IESS 2015

THE 3RD INTERNATIONAL CONFERENCE
ON INDUSTRIAL ENGINEERING AND SERVICE SCIENCE

Melia Purosani Hotel - Yogyakarta, 1 - 3 September 2015

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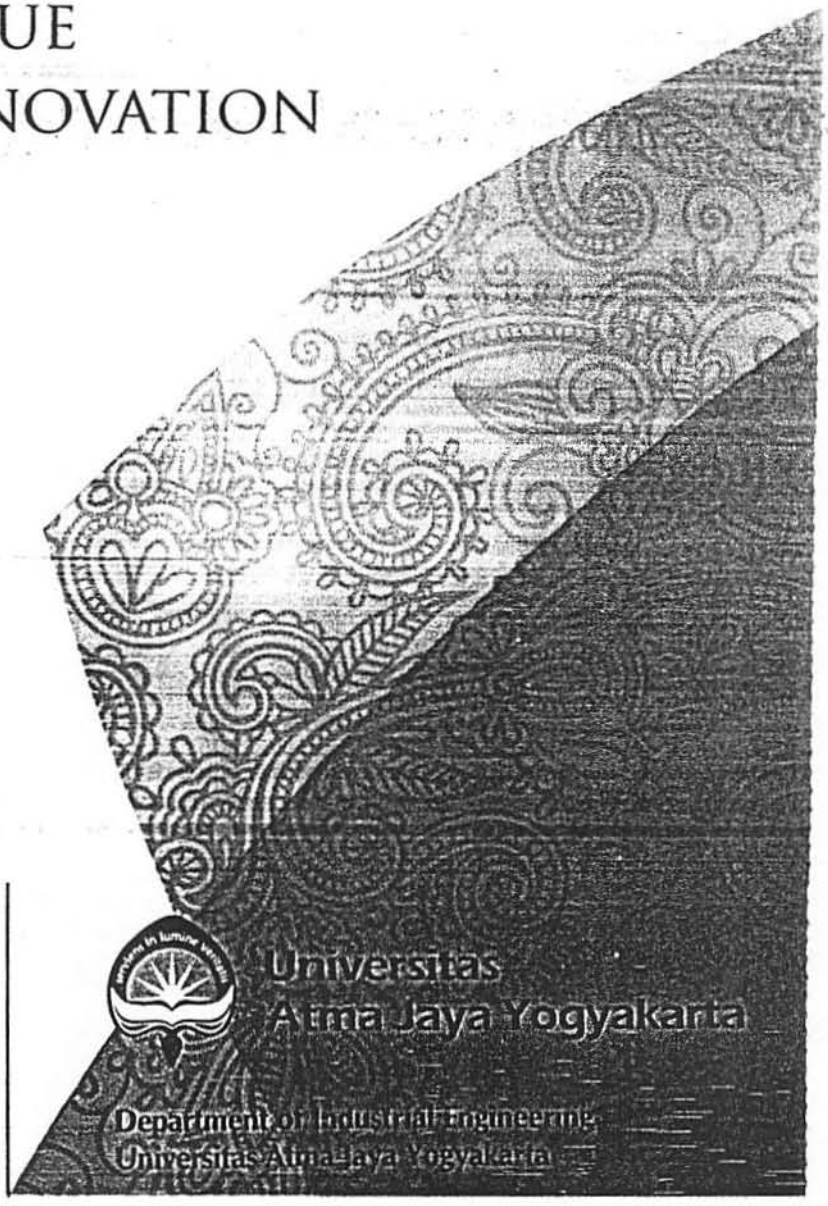

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Industrial Engineering Department, Institut Teknologi Sepuluh Nopember (ITS) Surabaya and Universitas Atma Jaya Yogyakarta - Indonesia

Supported by:
Rajamangala University of Technology Suvarnabhumi (RMUTSB) - Thailand
Universitas Islam Indonesia (UII) - Indonesia

ISSN: 2338-7939

Edited by:

Iwan Vanany
Nani Kurniati
Dyah Santhi Dewi

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Proceeding of Industrial Engineering and Service Science , 2015

