Designing a Bag for Computing Students of General Sir John Kotelawala Defence University by Using a Kansei Engineering Methodology

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Abstract*: As computing undergraduate students, a bag that can accommodate all personal requirements is essential during university life. The bag itself should possess qualities such as space, durability, comfortability, safety, and most importantly provide proper protection for electronic devices carried by computing students. This study aims to design a bag that addresses the existing problems in the bag provided by the university for computing undergraduates. This paper presents an integrative framework of Kansei Engineering (KE), and the Kano model (KM) applied to produce the design of the bag. To explore the relationship between the quality attributes of the design and Kansei, the Kano model is incorporated into KE, which collects and communicates the emotional demands of the consumer. In this study, the bag used daily by computing students is utilized as a case study to demonstrate how KE and KM are integrated into the product development process. The results of this research were generated from thirteen Kansei words which were produced from a questionnaire. The final design of the bag was developed by evaluating total customer satisfaction. As per the results, the final design of the bag was of urban shape with a padded top grip and straps. Polyurethane/ Thermoplastic Polyurethane (PU/TPU) was chosen as the outer fabric for durability and water-resistant quality while polyester ripstop was chosen as the inner lining for the bag to make it lightweight.*

Keywords: *Kansei Engineering, Kano Model, University Bag, Computing Students*

1. Introduction

A commercially successful product is fabricated based on the potential to recognize the latest needs of the consumer and develop a product that is cost-effective to immediately satisfy those needs. When producing a mercantile product, the following aspects must be considered: quality of the product, the time required for development, level of expertise required for development, cost of the product, and cost of development (Ulrich and Eppinger, 2011). A quality product design will benefit the manufacturers in creating profitable products that will appeal to a wide audience (Rodgers and Milton 2011).

"Kansei" in simple terms is a Japanese word that refers to the emotions or psychological feelings of a human (Nagamachi, 2002). It is the psychological feeling or the emotions of the customers from a certain product or an environment. Kansei Engineering refers to the conversion of these emotions or the psychological feeling of a consumer into the design process of a product (Nagamachi, 1999). A product can be a service or information and can be either tangible or intangible. Hence Kansei Engineering can be applied to both tangible and intangible products (Schütte, 2002). When a user or customer decides to acquire a product, a certain image would come up to their mind. For example, when buying a bag, a customer would think of a colour, size, material, design, and many more. Kansei Engineering aims to address these thoughts when designing a new product.

There are three focal points of Kansei Engineering. They are, how to understand the emotions of customers, how to translate the emotions of customers, and how to build a system and organization by adopting Kansei-based Design. Kansei Engineering has been adopted by many automobile companies, the construction industry, home electric appliances, cosmetic industries, and costume industries (Nagamachi, 2002). As Kansei Engineering is a user-centred development approach, the design of a product can be made according to a particular user as it focuses on their desires and demands. When identifying the user's thoughts, it is necessary to find appropriate Kansei words that represent the customer's thoughts accurately.

Most computing students find the KDU bag to be exhausting to carry because of its weight. The material of the bag is of lower quality and is not very durable as it is not fabricated with a strong handle, straps, and zippers. The KDU backpack does not have enough space to carry all the necessities for a computing student, particularly because there is insufficient room for a laptop or any in it. The laptop compartment lacks adequate padding, which makes it extremely unsafe as the laptop can be damaged if the bag drops. Moreover, the laptop may potentially be harmed if water leaks into the backpack as the bag or the laptop compartment is not water-resistant. This can certainly make carrying the laptop in the KDU bag challenging on rainy days.

The back of the bag is also not completely padded, which might result in unnecessary additional pressure causing discomfort that will eventually lead to pain in the shoulders, neck, and back when worn regularly. The appearance of the bag is not significantly attractive as the shape of the bag is not appealing to most KDU computing students and as all the KDU bags are identical, it is particularly challenging to uniquely identify each one separately especially when a lot of bags are placed together.

As the current KDU bag provided for computing students have certain issues, an appealing new bag is in need. This research aims to utilize the Kansei Engineering Method to produce an appealing design for a bag for KDU computing students that is comfortable, spacious, high quality, strong, long-lasting, lightweight, water-resistant, and most importantly provides proper protection for electronic devices carried by computing students.

