Widyakala Journal
p-ISSN 2337-7313
e-ISSN 2597-8624

Volume 12, Issue 02, September 2025
DOI: https://doi.org/10.36262/widyakala.v12i2.1198
https://ojs.upj.ac.id/index.php/journal_widya/

Designing Secondary Packaging for Skincare Products Using the Kansei Engineering Method

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Received 25 January 2025, Revised 30 July 2025, Accepted 06 September 2025

Abstract — The use of secondary packaging in skincare product bundles is essential for the shipping process. Relying solely on bubble wrap presents drawbacks, as it is non-reusable and lacks aesthetic value. The absence of optimal secondary packaging increases the risk of product damage during distribution and reduces visual appeal, ultimately affecting consumer perceptions of quality and brand credibility. Therefore, the design and development of suitable secondary packaging is necessary. This study aims to identify appropriate design elements based on user perceptions using the Kansei Engineering method, which has proven effective in product development. A total of 43 Kansei words were extracted from 39 packaging samples, resulting in two primary design concepts: "Practical-Modern" and "User Friendly- Untenable" The selected design elements include: leather and plastic materials (X1.6), pouch shape (X2.7), leather handle with divider (X3.7), four-sided flip-top closure (X4.9), modern design style (X5.1), and transparent red color (X6.10). The highest correlation value (PCC = 0.8963) was found in the "shape" element, indicating its strong influence on consumer perception. The final design was implemented as a physical mockup. Evaluation results showed that 59.4% of respondents preferred the design concept reflecting ease of use. Fuzzy Logic analysis confirmed these findings, placing the design in a neutral category leaning toward user-friendliness. These findings offer valuable insights into how emotional consumer preferences can inform secondary packaging strategies for skincare products.
Keywords: *design elements, fuzzy logic, kansei engineering, skincare, QTT-1*

Abstrak — Penggunaan kemasan sekunder pada paket skincare, sangat diperlukan untuk proses pengiriman. Paket skincare yang hanya menggunakan bubble wrap pada saat pengiriman memiliki kekurangan, yaitu non-reusable dan kurangnya visual yang estetik pada produk. Ketiadaan kemasan sekunder yang optimal dapat meningkatkan resiko kerusakan produk selama distribusi serta mengurangi daya tarik visual, yang pada akhirnya berdampak negatif terhadap persepsi konsumen terhadap kualitas dan kredibilitas merek. Maka, perlu adanya perancangan dan pengembangan kemasan sekunder pada paket skincare. Penelitian ini bertujuan untuk menentukan elemen desain yang sesuai dengan konsep menggunakan metode *Kansei Engineering*. *Kansei Engineering* merupakan metode yang sudah terbukti optimal dalam pengembangan produk. Hasil penelitian diperoleh 43 kata Kansei dari 39 sampel dengan konsep desain "Praktis-Modern" dan "Untenable-User Friendly". Elemen desain yang dihasilkan adalah: Material kulit dan plastik (X1.6), Bentuk Pouch (X2.7), Fitur Handle kulit dengan sekat (X3.7), Penutup Flip top 4 sisi (X4.9), Gaya Desain Modern (X5.1), dan Warna Transparan merah (X6.10). Nilai PCC tertinggi adalah elemen "Bentuk" yaitu sebesar 0,8963, sehingga variable bentuk sangat mempengaruhi persepsi pelanggan. Desain tersebut kemudian diwujudkan dalam bentuk mockup fisik. Hasil evaluasi menunjukkan bahwa 59,4% responden memilih desain dengan konsep "Untenable dan User Friendly" Analisis *Fuzzy Logic* menguatkan temuan ini dengan menunjukkan bahwa desain berada pada kategori netral, cenderung ke arah kemudahan penggunaan. Temuan ini memberikan wawasan penting mengenai bagaimana preferensi emosional konsumen dapat digunakan dalam strategi pengembangan kemasan sekunder produk skincare.
Kata Kunci: *elemen desain*, *fuzzy logic*, *kansei engineering*, skincare, QTT-1

INTRODUCTION

Globalization and technological advancement have driven the dominance of imported skincare products in the Indonesian market. Foreign products have successfully attracted consumers through continuous innovation and aggressive marketing strategies. Meanwhile, local products continue to strengthen their position amidst the competition by emphasizing local values and competitive quality. In 2022, the skincare industry in Indonesia showed rapid growth, driven by global trends and increasing public awareness of the importance of self-care (Nawiyah et al., 2023). In facing this competition, visual aspects and consumer experience have become key strategies, one of which is through effective and attractive packaging design.

