

USERS' EMOTIONAL RESPONSES AND PERCEIVED PRODUCT QUALITY TOWARDS SUSTAINABLE DESIGN

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ABSTRACT

Emotion of a product has influenced the user interaction and enhanced the value and quality. Also, the quality performs as a cognitive response influencing the user in distinguishing the quality of a product. Nowadays, many product designers have trouble in interpreting potential meanings and perceiving the quality of a product in product development process that should be contributed for sustainable design. The strength of this study emphases not only in identifying and verifying the variable of user's emotional responses and perceptions in the product quality, but also focuses in developing a new theory of sustainable product design method towards sustainable design. A survey with the involvement of the end users (consumer product) was conducted in this study. The results recognized certain variables of user's emotional responses and perceptions towards the product quality, which is a significant contribution towards product sustainability and as well as increasing its success in the market. In addition, a new theories of Sustainable Product Design Method (SPDM) has been introduced.

Keywords: *New product development, Emotional responses, Perceived product quality, and Sustainable design*

1. INTRODUCTION

In recent years, the characteristics of a product produce reflective consequences in the way that the products being perceived and sustaining its existence in the market. A product design regulates from a user's first impression and determines how it can communicate about function. The design of a product would build a user's interpretation regarding the product attributes (Bloch, 2013; Alli & Mohd Rashid, 2018) and would directly apply to their product choice (Sundar et. al., 2014). An interpretation that is based on physical characteristic of a product could influence the product sustainability and its robustness as well as creates emotional connections with the user (Blijlevens, 2012). Characteristics such as shape, form, texture and color would be looked as the function and aesthetic elements and are often related to a person's exposure to the influence of the product and understanding of product meaning (Taha et. al., 2012; Taha et. al., 2013; Sundar et. al., 2014; Alli, 2018).

The importance of understanding the user has increased over the years. Thus, a common practice on many design industries would include involving user in product development. The users can positively contribute in creating a product that satisfies the expectations and thus, increasing the product quality and the probability of the success of the product on the market. However, the involvement of the user in the early stage of product development process has been identified as a critical success factor for new product development (Taha et. al., 2012; Taha et. al., 2013; Alli, 2018). As a result, many product designers often face difficulties in integrating potential meanings and perceived quality of a product in the early stage of product development process (Bloch, 2013;

Sundar et. al., 2014; Alli & Mohd Rashid, 2018; Alli, 2018). This had caused the users to misunderstand the assessment of the product, appreciate less of product, and do not know and have difficulties in recognizing of product meaning and function and consequently, produce less sustainability factors. Previous study done by Taha et. al., (2013), Alli & Mohd Rashid (2018) and Alli (2018), stated that one of the reasons of the aforementioned problem is lack of awareness to be included in the variables of user's emotional responses and perceptions towards product quality during the product planning and development process.

Hence, a new design philosophy should be familiarized to reach towards designing a long-lasting product desire, and have a deep affection between users and the product. The main objective of this paper was to study which elements of users' emotional responses and their perceptions towards product quality contributing in design sustainability. This study is valuable in providing a good understand of product meaning and develop an appropriate guideline for product designer in establishing the product requirements and as well as increasing its success in the market.

2. RESEARCH BACKGROUND

2.1 User Emotional Responses

User emotional responses have been essential for product design study since late 1980s. User emotional responses are described as feeling that result in psychological and physical changes that stimulate behavior and contemplation. It also seems to rule human beings' everyday lives due to the fact that it could make the users' choices primarily based on their moods either happy, unhappy, indignant, bored or even frustrated. Emotion is normally described as a complex state of response that ends in physical and psychological alterations that have an effect on thought and behavior. Whilst, user emotional responses in design can build a strong emotional attachment and empathy between user and products that can also influence user behavior (Chapman, 2015). According to Laurans & Desmet (2012), there are 14 emotions that are used to describe the product users with pictorial illustrations used in PrEmo2 software and associated to product characteristic are illustrated (see Figure 1).