This paper discusses the steps involved in the designing of a proper bag for computing students of KDU with the use of Kansei engineering. It consists of previous similar work, methodology and experimental design, results and discussion, and conclusion.

2. Literature Review

A. Sling Bag

In the paper, Chalis Fajri Hasibuan explains the design of a sling bag by using Kansei Engineering technology (Fajri Hasibuan, 2020). The research aim was to develop a women's bag by using the sling bag as a model which showed a decline in sales. Data was gathered using direct observations and interviews which were then analyzed in designing the sling bag. The material of the sling bag was designed using fabric, the shape of the bag was a rectangle, the size is medium-sized, and the colour was a variant that is black and milk brown. In this research, 23 Kansei words were initially selected, which was later reduced to 7. The 7 Kansei words include cool, elegant, simple, long-lasting, light, medium, and plain.

B. Baby Bag

The baby bag was designed using Kansei Engineering by D Janari and A Rakhmawati to satisfy the customer expectations in the market. It was designed by focusing on 18 Kansei words and three design parts. The research was conducted using interviews and a series of questionnaires which were performed in 3 stages. The Kansei words are selected such that each word was selected by more than 90 percent of the total respondents. Kansei words of special, regular, small, and complicated were excluded as they were selected by less than 90% of the total respondents. The research was carried out by identifying the main features of the baby bag such as a pocket for the bottle, space needed for clothes, a pocket for heating the bottle, diaper space and top, and side and shoulder grips (Janari and Rakhmawati, 2016).

III. METHODOLOGY AND EXPERIMENTAL DESIGN

A. Materials and methods

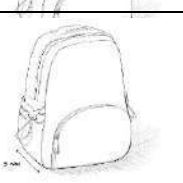
One of the mainly used methods for product development is 'Kansei Analysis' which we have employed in designing our product. To commence the Kansei analysis, the concept related to our study is designing a bag for computing students of KDU which can serve most of the requirements of a computing undergraduate. As undergraduates of KDU, our group was well aware of the problems we face daily when using the existing bag design and proposed a new design to address the above-mentioned issues.

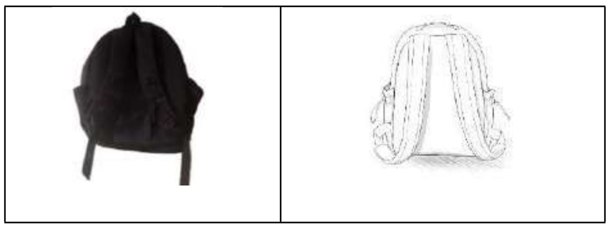
The preliminary stage consisted of identifying the function of each part of the bag that could be separated as compartments which are mentioned below.

- Space for books, water bottle, and lunch box
- Space for laptop and other related accessories (laptop charger, mouse, pen drives, cables, etc.)
- An easily accessible hidden pocket that can hold cash, wallet, and University ID

In addition to the compartments, the proposed design will contain a top handle that can carry the bag vertically. We addressed the lack of uniqueness in the existing design by providing a small transparent holder in the top handle that can place the consumer's name tag to easily identify one's bag. It also contains typical shoulder straps to be carried as a backpack. The initially proposed design with dimensions of 12.7x5x17 inches (Length x Width x Height) in comparison with the existing design is shown below.

Table 1: Design of the bag

Existing bag design	Initially proposed design
	
	



Source: Authors

In the next stage of the statistical procedure, a set of suitable Kansei words related to the product were selected. The participants of the survey will rate the design sample using the Kansei words through a Semantic Differential (SD) scale followed by a statistical analysis of the relationship between Kansei words and the product design elements which will be discussed in detail in the following sections.

B. Data collection techniques

The research was conducted by means of a questionnaire, interviews, and also through the data gathered by direct observations(Schütte, 2002). The target audience of the survey is computing undergraduates of KDU. The questionnaire included feedback on the existing bag design and an initially proposed design sample based on the chosen set of Kansei words. Thereby collected feedback helped us to create a product that is multi-functional in design which will be discussed in the following sections.