Packaging has become an essential element in brand communication strategy because it not only functions to protect the product but also creates visual and emotional appeal. In the digital era, which heavily relies on visual media, packaging is no longer merely a complement but an integral part of the consumer experience. Attractive packaging can strengthen brand identity, increase trust, and even influence purchasing decisions. The phenomenon of unboxing and the proliferation of product reviews on social media have further positioned packaging as a powerful marketing tool in shaping perceptions of product quality (Abdullah, 2021).

In the packaging system, secondary packaging plays a vital role in protecting products during storage and distribution processes. This function includes protection against impact, pressure, contamination, and damage during shipping. According to Julianti (2014), appropriately designed secondary packaging can prevent physical product damage, such as leakage or deformation. Widiati (2019) also added that secondary packaging plays an important role in maintaining product quality throughout the supply chain so that quality is preserved until it reaches the hands of consumers.

Nevertheless, many cases of skincare product damage caused by weak secondary packaging systems are still found. Aprilia et al. (2023) noted that around 30% of skincare products experienced damage or leakage during distribution. This problem often arises due to excessive focus on primary packaging, which only highlights visual elements such as logos, composition, and dimensions without thoroughly considering protective aspects (Arianto, 2022). In addition, the use of bubble wrap as an additional protection solution is considered inadequate, as it is not specifically designed for cosmetic needs. This is further exacerbated by the trend of consumer reviews on social media that assess product quality based on the physical condition of the packaging upon first receipt (Fayazi et al., 2015).

With increasing consumer expectations regarding visual experience and packaging protection quality, a design approach is needed that is not only aesthetic but also functional. Effective packaging design must consider elements such as shape, color, texture, dimensions, special printing, and spatial and material efficiency. Approaches such as reversible packaging have also begun to gain attention because they support not only aesthetics but also sustainability (Julianti, 2017). The balance between aesthetic and functional aspects is the main challenge in the development of today's skincare packaging design.

To address this challenge, the Kansei Engineering approach is used in the design development process based on consumers' emotional preferences. This approach connects consumers' emotional perceptions with design attributes through the mapping of Kansei words that represent feelings toward the packaging (Rahmayani & Desrianty, 2015). Thus, the resulting product is not only visually appealing but also evokes a positive emotional response that affects consumer loyalty. Sari (2019) stated that this method is effective in designing psychologically relevant products because it integrates aesthetics, ergonomics, and consumer psychology.

Kansei Engineering is usually combined with advanced analytical methods such as Principal Component Analysis (PCA), Quantification Theory Type 1 (QTT-1), and Fuzzy Logic to enhance result objectivity. PCA is used to simplify data and identify the main components that most influence design preferences. QTT-1 measures the relationship between Kansei Words and design attributes, producing R-square values and partial correlation coefficients (Djatna & Kurniati, 2015). Meanwhile, Fuzzy Logic is used to assist in selecting the most representative main components through a fuzzification process that flexibly adjusts inputs and outputs within a control system (Nasution et al., 2022).

The Kansei Engineering (KE) method has demonstrated strong potential in aligning packaging design with consumers' emotional preferences, and its effectiveness has been validated across various product studies. Rohmah et al. (2020) applied KE to identify the most preferred facial moisturizer packaging using Kansei words, resulting in an optimal design concept. Johan et al. (2024) confirmed KE's effectiveness in designing sago rice packaging, where preferred attributes such as standing pouch shape, aluminum foil material, and multicolor labels reflected key Kansei impressions like practical and innovative. Rahmayani & Desrianty (2015) also supported KE's reliability in designing loose powder packaging that met both visual and ergonomic expectations. These findings reinforce KE as a robust tool for creating emotionally engaging packaging, with future developments encouraged toward integrating technologies like Augmented Reality (AR) and sustainability principles.