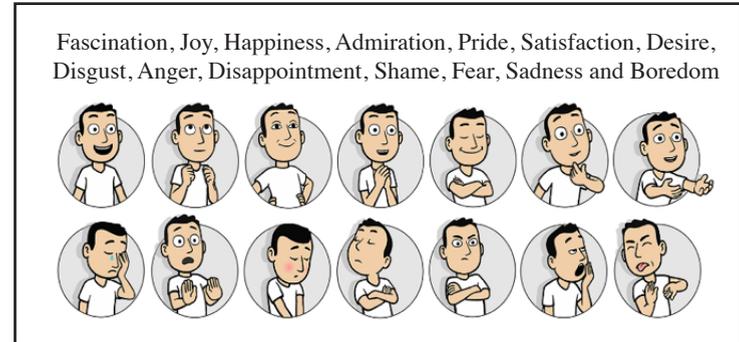


Figure 1: Pictorial Illustration in PrEmo Software (Laurans & Desmet, 2012)

2.2 Perceived Product Quality

Perceived product quality is different from actual or objective quality, product-based quality and manufacturing quality. Perceived product quality is more towards users' evaluation regarding the excellence of a product that meet the individual's expectations. User's perceived product quality could be defined as judgment on how a product or services as quality could be described in terms of the moment at which the users receive information about the characteristics of the products (Tamimi & Sebastianelli, 2016). Ultimately, the quality of a product is related to the users' experiences and personal taste, and not the opinion of the product designers or anyone else in the manufacturing company. Moreover, the users' decision making is also considered as a perceived quality that has become an option within a given category that the product features that could become indicators for the users; aesthetic, functional, and emotional. A study by Garvin (1987), identified that there are eight dimensions of product quality, as a framework-conceptualizing user needs (see Table 1).

Table 1: Dimensions of Quality Use for Strategic Evaluation (Garvin, 1987)

Product Quality	Description
Performance	Product's primary operating characteristics. It is involved measurable attributes; brands can usually be ranked objectively on individual aspects of performance.
Features	Secondary characteristics that develops basic function of the product to user.
Reliability	It reflects that a product will not fail within a specific time period. Reliability are also the mean time to first failure, the mean time between failures, and the failure rate per unit time.
Conformance	This dimension is a product's design and operating characteristics that meet specified standards, which physical and performance characteristics of product meet design specification.
Durability	The item will be used until it is no longer able to operate. It measure the length of a product's life.
Serviceability	It indicate the speed, which the product is ease, courteousness, and competence of repair when it breaks down.
Aesthetics	It specifies a personal judgment and a reflection of user preference to a product. It appeals to our five senses; looks, feels, sound, taste, or smells.
Perceived Quality	The quality attributed to a product based on indirect measure or subjectively assessed.

2.3 Sustainable Product Design

Sustainable product design is understood as a collection of approaches, which generally contain product design for ease of disassembly, product life cycle, recycling, and product materials to enhance energy consumption and reduction in environmental effect that considers longer-lasting products in relation to the physical and emotional dururances. The idea of sustainability has become progressively important all over the world because of the incorporated approach indicators that link a community's economy, environment, and society. A study by Amekudzi, et. al., (2015), defined sustainability as the interaction of its three main parts, and example of features intersection as constraints to any two parts in their three-dimensional "sustainability footprint" metric (see Figure 2). This concept can be integrated to the design field where product designers examine the aspect in the product development process to be fulfil with the principles of social, economic, and environmental sustainable.

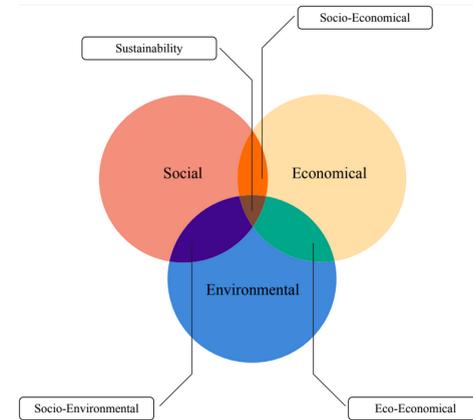


Figure 2: Three-Dimensional of Sustainable Intersection (Amekudzi, et. al., 2015)

According to Eizenberg & Jabareen (2017), the elements of social sustainability are constructed into four interrelated concepts (Eizenberg & Jabareen, 2017). Each performs a specific function within the social sustainability framework including perceptions of safety, equity, eco-prosumption, and sustainable urban forms. Then, an economical sustainability is also important to produce products and services. It contains product life cycle, product innovation, productivity cost, and durability (Gupta et. al., 2015). Meanwhile, environmental sustainability involves an approach to the engineering processes, products, and structure that provides a less negativity or effect on environmental systems related to resources availability and technology (Pappas, 2012).

