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Full Length Research Paper

Identifying emotional factors for quantitative evaluation of perceived product values

Po-Ying Chu[1]*, Li-Chieh Chen[1], Wan-Li Wei[2] and Yu-Hung Chien[3]

[1]Graduate Institute of Design Science, Tatung University, Taipei, Taiwan.
[2]Department of Product Design, Ming Chuan University, Taoyuan, Taiwan.
[3]Department of Technology Application and Human Resource Development, National Taiwan Normal University, Taipei, Taiwan.

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The objective of this research was to identify emotional factors that affect the perceived value of products. After collecting 400 statements from consumer case studies, the authors summarized these statements into fifteen elements. Principal component analysis was then used to extract four emotional dimensions: Features (F), Association (A), Social-esteem (S), and Engagement (E). This system was called the FASE Index. To validate the applicability of these factors, this study used two design cases and the fuzzy analytic hierarchy process (FAHP) to quantitatively measure the perceived value of products. The results showed that the FASE index was sensitive enough for evaluating different products. In addition, there were no significant differences between the experiences of designers and potential consumers in these cases.

Key words: New product development, fuzzy analytic hierarchy process, emotional design, perceived value.

INTRODUCTION

In the process of designing and developing a new product, it is crucial for the management team to investigate consumer preferences and to meet the client's demands. When consumers consider purchasing a product or service, they usually base their choices on aspects such as quality, functionality, usability, cost performance index (CPI), which is the ratio of earned value to the actual cost of the work performed, and other traits. However, cost efficiency is not the sole factor under consideration in consumer behaviour studies. Many products today not only have utility value, which appeal to the rationality of consumers, such as quality, functionality, and usability, but many products also have an emotional appeal that emphasises hedonic values such as feelings, interactions and user experiences. Hence, when the price or functionality of a product is just the one of many factors to be considered, consumers often base their holistic assessment of the product and their decision making on what they know, feel or understand about the product. Strengthening the emotional and creative as well as the innovative aspects of a design is thus seen as a key factor in enhancing a product's perceived value.

Although successful product design is regarded as an important driving force for companies to maintain their competitive edge, designers frequently encounter the problem of not knowing the preferences and responses of their consumers. However, if the targeted customers have no way of knowing the designers' ideas and creative processes, they often severely criticise the product because they cannot perceive the key values of the design. If a common language that could communicate a product's emotional dimensions could be developed, then the gap in perception between designers and consumers could be closed.

In order to address this issue, the objective of this research was to discover the factors that influence the perceived value of products from the emotional perspectives of consumers and designers.

LITERATURE REVIEW

Product design and perception differences

Design is a process that consists of a series of creative

*Corresponding author. E-mail: juby@ttu.edu.tw. Tel: +886 22592 5252 ext: 3466. Fax: +886 22586 7348.

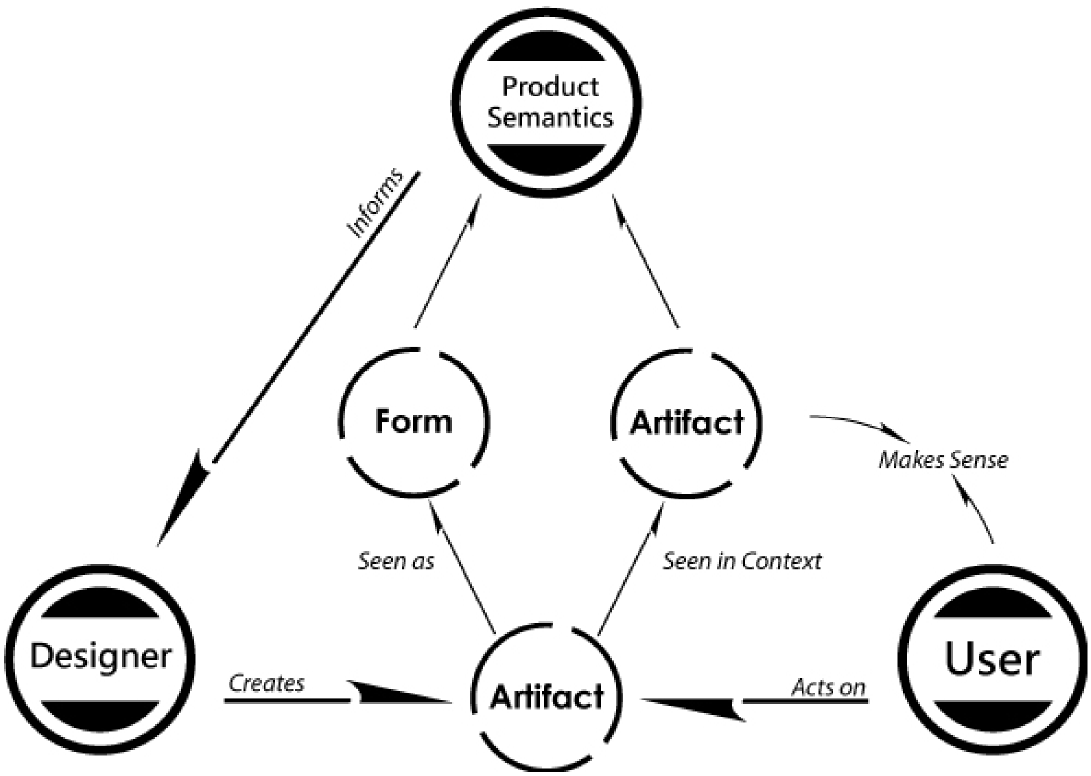

Figure 1. Krippendorff's product semantics (1984)

activities and often involves complex uncertainties. Designers use their imagination to create products that are ultimately selected and used by consumers. Although both product formation and consumer response are determined by many correlated factors and are difficult to predict, it is still possible to develop models for design guidance (Crilly et al., 2009). For instance, both Krippendorff (1984) and Norman (1988) indicated that the key connections for communicating a message are formed between the designer, the product, and the user (Figure 1). In practice, however, designers and users do not necessarily share the same interpretations of the product. Additionally, designers often misunderstand the actual demands of consumers, especially from an emotional perspective (Bahn et al., 2009). There are abundant examples of products that have creative, ingenious designs, but have poor sales performance due to the difference in perspective between designers and users (Krippendorff, 1984).

