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Integrative Framework of Kansei Engineering (KE) and Kano Model (KM) applied to Light Bulb Changer

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Abstract

Currently, any industries face higher competition in their business pertinent to the customers' demands and product design requirements. Customer requirements and satisfaction measurement can be achieved through various methods. This paper presents an integrative framework of Kansei engineering (KE) and Kano model, applied to a product (light bulb changer LBC). KE captures and translates the emotional needs of the customer (Kansei), whereas Kano model is inserted into it to investigate the relationship between service quality attribute performance and Kansei. On this research, the integration between KE and KM in product development approach is applied though a daily life product as a case study (LBC product). The results show that the mechanical mechanism consisting of spring fingers with pvc, round grip and plastic telescopic pole is preffered by customers. This study found that the perceived or quality attributes are influenced by the emotional design or Kansei response. It provides the useful spectrum to other researchers to gain more powerful product development in the future, and stay on the customer satisfaction and requirement track.

Keywords

Kano method (KM); Kansei Engineering (KE); Product Development Process (PDP); Semantic Differential (SD)

1. Introduction

The customer satisfaction is one of the challenges on how they can deliver the quality of the product for their success and survival in today's competitive environment. Kansei engineering can be used as a tool for creative product development generating new revolutionary solutions (Koleini et al., 2014). Also, Kano questionnaire is very helpful in measuring customer satisfaction (Mostafa et al., 2013). Qiting et al. made a questionnaire to determine the customer needs and satisfaction at Shanghai Disneyland (Qiting et al, 2012).

Integration between kansei engineering and kano model is a new field to develop products and services to achieve customer satisfaction fulfillment. Lanzotti and Tarantino suggested the idea of integration of KE and KM existing in PD (Lanzotti and Tarantino, 2008). Schutte et al applied this integration in the service development (Schutte et al., 2004). Fevi et al proposed an integration framework of KM and KE towards a product used in our daily life; pen design development (Fevi et al., 2014).

This research tries to find out the relevant features in the product development process and how they meet the characteristics required by the customers using Kansei Engineering (KE) and Kano Method (KM). Both approaches

are integrated as the structural model of customer satisfaction that will be functioned to help the designer or producer to generate the questionnaire as an initial process to gain the data collection.

Neither KE nor KM are sufficient to make the customer fully satisfied. So, integration helps to achieve customer requirements (CR) fulfillment. Figure 1 shows the integration approach between KE & KM.

In this study, we illustrate the integration between KE and Kano model through a procedure that helps in increasing customer satisfaction and maximizing profit applied to a certain product (light bulb changer). This helps to determine the strength and weakness in the integration process to be able to develop the procedure in the future. Also, a complete analysis of questionnaire results and obtaining the most important KWs and elements of the product will be applied.

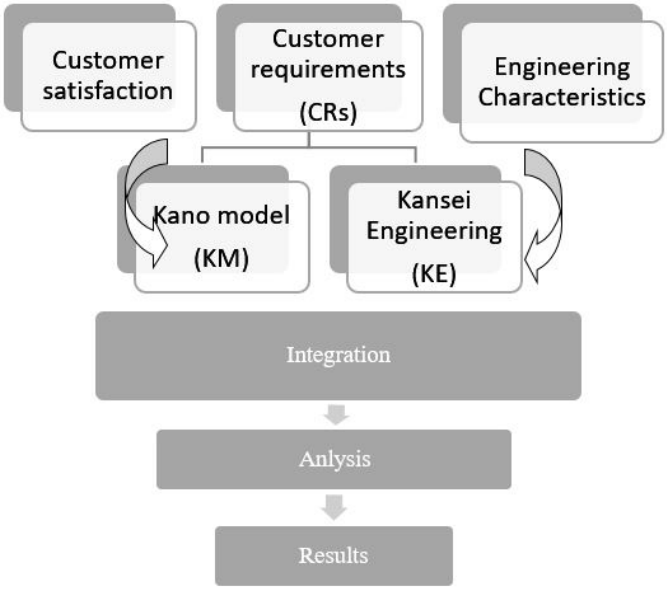

Figure 1. The integration approach between KE & KM

2. Methodology

The integration approach between KE and KM depends on three basic phases; collection of Kansei words, relating KWs with engineering characteristics, and implementing Kano model.