2.4 Users' Emotional Responses and Perceived Product Quality Approach

Numerous different methods have been developed to assist the product designers in understanding the end users. Most were introduced from areas, such as economic, marketing, operation management, and manufacturing. The approach exercise attempt to evaluate the quality of a product such as manufacturing-based approach, product-based approach, transcendent or judgmental approach, user-based approach, value-based approach, and quality characteristics. According to Metso (2016), the manufacturing-based approach focuses on producing a product with a predetermined quality level, while user-based approach is based on needs and expectations. The product that satisfies the users' needs are considered to have superior quality.

A study by Kaplan et. al., (2013) stated that the proposed for measuring emotions responses are identified by four types of evaluations. First, emotions are referred to as sentient and individuals' reflection on the feeling states. Questionnaires were being used to measure emotions in scales. Second, emotions cause physiological reactions from peripheral nervous system. Emotions are measured by physiological changes in body, for example, measuring heart rate and other variables that vary during emotional stimulation. Third, emotions are cognitive evaluation and labeling process. It can be measured from attribution and judgment. And fourth, emotions reflected facial expressions and response, which helped the researchers to find methods by measuring behavioral observations such as facial and vocal expressions. Whilst, many people including product designers and manufacturers are unintentionally concentrating on physical appearance (visceral level) and functionality (behavioral level) of a product that are easily replenished, then on an emotional way (reflective level), to produce and maintain continuing emotions (Aftab & Agustin, 2017). Norman (2007) established three levels of emotional design attachment and used as approaches towards the ability for a design object to elicit intended user emotions (see Figure 3).

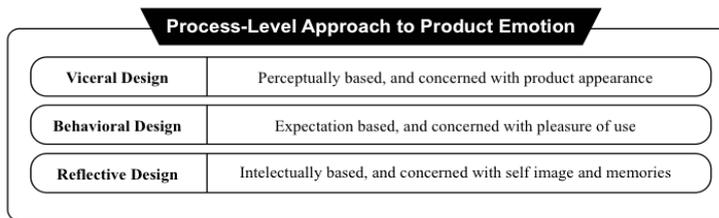


Figure 3: Process-level Approach to Product Emotion (Norman, 2007)

2.5 Strategy for Sustainable Design

Sustainability aspects is crucial in increasing demands in the design. Sustainable design is introduced to change conservative design and manufacturing practice, and considerate with environmental essentially. Sustainable design is understood as a collection of approaches, which generally contain product design for ease of disassembling, product life cycle, recycling, and product materials to enhance energy consumption and reduction of the environmental effect (Gant, 2017). It is important to have an understanding on relationship

between users and product that can improved its sustainability. In addition, the key for a sustainable value of products lays with the users by the constant interactions in how they provide a meaning to the things. A well-defined user as being important for sustaining and contributing in product success (Taha et. al., 2012; Taha et. al., 2013; Alli & Mohd Rashid, 2018; Alli, 2018). However, users' decision regarding a product is crucial towards its sustainability and success in the market. This is necessary to inspire the product designers to establish the product characteristic based on the variables of users' emotional responses and perceptions towards product quality. In addition, the product designers also need a guideline that could be used at the early stage of the design process or product assessment study.

3. METHOD

Sixty (60) respondents had participated in a survey to gather the data for the research. They represented the end users of product consumer. A kitchen appliance or more specifically, electric kettle with three designs had been chosen to epitomize a product that needed to be evaluated by then end users (see Figure 4). These electric kettles were carefully selected based on the sales reputation and seemingly numerous feedback from the users. The survey was directed by means of a questionnaire distributed among the end users in some of the established electrical store, Harvey Norman located in several urban locations in Selangor, Malaysia. The questionnaire was intricately designed around the expected respondents' background and information to be gathered from them since they are the end users of the product being investigated by the study. The results were analysed using the statistical Package for Social Science (SPSS). The results were gathered and presented as conclusion to the study.