The reason why designers and users fail to communicate perfectly is mainly due to differences in background, as the designer's mode of thinking does not necessarily correspond to the user's thinking (Preece et al., 2006). Hence, bridging the gap between designers and users has been a challenging topic that research specialists have attempted to tackle. To address this issue, it was important to find an index for assessing the emotional dimensions of a product design and provide a form of communication between designers and users that could help to reduce differences in perception. Furthermore, since the perception of products could possibly be affected by emotions, available theories relevant to emotional design should not be neglected.

Emotional design

Emotional design has become the focus of a large number of research topics, and terms such as 'emotional engineering', 'affective design', 'affective ergonomics', and 'design for human senses' (Engage, 2005) have begun to appear in various disciplines.

Jordan (1999) drew on Maslow's theory of the five levels of basic needs, which were presented in 1943, to formulate his own theory on product qualities and users' needs. The three levels proposed by Jordan were functionality, usability and pleasure. Within Jordan' (2000) theoretical framework, he combined Tiger's (1992) theory to divide the element of pleasure into four dimen-sions: physio-pleasure, psycho-pleasure, socio-pleasure, and ideo-pleasure. Norman (2004) came up with the concept of 'emotional design', which stressed the importance of emotional design on decision making in our daily lives. Norman further divided emotional design into three levels: visceral, behavioural, and reflective. The visceral level refers to the initial impact, which is the initial response evoked by a product’s appearance, texture and material. The behaviour level refers to an unconscious response, such as the pleasure an individual experiences after taking a shower, while the reflective level refers to an individual’s conscious response to the product.

As for the assessment of emotions, there are a number of emotional scales and techniques recorded in past studies. For example, Mehrabian and Russell (1974) used a 34-item questionnaire to form the PAD (Pleasure-Arousal-Dominance) dimensions model, Izard (1977) used a questionnaire with 30 adjective items to form the DES (Differential Emotions Scale), and Lang (1985) came up with a non-verbal pictorial assessment technique called SAM (Self-Assessment Manikin). These methods have been applied to the fields of consumer experience marketing and context-aware information management, which has generated effective results (Richins, 1997; Machleit and Eroglu, 2000; Huang, 2001). Nevertheless, these assessment techniques were not created for the purpose of product development. More importantly, these techniques mostly assess ‘primary emotions’ but do not cover the wide range of emotions involved with product experiences (Smith, 2008; Design and Emotion Society, 2006). Another tool that was often associated with emotional design was Nagamachi’s (1995) concept of ‘kansei engineering’, which was initially proposed in the 1970s. Kansei engineering focused on a specific response that a product elicits in the user (for example, speed or advanced technology) to utilise a microscopic perspective to translate a consumer's feelings and image of a product into practical design elements.

Emotions play a large part in altering the operation of perception parameters. When a product design contains qualities of relaxation and pleasure, the design often helps the users change their thinking from a rational mode to a mode based on emotions. Furthermore, in addition to identifying the emotional dimensions of a product, specific methods need to be developed to assess the perceived value of products from an emotional perspective. These methods may adopt or modify the features of existing ones in the field of design decision making.

Design decision making and FAHP

Substantial research has been completed on quantitative analysis methods that could be used for decision making and applied to fields related to product development. Methods that are commonly used in quantitative assessment include: the grading method, the ranking method, the Delphi method, analytic hierarchy process (AHP), analytic network process (ANP), quality function deployment (QFD), multi-criterion decision making (MCDM), multi-attribute decision making (MADM) and data envelopment analysis (DEA) (Hsiao, 1998; Seydel, 2006; Wei and Chang, 2008). In the past, these quantitative methods did not take into account the unquantifiable nature of the subjectivity and ambiguity inherent in human thinking. Therefore, many scholars started applying Zadeh’s (1965) fuzzy theory to account for the shortcomings of other methods. Fuzzy theory originated from the notion of the fuzzy set as a method to quantify the subjective thinking process of human beings. Zadeh (1999) also suggested that the human language was an unquantifiable variable that could be better accounted for by using fuzzy set theory.

In addition to the vagueness of human expression, decision making always involves the consideration of various criteria at different levels of abstraction or hierarchy. Therefore, a decision method must be robust enough to deal with such conditions. AHP is the decision method that has been widely used in practice (Saaty and Takizawa, 1986).

The most distinguishing feature of AHP is its ability to decompose a complicated problem into a hierarchy of simpler elements. Then, each of the elements can be compared to one another and converted into a numerical value that can be evaluated in a process of assessment or decision making. Figure 2 shows the hierarchical structure of AHP. If Symbol A depicts the final goal, then Symbol B represents the various targets, and Symbol C represents the evaluation criteria. Together, these elements form the hierarchical structure in a decision-making plan.

Since Saaty (1980) first proposed the AHP, which was based on the pairwise comparison method, it has been modified and improved by van Laarhoven and Pedrycz (1983) as well as Buckley (1985) through the addition of fuzzy theory. The new process was renamed FAHP. The various advantages of FAHP (fuzzy analytic hierarchy process) made it a popular choice in the management decision field. Even today, FAHP is still widely used by scholars and experts for examining multi-criteria decision making.