C. Collection of Kansei Words

Kansei words can generally vary from 50-600 based on the chosen domain. Thus, it was necessary to collect Kansei words that will reflect the needs of the user and help us in the design process(Hattori et al., 2011). Initially, a larger database of words was chosen which were then reduced to obtain a smaller set of words that complemented the design elements of the proposed bag design (Backar, 2019).
Table 2 shows the set of 13 words that were collected that matched the design of the bag.

Figure **1**. Identified Kansei words

Source: Authors

D. Semantic Differential (SD) scale

Determining the final design depends on the results of the data processing on Kansei engineering. For this purpose, a rating scale called a 'Semantic differential scale' is used which assesses the connotative significance of things, actions, and ideas. The connotations are a standard visual analog scale (vas) and a 7-grade Likert scale that is used to determine how someone feels about a certain object, event, or concept. The SD scale we employed in our questionnaire was of 5 levels ranging from 1-5. The extremes on the opposing sides of the scales were represented as 1 – "not at all" and 5- "very much" to make sure the word was clearly understood by the participants.
Table 2 shows an example of the SD response of participant no 1.

Table 2: An example of the response of participant 1

	Kansei word	1	2	3	4	5
1	Comfortable				×	
2	Light		×			
3	Water-Resistant					×
4	Spacious					×
5	Safe				×	
6	Durable					×

Source: Authors

E. Importance weighting

In our study, we used the SD scale to pick the most important words out of the already chosen set of 13 words. The words with a high grade and a higher calculated weight are chosen as important words (Backar, 2019).

$$\text{Weight} = \frac{(\text{Total grade of the word})}{(\text{Largest grade in SD scale} * \text{No. of participants})}$$

Therefore, according to the chosen SD scale and no. of participants in our study, the formula to calculate weight is as follows.

$$\text{Weight} = \frac{(\text{Total grade of the word})}{(5 * 88)}$$

The following table represents the grades and weights of the Kansei words.

Table 3: Grade and weighting of Kansei words

Kansei word	Grade	Weight
Unique	132	0.3000000000
Simple	65	0.1477272727
Strong	136	0.3090909090
Elegant	105	0.2386363636
Quality	136	0.3090909090
Light	177	0.4022727272
Comfortable	190	0.4318181818
Safe	190	0.4318181818
Minimalist	123	0.2795454545
Durable	167	0.3795454545
Water-resistant	155	0.3522727272
Spacious	173	0.3931818181
Size	103	0.2340909090

Source: Authors

The words that have the highest degrees and the highest were selected and those words are comfortable, safe, spacious, light, durable, and water-resistant.

F. Relating KE engineering characteristics

By brainstorming, a certain set of elements or characteristics of the product design was chosen, all of which are related to the six most important Kansei words identified. Those important Kansei words and selected product characteristics were then combined to create a questionnaire which is known as the 'Kano Questionnaire'. We used a Kano Questionnaire to classify customer requirements through a separate questionnaire (Rajasekera and Karunasena, 2013). In Kano Questionnaire, the appropriate questions involving the requirements of the product were included.

The Kano Questionnaire for this study is divided into two sections, functional questions, and dysfunctional questions to assess the bag's design. (Shape, handle's grip, and the material properties - durable, light, and water-resistant)

The functional form of the question is written as to how a customer would feel if that feature were present in the product and the dysfunctional form of the question is Written as to how acustomer would feel if that feature is not present in the product. Simply, the dysfunctional form of the question is the negative of the functional question (Usertimes, 2019).

In our study, we created twenty-four questions in total, twelve of which are functional and twelve of which are dysfunctional. The functional questions from the Kano Questionnaire that we prepared are displayed in Tabl

Table 4: An example of functional questions in the Kano questionnaire

The shape of the bag
1). The 'urban' shape makes the bag spacious. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 2). The 'school' shape makes the bag spacious. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.
Top handle
3). A padded top handle seems to be more comfortable. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 4). A non-padded top handle seems to be more comfortable. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.
Material of the bag
• Durable:
5). A bag made of Ripstop Nylon seems to be durable. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 6). A bag made of PU/TPU seems to be durable. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 7). A bag made of Nylon seems to be durable. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.
• Light:
). A bag made of PU/TPU (polyurethane/thermoplastic polyurethane) makes it light. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 9). A bag made of Polyester Ripstop makes it light. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 10). A bag made of Inverted Polyester makes it light.