2.1. Collection of Kansei words:

Table 1 shows the 78 words that have been collected and gathered to form a new database for light bulb changer.

Table 1. Kansei words

Modern	Self-sacrificed	Classic	futuristic	Vulnerable	charming
Strong	Comfortable	Professional	Lively	Neutral	cheap
Expensive	Firm	Cool	Unique	Long	Organic
Domestic	Convenient	impressive	Lovely	Rustic	moderate
Real	Attractive	Surreal	alignment	Sensibility	flexibility
Friendly	Simple	sophisticated	adorable	low profile	public
Cute	Stylish	Luxury	monotonous	Bold	soft
Beautifully	Creative	masculine	light weight	Romantic	bright

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Table 1 continued

Healthy	Chic	refreshing	Boring	Neat	calm
Relaxing	Plain	Hard	Mellow	eye catching	artificial
Complex	Warm	Loose	Sleek	Stationary	transparency
Rough	Smooth	Durable	Thick	Vitality	safety
Tough	Brilliant	Pure	practical	Pleasant	Tasty

It was necessary to collect some of the words (Kansei words) that might reflect the needs of the customer and that relate to the product which will help us in thinking about the proposals for a new product suitable to the needs of the customer. Depending on the considered domain, the Kansei words generally vary from 50 to 600 (Nagamachi et al., 2008).

In order to get a complete selection of words all available sources have to be used, even if the words emerging seem to be similar or the same (Schutte, 2002).

2.2. Semantic Differential (SD) scale

Semantic differential is a type of a rating scale designed to measure the connotative meaning of objects, events, and concepts. The connotations are used to derive the attitude towards the given object, event or concept or is a standard visual analogue scale (vas) and a 7-grade-likert scale.In order to ensure that the word was properly understood, the extremes on the opposite sides of the scales were symbolized by (very much) and (not at all).

We weight every word to determine its importance, then select the most important words to be used in kano questionnaire. Thirty five participants were interviewed and asked to answer the SD scale questionnaire. Table 2 shows an example of the response of participant no 1.

Table 2. An example of the response of participant 1

	customer no: 1	light bulb changer							
	Kansei word	Not at all	1	2	3	4	5	6	7
1	modern							x	
2	strong					x			
3	expensive			x					
4	omestic						x		
5	real							x	
6	friendly		x						
7	cute						x		
8	beautifully							x	

2.3. Importance weighting

In our study, we use (SD) scale to measure the importance of each word and choose the most important words which have high grades, also we calculate the weight of each word to determine the importance of the word.

The weight = (the total grades of word) / (7*no of participant).

Table 3 represents the grade of kansei words and importance weighting.

After selecting the words that have the highest degrees and the highest weights. We collect all selected words in a table (meaning table; table 4). Table 4 shows that the six words that have the highest grade are comfortable, convenient, attractive, simple, light weight, and durable.

2.4. Relating KE with engineering characteristics (ECs)

The chosen elements (characteristics) related to the most appropriate word of kansei words by brainstorming. These words & elements are combined together in a questionnaire (Kano Questionnaire). Sauerwein et al. focused that each question must be involved some requirements of the product related to kansei words which must be suitable with this requirement (Sauerwein et al., 1996).

In this study, the questionnaire includes three sections, two sections (functional and dysfunctional) to check the LBC design (grip shape, grip material, telescopic pole) and one section to choose the LBC mechanism among (air suction, mechanical, and electrical). The number of questions are thirty four divided to seventeen functional questions and seventeen dysfunctional questions.

Table 5 shows an example of functional questions in the Kano questionnaire.

The questionnaires are distributed to 40 participants. By combining the answers of functional and dysfunctional requirements in the kano evaluation table 6, the product features can be classified into A (attractive), O (one-dimensional), M (must be), I (indifferent), R (reverse). Then, this data is analyzed by a mathematical approach.