To solve problems relevant to product design and development, some researchers applied FAHP to modular product design (Lee et al., 2001), the prioritisation of customer satisfaction attributes in target planning for automotive product development (Nepal et al., 2010), and the concept selection of automotive bumper beam design (Hambali et al., 2010).

Because the emotional responses of user experiences are always expressed using a language that has vagueness and uncertainty, FAHP is suitable for comparing design alternatives from an emotional perspective.

METHODOLOGY

Factors identification

The objective of this study was to identify the factors that influence the perceived value of a product from an emotional perspective. First of all, we held structured interviews with six professional designers as well as six consumers who were given open-ended

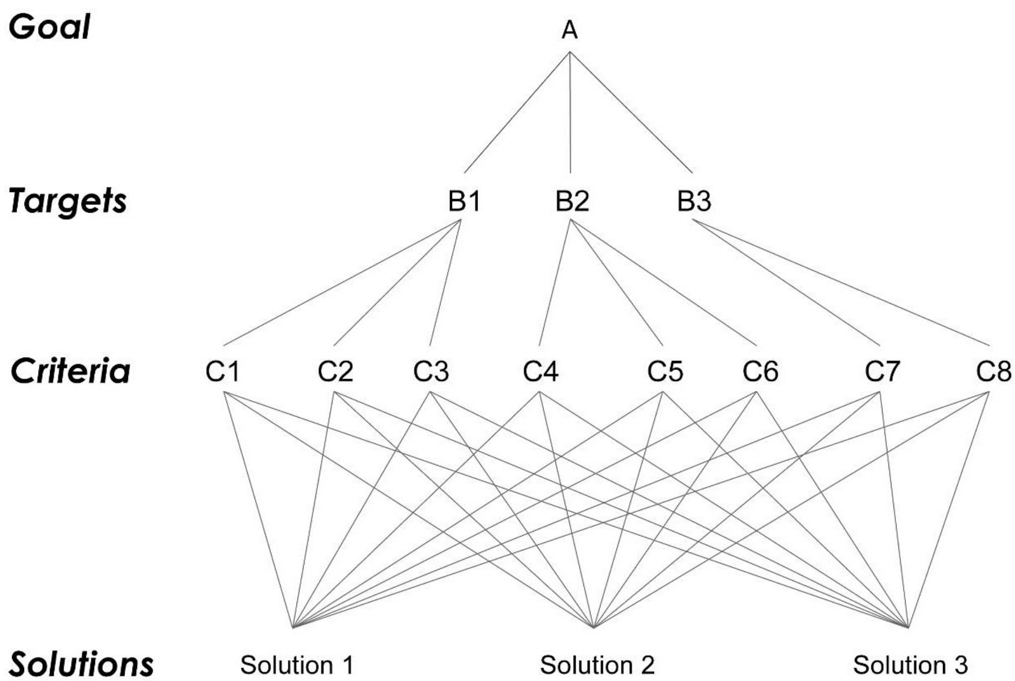

Figure 2. Hierarchical structure of AHP.

questionnaires to determine the reasons that consumers were willing to purchase a product due to its emotional value. More than 400 lines of statements were collected. Using protocol analysis, a focus group of four research members (which included two professors, one senior designer and one manager) coded the statements and grouped them into 15 characteristics that affect the perceived value of a product. The characteristics included high-quality aesthetics, worthy of collection, facilitating health and welfare (similar to 'feng shui' in traditional Chinese terminology), an interesting metaphor, special texture, a reflection of the owner's extraordinary taste, evoking memories of wonderful times, a unique style, outstanding function, a comfortable atmosphere, attractive colours, interesting background story, a reflection on the owner's professionalism, providing romantic feelings, and an eye-catching appearance.

Secondly, we included these characteristics in a subsequent questionnaire survey to extract the major dimensions. In the survey, 156 participants were invited to rate the likelihood of purchasing products due to these characteristics by using a 9-point Likert scale. This scale served a method of ascribing quantitative value to qualitative judgement. Statistical tests revealed that there was no particular bias or trend in gender, age, and educational background among these participants.

We then continued to use principal component analysis with varimax rotation to extract the major dimensions. Components with eigenvalues that were greater than one were retained. The four main characteristics represented 70.126% of the total variance. Because the loading of attractive colours and interesting background *story* did not exceed a variable of 0.50, these factors were omitted from the original set of characteristics. The results are included in Table 1.

The four factors were named Features, Association, Social-esteem, and Engagement, respectively (the overall process was named FASE). The dimensions of the four factors along with the remaining criteria were used together to construct a hierarchical index, which was named the FASE Index (Figure 3). This index could be used as a structure for design communication as well as hierarchical criteria for design evaluation from an emotional perspective.

Case studies

To validate the applicability of these factors, this study included studies of two different USB flash drives to demonstrate the proposed index and evaluation method (Figure 4). The first flash drive was the 4 GB YEGO Y-shaped flash drive, which had an average selling price of NT$ 580 (New Taiwan Dollar). The second one was a 4 GB penguin-shaped flash drive sold for $NT 800. Both of these products were priced higher than most flash drives that have the same functions (which were priced below $NT 320). This difference in price could be attributed to the emotional design concepts that were mentioned in a previous section. This study examined whether or not designers and consumers exhibited any differences in emotional dimensions. The designer of each flash disk was willing to participate. The main subjects for this experiment included the original designers of each flash disk as well as 12 subjects (potential consumers) who positively reviewed the product and were willing to pay a higher price for it.

