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Product design development of a three-in-one tote bag using the Kansei Engineering method

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Abstract
The existing tote bag designs are often open at the top and vulnerable to pickpockets. Straps cannot be adjusted in length. Narrow straps, size, and the weight of their bags are causing pain. This study aims to develop a multifunctional tote bag to meet consumer needs to make it easier to carry goods of various sizes using only one bag. The population in this research is women and tote bag users who live in Tuban, East Java. The sample in this study was 30 tote bag users determined using a purposive sampling technique with the criteria being tote bag users for at least one month and aged 16-45 years. The data collection tool in this study is the Google Form questionnaire. The method in this study uses Kansei Engineering. The data were analyzed by SPSS 26. The results 14 Kansei words represent consumer desires for product development of multifunctional tote bags and are grouped into four factors: function, appearance, impression, and capacity. The old tote bag design is different from the three-in-one tote bag design based on the results of the Wilcoxon signed-rank test with a significance value of 4 factors < 0.05.

Keywords:
Design;
Kansei Engineering;
Kansei Word;
Three-In-One;
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INTRODUCTION

Indonesia is inhabited mainly by a productive age population (15-64 years) with high daily mobilization [1]. People tend to bring various kinds of goods of different sizes to support activities. A bag is an essential item that can load everything to support activities. The bag has many types, made with various models and designs, to adapt their functions. Some are used for daily activities and travelling, and others are used only as a fashion statement [2]. A tote bag is one commonly used for carrying and transporting essentials. They are big and very roomy and can load many kinds of stuff for any purpose [3]. The tote bag was designed to be simple and multifunction [4].

However, the existing design has several weaknesses. First, the tote bag design is open at the top, allowing the user to be vulnerable to pickpockets [5]. Second, the straps are not adjustable and come in thin width, forcing the user to carry the bag only with the shoulder. The not adjustable and thin strap gives an uncomfortable experience and causes shoulder pain in many tote bag users [6]. Third, tote bags are made with the aim of being affordable. Tote bags are generally more cost effective to purchase because they are easier and cheaper to make [7].

Therefore, a tote bag like this cannot be used for formal events or fashion items. Fourth, the users usually choose tote bags to save money because they can load many kinds of stuff just in one bag due to their big size [8]. However, the big size of the bag may cause pain and uncomfortable for many people because the big bag is heavy and not fashionable [9]. Therefore, the design of tote bags should be adjustable as needed. When the user needs to carry many things, the bag can expand into a larger size, and when the user does not bring many things, the bag can be folded into a smaller size to make it comfortable and fashionable.

The product development trend is changing to become consumer-oriented. Manufacturers consider consumer needs as an essential product development aspect [10]. The development of a multifunctional tote bag uses Kansei engineering to analyze the implicit needs of consumers and relate them to the character of the product design. Kansei Engineering uses words as sensors for emotions [11]. The Kansei word is important because consumers cannot explicitly explain their desires [12]. Kansei engineering can interpret consumers' impressions, feelings, and desires (Kansei word) for products or concepts that have existed before to design solutions and design parameters [13].

There are several studies on bags. (1) Sling bag design to develop women's bags to increase the added value of sling bag products in the trade business [14]. (2) The design and development of emergency bags for school children to design a disaster preparedness kit or go bags for children aged six years and 12 years old to increase their chance of survival and improve their participation, awareness, and preparedness in emergencies [15]. (3) Flexible bag multifunctional souvenir design to determine university souvenirs' product attributes and specifications [16]. (4) Sling bag design analyzes the strength of university merchandise at the national and international levels [17]. (5) Tote bag visual creation helped students produce quality designs and plan good channels to sell well, thus achieving the curriculum objectives [18]. (6) Tote bag design focuses on the logo's visual identity and is applied to some promotional media as needed to increase the number of tourists [19]. However, no research focuses on adjustable tote bags that can be transformed according to consumer needs.

Kansei engineering has been successfully used to develop many products in various industries, such as the design of Berastagi souvenir clothes [20], safety hijab design [21], sling bag design [14], chair design read [22], automotive dashboard design [23], Golf Gloves [24], post-stroke rehabilitation bicycle [25], electric motorcycle [12], portable shopping trolley design with a scooter [26], and train passenger seat design [27].

In this study, Kansei engineering is used to determine the design that suits the wishes of consumers. This research aims to develop a new tote bag design that is more secure and adjustable for any purpose.