The mathematical model is to measure the customer satisfaction or dissatisfaction:

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)

Table 3. Grade and weighting of Kansei words

KWs	GRADE	weight	KWs	GRADE	weight
Modern	144	0.587755102	bright	106	0.432653061
Strong	129	0.526530612	soft	139	0.567346939
Expensive	102	0.416326531	public	136	0.555102041
Domestic	68	0.27755102	flexibility	87	0.355102041
Real	103	0.420408163	moderate	97	0.395918367
Friendly	60	0.244897959	conservative	107	0.436734694
Cute	67	0.273469388	cheap	183	0.746938776
Beautifully	132	0.53877551	charming	87	0.355102041
self-sacrificed	87	0.355102041	sexy	104	0.424489796
Comfortable	190	0.775510204	chic	128	0.52244898
Firm	136	0.555102041	refreshing	114	0.465306122
Convenient	173	0.706122449	boring	83	0.33877551
Attractive	181	0.73877551	neat	78	0.318367347
Simple	189	0.771428571	calm	87	0.355102041
Stylish	151	0.616326531	relaxing	78	0.318367347
Creative	113	0.46122449	plain	65	0.265306122
Classic	132	0.53877551	hard	136	0.555102041
Professional	80	0.326530612	mellow	103	0.420408163
Cool	108	0.440816327	eye catching	127	0.518367347
Impressive	92	0.375510204	artificial	100	0.408163265
Surreal	102	0.416326531	complex	82	0.334693878
Sophisticated	119	0.485714286	warm	68	0.27755102
Luxury	99	0.404081633	loose	60	0.244897959
Masculine	74	0.302040816	sleek	97	0.395918367
Futuristic	155	0.632653061	stationary	87	0.355102041

Continued on next page

Table 3 continued

Lively	100	0.408163265	transparency	120	0.489795918
Appealing	105	0.428571429	rough	102	0.416326531
Lovely	113	0.46122449	smooth	120	0.489795918
Alignment	133	0.542857143	durable	167	0.681632653
Adorable	113	0.46122449	thick	143	0.583673469
Monotonous	95	0.387755102	vitality	134	0.546938776
light weight	177	0.72244898	safety	190	0.775510204
Vulnerable	100	0.408163265	tough	106	0.432653061
Neutral	81	0.330612245	brilliant	139	0.567346939
Unique	132	0.53877551	pure	126	0.514285714
Rustic	120	0.489795918	practical	103	0.420408163
Sensibility	121	0.493877551	crunchy	101	0.412244898
low profile	123	0.502040816	organic	88	0.359183673
Bold	102	0.416326531	healthy	100	0.408163265
Romantic	108	0.440816327			

Table 4. The meaning table

No	Kansei words	Meaning	Positively correlated to KW	Negatively correlated to KW
Word 1	Comfortable SD words: -Miserable - comfortable	Providing physical well-being or relief	-light -good -pleasant	-miserable -boring
Word 2	Convenient SD words: -Inappropriate -Convenient	Fitting in well with person's needs.	-suitable -appropriate	-Inappropriate -unsuitable
Word 3	Attractive SD words: -Barren -attractive	Pleasing or appealing to the senses.	-Lovely -likable	-Barren -Unattractive
Word 4	Simple SD words: -complex -simple	Easily understood or done; presenting no difficulty.	-Noncomplex -uncombined	-Complex -intricate
Word 5	Light weight SD words: -heavy -light weight	Easy to carry it.	-Easy to carried.	-heavy
Word 6	Durable SD words: -Jerrybuilt -durable	Able to withstand wear, pressure, or damage; hard-wearing.	-Industrial -strength - tough	-Jerrybuilt -Nondurable

Table 5. An example of functional questions in the Kano questionnaire

Grip Shape
1- A LBC with a round grip on the handle helps me to feel comfortable as it gives physical relief while using it. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 2- A LBC with a hexagonal grip on the handle helps me to feel comfortable as it gives physical relief while using it. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 3- A LBC with a triangular grip on the handle helps me to feel comfortable as it gives physical relief while using it. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.
Grip material
4-A LBC with grip made of foam sponge seems to be convenient. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 5-A LBC with grip made of PVC seems to be convenient. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 6-A LBC with grip made of soft rubber seems to be convenient. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.
Telescopic pole
7- Using a telescopic pole made of plastic makes it feel light weight. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 8- Using a telescopic pole made of Aluminum makes it feel light weight. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 9- Using a telescopic pole made of Tin makes it feel light weight. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.
9- Using a telescopic pole made of Tin makes it feel light weight. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.