To collect and calculate the data systematically, this study employed the FAHP method and pairwise comparison to compute the weight distributions of the FASE Index based on methods employed by van Laarhoven and Pedrycz (1983), Buckley (1985) and Teng and Tzeng (1996). The procedure included five steps: (1) establish a pairwise comparison matrix; (2) establish triangular fuzzy numbers; (3) establish a fuzzy positive reciprocal matrix; (4) calculate the weight of the fuzzy positive reciprocal matrix; and (5) defuzzification and normalisation. The detailed data are illustrated in the following steps.

Step 1: Establishing a pairwise comparison matrix

The entries for a pairwise comparison matrix were derived by

Table 1. The result of principal component analysis for emotional dimensions.

Characteristic	Factor 1	Factor 2	Factor 3	Factor 4
High-quality aesthetics	**0.761**	0.069	-0.062	0.222
Special texture	**0.744**	0.194	0.231	-0.129
Outstanding function	**0.684**	-0.279	0.360	0.026
Unique style	**0.662**	0.258	0.395	0.009
Provides comfortable atmosphere	-0.109	**0.818**	-0.008	0.159
Provides romantic feelings	-0.077	**0.735**	0.080	0.441
Interesting metaphor	0.363	**0.723**	0.232	-0.082
Evoking memories of wonderful times	0.425	**0.712**	-0.141	0.110
Eye-catching appearance	0.030	0.182	**0.838**	0.126
Reflects the owner's extraordinary taste	0.187	0.075	**0.836**	-0.020
Reflects the owner's professionalism	0.283	-0.243	**0.756**	-0.103
Facilitating health and welfare	-0.029	0.177	-0.121	**0.854**
Worthy of collection	0.362	0.158	0.339	**0.574**
Eigenvalue	2.618	2.582	2.526	1.391
% Variance	20.137	19.860	19.429	10.699
Cumulative %	20.137	39.998	59.427	70.126

Bold Text indicates the absolute value of factor loading was greater than 0.5

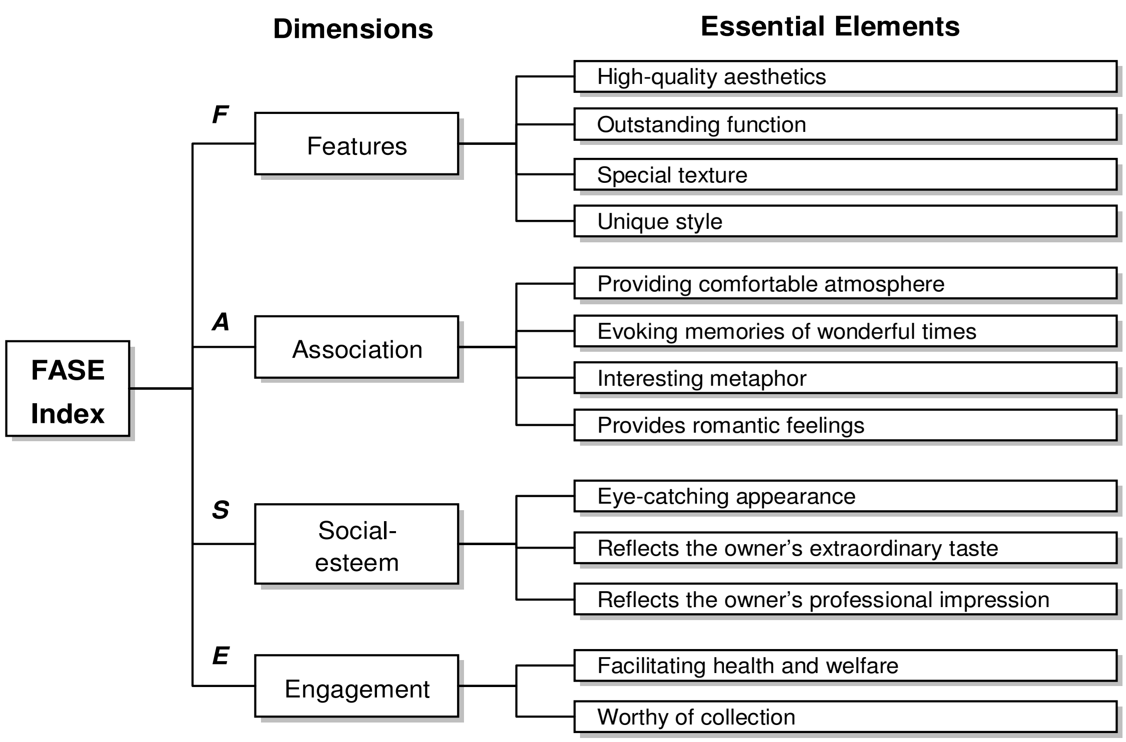

Figure 3. The four dimensions and thirteen evaluation criteria in the FASE index.

calcu-lating the relative importance of factors, which were the proportion values evaluated by participants in the questionnaire. The ratios between Factor 1 and other factors, from Factor 2 to Factor n, were expressed by $\tilde{a}_{12}, \cdots, \tilde{a}_{1n}$, respectively. By sequen-tially calculating the degree of proportional importance between the pairwise factors of Factor 1 and Factor n, a pairwise comparison matrix was established.