MATERIAL AND METHODS

Material

An online survey was conducted from July 19 until August 2, 2021, to learn the customer's perception of the existing tote bag using Kansei Word. The survey was started by interviewing potential respondents who met the inclusive criteria, i.e., (1) Indonesian women, (2) aged 16-45 years old, and (3) using the tote bag for at least a month. Then, an online questionnaire using Google Forms was given to the potential respondent. Thirty complete questionnaires were sent back and processed to the next stage. The number of respondents was sufficient to use in Kansei engineering [28]. The respondents will receive three serial questionnaires to obtain the corresponding answer to capture the consumer's wishes about the new tote bag design.

Method

The procedure in this research was consistent with four-step of the Kansei Word method [29]: (1) Kansei Survey; (2) Data Analysis; (3) Data Interpretation; (4) New Product Design. The first step is the Kansei survey consists of three serial questionnaires: (1) seven demographic-related questions and 45 stimuli Kansei Words collected from the literature review were given to collect consumer perceptions; (2) the semantic differential scale questionnaire was given using a five-level rating to evaluate 25 paired of Kansei word and the word that denies the Kansei word; (3) eight differential perception questions with a five-level rating were given to determine whether there is a difference between the old product design and the latest product design. The second step is data analysis. Kansei words that have been obtained are then analyzed using statistical methods. The third step is data interpretation using a tree structure from 0-order to physical design or the zero-order Kansei concept. The last step is the new product design. The product will be visualized in the form of a product design for further validation with different tests.

Data analysis in this study uses SPSS 26 and is divided into four stages. (1) validity test to determine the level of validity of each Kansei word. If there are still invalid Kansei words, further iterations will be carried out until all valid Kansei words are obtained. The Kansei word used in the following process results from the last validation test iteration. A valid Kansei word has a value of R count > R table. (2) reliability test to determine each Kansei word's consistency level. The requirement for the reliability value of Cronbach's Alpha is greater than 0.7. (3) factor analysis using KMO (>0.5) and Bartlett's Test of

Sphericity (<0.05) to direct the process of mapping design elements by grouping Kansei words into smaller groups (factors/clusters). Grouping of factors is based on the total accepted Eigenvalues > 1. (4) difference test using the Wilcoxon signed-rank test to determine whether there is a difference between the old and new designs. The following hypotheses: H0: there is no difference between the old design and the new design; H1: there is a difference between the old and the new design. Test Criteria: H0 is accepted if the significance level is > 0.05; H1 is accepted if the significance level is < 0.05.

RESULTS AND DISCUSSION

Kansei Survey

The demographic characteristics of the 30 respondents in this study were dominated by women aged 22-27 and 28-33. A total of 15 people have used tote bags for more than 24 months. Tote bags are most widely used for groceries. The majority of respondents have more than three tote bags of different sizes. Tote bags with a price of less than IDR 50,000 are the most bought, and if there will be any repurchases, they are willing to pay the same price. The complete demographic characteristics refer to Table 1.

Table 1. Demography characteristic of the tote bag user respondent

Characteristic		Frequency
Age (years)	16-21	0
	22-27	13
	28-33	13
	34-39	3
	40-45	1
Duration of usage (months)	1-12	10
	13-24	5
	>24	15
Usage purpose	Work	14
	Grocery	22
	School	9
	Travel	15
	Others	2
Number of tote bags owned	1	1
	2	9
	3	7
	>3	13
If you have more than one tote bag, are the sizes different?	Yes	27
	No	2
How much did you buy a tote bag?	<Rp50,000	11
	Rp50,001-Rp100,000	9
	Rp100,001-Rp150,000	5
	Rp150,001-Rp200,000	0
	>Rp200,000	5
If you buy another tote bag, how much are you willing to pay?	<Rp50,000	11
	Rp50,001-Rp100,000	10
	Rp100,001-Rp150,000	4
	Rp150,001-Rp200,000	1
	>Rp200,000	4

Data Analysis

The 45-word stimuli were given to the respondent to enlarge their reference, and the most chosen 25 Kansei words were obtained from the respondents from the first questionnaire. The results of the Kansei Word questionnaire can be seen in Table 2.