Previous studies have widely applied Kansei Engineering to link consumers' emotional perceptions with product design. However, understanding user needs remains essential. To explore this aspect, a survey was conducted involving 30 active skincare users to identify their perceptions of existing packaging in the market. The results revealed that 45.2% of respondents considered packaging development important, while 54.8% deemed it very important. These findings indicate a high level of consumer concern toward packaging, particularly in terms of functionality, visual appeal, and sustainability. Common complaints included difficulties in opening, lack of practicality, unappealing design, and poor environmental friendliness. Based on these insights, this study aims to identify optimal packaging design elements aligned with user preferences and implement them in a mockup of secondary packaging that is more responsive to both emotional and functional consumer needs.

RESEARCH METHOD

This study was conducted using the Kansei Engineering method, supported by Quantification Theory Type 1 (QTT1) and Fuzzy Logic.

Problem Identification

At this stage, problem identification is carried out to determine the research domain so that priorities in the research can be identified. Problem identification is carried out through initial online and offline surveys of respondents. This survey aims to determine the importance of secondary packaging in the development and improvement of skincare product packaging.

Packaging Sample Collection

The sampling of secondary packaging for skincare products was conducted online. This process aimed to understand the product design elements in accordance with the framework proposed by (Djatna & Kurniati, 2015). The adopted methodology was Kansei Engineering, which requires the collection of at least 20 to 25 samples to capture the diversity of characteristics and packaging types (Sari, 2019). The sample selection process was based on the identification of relevant design elements, including form, aesthetics, materials, and packaging functionality (Sari et al., 2020).

Evaluation of Packaging Design Concepts

The evaluation of secondary packaging design for skincare products was conducted using a Semantic Differential questionnaire based on a 7-point Likert scale, which was specifically designed to quantitatively capture affective perceptions. This scale was selected due to its capacity to detect subtle differences in user responses, thereby improving the accuracy of emotional measurement (Fu et al., 2024). Respondents were selected using a purposive sampling technique, targeting loyal users of skincare products to ensure the alignment of sample characteristics with the study's objectives. A minimum of 30 participants were involved to ensure data sufficiency and enhance the reliability of the findings (Campbell et al., 2020). Prior to the evaluation phase, packaging design concepts were developed using the Kansei Engineering approach and further analyzed through Principal Component Analysis (PCA), which resulted in the identification of two dominant design concepts: Practical-Modern and User Friendly-Untenable (Aprilia et al., 2023).

Morphological Analysis

This stage involved conducting a morphological analysis of the collected packaging samples. The purpose of this analysis was to identify and break down the visual form elements of the product into smaller components, allowing for a more systematic mapping of the relationship between design characteristics and user perception (Lei et all., 2024). Each main design component was systematically analyzed, sequentially numbered, and categorized based on type and identification code to facilitate the mapping of relationships between design elements and user perception (Du et al., 2024). The identification of packaging elements was carried out through structured discussions with expert panelists in the fields of design and packaging. The criteria for selecting experts included involving a minimum of 5 to 10 individuals with relevant expertise and more than 10 years of experience in the field (Sari, 2019), to consolidate and unify similar opinions derived from individual assessments. The identified design elements were then used as variables for further analysis using the Quantification Theory Type 1 (QTT1) method (Sari, 2019).

Analyzing the Correlation Between Packaging Design Elements and Design Concepts.

The correlation between packaging design elements and design concepts was analyzed using the Quantification Theory Type 1 (QTT1) method, executed via R programming. R is a widely adopted open-source statistical computing language, particularly prominent in big data analytics and complex data modeling due to its flexibility, robust packages, and community support (Wang et al., 2021). Its integration in this study facilitates efficient computation of regression models and handling of multidimensional design data. The analysis was structured into the following six steps (Ghiffari, 2018):

- **Step 1:** Establish a Kansei relational framework to connect Kansei responses with experimental packaging samples based on paired image words.
  The regression model is formulated as follows:

$$y_s^k = \sum_{i=1}^{n} \sum_{j=1}^{c_i} \beta_{ij} x_{ij} + \varepsilon \quad (1)$$