For instance, the designer of the Y-shaped flash drive (coded as Designer Y) was invited to provide the reciprocal judgment matrix based on pairwise comparison of the criteria at the FASE level.

$$\tilde{Y} = \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \cdots & 1 \end{bmatrix} = \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ 1/\tilde{a}_{12} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ 1/\tilde{a}_{1n} & 1/\tilde{a}_{2n} & \cdots & 1 \end{bmatrix} = \begin{matrix} \\ F \\ A \\ S \\ E \end{matrix} \begin{matrix} F & A & S & E \\ \left[\begin{matrix} 1 & \tilde{3} & \tilde{4} & \tilde{3} \\ \tilde{3}^{-1} & 1 & \tilde{3} & \tilde{3} \\ \tilde{4}^{-1} & \tilde{3}^{-1} & 1 & \tilde{3}^{-1} \\ \tilde{3}^{-1} & \tilde{3}^{-1} & \tilde{3} & 1 \end{matrix}\right] \end{matrix}$$

Step 2: Establishing triangular fuzzy numbers

To fuzzify the number, we used triangular fuzzy numbers (TFN) as defined by van Laarhoven and Pedrycz (1983). Because the assessment model for this study used natural language as its linguistic variable, we used Absolutely, Very Strongly, Essentially, Weakly and Equally to express the degree of importance provided by the assessor.

These linguistic variables were converted into fuzzy numbers to calculate the actual emotional value for each assessed factor. The linguistic standards and triangular fuzzy numbers are listed in Table 2.

We then expanded each element of the matrix according to the definition of the triangular fuzzy number as follows:

$$\tilde{Y} = \begin{matrix} \\ F \\ A \\ S \\ E \end{matrix} \begin{matrix} F & A & S & E \\ \left[\begin{matrix} 1 & (2,\ 3,\ 4) & (3,\ 4,\ 5) & (2,\ 3,\ 4) \\ (0.25, 0.33, 0.50) & 1 & (2,\ 3,\ 4) & (2,\ 3,\ 4) \\ (0.20, 025, 0.33) & (0.25, 0.33, 0.50) & 1 & (0.25, 0.33, 0.50) \\ (0.25, 0.33, 0.50) & (0.25, 0.33, 0.50) & (2,\ 3,\ 4) & 1 \end{matrix}\right] \end{matrix}$$

Step 3: Calculating fuzzy weight

We used Buckley's (1985) approximation method to calculate fuzzy weight distribution. The approximation method not only considered consistency but also incorporated the concept of normalisation. The formulas below were used to obtain the fuzzy weight. The geometric mean of the respondent's triangular fuzzy number of $\tilde{r}_1$ in the matrix could be calculated as follows:

$$\tilde{r}_i = (\prod_{j=1}^{n} a_{ij})^{1/n} = ((1\times2\times3\times2),(1\times3\times4\times3),(1\times4\times5\times4))^{\frac{1}{4}}$$
$$= (1.86121,\ 2.44949,\ 2.990698)$$

Similarly, the remaining $\tilde{r}_i$ was obtained. Next, the fuzzy weight value in each row of the matrix could be calculated.

$$\tilde{Y}_1 = \tilde{r}_1 \otimes (\tilde{r}_1 \oplus \tilde{r}_2 \oplus \tilde{r}_3 \oplus \tilde{r}_4)^{-1}$$
$$= (0.298173,\ 0.4994938,\ 0.80384)$$

Using the same method, the fuzzy weight value $\tilde{Y}_i$ could be obtained to construct the fuzzy weight matrix $\tilde{Y}_{FASE}$.

$$\tilde{Y}_{FASE} = \begin{matrix} \mathrm{F} \\ \mathrm{A} \\ \mathrm{S} \\ \mathrm{E} \end{matrix} \begin{bmatrix} (0.29817,\ 0.49949,\ 0.80384) \\ (0.16020,\ 0.26837,\ 0.45203) \\ (0.05756,\ 0.09213,\ 0.17174) \\ (0.08010,\ 0.14001,\ 0.25013) \end{bmatrix}$$

Step 4: Defuzzification and hierarchical association

Because the weight for every assessed item that was obtained is a fuzzy number, defuzzification must be utilised to convert them into non fuzzy values. This study uses the centre of gravity method proposed by Teng and Tzeng (1996) for defuzzification, which aimed to solve the gravity of triangulations and to find the central value for entire fuzzy sets. For instance, the crisp values of DF_{Y_1} were calculated as follows:

$$DF_{Y_1} = \frac{(uw_i - lw_i) + (mw_i - lw_i)}{3} + lw_i = 0.53384$$

The weight matrix DF_Y could be constructed row by row with the same procedures. Furthermore, to integrate the matrix derived from sub-criteria, the normalised weight matrix NW_{FASE}^{Y} was obtained as follows:

$$DF_Y = \begin{matrix} F \\ A \\ S \\ E \end{matrix} \begin{bmatrix} 0.53384 \\ 0.29354 \\ 0.10714 \\ 0.15675 \end{bmatrix},\ NW_{FASE}^{Y} = \frac{DF_{wi}}{\sum DF_{wi}} = \begin{matrix} F \\ A \\ S \\ E \end{matrix} \begin{bmatrix} 0.48919 \\ 0.26899 \\ 0.09818 \\ 0.14364 \end{bmatrix}$$

Repeating the aforementioned steps, the weights of the thirteen sub-criteria at the second level could be obtained. For instance, the matrix of the four sub-criteria in the F dimension was determined as follows;

$$NW_F^Y = \begin{matrix} F_1 \\ F_2 \\ F_3 \\ F_4 \end{matrix} \begin{bmatrix} 0.11389 \\ 0.06312 \\ 0.29470 \\ 0.52829 \end{bmatrix}$$

to obtain the overall weight of the p-th sub-criteria at the second layer of the i-th dimension at the first layer, we aggregated the weights by multiplication. Using the mechanical aesthetic sub-criterion of the F dimension as an example, the final weight value of such a sub-criterion could be aggregated as follows:

$$OW_p = NW_i \times NW_{ip} = 0.48919 \times 0.11389 = 0.05572$$

The final FASE Index weight results for Designer Y are listed in Table 3.