Table 2. Result of Kansei's words

Code	Kansei Word	Code	Kansei Word
KW1	Simple	KW14	Long-lasting
KW2	Humble	KW15	Opaque
KW3	Multifunction	KW16	Effective
KW4	Thick material	KW17	Comfortable
KW5	Spacious	KW18	Not complicated
KW6	Pocket available	KW19	Efficient
KW7	Minimalist	KW20	Durable
KW8	Good	KW21	Practical
KW9	Convenient	KW22	Storable
KW10	Big	KW23	Innovative
KW11	Capacious	KW24	Water-proof
KW12	Adaptable	KW25	Adjustable strap
KW13	Strong		

The validity test determines the level of validity of each Kansei word. If there are invalid Kansei words, further iterations will be carried out until all valid Kansei words are obtained. The validity test uses a comparison of the values of the R count and R table value. In this study, the degree of freedom (df) = N – 2 = 28 with a significance level of 0.05. So, it can be seen that the value of the R table used is 0.361. This value will be compared with each tested Kansei Words R count value. If the value of the R table (0.361) is smaller than the value of the R count, then the data is declared valid and can be used in the following research stage. The validity test was carried out with two repetitions (iterations), resulting in 20 valid Kansei words *multifunction, thick material, spacious, good, convenient, big, capacious, adaptable, strong, long-lasting, effective, comfortable, not complicated, efficient, durable, practical, storable, innovative, water-proof, and adjustable strap*.

The next step is a reliability test to determine the level of consistency of each Kansei word. Cronbach's Alpha value in the reliability test is greater than 0.7. The result of the reliability test is 0.905. Therefore, the 20 Kansei words are reliable to processed in the next stage.

Valid and reliable Kansei words will be used for factor analysis using KMO and Bartlett's Test of Sphericity. Factor analysis will eliminate invalid Kansei words. Kansei words that will be analyzed further are those with Measure of

Sampling Adequacy (MSA) values > 0.5 and Communalities > 0.5. It will be invalid if it is not met according to these criteria. Iterations will continue until all Kansei words are valid.

The first iteration contains two invalid Kansei words. The second iteration contains three invalid Kansei words. The third iteration contains one invalid Kansei word. The fourth iterations of Kansei words have 14 valid values. Furthermore, the 14 Kansei words were continued in the following analysis. The result of iteration fourth can be seen in Table 3.

KMO and Bartletts's Test of Sphericity was repeated (iteration) up to four times, adjusting the MSA and Communalities Kansei word results. The significance value of Bartlett's Test of Sphericity is less than 0.05, which shows Kansei words can be used in this research.

Kaiser-Meyer-Olkin (KMO) value is greater than 0.5, which shows the samples are adequate for factor analysis. The result of KMO is 0.726, and the significance of Bartlett's Test of Sphericity is 0.000, valid to proceed to the next stage.

The following process is grouping Kansei words into several factors/clusters. The formed factors are four based on the total Eigenvalues received > 1. The results of the total Eigenvalues can be seen in Table 4.

After that, 14 Kansei words were grouped into four factors based on the Result of the Rotated Component Matrix, as listed in Table 5.

Table 3. Result MSA and Communalities of Fourth Iteration

Kansei Word	Iteration 4		Information
	MSA*	Communalities	
KW4	0.822	0.801	Valid
KW5	0.755	0.774	Valid
KW8	0.585	0.752	Valid
KW10	0.573	0.612	Valid
KW11	0.639	0.797	Valid
KW14	0.672	0.782	Valid
KW16	0.741	0.633	Valid
KW17	0.724	0.843	Valid
KW18	0.819	0.803	Valid
KW19	0.876	0.812	Valid
KW20	0.633	0.835	Valid
KW21	0.788	0.773	Valid
KW23	0.848	0.717	Valid
KW25	0.742	0.811	Valid

Table 4. Result of The Total Eigenvalues

Component	Total Eigenvalues
1	6.171
2	1.884
3	1.509
4	1.181

Table 5. Result of rotated component matrix

Kansei Word	Component			
	Function	Appearance	Impression	Capacity
KW4	0.040	0.147	0.043	0.881
KW5	0.103	0.284	0.422	0.710
KW8	0.222	0.185	0.808	-0.125
KW10	-0.197	0.656	0.347	0.151
KW11	0.060	0.159	0.806	0.344
KW14	0.170	0.801	0.216	0.256
KW16	0.449	0.295	0.577	0.104
KW17	0.369	0.773	0.330	-0.033
KW18	0.827	0.331	0.080	-0.057
KW19	0.748	0.300	0.398	0.061
KW20	0.273	0.719	-0.066	0.489
KW21	0.815	-0.119	0.287	0.110
KW23	0.216	0.291	0.587	0.491
KW25	0.730	0.021	-0.095	0.518

Kansei words will be included in one of the four factors created by looking at the component values that are > 0.5. If there is more than one value > 0.5, then the largest value is taken. Therefore, the grouping factors are named Function, Appearance, Impression, and Capacity.