- **Step 2:** Estimate the standard regression coefficients and constant using the following model:

$$y_s^k = \sum_{i=1}^{n} \sum_{j=1}^{c_i} \beta_{ij} x_{ij} + \overline{y_s^k} \quad (2)$$

$$\beta ij = \beta ij - \tfrac{1}{n} \sum_{j=1}^{Ci} \beta ij \; xijs \quad (3)$$

$$\Sigma_s^k = \frac{1}{n} \sum_{s=1}^{n} (y_s^k)^2 \quad (4)$$

- **Step 3:** Construct the Canonical Correlation Coefficient (CCR) matrix for all variables.
- **Step 4:** Calculate the multiple correlation coefficient RRR to assess the strength of the relationship among variables.
- **Step 5:** Determine the Partial Correlation Coefficients (PCC) of design elements to clarify their individual influence on the product sample response.
- **Step 6:** Identify the statistical significance of each category, indicating its contribution to the predicted concept score for a given product design.

Packaging Model Creation

The final visualization of the packaging design was conducted to validate the predefined visual elements, encompassing aesthetics, functionality, and color schemes based on consumer perception (Sari et al., 2025). This process began with data processing using R software, followed by the creation of two-dimensional graphic designs in Adobe Illustrator. Subsequently, a physical three-dimensional mock-up was constructed using manual stitching techniques to simulate the final packaging form and assess its alignment with user expectations.

Evaluation of the Packaging Mockup Using Fuzzy Logic

This method is expected to support the identification of optimal design concepts based on the results generated by QTT1 analysis. Fuzzy Logic operates by integrating two sets of input variables, which are then processed through a fuzzification stage to determine output values that align with the requirements of the control system (Nasution et al., 2022). The following outlines the procedure for developing the Fuzzy Logic model:

1. **Defining Input and Output Variables**
   The first step in the fuzzy logic method involves identifying the input and output variables, followed by determining the degree of membership of each input in the corresponding fuzzy sets through the process of *fuzzification*. Inputs are expressed as numerical values within the range of 0 to 1. The output represents the degree of membership in a linguistic category, also within the interval of 0 to 1 (Auliaty & Sukirman, 2023).

2. **Construction of Membership Functions**
   This study adopts triangular fuzzy numbers, which are considered more computationally efficient than trapezoidal fuzzy numbers, as they contain a single peak with a full membership value of 1 (Auliaty & Sukirman, 2023). Each linguistic variable is defined based on the fundamental structure of its components. The triangular membership function is formulated as follows:

$$\mu_A(x) = \begin{cases} 0, & x < a, \\ \dfrac{x-a}{b-a}, & a \leqslant x \leqslant b, \\ \dfrac{x-c}{b-c}, & b \leqslant x \leqslant c, \\ 0, & x > c. \end{cases} \quad (5)$$

3. **Formulation of Fuzzy Rules**
   Fuzzy rules are established to represent the relationships between input and output variables within a fuzzy knowledge-based system. A typical rule takes the form:
   IF x is A THEN y is B,
   where *x* and *y* are crisp values, and *A* and *B* are fuzzy sets. The clause following *IF* is called the *antecedent*, while the clause following *THEN* is the *consequent*. These rules can be extended using fuzzy operators such as AND and OR. The general form of a fuzzy rule is expressed as:

Rule = IF XI = AI and ..... Xn = An THEN Y = B (6)

Where AI...., An, and B are linguistic terms derived from the input variables XI, Xn, and the output variable Y. This formulation serves to model causal relationships between multiple input conditions and an output response using linguistic descriptors. It enables the system to approximate human reasoning under uncertainty by mapping qualitative input states to corresponding qualitative outputs, thereby facilitating decision-making in environments with imprecise or incomplete information.

Fuzzy Rule Evaluation

In this stage, several packaging mockup samples are randomly selected and evaluated using the fuzzy rule base that has been previously constructed. The inference process applies the fuzzy rules to the actual input values to assess the degree of alignment between the mockup design and the intended design concep (Fungki Wahyu & Billy Hendrik, 2023).

RESEARCH RESULTS AND ANALYSIS

Problem Identification

This research identifies problems through observations of 30 respondents. The respondent criteria used in this study are people who purchase skincare at least 5 times a year. The observation results showed 54.8% of respondents stated that it was very important and 45.2% of other respondents stated that it was important that skincare packaging needed to be developed.

