatra boasts diverse types of wickers, including woven *Mansiang* found in the Taratak area of Kubang village, Guguak Sub-district, Lima Puluh Kota Regency, commonly known as *Kambuik* [11]. This woven bag craft, utilizing *Actinoscirpus Grossus*, a grass species belonging to the *Cyperaceae* family, thrives in swampy or flooded areas and rice fields, such as *Jorong* Taratak Kubang. The local community in *Jorong* Taratak Kubang has long used *Kambuik* as a provision bag for agricultural work and as a shopping bag in traditional markets [12]. *Kambuik*'s exceptional load-bearing capacity ensures it maintains its original shape and lasts for years, unlike plastic bags that tear easily. Originating from Minangkabau, West Sumatra Province, Indonesia, *Kambuik* bags are an environmentally friendly alternative for shopping, made from woven *Mansiang* leaves.

Traditional woven material shopping bags, like *Kambuik*, were commonly used by previous generations before the widespread adoption of plastic bags. Today, these bags remain relevant and practical, offering long-term durability. Furthermore, *Kambuik* bags represent a form of traditional handicraft art from West Sumatra that deserves preservation. By promoting *Kambuik* bags, the Padang City Government aims to significantly reduce plastic waste while supporting regional handicraft products.

Amidst the zero-waste movement, *Kambuik* emerges as a promising alternative to plastic shopping bags, given its eco-friendly composition derived from plants. Considering the introduction provided, this study aims to investigate the design of eco-friendly shopping bag products that meet consumer requirements in traditional markets in Padang City, employing the House of Quality (HoQ) methodology. The QFD process entails market segmentation research to identify our target customers, understand their characteristics and needs, and evaluate the level of market competition. The findings from market research will inform the design of technically appropriate products aligned with customer preferences. Subsequently, process design will outline the manufacturing stages and characteristics of each part, followed by determining the production operations, process flow, and quality control measures. Finally, the study will propose a marketing strategy for promoting and distributing *Kambuik* bags in traditional markets in Padang City.

2. METHODS

2.1 Product design and development

Product design and development is a series of activities starting from the analysis of market perceptions and opportunities, and then ending with the production, sales, and delivery stages of the product. Product development consists of drafting clearer and more systematic concepts for new product ideas or modifications of old products in the form of technical drawings to meet product consumer needs, both physical products and service products. Observations were made to determine the number and specifications of Eco-friendly shopping bags that already exist and are used in buying and selling activities. Interviews were conducted to find out directly about the needs and desires of consumers regarding Eco-friendly shopping bags. The results of these observations and interviews will then be used as a reference

in making statement variables that will be asked of consumers.

2.2 The identification stage

The identification stage of consumer needs is carried out to determine the needs and desires of consumers with the level of importance of the statement variable on the design of Eco-friendly shopping bags to be designed. The data used in the identification of consumer needs is data from previous interviews and then made in the form of a questionnaire [13, 14]. Based on the results of the identification of consumer needs through interviews, the statement variables that will be submitted to respondents are divided into 8 product dimensions according to David Garvin, which consist of performance, durability, reliability, conformance, features, esthetics, Service ability, and perceived quality [15]. The questionnaire that has been made will then be distributed with a minimum sample size of 30 respondents.

2.3 The validity and reliability test

The validity test in this section is to measure the extent to which this questionnaire can measure what is being measured. Determination of validity is done by using the Pearson coefficient formula to see the relationship between the value of the statement variable and the total value [16, 17]. The reliability test aims to show the extent to which the answers to the questionnaire are consistent at different times. Determination of the reliability of the measuring instrument using Cronbach's alpha coefficient [18, 19]. The value of this coefficient has a range of values from 0 to 1. A Cronbach's alpha calculation value that is close to 1 indicates a more reliable instrument and a Cronbach's alpha calculation value that is close to 0 indicates an increasingly unreliable instrument [20]. If the reliability test states that the instrument used is not reliable, then the questionnaire must be re-compiled. Reliability testing was carried out using SPSS 27 software in the reliability analysis module with Cronbach's alpha. The desired reliability test value can be seen in the alpha coefficient value. The data that has passed the statistical test will then be made into a house of the quality matrix, with the following stages: 1) Planning Matrix; 2) Technical Response; 3) Relationship Matrix; 4) Technical Correlations; and 5) Technical Matrix.