Using the same method, the FASE Index weight results for the designer of the penguin flash drive (coded as Designer P) are

Figure 4. Pictures of the two USB flash drives selected for the focus group in this case study.

Table 2. Triangular fuzzy numbers.

Fuzzy number	Linguistic scale	Positive triangular fuzzy number
$\tilde{9}$	Absolutely	(8, 9, 9)
$\tilde{8}$	Intermediate	(7, 8, 9)
$\tilde{7}$	Very strongly	(6, 7, 8)
$\tilde{6}$	Intermediate	(5, 6, 7)
$\tilde{5}$	Essentially	(4, 5, 6)
$\tilde{4}$	Intermediate	(3, 4, 5)
$\tilde{3}$	Weakly	(2, 3, 4)
$\tilde{2}$	Intermediate	(1, 2, 3)
$\tilde{1}$	Equally	(1, 1, 2)

shown in Table 4.

To compare the responses from twelve potential consumers, the authors repeated the above steps for both the Y-shaped and penguin flash drives to obtain weights from the potential consumers at the first level (Table 5).

Following the same procedures, the aggregated weights of the thirteen sub-criteria for Y-shaped and Penguin flash drives were obtained and listed in Tables 6 and 7, respectively.

RESULTS AND DISCUSSION

To study whether the FASE index could reflect the properties of different sample products, we conducted a chi-square test on the frequency of dominance among four dimensions collected from 12 potential consumers. The results showed that there was no significant correlation between the Y-shaped flash drive and the Penguin flash drive ($\chi^2_{(3)} = 2.591$, $p = .459 > 0.05$). The following radar chart (Figure 5) also illustrates the differences in the FASE Index for these two sample products. Compared to the Penguin flash drive, the Y-shaped flash drive was superior in the Social-esteem dimension. However, the Y-shaped flash drive did not offer enough engagement and association compared to the Penguin flash drive.

Furthermore, for the Y-shaped flash drives, the weight distribution for the thirteen sub-criteria between the designers and the potential consumers showed a significant correlation (Pearson Correlation =0.576, p=0.037< 0.05). For the penguin flash drive, the Pearson Correlation was as high as 0 .667 (p=0.013< 0.05), which was also a strong correlation. The weight distributions of the thirteen sub-criteria of the Y-shaped flash drive are illustrated in Figure 6. The two curved lines demonstrate that there were similar trends; although the weight values for F4 (high-quality aesthetics) were not consistent with the predictions of the designers. The weight distribution diagram of the thirteen sub-criteria for the penguin flash drive is presented in Figure 7. The trends were similar to the trends for the Y-shaped flash drive. The lines differed only at two sub-criteria. For A3 (interesting metaphor), consumers did not have an experience as high as the designer's predictions. For E2 (worth as part of a collection), consumers' weights were higher than the initial predictions of the designer.

Table 4. FASE Index weights (from the designer of the penguin flash drive).

Dimension	Weight	Rank	Sub-criteria	Final weight	Rank
F	0.32242	2	F1	0.01396	12
			F2	0.09086	5
			F3	0.04272	8
			F4	0.17487	2
A	0.43372	1	A1	0.03365	9
			A2	0.08785	6
			A3	0.24420	1
			A4	0.06802	7
S	0.12919	3	S1	0.09396	4
			S2	0.02449	10
			S3	0.01074	13
E	0.11467	4	E1	0.01442	11
			E2	0.10025	3

Table 5. FASE weight values from potential consumers.

Yego Y- shaped flash drive	**F**	**A**	**S**	**E**
U1	0.2900	0.4923	0.1511	0.0666
U2	0.2775	0.1250	0.5337	0.0638
U3	0.5571	0.1201	0.2667	0.0561
U4	0.2900	0.1511	0.4923	0.0666
U5	0.1396	0.4288	0.0951	0.3365
U6	0.1661	0.3900	0.0979	0.3460
U7	0.3900	0.0979	0.3460	0.1661
U8	0.4501	0.1072	0.0601	0.3826
U9	0.6397	0.0810	0.1958	0.0835
U10	0.5337	0.0638	0.2775	0.1250
U11	0.5040	0.1547	0.0788	0.2625
U12	0.0799	0.1924	0.5107	0.2170
Dominant frequency	6	3	3	0
Mean	0.3598	0.20035	0.25882	0.18102
Penguin flash drive				
U1	0.6479	0.0981	0.2067	0.0473
U2	0.5494	0.1050	0.0931	0.2525
U3	0.0899	0.6009	0.0575	0.2517
U4	0.0683	0.4115	0.1549	0.3654
U5	0.0969	0.4622	0.0624	0.3784
U6	0.3147	0.3149	0.0661	0.3043
U7	0.3460	0.3900	0.1661	0.0979
U8	0.2222	0.0539	0.6084	0.1154
U9	0.4402	0.0893	0.0793	0.3912
U10	0.2818	0.1325	0.0433	0.5424
U11	0.5107	0.2170	0.0799	0.1924
U12	0.3392	0.2999	0.1192	0.2418
Dominant frequency	5	5	1	1
Mean	0.32559	0.26461	0.14474	0.26506

Table 6. FASE Index weights (from the 12 potential consumers' evaluations of the Y-shaped flash drive).

Dimension	Weight	Rank	Sub-criteria	Final weight	Rank
F	0.35981	1	F1	0.03592	11
			F2	0.04131	8
			F3	0.18424	1
			F4	0.09834	5
A	0.20035	3	A1	0.04058	9
			A2	0.03220	12
			A3	0.09922	4
			A4	0.02835	13
S	0.25882	2	S1	0.12048	3
			S2	0.07699	6
			S3	0.06134	7
E	0.18102	4	E1	0.04016	10
			E2	0.14086	2

Table 7. FASE Index weight (from the 12 potential consumers' evaluations of the Penguin flash drive).