Packaging Sample Collection

A total of 39 packaging samples were selected for further analysis, as presented in Figure 1. These samples were the result of a multi-step screening process that began with the collection of 50 packaging references sourced from various online platforms, including Google, Pinterest, Instagram, and online marketplaces. This approach was adopted to ensure a diverse representation of packaging designs beyond conventional formats (Faizi & Sari, 2025). To refine the selection, a comparative assessment was conducted, eliminating samples with overlapping characteristics in terms of material, shape, dimensions, label design, and packaging features. Ultimately, only distinct and unique designs were retained for subsequent evaluation (Sari, 2019).

Figure 1. Packaging Sample

Evaluation of Packaging Design Concepts

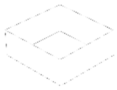
To evaluate consumers' emotional perceptions (Kansei) toward the packaging design, a survey was conducted using a 7-point Semantic Differential scale questionnaire. Respondents were selected through purposive sampling, targeting individuals identified as loyal skincare users. This sampling approach was intentionally employed to ensure the inclusion of participants with relevant experience and emotional familiarity with skincare products, thereby enhancing the validity and relevance of the affective data collected (Hartono, 2020). The questionnaire responses generated quantitative data, which were subsequently processed using Microsoft Excel to calculate descriptive statistics, including minimum, maximum, mean, and standard deviation values. These statistical outputs served as the foundational dataset for further analysis using Quantification Theory Type 1 (QTT1) and Fuzzy Logic methods.

Morphological Analysis

The morphological analysis conducted in this study aimed to establish a systematic link between consumers' affective responses such as perception, emotion, and preference and key visual and functional attributes of packaging. Packaging morphology is defined as a set of observable characteristics, including structural form, dimensions, materials, color schemes, and usability-enhancing features (Sari et al., 2024). A total of 39 packaging samples were examined, and relevant design components were identified through expert evaluation. The findings were categorized into two primary groups: structural elements and visual design attributes. These components were subsequently utilized as input variables in the Quantification Theory Type 1 (QTT1) analysis (Sari, 2019). A detailed overview of the morphological characteristics for each sample is presented in Table 1.

Table 1. Morphological Analysis

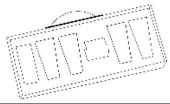
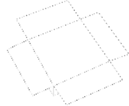
Factor	Material (X1)	Shape (X2)	Feature (X3)	Lid Shape (X4)	Style Design (X5)	Color (X6)
Type 1	Plastic Rigid	Square	Ribbon Handle	Zipper	Modern	Blue

						
Type 2	Carton	Rectangle	Leather Handle	Slide	Elegant	Brown
Type 3	Fabric	Triangular Prism	Handle by Material	1-Sided Flip Top	Funny	Pink
Type 4	Cardboard	Tube	Plastic Handle with Bulkhead and Window	Clip	Minimalism	White
Type 5	Corrugated	Trapezoid	Rope Handle with Bulkhead	Telescope	Colorfull	Green
Type 6	Leather and Plastics	Hearth Shape	Handle by Material with Bulkhead	Tuck End	Feminim	Red
Type 7		Pouch	Leather Handle with Bulkhead	2-Sided Flip Top	Classic	Purple
Type 8		Bag	Ribbon Handle with Bulkhead	3-Sided Flip Top		Red and Tranparant
Type 9		Rounded Square	Handle by Material with Bulkhead and Window	4-Sided Flip Top		Blue and Tranparant
Type 10		Octagon	Bulkhead	Gable		Transparant Red
Type 11			Bulkhead with Window			Purple, Pink and Yellow
Type 12			No Feature			

Analyze the Correlation of Packaging Design Elements with the Concept and Create a Packaging Mockup.

The results of the QTT 1 bar graph show the design elements that are prioritized in each concept. Data are selected based on positive values or the longest graph to the right of each factor (Sari et al., 2021). Based on the QTT 1 results, the structural and design elements are shown in Table 2.

