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QFD and Fuzzy Kano model based approach for classification of aesthetic attributes of SUV car profile

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Abstract
The aesthetic appearance and features of a product are the most censorious elements for the accomplishment of a product in the industry. An aesthetic is the quality element which adds value to the product design. Product design is a basic need of every manufacturing company in which visual aspects play an important role to enhance the customer satisfaction. Therefore, Quality Function Deployment (QFD) can be considered as an effective tool for translating the customer's voice into the design of the product and its specifications. The Kano model helps to identify the desires of a product that brings greater satisfaction or dissatisfaction level to the customer. Kano model tells the connection between the product's attributes and its satisfaction to the customer. For achieving better results, Fuzzy Kano model has been more favorably applied over traditional Kano model. In this work, an approach of Integration of Kano model into QFD has been applied with an aim to examine the customer satisfaction based on aesthetic sentiments. A Sport Utility Vehicle has been selected for the study. The aesthetic attributes have been selected with the help of QFD and their importance and classification have been calculated using both Fuzzy Kano and Traditional Kano model. The result of Fuzzy Kano and Traditional Kano model has also been compared to calculate the effectiveness of the applied approach.

Keywords Kano model · Quality function deployment · Fuzzy Kano model · Aesthetic attributes · Product design · Customer satisfaction

Introduction

Today's customer purchases a particular product not only because of its technical specification and advancement in technology but also consider an aesthetic attributes which play an important role in purchasing a product. It is generally recognized that the attractiveness of a product plays an important role in achieving the market success of a company (Chang et al. 2007). The visual aspects of products transmit/convey feelings that may be appear/seem as cheerful, boring, friendly, expensive, rude or childish (Murdoch and Flurscheim 1983; Creusen 2005). Insertion of aesthetic aspects in product design process can create higher potential of the product in the market. The modern customer selects product not only on the basis of satisfaction level achieved by their physical specification, for example, performance, quality or price but also behave sentimentally when deciding to buy a specific product (Lai et al. 2006; Yadav et al. 2016).

Many researchers have tried to find out the properties of products which are associated with the aesthetic satisfaction. Berlyne (1971) has proposed an inverted U-shaped relation between aesthetic preference and complexity. Three kinds of customers answers have been proposed to classify the product varieties like: (1) Aesthetic Impression: it refers to the sensation that comes from the perception of pleasant appearance or gloomy appearance. (2) Semantic interpretation: it refers to what a product is look to say about its physical properties such as, function, mode-of-use and qualities, and (3) Symbolic Association: it refers to the perception of what a product says about its customer: the personal and social significance connected to the product design (Crozier 1994; Cupchik 1999; Lewalski 1988; Baxter 1995; Norman 2004; Crilly et al. 2004; Chang et al. 2007).

Hekkert et al. (2003) have expressed that products having the most desirable combination of prototypical and originality by virtue of being new and surprising are preferred aesthetically. Ullah et al. (2016) have provided the means

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of integrating CAD, TRAIZ, and customer needs under the umbrella of a customer needs assessment process. It seems essential to identify the aesthetic requirements of customers and then converts those requirements into product specifications and design which is helpful and important to make the product challenging in the market (Tontini 2003). So, there is a need of effective approaches that can help the designer to increase the satisfaction level of customers.

QFD may be defined as a customer-oriented approach that converts the customer demands into product specification and design, and reduces the cost of products as well as development cycle time. QFD was firstly developed at Mitsubishi's Kobe Shipyards in 1972. QFD has been applied to fulfill customer needs and improve the satisfaction level of customer. QFD is an effective tool for translating the customer voice into the product's specification and design for the advance growth of product (Sullivan 1986; Tan et al. 2000). QFD has been successfully applied by various researchers. Shin and Kim (2000) have developed a formal approach to reduce the size of an HOQ chart using the concept of design decomposition. The decomposition approaches developed attempt to partition an HOQ chart into several smaller sub-HOQ charts which can be solved efficiently and independently. Chen et al. (2010) have applied QFD in the semiconductor industry. Kasaei et al. (2013) have applied QFD for engineering material selection. Cardoso et al. (2014) have applied QFD for the development of an organic product. Kowalska et al. (2015) have applied QFD method to identify consumer preferences for a new characteristic of a sponge-fatty cake as well as designing of the high quality products of food industry. Lam et al. (2016) have used QFD to improve maritime supply chain resilience.