Data Interpretation

The factor grouping data is then interpreted to describe the Kansei word factors to make it easier to translate into specific product designs. Finally, product design elements are mapped using the zero-order Kansei concept, starting from 0-order to physical design. The results of the zero-order Kansei concept can be seen in Figure 1.

The Kansei concept can be used as a reference for creating new product innovations. The characteristics of these four Kansei words are described as follows:

a. Function: Tote bag functions to carry various goods. Based on the stuff category, they are grouped into three types: (1) to carry grocery items with a large tote bag size design (400x350x120); (2) to bring office needs with a medium tote bag size design (300x350x120); (3) for fashion items with a small tote bag size design (200x350x120). The tote bag also functions for various formal and informal activities, so the appropriate tote bag design is casual or semi-formal. The last function of the tote bag is efficiency, meaning that consumers do not need to have more than one various size of the tote bag. The design of tote bags should be adjustable as needed. When the user needs to carry many things, the bag can expand into a larger size, and when the user does not bring many things, the bag can be folded into a smaller size to make it comfortable. Thus, the design of the tote bag is a 3-in-1 design.
b. Appearance: The tote bag is designed using a metal zipper to make the goods carried safe

for appearance. The tote bag's shape is rectangular and has a long flat strap. Additional accessories on the tote bag are (1) an extra pouch at the front to store small items so they are easy to reach and neater, (2) D-rings nickel as a place to attach the hook strap, and (3) hooks nickel that functions as a connector to the tote bag. Nickel is particularly tough and corrosion-resistant [30], so it's suitable for D-rings and hooks used for a long time.

c. Impression: The tote bag consists of 1 large compartment inside to support accessibility, making it easy to take goods. The material used for the tote bag is denim. The advantages of denim are high durability, excellent strength, timeless fashion, and attractive aesthetics [31]. In addition, the tote bag strap is webbing polyester because it is a high-quality material with high tenacity [32].

d. Capacity: A tote bag's capacity is important because it determines the number and size of carrying items. Based on the capacity, the tote bag has 3 size designs: (1) large size (400x350x120); (2) medium size (300x350x120); and (3) small size (300x350x120). The tote bag strap has a minimum length of 450 and a maximum length of 900 with a strap width of 240.

New Product Design

The next step is to draw the design with the guidance of the Zero-Order Kansei Concept. Of the four factors formed, 19 physical designs were created to meet consumer demands and desires after being developed. A three-in-one tote bag with a zipper bag is proposed as an innovative solution to provide a more secure and adjustable bag in the length of the strap and the bag's volume.