Figure 4: Kitchen Appliances (Electric Kettle A, B, and C)

4. RESULTS

4.1 User Satisfaction

User satisfaction has become the source of innovation success in the market. Figure 5, illustrates the analysis of user's emotional responses evaluation within kettle A, B, and C. According to positive emotion value, fascination of kettle C has the highest score (70.8%) followed by kettle B (64.3%) and kettle A (59.1%). Joy value of kettle C scoring (66.3%) followed by kettle B (64.3%) and kettle A (61.4%). Meanwhile, the happiness of kettle C scoring (69.3%) followed by kettle B (65.9%) and kettle A (61.0%). When it comes to admiration, kettle C scores the highest with (67.9%) followed nearly by kettle B (67.0%) and kettle A (66.3%). Conferring to pride, the scores set kettle B first with (66.5%) followed by kettle C (64.4%) and kettle A (57.5%). By satisfaction, kettle A scores the highest value (71.1%) followed by kettle C (65.0%) and kettle B (63.5%). Lastly, the values of desire set kettle A scores (61.0%), kettle C with (60.5%) and lastly kettle B (57.5%).

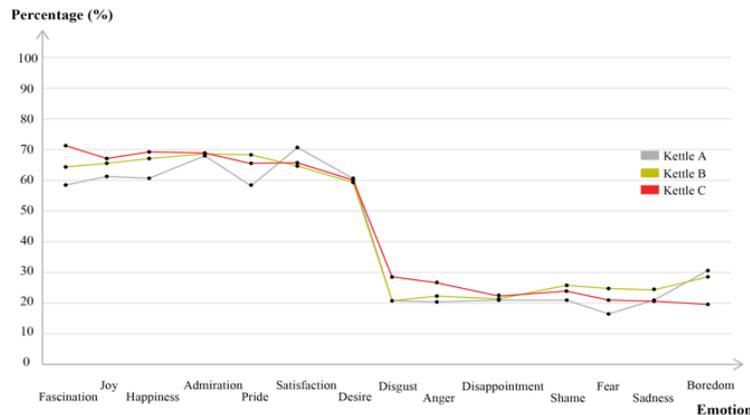


Figure 5: Analyses of Emotions Within Kettle Appearance

Whilst, the negative user's emotional responses through kettle A, B and C, disgust emotion set (21.0%) for kettle A and (21.4%) for kettle B followed by kettle C (28.0%). Anger indicates kettle A has the lowest value (20.4%) followed by kettle B (22.6%) and kettle C (26.5%). Regarding to disappointment emotion, kettle A (21.3%) has the lowest score followed closely by kettle B (21.6%) and kettle C (22.0%). When it comes to shame, kettle A has the lowest point with (21.3%) followed by kettle C (23.1%)

and (25.6%) for kettle B. Fear emotion indicates kettle A (17.3%) has the lowest point followed by the score from kettle C (21.6%) and kettle B (24.0%). Sadness tells kettle C (21.4%) has the lowest point followed closely by kettle A (21.6%) and kettle B (23.3%). Finally, boredom emotion shows kettle C (19.9%) as a lowest score followed by kettle B (28.3%) and kettle A (30.5%).

4.2 Aesthetic and Function Elements of Product Design

Both figure below provide an overview of aesthetic and function elements of product design. The results in Figure 6 show the aesthetics elements of product design, which were specify that appearance and color (83.3%) as the most importance of the aesthetics elements followed by shape (82.1%), form (80.8%), material (72.9%), texture (67.9%), interface (66.7%), emotion (59.2%), semantic (57.5%), and semiotic (53.8%).

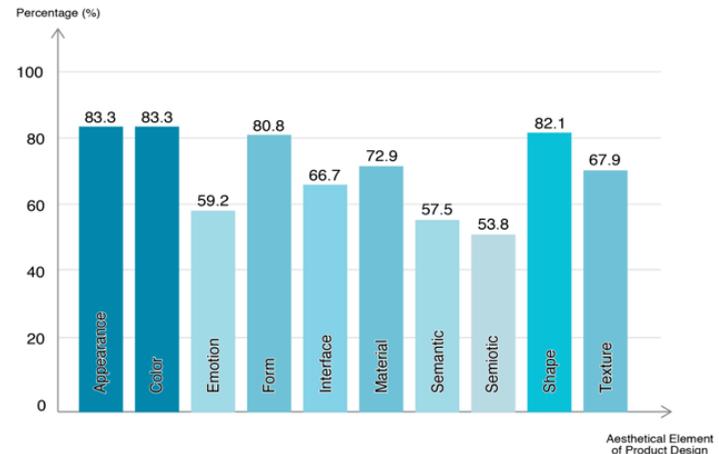


Figure 6: Aesthetics Elements of Product Design

While, Figure 7 shows the function elements of product design. The results identify usability (85.8%) is the mostly prioritized, followed by safety (84.6%), quality (82.9%), effectiveness (82.5%), reliability and technology (81.7%), ergonomic (77.9%), lifetime (71.7%), components (68.3%) and size (67.5%).