1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.
• Water-resistant:
11). A bag made of PU/TPU makes it water-resistant. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 12). A bag made of Nylon makes it water-resistant. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.

Source: Authors

The questionnaires are distributed to 40 participants. The Kano evaluation table (Figure 1) can be used to classify product features into the following categories: A (attractive), O (one-dimensional), M (must be), Q (questionable), I (indifferent), and R. (reverse). The data is then subjected to mathematical analysis. The goal of the mathematical model is to determine if customers are satisfied or dissatisfied (Backar, 2019):

Customer satisfaction (S.C) = (A+O) / (A+O+M+I)

Customer dissatisfaction (D.C) = (O+M) / (A+O+M+I)

Total C.S.C (T.C.S) = (A-M) / (A+O+M+I)

Customer Requirements ⇨ / ⇩		Dysfunctional				
		1. like	2. must-be	3. neutral	4. live with	5. Dislike
Functional	1. like	Q	A	A	A	O
	2. must-be	R	I	I	I	M
	3. neutral	R	I	I	I	M
	4. live with	R	I	I	I	M
	5. dislike	R	R	R	R	Q

Figure 22. Kano Evaluation Table/ Kano Matrix

Source: Pan Qiting, Uno and Kubota, 2013

Customer Requirements:

A: Attractive, O: One dimensional, M: Must be, Q: Questionable result, R: Reverse, I: Indifferent

Later, the Kano Questionnaire's gathered results were analysed, and the consumer requirements were identified by those results.

3. Results and Discussion

In the data collection survey, some basic questions were asked regarding the current KDU bag from KDU computing undergraduates which helped to identify the requirements that they look for in a bag for daily use.

A. Data Gathered from the Survey on the Current KDU Bag

Based on the survey conducted, 73.3% of undergraduates are not satisfied with the appearance of the current bag of KDU. The survey results represent that 67% of undergraduates are satisfied with the space of the bag and 80.7% of undergraduates are not satisfied with how the bag protects personal devices such as laptop and other accessories. The survey results showed that 78.4% of the survey participants who are undergraduates are not happy with the durability of the bag. It further implies that 84.1% of undergraduates are finding it to difficult uniquely identify their bags.

Other suggestions regarding a new bag design are mentioned below.

- The colour must be black.
- A bag with a comfortable design.
- An elegant bag that is lightweight and minimal.
- Hidden pocket for money or any other valuables.
- A bag that doesn't change its shape when we packed our goods.
- Change the fabric.

B. Survey Results of Kansei Words

The overall survey results of the participants on the selected Kansei words regarding the initial design are shown below.

Unique (58%)	Light (39.8%)
Simple (46.6%)	Durable (63.6%)
Strong (65.9%)	Water Resistant (62.5%)
Size (42%)	Comfortable (72.7%)
Elegant (31.8%)	Spacious (38.6%)
Quality (67%)	Minimal (23.9%)

Other responses except for the Kansei words.

- Strong Zippers and Strong Plastic Parts
- The shape of the bag is very important

C. Feedback for the Proposed Design

After a survey on behalf of the proposed design, the results were obtained relatively based on opinions on a scale of 1-5. According to the results, 31.8% expected the comfortability of the bag to be 3 on a scale of 1-5. When considering the weight of the bag, an equal score is displayed on 3 and 5 on a scale of 1-5.

As for the water-resistance quality, 26.1% of the population has given a score of 5 on a scale of 1-5. Regarding bag space, 31.8% of the population voted on a score of 4 on a scale of 1-5. When it comes to durability 28.4% of the population have voted on a score of 5 which is the highest on a scale from 1-5. Based on the survey 28.4% of the population have voted on a score of 5 on a scale from 1-5 where they expect higher safety from the bag to their accessories.