Balinese Aromatherapy Product Development Based On Kansei Engineering And Customer Personality Type

Taufik Djatna[1]; Luh Putu Wrasiati[2]; Ida Bagus Dharma Yoga Santosa[1]

[1]Post Graduate Program of Agro-industrial Technology, Bogor Agricultural University, Bogor, Indonesia
[2]Agro-industrial Technology Department, Udayana University, Denpasar, Indonesia
taufikdjatna@ipb.ac.id

ABSTRACT

Balinese aromatherapy products have such local indigenous that attracts customer attention. The combination of aromatherapy product and Balinese culture make this product become unique and famous in the market. In this research affective engineering approach based on Kansei Engineering was applied to develop Balinese aromatherapy product. Customer personality type based on Hippocrates and Galen theory was involved in the development process. According to its main motivation, three research objectives were proposed (1) to generate the new design concept of Balinese aromatherapy product using Principal Component Analysis (PCA), (2) to identify the relevant product design element using Relief method, and (3) to generate the quantification model of aromatherapy product design using Fuzzy Quantification Theory Type 1 (FQTT1). The result of PCA method showed the extraction of KW collected has been reduced twelve components into one principal component to represent new design concept named "Balinese Traditional" (BT). By using Relief method, ten relevant design elements have been generated from twelve design elements identified. According to the result of FQTT1 analysis, a linear quantitative model has been built for each personality type to explore the relationship between customer's emotional feelings and product design elements. From these models, design support information has been generated to assist product designers in decision making for the new Balinese product design. In general, the result showed that all design specification of Balinese aromatherapy product were specific for each personality and most of them were productive as the new design rules.

Keywords: *Aromatherapy product, Kansei Engineering, Customer personality type, Fuzzy Quantification Theory Type-1*

1. Introduction

Balinese aromatherapy products such as aromatherapy scrub, incense, massage oil, soap, and many more, were coped high value of business since Bali has chosen as "The Best Spa Destination of The World in 2009" on SENSE Magazine version [1]. In addition, from 2009 to 2013, about 2,803,181 visitors came to Bali with 9.5% increased for each year [2]. Considering this condition, in order to winning the competition in this sector, the need of the development of aromatherapy product has always been a challenge as well as the changing of customer demands and expectations.

Basically, Balinese aromatherapy products have such uniqueness which attracts the consumer to buy them. This uniqueness refers to product Balinese sense which have a big contribution to make the product become famous in the market [3], where Wijaya [4] said that the famous product refers to the product which could fulfill the customer need. Generally each customer has particular criteria on which they want to buy related to their personality, for instance, the extrovert customers prefer gold color than black or grey. The condition was supported by Jordan [5] who said that people tend to imagine products as having personalities and they tend to express a preference for products that they perceive as reflecting their own personalities. Another aspect that has important role on product development is product design elements which make the differences of the products and gives the impression to customers directly [6].

As mentioned previously, Balinese sense, customer personality, and design elements considered as three important dimensions that make Balinese aromatherapy product become famous in the market. In this research, *Kansei* Engineering (KE) were chosen to synthesize these dimensions in order to develop Balinese aromatherapy product design. In 1992, KE was introduced by Mitsuo Nagamachi as a product development method which translated customer's impression into design specification [7]. The word *Kansei* refers to Japanese term

for the impression, feeling, or the image of something. In this research, the words that represent impression, feeling, or image of customers about Balinese aromatherapy product is identified as *Kansei* Words (KW).

In this paper, Balinese aromatherapy massage oil was chosen as the research object to develop, Fuzzy Quantification Theory Type 1 were used to synthesize three dimensions of *Kansei*. By using this method, new design formulations were generated and represented by linear model approach. Furthermore, the recommendation of design element combination and proportion were obtained directly based on customer personality type. In particular this information obtained would be powerful especially for product designer to develop the product in order to fulfill customer subjective preferences. Finally, according its motivation, three main objectives were proposed in this research: (1) to generate the new design concept of Balinese aromatherapy product, (2) to identify the relevant product design element, and (3) to generate the quantification model of aromatherapy product design.