The population in this study were the visitors (buyers) at the traditional market located in the Koto Tangah sub-district, Padang City, West Sumatra Province, amounting to 197,797 society. The number of samples that will be tested in the study using the Slovin equation [21], so the number of samples is 122 respondents. In this research, the validity test was carried out using internal validity, where the calculation used the product-moment correlation coefficient. By using a significance level of 5% and degrees of freedom (df = n − 2) namely 122 − 2 = 120, the r table value is 0.1779. A variable is considered valid if the calculated r is greater than the r table. From the results of the tests carried out, it can be concluded that all service attributes for all types of questionnaires are valid. Because the Cronbach's Alpha value is 0.786>0.60, as is the basis for decision-making in the reliability test, it can be concluded that the 20 or all questionnaire question items are reliable or consistent.

The reliability test process gives results consistently for these measurements the same, with Cronbach's alpha ≥0.600 [22, 23]. The questionnaire was asked to respondents who shop at the traditional market of LubukBuaya, Padang City. The number of questions asked to respondents was 20 questions which were divided into 8 dimensions of product quality according to Garvin. The sampling technique uses accidental sampling. Accidental sampling is a technique for determining samples based on chance, that is, research objects that coincidentally/accidentally meet the researcher are used as samples, if it is deemed that the person they happen to meet is suitable as a data source. The list of statement variables based on product quality dimensions can be seen in Table 1. Based on the identification of data on the characteristics of consumer needs regarding Eco-friendly shopping bag products, they are as follows.

Table 1. List of statement variables based on product quality dimensions

No.	Dimension	Statement Variables
1	Performance	Not damaged when used to carry groceries
		Pockets are easy to fold when not in use
		Minimum weight that can be accommodated by the bag
2	Durability	The raw material used is the type of *Mansiang* leaves
		Easy to clean
3	Reliability	Can be used to carry all kinds of goods
		There are two sizes of pockets (large size and small size)
4	Conformance	Shopping bag length
		Shopping bag height
		Shopping bag thickness
		The color of the sewing thread is different from the color of the shopping bag
		Shopping bag handle length
5	Features	*Mansiang* leaf shopping bag only consists of one color
		There are several colors of shopping bags
6	Esthetics	No design on shopping bag (plain)
		There is an additional design on the shopping bag
		There is a logo of the shop that takes out the shopping bag
7	Service ability	Guarantee 1: if the first use of the shopping bag is damaged in the woven *Mansiang* leaf or stitches, the consumer can immediately ask for a replacement with a new shopping bag with the return of the damaged shopping bag
		Guarantee 2: if after several uses there is damage to the stitching of the shopping bag, you can exchange the old shopping bag for a new one by paying half the price.
8	Perceived quality	Eco-friendly raw materials

After testing validity and reliability testing, the next step is HoQ. The quality house is a matrix that describes all the information needed to develop improvements in service quality. The HoQ stages are as follows:

- Importance to Customer (IC): IC value shows how much importance each attribute has for plastic shopping bag users.
- Customer Satisfaction Performance (CSP): The results can be seen in Table 2. For more details, the Weight Average Performance (WAP) formula is as follows.

$$WAP = \frac{\sum Performance\ Weight}{Performance\ Weight} = \frac{\sum(satisfaction\ level\ scale) \times Performance\ Weight}{Performance\ Weight}$$