D. Discussion

After thoroughly analysing the results collected through the participants of the surveys, we finalized the design of the bag. As Kansei is based on human feelings and a design that affects human emotions, the goal was to come up with a design that will be appealing to the audience as well as serve the functionalities optimally.

Through careful consideration, the ideal material was chosen for the building of the bag. As for the chosen fabrics; outer fabric - PU /TPU, straps – webbing, and inner lining – polyester ripstop. Also, by using PU/TPU as the outer fabric the bag will have a finish resistant to water and wear while retaining its shape. Polyester ripstop was chosen as it will make the bag lightweight. Backstrap straps tend to get the most wear out of any part of the bag. Therefore, we decided on webbing for the straps (commonly made from cotton, nylon, polyester, or polypropylene) or ripstop nylon, both of which are durable enough to stand up to the pressures of frequent handling.

In addition to that, the top handle and straps are padded to provide a comfortable grip when carrying. The back of the bag is padded as well reducing the pressure applied to the bag's content while providing protection. The bag will have a name tag holder as per the initial sketch (Figure 5). The black colour was chosen as the bag's colour as most of the participants preferred black.

The inside of the bag contains a separate padded compartment for the laptop that can hold the laptop in a fixed position through a small strap (Figure 4). Other accessories can be placed in the pockets placed outside the laptop compartment. We also included the suggestion for a hidden pocket to hold things of value (Figure 4).

The dimensions of the bag were decided as 12.7x5x17 inches (Length x Width x Height) where any laptop size can be contained unlike the current KDU bag where 17-inch laptops cannot fit inside (Figure 4). The adjustable side pockets can be used to carry anything including a water bottle of any size. Moreover, the design was made to stand out as simple, elegant, and minimal while highlighting the university logo (Figure 4).

Figure 3. Front view of the final design

Source: Authors

Figure 4. Back view of the final design

Source: Authors

Figure 5. Cross-sectional view of the final design

Source: Authors

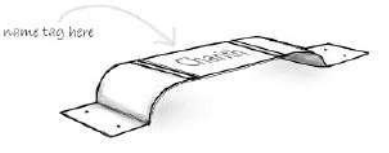


Figure 6. Name tag holder on the top handle

Source: Authors

4. Conclusion

The purpose of this study was to design a bag for KDU computing students by integrating the Kansei Engineering approach and the Kano.

Following an analysis of the issues faced with the bag's current design, a set of appropriate Kansei words were chosen according to the Kansei methodology approach to suggest a new design that would address the existing problems. An initial survey was conducted to gather information about opinions regarding the current bag design and the initially suggested design based on the selected set of Kansei words. Then, from the selected 13 words, the most important words were selected based on their grades and weights. The six most significant Kansei words were then combined with a set of product design elements or characteristics to construct a Kano questionnaire. Different aspects of the design of the bag (shape, handle grip, and material properties—durable, light, and water-resistant) were evaluated in this questionnaire. The specific consumer requirements were classified using the data obtained from the Kano questionnaire, and then the customers' satisfaction and dissatisfaction factors were determined.

Considering the benefits of this new design, such as the ease of storing any size laptop and the safety of carrying cash, credit cards, keys, etc. in hidden compartments can be highlighted. Additionally, the design is comfortable and convenient to use and is elegant and minimal. Moreover, the bag also includes several pouches and zippered pockets for organizing items. Through the use of padded handles, straps, and padded back, this bag addresses health issues such as excessive strain on bones and muscles, muscular strains, and spasms of the back and neck.

By analyzing the data obtained, the bag was decided to be built using PU/TPU fabric as it is a water-resistant, wear-resistant material that can retain its shape. However, as the PU/TPU material is significantly more expensive in comparison to other materials, this might be a shortcoming in the current design as the selected materials can be costly. This can be improved in the future through additional research, which would help to identify reasonably priced materials that can maintain the quality and properties of the bag.

Nevertheless, the design can be incorporated with built-in headphone ports, charging ports to charge laptops and mobile phones simultaneously as well as appropriate pockets and pouches in the future.

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