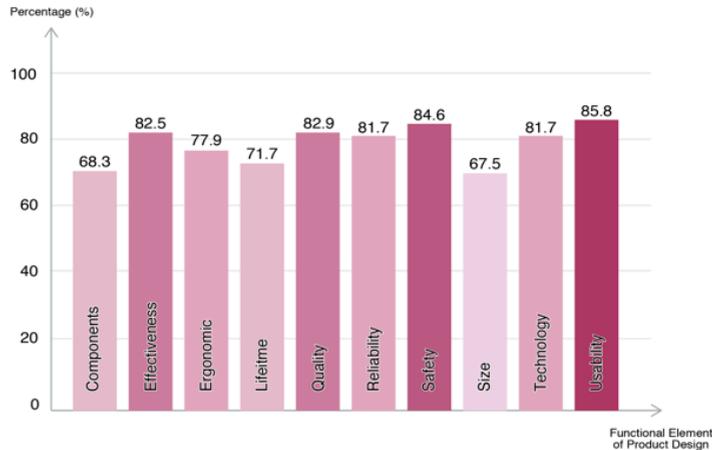


Figure 7: Function Elements of Product Design

4.4 Product Quality Characteristics

Figure 8 demonstrates the characteristics of product quality. A results indicate durability (87.8%) is the most significant for product quality followed by perceived quality (85.9%), performance (85.6%), aesthetics (85.5%), conformance (85.0%), serviceability (84.8%), features (84.4%), and lastly reliability (82.8%).

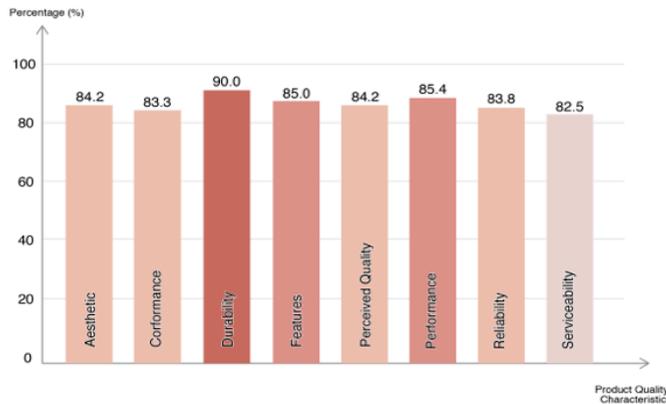


Figure 8: Product Quality Characteristics

4.5 Elements of Sustainable Design

Figure 9 illustrates elements of the three dimensions of sustainable design. Based on these levels, social, economical, and environmental most importance elements are performance (82.1%), followed by accessibility (81.3%), reuse (80.8%), material (80.4%), resource (79.2%), development (75.4%), value (74.6%), cost (70.8%) and lastly equity (67.1%).