Furthermore, Customer Expected Performance (CEP) is part of the CEP, which is obtained from the formula:

$$WAP = \frac{\sum Expected\ Performance\ Weight}{Performance\ Weight}$$

- Goals: The goal here shows the level of satisfaction performance that is expected to be achieved by the producer to fulfill every consumer's wishes.
- Improvement Ratio (IR): IR is a measure of how much the management must do to improve service quality, which can be seen in the following formula:

$$IR = \frac{Goal}{CSP}$$

- Sales Point: Sales point is determined by the management where this value reflects the ability to sell services and products based on how well each user's wishes can be fulfilled.
- Raw Weight (RW) and Normalized Raw Weight (NRW). RW: This section contains calculated values from data and decisions made during the planning matrix. The value of Raw Weight for each customer need is: Raw weight = (importance to customer) × (improvement ratio) × (sales points). NRW: This section contains the Raw Weight value, scaled in the range between 0 to 1 or expressed as a percentage. The value of normalized raw weight is:

$$NRW = \frac{Raw\ Weight}{Raw\ Weight\ Total}$$

3. RESULTS

Respondent characteristic data is used to determine whether the respondent in filling out the questionnaire is by the specified conditions. Respondent characteristic data consists of questions regarding age, gender, and the required respondent characteristic data, namely data on consumers who shop at traditional markets bringing their shopping bags. Among the respondents, 61.48% were female and 38.52% were male. Of the majority of respondents, when shopping at traditional markets, 62% do not bring their shopping bags. The next stage of QFD implementation is the stage of making HoQ houses, at this stage, the preparation of customer needs

and technical characteristics of shopping bag products is known from the results of the questionnaire, then determines the level of relationship as shown in Table 2 below.

Table 2. 20 customers' needs and 8 technical characteristics in the HoQ

House of Quality (HoQ)		Customer Importance	Shopping Bag Material Made of Woven Mansiang Leaves	Shopping Bag Height (35 cm)	Shopping Bag Length (55 cm)	Thick Shopping Bag (8 cm)	Sewing Thread	Handle Strap Length	Color Used	Logo	Target Value	Sales Point	Improvement Ratio	Weight Normalization
Performance	Not damaged when used to carry groceries	4.189	9				9	3			4.098	1.5	2.732	5.282
	Pockets are easy to fold when not in use	4.171	9		1	9	1	1			4.041	1.5	2.694	5.042
	Minimum weight that can be accommodated by the bag	4.257	9								4.148	1.5	2.765	4.802
Durability	The raw material used is the type of Mansiang leaves	3.800	9						1		3.770	1.5	2.514	4.802
	Easy to clean	4.286	9								3.975	1.5	2.650	4.922
Reability	Cn be used to carry all kinds of goods	4.543	9		3	3	3				3.950	1.5	2.634	4.842
	There are two sizes of pockets (large size and small size)	4.143	3								3.901	1.5	2.601	4.562
Conformance	Shopping bag length	4.057	3		9						3.702	1.5	2.468	5.042
	Shopping bag height	4.000	3	9							3.678	1.5	2.452	4.522
	Shopping bag thickness	4.114	3			9					3.769	1.5	2.512	4.842
	The color of the sewing thread is different from the color of the shopping bag for storing	3.343	3				9				3.264	1.5	2.176	4.682
	Shopping bag handle length	3.714	3					9			3.496	1.5	2.331	4.482
Futures	Mansiang leaf shopping bag only consists of one color	3.343							9		3.258	1.5	2.172	4.802
	There are several colors of shopping bags	3.914							9		3.533	1.5	2.356	4.562
Esthetics	No design on shopping bag (plain)	3.543							1		3.325	1.5	2.217	4.122
	There is an additional design on the shopping bag	3.714							3		3.517	1.5	2.344	4.882
	There is a logo of the shop that takes out the shopping bag	3.400							1	9	3.525	1.5	2.350	5.882
Service ability	Guarantee 1: if the first use of the shopping bag is damaged in the woven Mansiang leaf or stitches, the consumer can immediately ask for a replacement with a new shopping bag with the return of the damaged shopping bag	3.800	9								3.817	1.5	2.544	6.882
	Guarantee 2: if after several uses there is damage to the stitching of the shopping bag, you can exchange the old shopping bag for a new one by paying half the price.	3.286									3.475	1.5	2.317	7.882
Perceived quality	Eco-friendly raw materials	4.429									3.933	1.5	2.622	8.882
	Technical Importance Rating (%)		43,42	4,71	7,11	11,55	11,21	6,57	11,42	4,01				
	Relative Weight		331.5	36.0	54.3	88.2	85.6	50.2	87.2	30.6				
	Design priority		1	8	5	2	4	6	3	10				