Kano and his colleagues in 1984 developed a concept to find out various Kano categories of each attribute through a customer survey. Kano model is the customer satisfaction model based on product quality feature. The Kano model of customer satisfaction classifies quality criteria into different categories namely Must-be quality, One-dimensional quality, Attractive quality, Reversible quality and Indifferent quality. These Kano categories represent the effect of product attribute on customer satisfaction and dissatisfaction level. Kano model has been successfully applied by various researchers. Ullah and Tamaki (2010) have proposed an approach to measure the information content of customer answers integrating the real and simulated customer answers. This is helpful for identifying the correct status (Must-be, Attractive, One-dimensional, Indifferent, or Reverse) of each product attribute. Mikulic and Prebezac (2011) have reviewed the most commonly used approaches for the classification of quality attributes according to the Kano model. The result shows that the Kano questionnaire and the direct-classification method are the only approaches that are capable of classifying Kano attributes in the design stage of a product.

Rashid and Ullah (2016) have describe a methodology to identify the status of a product feature in terms of must-be, should-be, or could-be categories and the collected customer opinions are computed using a logical approach. Dou et al. (2016) have proposed a combined Kano model and IGA approach for more effective product customization to conduct customer-driven product design by fully considering their individual preferences and simultaneously enhancing effective user involvement. He et al. (2017) have proposed an Importance-Frequency Kano (IF-Kano) model to determine appropriate Kano categories of CRs and target values of engineering characteristics (ECs) to achieve the best balance between enterprise satisfaction and customer satisfaction (CS). Ilbahar and Cebi (2017) have proposed a novel Fuzzy Kano approach to analyze and classify design parameters according to customer expectations in order to evaluate the usability of e-commerce websites in a more comprehensive manner.

The Kano model can be implemented to classify the product specification with the help of questionnaire. The questionnaire used in traditional Kano model seems incapable to highlight the critical thoughts of a customer. In Kano questionnaire, the customer has only one option to select and sometime customers get confused in selecting a single option among other available options and want to distribute their preferences to some other options. To overcome this issue, Fuzzy set theory based Kano model can be applied to deal with this type of issues and has been discussed.

Approaches used

Quality function deployment (QFD)

QFD is a customer-oriented tool that provides the path for translating customer voice or needs into product specification. QFD was first practiced in the 1970's as a system by a Mitsubishi engineer, Yoji Akao, at the Kobe Shipyard in Japan. QFD has been widely used for quality improvement around the world. It is the effective approach which provides methodical support to design team for the development of new product according to the customer needs. House of quality is the most commonly used matrix in QFD as in shown in Fig. 1. As per the House of Quality (HoQ), customer needs can be converted into product characteristics. Hence, precision of customer requirements input is crucial for implementing the HoQ with success (Zhang et al. 2014). Toyota have halved their designing costs and decreased the time of development by a one-third after using QFD (Hauser and Clausing 1988, Chapter 4). Djekic et al. (2016) have applied QFD for examining the shelf-life of Agaricus Bisporus Porto-

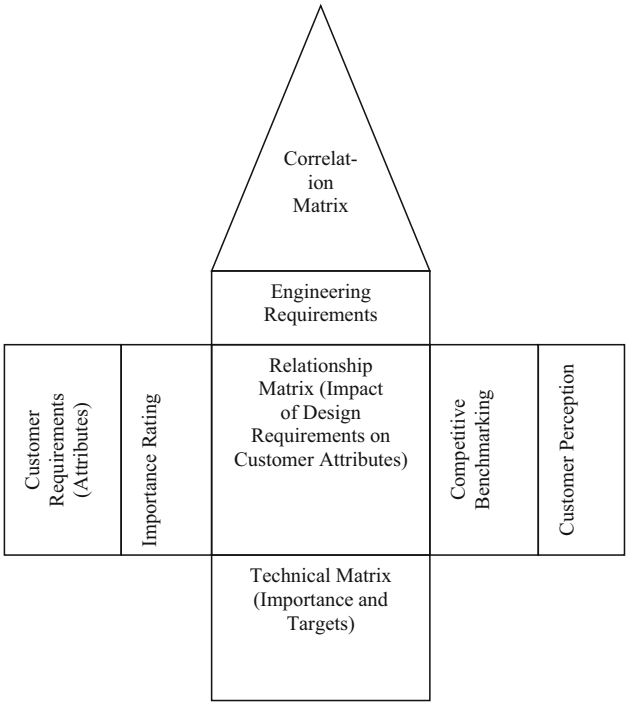

Fig. 1 House of quality matrix

bello. Zadry et al. (2015) have applied QFD for Identification of design requirements for ergonomic long spinal board.

Kano model

Kano et al. (1984) have developed an effective approach which categorizes the user requirement into different Kano categories. The Kano model divides the product features into five categories as shown in Fig. 2. In a real buying situation, the customer cannot be able to correctly state the desired product attributes. Therefore, the Kano model provides a necessary support for identifying the actual needs of the customer.