Dimension	Weight	Rank	Sub-criterion	Final weight	Rank
F	0.32559	1	F1	0.02947	11
			F2	0.09367	5
			F3	0.03931	8
			F4	0.16314	2
A	0.26461	3	A1	0.03730	9
			A2	0.04739	7
			A3	0.11451	3
			A4	0.06540	6
S	0.14474	4	S1	0.10069	4
			S2	0.02800	12
			S3	0.01605	13
E	0.26506	2	E1	0.03609	10
			E2	0.22897	1

From the case study, the designer of the Y-shaped flash drive believed that the first five characteristics of this drive were "outstanding function, high-quality aesthetics, evoking wonderful memories, interesting metaphor and worthy of collection". However, the first five characteristics perceived by potential consumers were outstanding function, high-quality aesthetic, interesting metaphor, eye-catching appearance, and worthy of collection. The results demonstrate that the designer and the consumers had four items in common among the first five characteristics. The averages of the two groups were 0.076 and 0.056 for the penguin flash drive, and the correlation between the two was 0.508. The *t* test results ($t_{(12)}$=1.180, p =0.261>0.05) showed that the experiences of designers and potential consumers did not have significant differences in the second layer. Upon further observation of the penguin flash drive, the designer considered interesting metaphor, high-quality aesthetic, worthy of collection, eye-catching appearance, and special texture to be the most important characteristics. Consumers considered worthy of collection, high-quality aesthetic, interesting metaphor, eye-catching appearance, and *special texture* to be the most important characteristics. Although the rank orders of these characteristics were

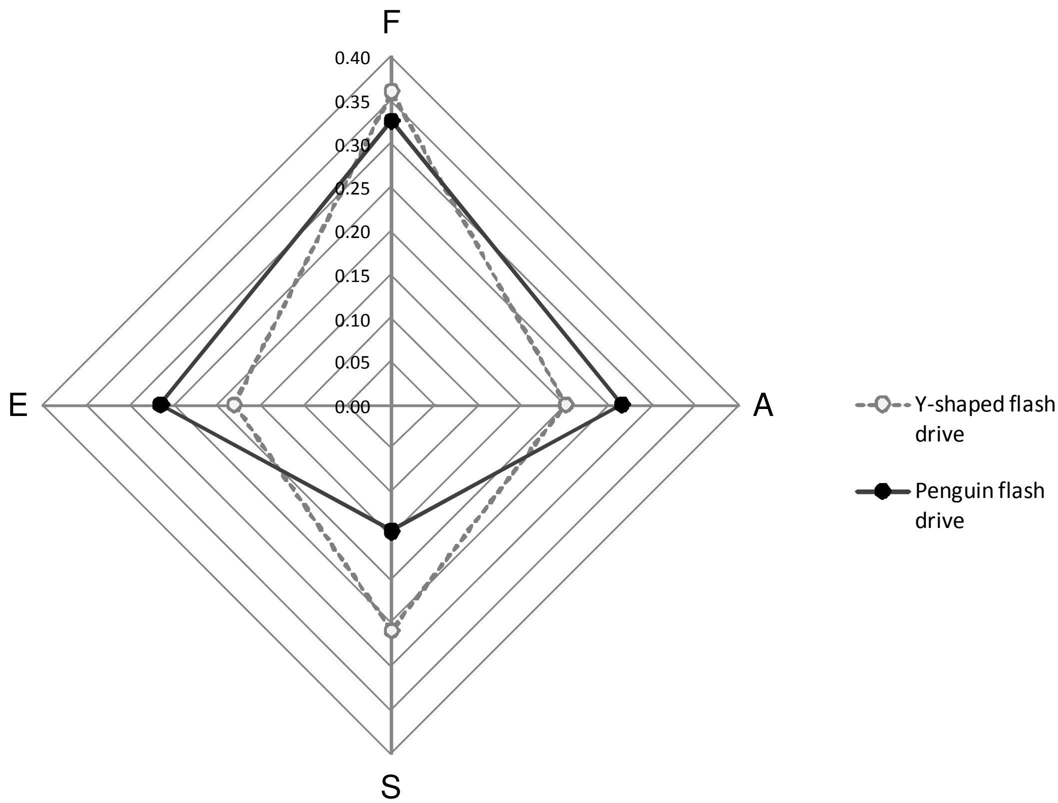

Figure 5. A radar diagram of the evaluation results for the two flash drives.