Table 2. Selected Design Elements

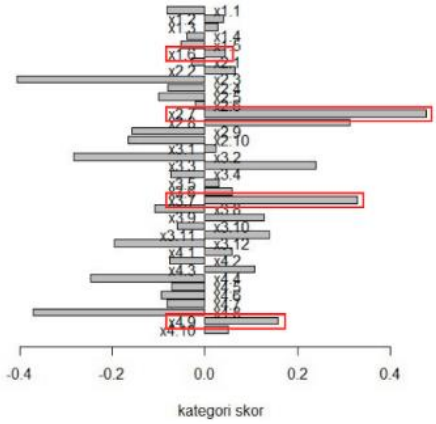
Elemen Design	**Type**
Material (X1)	Leather and Plastics (X1.6)
Shape (X2)	Pouch (X2.7) 
Feature (X3)	Leather Handle with Bulkhead (X3.7) 
Lid Shape (X4)	4-Sided Flip Top (X4.9) 
Style Design (X5)	Modern (X5.1)
Color (X6)	Transparant Red (X6.10)

The selected elements will be used in the creation of the mockup. Mockup making also uses mind mapping and moodboard to determine additional design elements. The concept of User Friendly is interpreted by the use of lightweight and transparent materials such as PVC mica, a shape that is not too large and features handles and dividers. The structure and design elements contained in this packaging are in accordance with consumer preferences for skincare packaging, consumers want skincare packaging that is easy to carry, easy to store, reusable, has a simple design, is waterproof and uses transparent materials so that consumers can see the contents of the product inside without having to open the packaging. The results of the QTT 1 bar graph and mockup can be seen in Table 3.

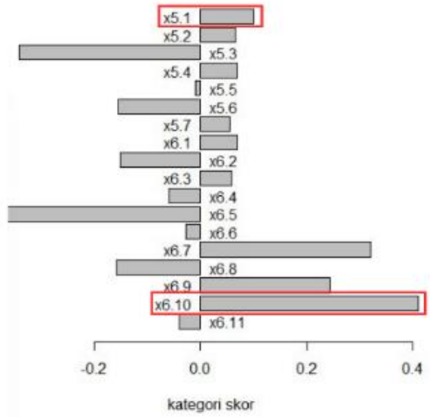
Table 3. Result QTT1 *Untenable – User Friendly*

Concept Design *Untenable - User Friendly*

Struktur



Desain



Mockup

The results of running QTT1 will be analyzed to determine the concept to be used in packaging development. Prioritization of design concepts is seen through the largest R-square value (Coghlan, 2014). The R square value of the structure and design elements obtained in the Practical - Modern concept is 0.7789 and 0.3036 and the Untenable - User Friendly concept is 0.9662 and 0.5018. So that the concept of Untenable - User Friendly is used as a concept in packaging development.

The packaging element that has the most influence on consumer perception can be known through the Partial Correlation Coefficient (PCC) value (Sari, 2019). In the selected concept of Untenable - User Friendly, the PCC value obtained for each element is X1 = 0.4747924, X2 = 0.8963993, X3 = 0.8251219, X4 = 0.8046167, X5 = 0.5522661 and X6 = 0.6699029. The element that has the largest PCC value is X2 "Shape" of 0.8963993, so "Shape" is the element that most influences consumer perception.

The mockup contained in Table 3 was evaluated to 32 respondents, the results showed that 96.6% of respondents stated that the mockup had illustrated User Friendly packaging. The evaluation results also show that the mockup with the concept of User Friendly is chosen as a suitable packaging for skincare packaging. This shows that the QTT1 results are in accordance with consumer preferences because the largest R-square value is found in packaging with the User-Friendly concept.

Packaging Evaluation with Fuzzy Logic

Fuzzy Inference System (FIS) is an analysis method that uses fuzzy logic to examine uncertainty and ambiguity in making a decision (Fungki Wahyu & Billy Hendrik, 2023). FIS can evaluate all rules simultaneously to produce a conclusion (Rizky & Hakim, 2020). Fuzzy Logic is able to manage uncertainty using linguistic variables (e.g. "bright", 'sleek', "modern") and membership values that reflect levels of preference. In this way, designers can produce designs that are more aligned with consumer desires.