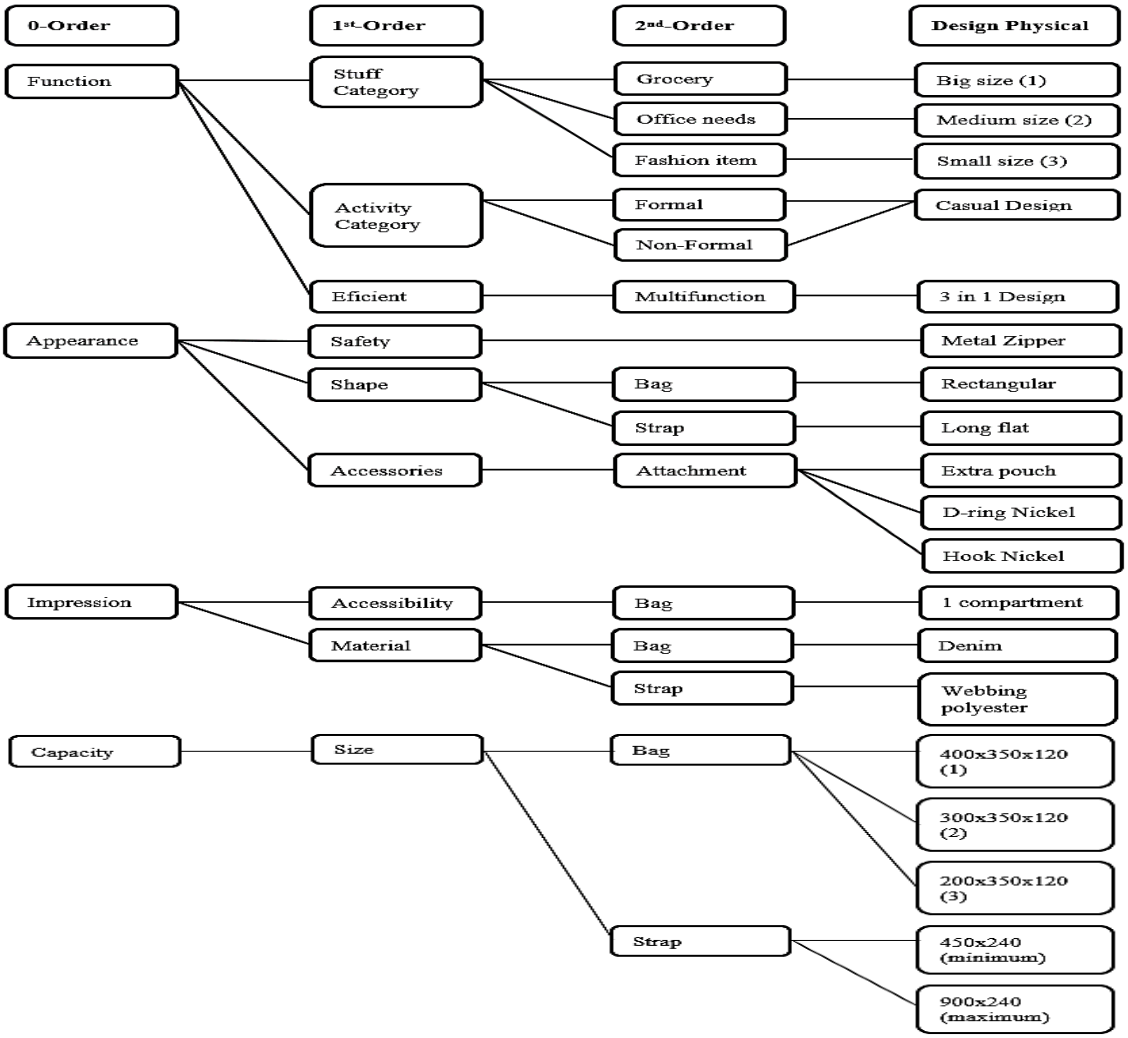

Figure 1. The result of The Zero-Order Kansei Concept

The design is proposed to adapt to every purpose by considering economic, fashion, and comfort aspects. The results of the visualization of the physical design can be seen in Figure 2.

The three-in-one tote bag can be folded up for transformation. Based on Figure 3, picture 1 shows the small-sized tote bag, picture 2 shows the medium-sized tote bag, and picture 3 shows the big-sized tote bag. The small-sized tote bag can turn into a medium-sized tote bag if the inner part is pulled out. Then the medium-sized tote bag can turn into a big-sized if the inner part is pulled out.

Design Validation

The last step is the difference test used to determine whether there is a difference between the old product design and the latest product design. The results of the *Wilcoxon signed-rank test* are all Factors (Function, Appearance, Impression, and Capacity) accepted H1 Hypothesis. Thus, there is a difference between the old and the new design.