2. Methodology

The methodology was designed to accomplish the research objectives. In this paper, Balinese aromatherapy massage oil has been chosen as product domain to develop. Furthermore, the research methodology is represented in Figure 1.

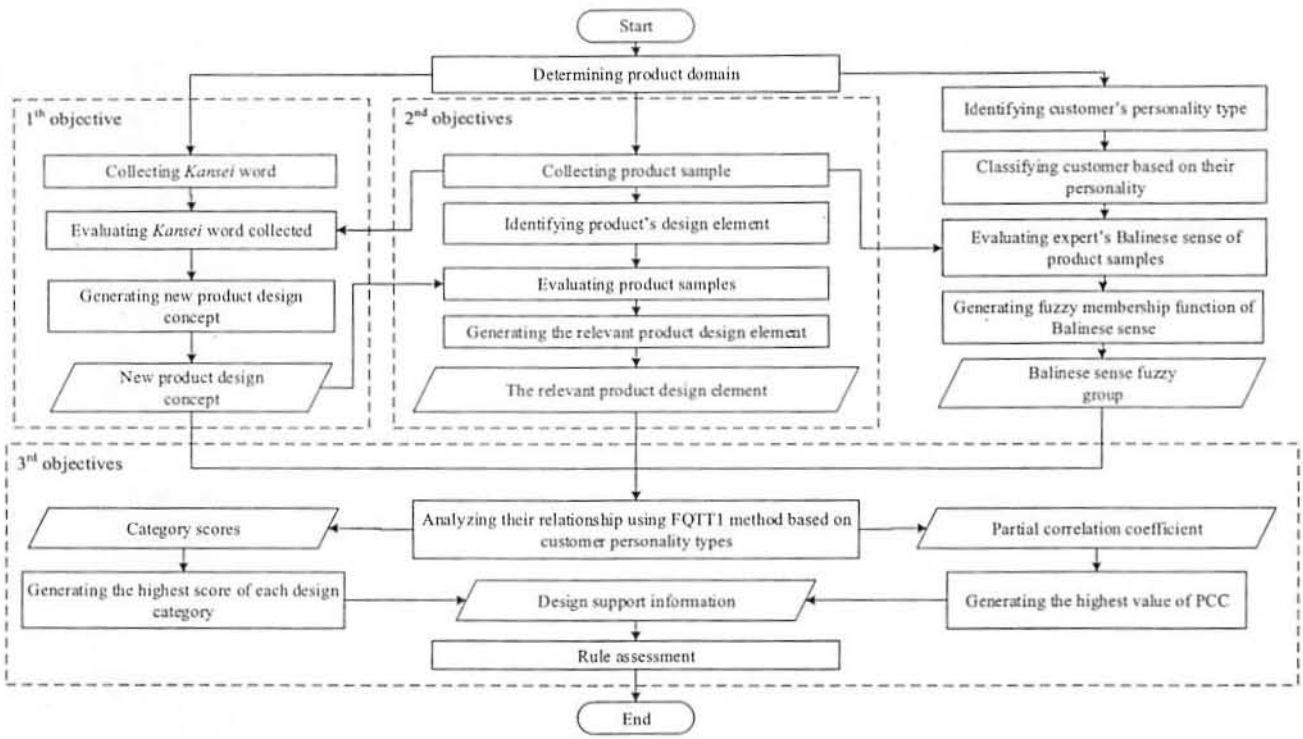

Figure 1. Research methodology flow chart

The research began with the identification of product domain as the research object. Afterward, the KW were collected by interviewing the experts and followed by generating a new Balinese aromatherapy design concept to achieve the first objective. Then to achieve second objective, design elements were identified for each sample collected and were evaluated according to the new design concept to obtain the relevant design element. Finally, the new design concept and the product design elements were synthesized for each customer personality type to achieve the third research objective. In this research, R language version 3.1.3 were used as a tool of data processing.