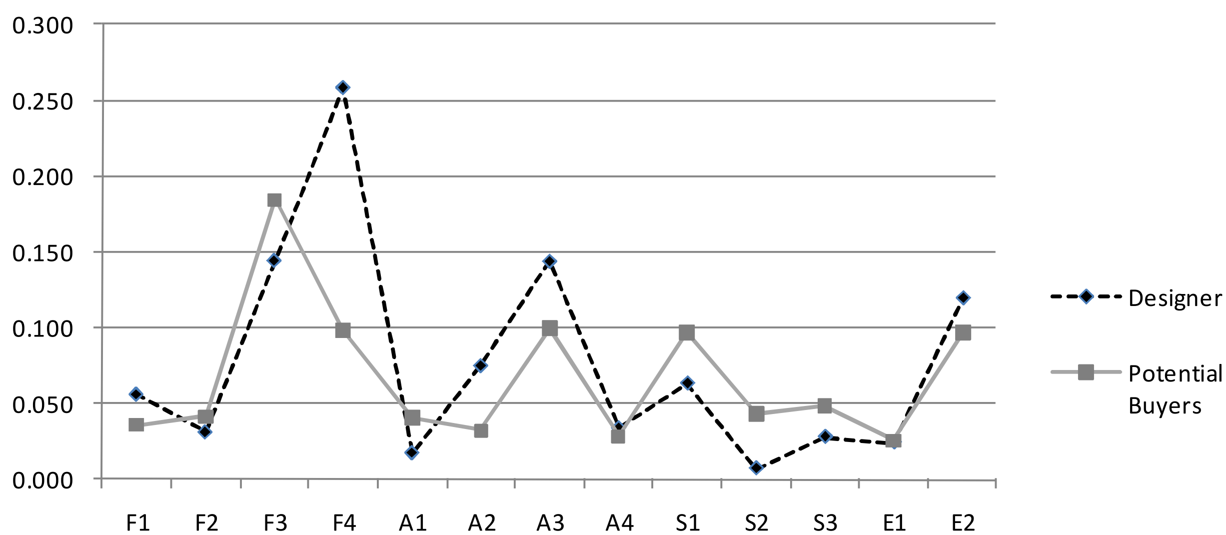

Figure 6. Line graph of the 13 sub-criteria for the Y-shaped flash drive.

different, the first five characteristics were the same.

Based on the statistics for the two flash drives, the weights of proposed emotional dimensions from the original designers and potential consumers did not result in significant differences. However, it was interesting to note that within the four main dimensions of the first layer, the S (Social-esteem) dimension had different results between designers and customers. In other words, consumers would like to purchase the flash drive because they hoped it would have an eye-catching appearance, but the designer did not have similar expectations. This difference could be attributed to the modesty

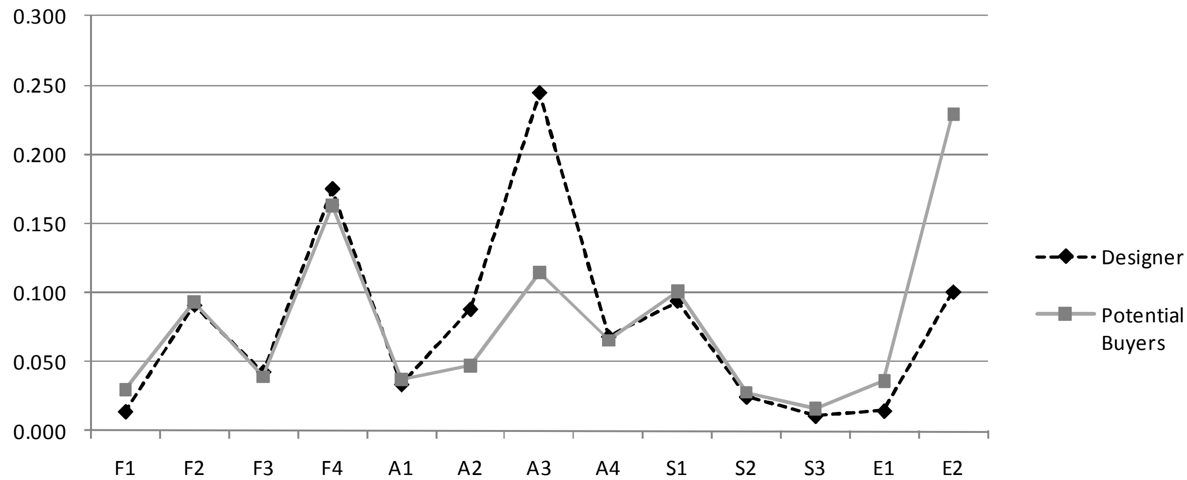

Figure 7. Line graph of the 13 sub-criteria for the Penguin flash drive.

of the designer or due to the fact that this product won an international design award and was well-known, which may have led the consumer to feel proud of owning it.

Interesting results also appeared among the sub-criteria. Although four out of the five main characteristics for the experiences of designers and potential consumers were the same, the eye-catching appearance characteristic perceived by customers was not one of the original expectations of the designer. In contrast, the designer hoped to bring out the concept of wearing an Asian school uniform to achieve the goal of evoking memories of wonderful times in childhood, but failed to deliver that message to consumers. This finding could possibly be attributed to the fact that the personal experiences of designers and potential consumers are different.

Conclusion

This study summed up 400 lines of statements for consumer case studies and based on protocol analysis, these statements were converted into 15 elements that encompass the emotional factors that affect the perceived value of products. Then, we used the data from 159 questionnaires as well as principal component analysis to extract the four main emotional dimensions: Features (F); Association (A); Social-esteem (S) and Engagement (E). The index of these four main dimensions was called the FASE Index. Then, we used FAHP to evaluate products in case studies.

To conduct an experiment, this study used two different USB flash drives that were in great demand and sold at noticeably higher prices than other flash drives. The results of this experiment showed that the FASE Index could effectively calculate the emotional dimension of a product in a quantitative manner. The cases used in this study also showed that the FASE index was sensitive to different products. In addition, for successful products, the differences in the experiences between designers and potential consumers were minimal.

Application of the FASE Index could allow designers to design their products based on the characteristics expected by their potential clients and to avoid situations in which designers and clients fail to communicate properly. In addition, suppliers could categorise their products according to the FASE Index by using the index to define the unique characteristics of a product or design project. This organisation could be beneficial for marketing specialists when they are carrying out market segmentation analysis and competitor analysis.

Although the FASE index has been developed, there are some other research issues. For example, if a company would like to develop product alternatives targeting diverse customers across different cultures, how to correctly assessing the weighting among emotional dimensions become an important issue. Furthermore, when a product design team would like to use the FASE index for evaluating design alternatives, how to aggregate the results from members with different experiences remains an open question. These research directions deserve further studies in the future.

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