Based on Table 3 below, it can be seen that there are 20 customer needs and 8 technical characteristics in the HoQ house. Furthermore, consumer needs can be interpreted by translating these needs into technical characteristics. Technical characteristics are carried out by grouping needs that have similar characteristics by referring to the technical language, as presented in Table 3 below.

Table 3. List of technical requirements

No	Technical Requirements
1	Shopping bag material made of woven Mansiang leaves
2	Shopping bag height (35 cm)
3	Shopping bag length (55 cm)
4	Thick shopping bag (8 cm)
5	Sewing thread
6	Handle strap length
7	Color used
8	Logo

The relationship between customer needs and technical characteristics is also known as the customer between, where there are 3 symbols to determine the level of relationship between customer needs and technical characteristics. The symbol used is *O* which indicates a very strong relationship between technical characteristics and customer requirements and has a value of 9, the use of the *O* symbol indicates a moderate relationship between technical characteristics and customer needs and has a value of 3, and the use of the symbol Δ indicates the relationship between technical characteristics and customer requirements weak and has a value of 1. The calculation results of the absolute importance

level it is obtained that the value of the biggest concern is the material for shopping bags that use *Mansiang* leaves.

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The largest absolute value means it is a capable technical specification that answers the needs of most consumers. Therefore, the problem of material materials *Mansiang* leaf bag raw materials needs attention in product concept design. From the calculation of the level of importance of consumer needs, the problem of the type of raw materials and product waste shopping bags that is Eco-friendly and has the highest degree of interest. Technical characteristics related to the type of material. So that the technical characteristics are made a top priority design is the raw material for bags made from *Mansiang* leaves. More details can be seen in Figure 1 below.

Figure 1. Technical requirements

Figure 2. Eco-friendly shopping bags

The relationship between one technical characteristic and another is shown in Figure 2, among others the relationship between the material of a shopping bag made of woven *Mansiang* leaves and the height of the shopping bag (35 cm) and the length of the shopping bag (55 cm) and the thickness of the shopping bag (8 cm) and the sewing thread is positive, meaning that the use of raw materials for bags is related pocket length. Virtual designs are created with the aim of providing a visual image to consumers based on the identification of consumer wants and needs. Figure 2 shows the design of an eco-friendly shopping bag from the results of a questionnaire to identify consumer wants and needs.

The raw material for *Kambuik* comes from *Mansiang* rice. After 8 months of harvest, *Mansiang* will be dried or dried in the sun first. When the *Mansiang* is dry, the *Mansiang* will be smoothed so that the surface is thin and the *Mansiang* is ready for weaving. The manufacture of a *Kambuik* with a standard size of 35x35 cm requires 80-100 *Mansiang*. For rope requires 60 strands of *Mansiang*. The eco-friendly shopping bag design has a length of 55 cm and a width of 35 cm. The use of shopping bags made of woven *Mansiang* leaves can be used as a bag to put things when shopping. The raw materials used in eco-friendly shopping bags are quality materials derived from the sorting of *Mansiang* leaves which are then woven into shapes like shopping bags. Eco-friendly shopping bag design is a design that when used does not reduce a person's appearance or style, there is even an aesthetic value of local wealth.

4. CONCLUSIONS

In an effort to improve product quality, it would be better for producers to use all stages of the QFD method. In order to meet the needs and desires of consumers for product quality improvement, support from various parties is necessary. Based on the research that has been done, it can be concluded that safe and eco-friendly *Mansiang* leaf shopping bags can be designed. Because the material used in making this eco-friendly shopping bag uses quality materials from woven *Mansiang* leaves. In the zero waste movement, *Kambuik* can be a solution to replace the use of plastic shopping bags, because it is made from plants and has no impact on the environment.

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