3. New Design Concept Identification

In this phase, firstly twelve *Kansei* words have been collected by means interviewing the experts which illustrated Balinese aromatherapy product consisted of "Unique", "Attracting", "Exotic", "Natural", "Balinese product", "Luxurious", "Artistic", "Bright", "Traditional", "Fashionable", "Eco-Friendly", and "Transparent". Afterward, all the *Kansei* words obtained have been evaluated by 30 customers of aromatherapy product using Likert scale (7

scale). Thus, the result of evaluation has been analyzed using Principal Component Analysis (PCA) method in order to reduce the dimension of KW collected and followed by generating a new concept of product design[8].

To deploy PCA in this research, firstly, defines **X** as a matrix of KW evaluation for p dimensions of KW which denotes as $\mathbf{X} = \{x_1, x_2, \ldots, x_p\}$ where $x_i \in \mathbf{X}$. Then calculates the mean (μ_i) of **X** for n product sample ($i = 1, 2, \ldots, n$) which denotes as $\mathbf{M} = \{\mu_1, \mu_2, \ldots, \mu_p\}$. The next step is to calculate the subtract matrix between **X** and **M** which denotes as $\mathbf{Y} = \{y_1, y_2, \ldots, y_p\}$. In order to see the correlation between KW, compute the covariance of matrix of **Y** which denotes as **C** with p x p dimensions. Thus, generate eigenvalue and eigenvector of **C** as formulated in (1) where eigenvector denotes as $\mathbf{B} = \{b_1, b_2, \ldots, b_p\}$ and eigenvalue denotes as $\lambda = \{a_1, a_2, \ldots, a_p\}$.

$$\mathbf{C} * \mathbf{B} = \lambda * \mathbf{B} \quad (1)$$

According the result of eigenvalue λ, it can be seen about how many principal component (PC) should be retained and the result of eigenvectors **B** showed the value of component's loading components. The result eigenvalue of each component is represented in Figure 2 and the result of component loading factors in two dimension of PC named PCA variables factor map is represented in Figure 3.

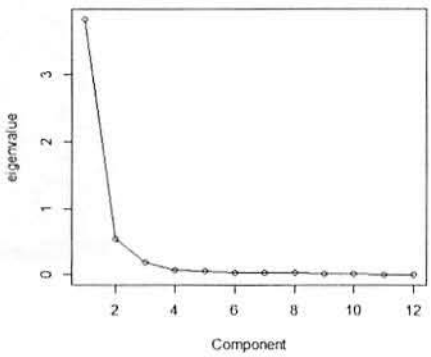

Figure 2. The result of eigenvalue

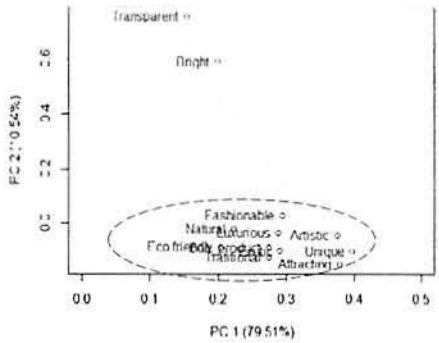

Figure 3. Variables factor map (PCA)

According PCA result, one principal component which has eigenvalue above 1 was generated to represent 79.51% of all the *Kansei* words as represented in Figure 2 and the *Kansei* words were grouped into their principal component as seen in Figure 3. Based on PCA result, "Balinese Traditional" (principal component 1) has been chosen to cope the group as a new design concept of Balinese aromatherapy product as the answer of first objective in this research.

4. Relevant Design Element Identification

In order to answer the second research objective, 25 Balinese aromatherapy massage oil have been collected. The result of design element identification phase showed that there were 12 categories with 34 variance of design elements which is represented in Table 1. Relief algorithm [9] was deployed to determine which relevant product design elements for BT image. Basically, Relief method is a feature weight based method inspired by instance-based learning which detects those feature which are statistically relevance to the target concept [9].