Table 6. Kano Evaluation Table

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

Customer Requirements:

A: attractive, O: one-dimensional, M: must-be, Q: questionable result, R: reverse, and I: indifferent.

3. Analysis of Kano Model Questionnaire Results

3.1. Grip shape analysis

The participants were asked to choose among (round, hexagonal, and triangular).

Table 7 illustrates the arrangement of customers' requirements and the values of satisfaction and dissatisfaction factor for grip shapes.

Table 7. Thearrangement of customers' requirements and the values of satisfaction anddissatisfaction factor for grip shape

Q #	D.C	S.C	Q	R	I	M	O	A	Q #
Grip shape	G.D	G.S							Grip shape
1&18	-0.6875	0.53125	1	7	6	9	13	4	1&18
2&19	-0.4482758	0.4827586	1	10	8	7	6	8	2&19
3&20	-0.25	0.25	0	20	14	1	4	1	3&20

Due to the result of total satisfaction factor, it's clear that (round shape) is the most satisfactory. So, the new design should consider the grip to be round.

3.2. Grip material analysis

The participants were asked to choose among (foam sponge, PVC, and soft rubber). Table 8 illustrates the arrangement of customers' requirement and the values of satisfaction and dissatisfaction factor for grip material

Table 8. Thearrangement of customers' requirements and the values of satisfaction anddissatisfaction factor for grip material

Q #	D.C	S.C	Q	R	I	M	O	A	Q #
Grip shape	G.M.D	G.M.S							Grip material
1&18	-0.6666666	0.4666666	0	10	6	10	10	4	4&21
2&19	-0.3846153	0.5	0	14	8	5	5	8	5&22
3&20	-0.5757575	0.3333333	0	7	11	11	8	3	6&23

Due to the result of total satisfaction factor, it's clear that (PVC) is the most satisfactory. So, the new design should consider the grip to be made of PVC material.

3.3. Telescopic pole material

The participants were asked to choose among (plastic, aluminum, tin). Table 9 illustrates the arrangement of customers' requirements and the values of satisfaction and dissatisfaction factor for telescopic pole material.

Table 9. The arrangement of customers' requirements and the values of satisfaction and dissatisfaction factor for telescopic pole material

Q #	D.C	S.C	Q	R	I	M	O	A	Q #
Telescopic pole material	T.M.D	T.M.S							Telescopic pole material
7&24	-0.513513514	0.648648649	0	3	4	9	10	14	7&24
8&25	-0.285714286	0	0	19	15	6	0	0	8&25
9&26	-0.333333333	0.095238095	1	18	13	6	1	1	9&26

Due to the result of total satisfaction factor, it's clear that plastic telescopic pole is the most satisfactory. So, the new design should consider the telescopic pole made of plastic.

3.4. Mechanical Analysis

The participants were asked to choose among (air suction, mechanical, and electrical). Table 10 repreents the result.

Table 10. Mechanical Mechanisms Result

Mechanism	Air suction	Electrical	Mechanical
Score	11	7	22

Due to the results, it's clear that (mechanical mechanism) is the most satisfactory. So, we will focus only on the results of mechanical mechanisms to show which one is the most satisfactory. The participants were asked to choose among (clamp&collet, spring fingers, and interference). Results are indicatd in Table 11.

Table 11. The arrangement of customers' requirements and the values of satisfaction and dissatisfaction factor for mechanical mechanisms

Mechanical Q#	M.D	M.S	Q	R	I	M	O	A	Mechanical Q#
13&30	-0.222222222	0.222222222	0	13	7	0	2	0	13&30
14&31	-0.5	0.6	0	2	4	4	6	6	14&31
15&3215&32	-0.272727273	0.272727273	0	11	7	1	2	1	15&32

3.5. The chosen elements

Due to the result of total satisfaction factor, it's clear that spring fingers mechanism is the most satisfactory. So, the new design should consider the mechanism to be spring finger (mechanical). Figures 2, 3, and 4 represents the elements and designs selected due to participants choices.