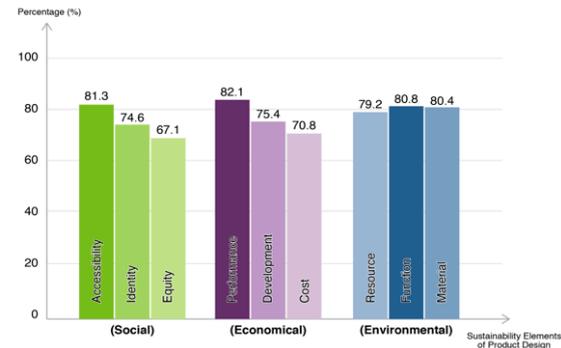


Figure 9: Elements of Sustainable Design

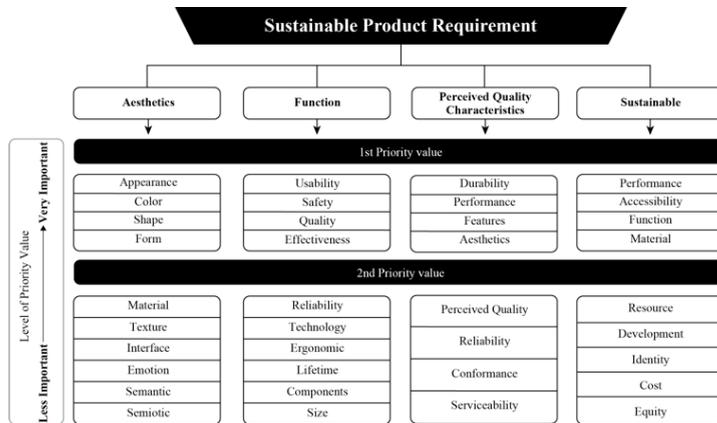
5. DISCUSSION

Sustainability aspects are becoming important in product design and increasing its demand. Sustainable design is introduced to change conservative design and manufacturing practice and be more considerate towards the environment. In this study, the results have shown that the user is a key for a sustaining value of products by the constant interactions, which how they gave a meaning to things. The users' emotional responses and perceptions towards product quality have significantly a huge impact on sustainable designs. To introduce a new product, it is necessary to have a good understanding between the relationship of the user and the product to improve the sustainability and as well as increase its success in the market.

Table 2 demonstrates the elements of sustainable product requirements of the electric kettles. These elements were gathered from the users' emotional responses and perceptions towards quality and sustainability of the products. Sustainable product requirements from the first priority value are identified from the mapping process of twenty (20) elements of product design, eight (8) elements of perceived quality characteristics and nine (9) elements of

sustainable design, which have been identified by the users. The elements were set based on the high priority to low priority value. It is shown that the appearance is mostly the highest priority for aesthetics elements followed by color, shape and form. While, the highest priority for function elements are usability, safety, ergonomic, and quality. Therefore, perceived product quality has identified that durability, performance, features and aesthetics are the highest priorities. As shown by the results, elements like performance, accessibility, functions and materials have been established as the top priorities for the end users to their definition of a sustainable product.

Table 2: Sustainable Product Requirements



Hence, the Sustainable Product Design Method (SPDM) has been developed in conjunction to the responses collected through the information gathered from the figure above (see Figure 10). The figure explains on product assessment as a decision-making as attempt to identify the main priority elements of sustainable product design specifications (SPDS) in fulfilling the requirements of the user, and which, can be integrated with the elements of sustainable product design (ESPD) to produce a sustainable product requirements (SPR) that contribute to sustainable product (SP). Hence, it would also provide success for the product in the market.

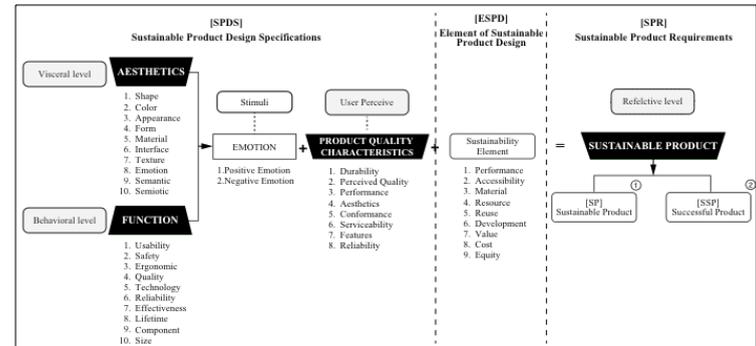


Figure 10 : Sustainable Product Design Method Process

In addition, a recommended formula is also has been projected (see Formula 1.0 below). The aforementioned formula would be utilised in an assessment process in identifying and verifying the sustainable product design specification (SPDS) and ultimately, establishing the sustainable product requirements (SPR). This process is divided into two steps. The first step is set in identifying the sustainable product design specification (SPDS) where both elements of emotional aesthetics (EAs) and emotional function (EFe) need to be incorporated with the product quality characteristics (PQC) in determining a sustainable product design specification (SPDS). Meanwhile, the second step is integrating sustainable product design specification (SPDS) with the elements of sustainable product design (ESPD), and thus, it will be determined a sustainable product requirements (SPR). Towards the end, the selected sustainable product requirements (SPR) should be able in the establishment of sustainable and successful products.

$$\text{Formula: } ([EAc] + [EFc] + [PQC]) = \text{SPDS}^{(1)}$$

$$([EAc] + [EFc] + [PQC]) = (\text{SPDS} + \text{ESPD}) = \text{SPR}^{(2)}$$

6. CONCLUSION

This study has introduced a new method namely Sustainable Product Design Method (SPDM). The SPDM is a process to identify and verify the three variables of users' emotional responses, perceived product quality and elements of sustainability in the early stage of the design process. SPDM is a design guideline that attempts to establish the sustainable product requirements (SPR) towards sustainable and successful product in the market.

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