Table 1. The result of design element identification

Design element	Type			
	1	2	3	4
Top shape (X_1)				
Body shape (X_2)				
Height and width ratio (X_3)	Wide	Narrow		
Copped ornament and bottle height ratio (X_4)	Low	Middle	High	
Material (X_5)	PET	Glass		
Cap color (X_6)	Gold	White	Grey	Black
Ornament item number (X_7)	Few	Middle	Many	
Label theme (X_8)	Flower	Non-flower		
Root in the bottle (X_9)	Exist	None		
Bottle color (X_{10})	Transparent	Semi-transparent	Non-transparent	
Bottleneck (X_{11})	Exist	None		

Label position (X_{12})	Attached	Hanged	Both

The equation of Relief is represented as in (2). To deploy Relief in this research, first, defines i^{th} design element as f_i where $\mathbf{F} = \{f_1, f_2, ..., f_m\}$, the weight of the i^{th} design element as w_{fi} where $\mathbf{W} = \{w_{f1}, w_{f2}, \ldots, w_{fm}\}$, and the result of customer evaluation for m dimensional features ($i = 1, 2, ..., m$) and n sample size ($t = 1, 2, ..., n$) which denotes as x_{ti} where $\mathbf{X} = \{x_{t1}, x_{t2}, \ldots, x_{tm}\}$.

$$w_{f_i} = \frac{\sum_{t=1}^{(n-1)} \sum_{j=(t+1)}^{n} diff(x_t, y_j)^2}{(n-1)} \tag{2}$$

Traditionally, Relief equation above runs using pairwise between data record (x_t and y_j) where x_t indicates an instance of customer evaluation and y_j indicates an instance neighbor of x_t. In equation above, function $diff(x_t, y_j)^2$ is calculated as in (3), where r_{fi} is a range unit of i^{th} design element to normalize the values of the function into the interval [0, 1].

$$diff(x_t, y_j)^2 = \left(\frac{x_t - y_j}{r_{f_i}} \right)^2 \tag{3}$$

As in (3), if pairwise between x_t and y_j are in the same class, then the value of function *diff* is negative. Otherwise, function *diff* will have a positive value when x_t and y_j are in a different class. Kira and Rendell [9] said that the relevant features means the features which has weight above 0. The result of weights of design elements of Relief which generated using R language which threshold was set on zero ($\tau = 0$) is represented in Figure 4.

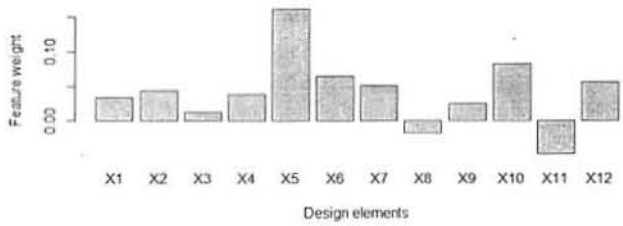

Figure 4. The result of Relief method

According the result, ten design elements which have the weight of attribute importance more than threshold ($w_i > \tau$) have been generated as the relevant design elements. These ten design elements consisted "X1", "X2", "X3", "X4", "X5", "X6", "X7", "X9", "X10", and "X12". The result implies that designers should focus on their attention more to these ten relevant design elements when the design objective of the product is to achieve a desirable BT image.

5. Balinese Aromatherapy Product Formulation Based on Customer Personality Type

In this phase, customer personality type was identified based on Hippocrates and Galen theory who classify the personality into four basic personality types: (1) Sanguine (animated, cheerful, humorist, extrovert, trendsetter); (2) Choleric (strong, adventurous, powerful, dominant); (3) Melancholy (analytical, individualist, details, planner, perfectionist); (4) Phlegmatic (friendly, easy going, peaceful, shy, adaptable); [10]. These personality types are the most popular and the oldest classification of personalities [11]. The evaluation was conducted using personality questioner test. From 30 respondents gathered, the evaluation showed that there were 9 sanguine, 10 melancholic, 3 choleric, and 8 phlegmatic that involved in this research.