The five different quality attributes are:

1. Must-be quality: Customer is not pleased with the fulfillment of quality attribute but if the quality attribute is not fulfilled it will cause customer dissatisfaction.
2. One-dimensional quality: Customer satisfaction level is directly proportional to the level of completion. Greater the level of fulfillment greater the customer satisfaction and vice- versa.
3. Attractive quality: Presence of these requirements leads to customer satisfaction. If these requirements are not present it will not create dissatisfaction.
4. Indifferent quality: This quality attributes do not create any effect to customer satisfaction level whether these requirements are available or not.
5. Reversal requirements: When reversible quality attribute is present, it will create customer dissatisfaction and satisfaction when they are not present.

To classify different types of customer needs, a survey among the customers should be conducted. A pair of question should be asked to the customer in such a way that how they feel if the particular attribute is available in the product and how they feel if the attribute is not present in the product. For both questions, customers choose one of the following responses as shown in Fig. 3. By combining the answer of both the question, the requirement can be classified in Table 1.

Fuzzy Kano model

The Traditional Kano survey allows the customer to select only a single response from the alternatives, but it overlooks the doubt of customer feelings. Whereas, the Fuzzy Kano survey allows the customer to select multi-response with the help of different Kano categories (Lee and Huang 2009). Both the Traditional Kano model and the Fuzzy Kano model use functional and dysfunctional questions to ask customers about their feelings related to the product. But in the traditional Kano model, the customer is allowed to answer the question only in a single way as shown in Fig. 3.

On the other hand, the Fuzzy Kano model uses a different mode to permit customers with customized standard to response each query, as well as another response for the same matter has been shown in Fig. 4.

Integration of Fuzzy Kano into QFD

The important attributes of the product will be calculated by QFD and the feelings of customers about these attributes will be asked. On the basis of customers feeling the attributes will be categories with the help of Fuzzy Kano questionnaire. The Traditional Improvement Ratio can be set in the function by using the theory of Kano's Model. Final Adjusted Importance can be calculated by multiplication of Self-Stated Importance and the Adjusted Improvement Ratio. Following function has been used for Improvement ratio (IR) and shown in Eqs. (1) and (2).

$$IR_{adj} = (1+m)^k \times IR_o \tag{1}$$

where IR_0 = Traditional Improvement Ratio, IR_{adj} = Adjusted Improvement Ratio.

$$m = \max(|SI|, |DI|) \tag{2}$$

where SI = Satisfaction Index and, DI = Dissatisfaction Index.

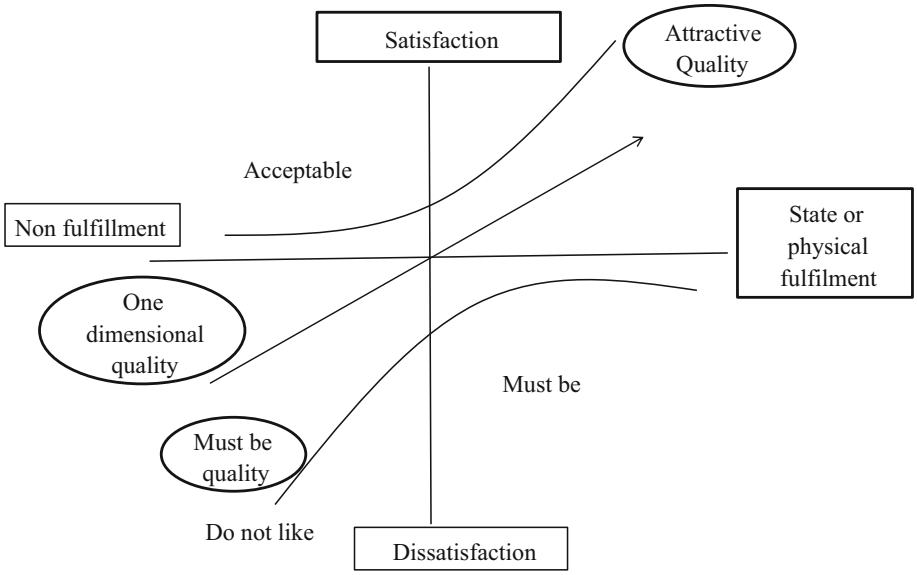

Fig. 2 Kano model of customer satisfaction

	Functional	Dysfunctional
Dislike		✓
Live- With		
Neutral		
Must-Be	✓	
Like		

Fig. 3 Traditional Kano model

Table 1 Kano Evaluation Table

Customer Require-ments	Non–Fulfilment					
Fulfilment		1.Like	2.Must-Be	3.Neutral	4.Live With	5.Dislike
	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

User Requirements are: *A* attractive, *O* one-dimensional, *M* must-be, *Q* questionable, *R* reversal, *I* indifferent

	Functional	Dysfunctional
Dislike	%	40%
Live- With	%	60%
Neutral	40%	
Must-Be	40%	
Like	20%	