Determine input and output variables

Based on the results of the design concept with the PCA method, 2 concepts are obtained that represent skincare product packaging, namely Practical - Modern (P - M) and Untenable - User Friendly (U - UF). Both pairs of concepts are used to evaluate the results of respondents' assessment of 39 packaging samples using the QTT1 method. The results of QTT 1 show that the U-UF concept has the highest R-square of 0.9662 for structure and 0.5018 for design elements, so the one used as an illustration of the fuzzy logic approach is the U-UF concept to build a fuzzy logic model. The assessment of the 39 packaging samples in Figure 1 was carried out using a Likert questionnaire with a 7-point scale (1 - 7). An assessment of the samples was carried out by 35 respondents on a U - UF scale of 1 - 7, where 1 represents the most Untenable concept and 7 represents the most User-Friendly concept. The assessment results are shown in Table 4. The first column shows the code of each packaging sample, columns 2 - 7 show the corresponding type for each sample based on morphological analysis. Sample I is used as an example, where the sample has a value as "User Friendly" packaging with an average value of 5.4 and each type number of the six factors is X1 = 6, X2 = 8, X3 = 7, X4 = 1, X5 = 4 and X6 = 7. So that 6 factors including X1 "Material", X2 "Shape", X3 'Features', X4 "Cover shape", X5 "Design style" and X6 "Color" are used as input linguistic variables, while the output linguistic variables are shown in Figure 2 where the value is obtained from the average assessment results of 35 respondents shown in Table 4.

Table 4. Input Data Source

Sample code	X1	X2	X3	X4	X5	X6	User friendly - Untenable			
							Mean	Min	Max	Stand. dev
A	2	2	11	6	4	1	4,8	1	7	1,9
B	4	2	10	2	2	3	4,6	1	7	1,8
↓	…	…	…	…	…	…	…	…	…	…
I	6	8	7	1	4	7	5,4	1	7	1,6
↓	…	…	…	…	…	…	…	…	…	…
WW	2	1	5	6	4	1	4,5	1	7	1,6
XX	4	2	6	3	1	1	4,8	1	7	1,6

Determine the Membership Function

This study uses a triangular membership function with an interval of 0 - 1 in representing the value of the six factors used in the fuzzy rules shown in Figure 2. The linguistic variables contained in Figure 2 are determined based on the number of types based on morphological analysis. For example, in Figure 2(e) X5 "Design style" has 7 types namely modern, elegant, funny, minimalist, colorful, feminine and classic, so there are 7 linguistic terms used in the fuzzy triangle shown in Figure 2(e). A scale value of 1-2 is used to indicate the relationship between the 2 types in the first peak characterized by the linguistic terms modern (M) and elegant (E). For example, a value of 1.5 means that the sample is a combination of 50% modern and 50% elegant. In the funny (F), minimalist (M) and classic (CS) design styles, the single values of 3, 4 and 7 were used because these types have no relationship with the other types.

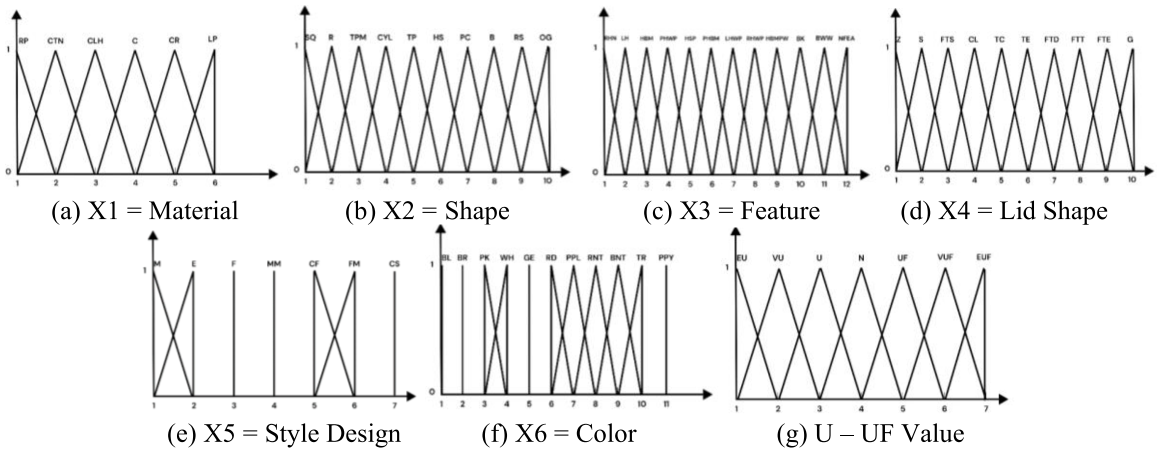


Figure 2. Membership Function

The results obtained from the assessment of 35 respondents with a 7-scale Likert questionnaire obtained an average value ranging from 1 - 7 which can be seen in Table 2. The value will be fuzzified with 7 triangular fuzzy numbers to indicate linguistic terms consisting of Extreme Untenable (EU) to Extreme User Friendly (EUF) derived from the membership function in Figure 2(g). Extreme Untenable has a membership function of (1.1.2), Very Untenable (1.2.3) and so on up to Extreme User Friendly (6.7.7).