Afterwards, FQTT1 was performed to find the relationship between qualitative descriptive variables that are given in values on [0, 1] and numerical object variables in the fuzzy groups given in the sample [12]. FQTT1 model as represented in (4) means determining a linear function of categories that best expresses the structure of the data by minimizing the object variation given and its error variance.

$$y(\omega) = \sum_{i=1}^{K} a_i \mu_i(\omega) \tag{4}$$

In model above, $y(\omega)$ expresses the objective function of ω^{th} sample and $\mu_i(\omega)$ is the degree of response to i^{th} qualitative category ($i = 1, 2, \ldots, K$), which has values on [0, 1]. The category weight (a) that minimizes the error variance is represented as in (5). In equation (5), matrix $\mathbf{A}$ denotes a set of K category weights, where $\mathbf{A} = \{a_1, a_2, \ldots, a_K\}$. Matrix $\mathbf{X}$ contains groups of qualitative categories of n sample given which denotes as $\mathbf{X} = \{\mu_i(1), \mu_i$

$(2),\ldots, \mu_i(n)\}$. Matrix **G** is a diagonal matrix of fuzzy group B ($\mu_B(\omega)$) that expresses the fuzzy set of n sample given as denotes in $\mathbf{G} = \text{diag}\,(\mu_B(1), \mu_B(2),\ldots, \mu_B(n))$. Finally, the objective functions of n sample given is contained in matrix **Y** which is defined as $\mathbf{Y} = \{y(1), y(2),\ldots, y(n)\}$. In this research, FQTT1 method performed to find the relationship between product design elements and customer personality type for describing image given.

$$\mathbf{A} = (\mathbf{X}^T\mathbf{G}\mathbf{X})^{-1}\,\mathbf{X}^T\mathbf{G}\mathbf{Y} \quad (5)$$

To perform FQTT1, firstly the new design concept for all product sample were evaluated by these 30 respondents using Likert scale and Balinese sense of the product was evaluated by experts. Fuzzy membership was then generated from expert evaluation of Balinese sense of the product with Likert 7 scale and one category was set to represent product Balinese sense with fuzzy membership ranged 0 to 1. As a result of the FQTT1 analysis, four prediction models were generated to represent the relationship between product design elements and the given product images for each personality with considered the product Balinese sense.

Sanguine's BT = $1.186\,X_{1.1} + 2.200\,X_{1.2} - 0.266\,X_{1.3} - 2.997\,X_{1.4} + 0.217\,X_{2.1} - 0.328\,X_{2.2} - 0.010\,X_{2.3} + 0.244\,X_{2.4} + 0.477\,X_{3.1} - 0.355\,X_{3.2} + 0.808\,X_{4.1} + 0.230\,X_{4.2} - 0.916\,X_{4.3} + 1.924\,X_{5.1} - 1.802\,X_{5.2} + 1.418\,X_{6.1} - 0.189\,X_{6.2} + 0.203\,X_{6.3} - 1.310\,X_{6.4} + 0.677\,X_{7.1} + 2.875\,X_{7.2} + 1.655\,X_{7.3} + 0.212\,X_{9.1} - 0.090\,X_{9.2} + 0.103\,X_{10.1} - 0.577\,X_{10.2} + 0.596\,X_{10.3} + 2.124\,X_{12.1} + 2.920\,X_{12.2} + 3.701\,X_{12.3}$ (6)

In model (6) and Figure 5, category score indicates the preference degree of Sanguine's emotional feelings on each category variables. If the grade is positive, the costumer's emotional feeling leans toward the BT image. For instance, in model (11), the category score of two selected values of the bottle material (X5) in "BT" image are 1.924 and –1.802. This result shows that the Sanguine's emotional feeling prefers the "BT" image if the bottle material is "PET".