Figure 2 represents the elements have been chosen due to achieving customer satisfaction in grip ship and grip material.

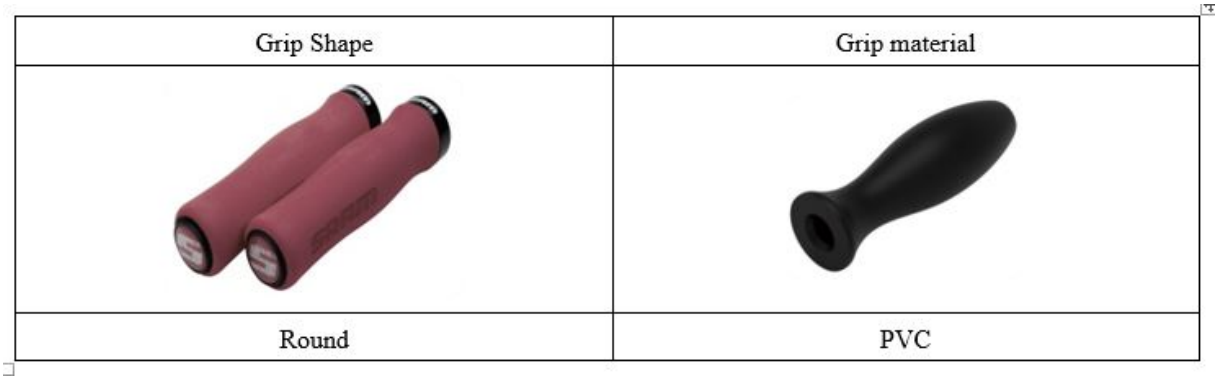

Figure 2. Grip shape and grip material

Figure 3 represents the elements have been chosen due to achieving customer satisfaction in telescopic pole material and mechanism.

Figure 4 represents the element has been chosen due to achieving customer satisfaction in mechanical mechanism.

4. Discussion and Conclusion

This study followed the known methods in collecting kansei words to establish a database. It also applied S-D Scale as a guaranteed way to determine the important kansei words to form a meaning table. But on the other hand it contributed remarkably in:

Telescopic pole	Mechanism
	
Plastic	Mechanical

Figure 3. Telescopicpole material and mechanical mechanism

Mechanical Mechanism

Spring fingers mechanical mechanism

Figure 4. Mechanical mechanism

- Applying the integration process on a new product with variable categories.
- LBC is a new product to the Egyptian market
- Contains four categories (grip shape, grip material, telescopic pole, and mechanism).
- Developing Kano questionnaire to be in harmony with the product categories and characteristics. The new construction of the questionnaire is rich with choices among mechanisms, then choices among different designs in every mechanism.
- Analyzing data using a simple but valuable method to get accurate and detailed results.
- This study was able to develop the procedure of integration between KE & KM by applying recommendations deduced by the previous studies. Most of previous studies neither either deal with many categories nor put elements and KWs in order, they concerned only in the most important element and KW.
- We made sure to mention all details in the integration process to be reliable in the future for other researchers or for industry men to follow. Most papers or studies we have faced didn't contain enough information to apply in industry.
- The significant conclusions for this study are as follows:

- The design (spring fingers mechanical mechanism with round, PVC grip and plastic telescopic pole) is the most satisfactory and it will be the best design that would achieve customers' pleasure. Also, it was found that the element (plastic telescopic pole) has the highest value of total customer satisfaction (T.C.S) = (0.135135) so it is considered the main priority in any design in the future.
- Mechanical mechanisms have the main priority at the beginning of any new design in the future.
- This study allowed us to put the elements of each category in order, so if it becomes difficult to use the most satisfactory element, we can use the one that follow it in order, hence we can maintain customer satisfied.

This study tried to focus on as many aspects and K.Ws as possible to get accurate and precise results. Also, it opens the door for other researchers to follow the same method to determine customer satisfaction in more important and complicated products with more aspects

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