Defining Fuzzy Rules

Rules are generally easier to define in linguistic form than in numerical form, rules are also often referred to as "IF - THEN" rules (Pourjavad, 2017). IF-THEN rules are defined as in formula (6). For example, in rule 1, it states that "IF X1 is K, X2 is PP, X3 is SDW, X4 is TE, X5 is MM and X6 is BR THEN Y is N with a Degree of Support (DoS) value of 0.20.

The average value of the assessment results of 35 respondents in Table 2 is used as output on fuzzy rules and generally has membership with linguistic terms. Given an example that can be seen in Figure 3 where sample A has an average assessment value of 4.8 which can be seen in Table 4. The value of 4.8 means that the sample is a member of Neutral (N) with a membership degree of 0.20 and is also a member of User Friendly (UF) with a membership degree of 0.80. The DoS value for each fuzzy rule can be seen in Table 5.

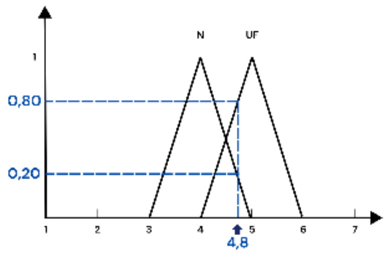


Figure 3. Membership Degree of U - UF Values in Sample A in Output Linguistic Terms

Fuzzy rules are formed through identification of structural and design elements with 39 packaging samples, resulting in 77 fuzzy rules shown in Table 5.

Table 5. Fuzzy Rules

	Rule	IF (Antecedent)						THEN (Consequent)	
		X1	**X2**	**X3**	**X4**	**X5**	**X6**	**U – UF (Y)**	**DoS**
A	**1**	CTN	R	BWW	TE	MM	BL	N	0.20
	2	CTN	R	BWW	TE	MM	BL	UF	0.80
↓	…	…	…	…	…	…	…	…	…
↓	…	…	…	…	…	…	…	…	…
XX	**76**	C	R	PHBM	FTS	M	BR	N	0,20
	77	C	R	PHBM	FTS	M	BR	UF	0,80

Testing Fuzzy Rules

An inference engine is a component that uses fuzzy rules in input data to obtain fuzzy outputs. In this process, various rules are combined and consider all possible combinations of inputs (Fungki Wahyu & Billy Hendrik, 2023). The next step is defuzzification to convert fuzzy values into concrete values or actionable actions, this measures how ambiguous values are integrated into consistent values (Fungki Wahyu & Billy Hendrik, 2023). Defuzzification is done using Center of Maximum (COM) with the following formula:

$$\mathrm{COM} = \frac{\sum_{i=1}^{n} yi \cdot \mu(yi)}{\sum_{i=1}^{n} \mu(yi)} \quad (7)$$

Where i is the linguistic term of the output linguistic variable, yi is the maximum value of each linguistic term i and μ(yi) is the joint membership function.

The fuzzy rules that have been made are then verified using the QTT 1 results to determine the U - UF value with the COM method through Matlab software. The value obtained through fuzzy logic evaluation is 4.00, where the value is in the Neutral (N) category because the material selected in the QTT 1 results is "rigid plastic" which is untenable.

CONCLUSIONS

Based on the results of the study, the selected design concept is in accordance with consumer preferences, showing consistency with the results of the Quantification Theory Type (QTT1). The R square value obtained is in accordance with consumer perception, where the selected concept is user-friendly, with design elements involving leather and plastic material X1.6, pouch shape X2.7, leather handle feature with divider X3.7, 4-sided flip top lid X4.9, modern design style X5.1, and red transparent packaging color X6.10. Based on fuzzy-AHP analysis, it was found that the most prioritized criteria or attributes are packaging shape, features, and lid.

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