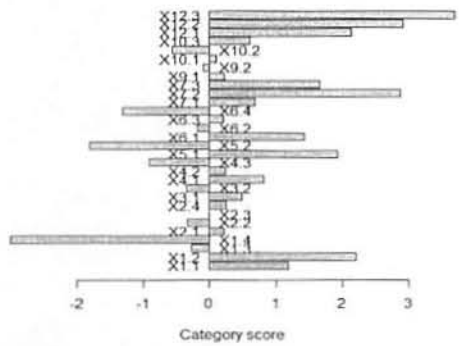

Figure 5. Optimum category score for sanguine design

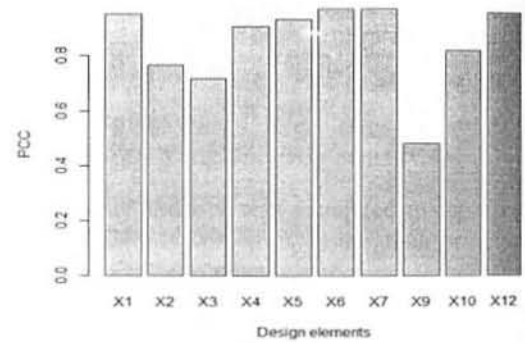

Figure 6. PCC for sanguine design

In Figure 6, partial correlation coefficient (PCC) indicates the degree to which design element affects design concept. According the result in Figure 6, the maximum PCC of sanguine "BT" image tends to cap color (X6). The result means design element "cap color" is most closely related to "BT" image among the others. Based on the models obtained, a design support information was generated to figure out the combination of product design element in term of new concept given. The result of design support information is represented in Table 2.

Table 2. The result of design support information of BT image

Design categories	Sanguine	Choleric	Melancholic	Phlegmatic
Top shape	Type 2	Type 3	Type 3	Type 2
Body shape	Type 4	Type 2	Type 4	Type 4
Height : width	Wide	Wide	Wide	Wide
Copped ornament : bottle height	Low	High	Low	Middle
Material	PET	Glass	PET	PET
Cap color	Gold	Gold	Grey	Gold
Ornament item used	Middle	Many	Many	Middle
Root in the bottle	Exist	None	Exist	None
Bottle transparency	Non-transparent	Transparent	Transparent	Non-transparent
Label position	Both	Hanged	Hanged	Both

According the result represented in Table 3, the most influential design element tends to "gold cap color" for Sanguine, "body shape type 2" for Choleric, "many ornament item used" for Melancholy, and "top shape type 2" for Phlegmatic. Generally, all the result showed the relationship between each personality and their most influential design element which tend to reflect their personalities.

Table 3. Controlling design element for each personality

Parameters	Sanguine	Choleric	Melancholic	Phlegmatic
Highest PCC	Cap color	Body shape	Ornament item used	Top shape
Design level	Gold	Type 2	Many	Type 2

In term of model evaluation, Fisher exact test was conducted to assess the rules productivity within design support information [13]. One respondent was selected randomly for each personality and 0.05 significance threshold ($\alpha = 0.05$) were used in this test. The rules of each design element were assessed for customer preference value above 4 related to BT concept. The productive rules were shown by the value of Fisher exact test $\leq \alpha$ [13]. The result showed that from 10 rules for each personality, there were 9 productive rules for Sanguine and Melancholic, 8 productive rules for Phlegmatic, and 7 productive rules for Choleric, In general, the result showed that the most of rules generated were productive for each personality design.

6. Conclusion

In this paper, a research has been conducted on Balinese aromatherapy massage oil to demonstrate how *Kansei* Engineering using FQTT1 analysis were applied to assist product designers in decision making of the new product design for each personality type. The result of PCA method showed the extraction of KW collected which reduced 12 KW into one word which represented a new design concept of Balinese aromatherapy product named "Balinese Traditional" (BT). By using Relief algorithm, ten relevant design elements have been generated which consisted of top shape, body shape, bottle height and width ratio, copped ornament and bottle height ratio, bottle material, cap color, ornament item used, root in the bottle existence, bottle transparency, and label position. According to the result of FQTT1 analysis, a linear quantitative model has been built for each personality type to explore the relationship between customer's emotional feelings and product design elements. From these model, the design support information has been generated to assist product designers in decision making for the new Balinese product design. In general, the result showed that all design specification of Balinese aromatherapy product were specific for each personality and most of them were productive as the new design rules. By closer impairing the product development of Balinese aromatherapy with customer personality type, a higher degree of global demand may be expected both for business and community. For future research challenges are consisted of how to scale up with a reliable manufacturing and financial engineering process within an integrated production system.

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