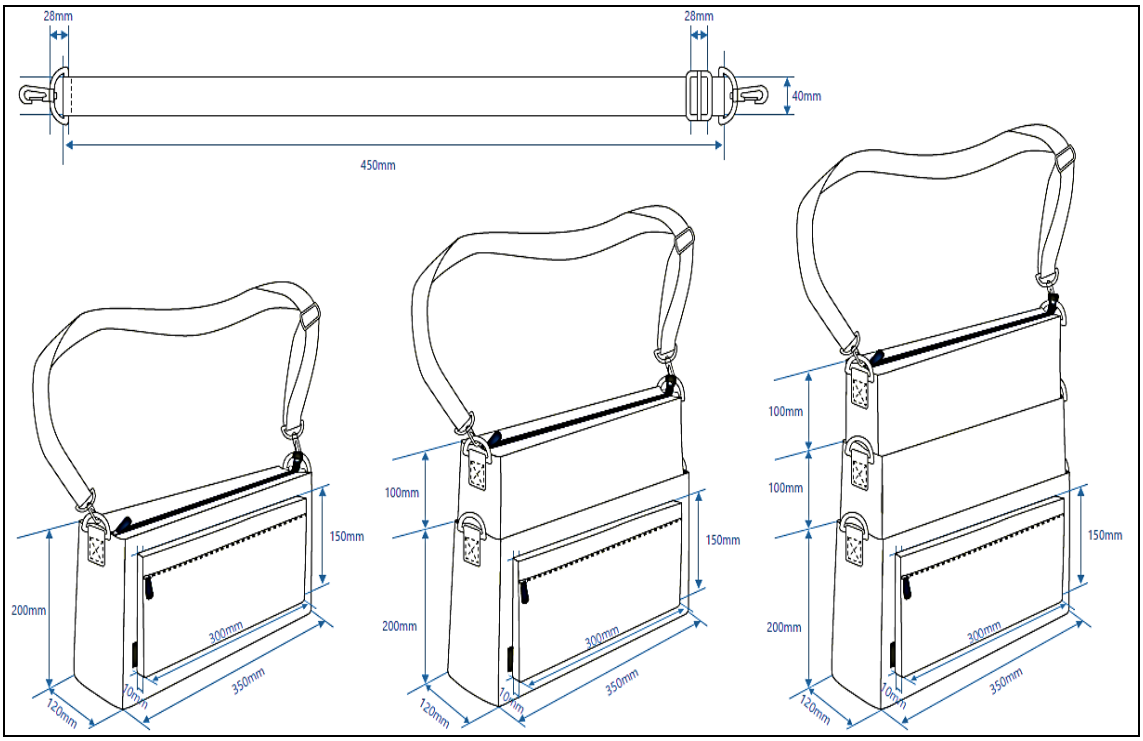

Figure 2. Three-In-One Tote Bag Design

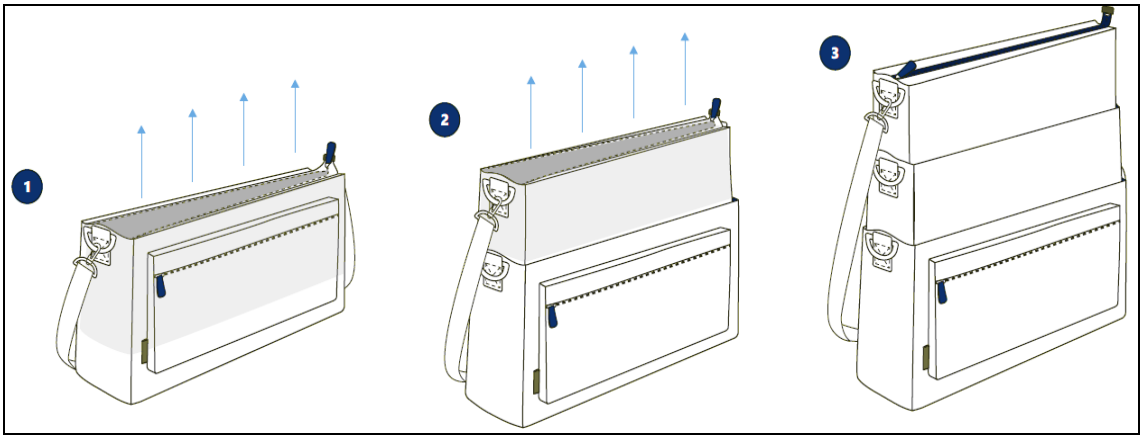

Figure 3. Three-In-One Tote Bag Transformation

CONCLUSION

The Kansei Engineering Method was applied to this research. The results are that 14 Kansei words represent consumer desires. A three-in-one tote bag with a zipper bag is proposed as an innovative solution to provide a secure bag and adjustable both in the length of the strap and the volume of the bag to adapt to every purpose with considering economic, fashion, and comfort aspects. The user doesn't need to bring more than one bag size anymore. The three-in-one design of the tote bag is adjustable as needed. When the user needs to carry many things, the bag can expand into a larger size, and when the user does not bring many things, the bag can be folded into a smaller size to make it comfortable and easier to bring everywhere.

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