Fig. 4 Fuzzy Kano model

Distinct Kano class decides the value of 'k', which can get by DI–SI plot (Tontini 2003). The value of 'k' may be 0, 0.5, 1 and 1.5 for Indifferent, Must-be, One Dimensional and Attractive quality correspondingly. An Adjustment Factor, which adjusts the Original Improvement Ratio and multiplication of Adjusted Improvement, can be achieved by the combined value of 'm' and respective Kano class. In this function, the highest importance will be given to attractive character and lowest importance to indifferent character i.e. 'k' is set as a 1.5 for Attractive quality and 0 for Indifferent quality. Indifferent quality can be innovative in nature and initially when they were present, the customer is Indifferent to them. Tan and Shen (2000) have discussed that the products those are of Attractive Quality are required to the

customer and it also exceeds the expectations and customer satisfaction. Kano (2001) has explicated that in a life cycle, Indifferent quality can be turned into the Attractive quality that's why they cannot be ignored at all. More weightage will be given to Attractive quality because of advance ideas of current customer demands. As Must-be quality alone could not make a product competitively. Earlier, Pawitra and Tan (2003) have subsidized the above discussed matter but they adjusted the Final Importance by using directly multiplier. The presented technique can be used to find the importance of several attributes with higher success rate. The major advantage of Fuzzy Kano model over the traditional method is the representation of unclear information with the help of different ways to express the feelings.

Integration of Kano model into QFD

Kano model helps to find out which requirement bring satisfaction to the customer when it is present in the product specification and which requirement bring dissatisfaction to the customer when it is not present in a product specification. Thus, to achieve higher customer satisfaction, the Kano model can be integrated into QFD. Hashim et al. (2012) have applied Kano model and QFD approach to make better design of school, workshops and workstation for teenagers with respect to ergonomic and customer requirement. Chaudha et al. 2011 have tried to integrate the Kano model into QFD for development of good website design. Tontini (2007) has integrated the Kano model into QFD for new product development. This study examines the feasibility of integrated approach for attaining the greater customer satisfaction level with aesthetic feeling.

Customer satisfaction coefficient

Customer satisfaction coefficient for traditional method

Berger et al. (1993) have presented a Customer Satisfaction (CS) coefficient to present the ideas or feeling of dissatisfaction or satisfaction that arrives from the non-completion or completion of a customer need. The following formulas have been used to calculate the CS coefficient (Berger et al. 1993; Matzler 1998).

$$SI = (A + 0)/(A + O + M + I) \tag{3}$$

$$DI = (-)(M + 0)/(A + O + M + I) \tag{4}$$

The value of SI (Eq. 3) & DI (Eq. 4) indexes can be varying from 0 to 1. In the formula of DI, negative (−ve) symbol signifies the customer dissatisfaction and increases in the direction of 0 to 1. The positive (+ve) CS coefficient limit from 0 to 1, and the satisfaction level of customer increases as the value come closer to 1. There is a slight effect on the customer satisfaction level when the value of +ve CS coefficient comes closer to 0. Simultaneously, it is important to take the −ve CS coefficient into concern. If CS coefficient comes closer to − 1 then the non-fulfillment of product specification will increase the dissatisfaction level of customer. The CS coefficient reaches to 0, indicate that if the feature does not meet will not cause dissatisfaction (Sauerwein et al. 1996).

Proposed customer satisfaction coefficient for Fuzzy Kano method

The proposed method stated that, for finding the Customer Satisfaction Coefficient the Reversal quality has been added to the denominator because Reversal is also a quality attribute that affects the customer demands in a various manner. The negative symbol denotes the dissatisfaction of the customer. The proposed method is helpful for Fuzzy Kano model for computing the relative weights of the aesthetic attribute of SUV profile and the similar method with Fuzzy values has also been applied in traditional Kano model for computing the relative weight of several aesthetic attributes of SUV profile.

The proposed method stated that the Customer Satisfaction Coefficient can be computed by Eqs. 5 and 6:

$$SI = (A + O)/(A + O + I + M + R) \tag{5}$$

$$DI = (M + O)/(A + O + I + M + R)(-1) \tag{6}$$

The value of 'k' can be found through various Kano categories those are founded by DI–SI plots. In this proposed method, the value of 'k' can be considered as − 1, 0, 0.5, 1 and 1.5 for Reversal, Indifferent, Must-be, One-Dimensional and Attractive quality correspondingly.

Here, the value of 'k' is considered as − 1 for Reversal quality because Reversal quality is vice versa of One-dimensional quality i.e., In Reversal quality, higher the fulfillment of product specification, higher the customer dissatisfied whereas, In One-dimensional quality, higher the fulfillment of product specification represents higher the customer satisfaction as shown in Fig. 5.

Aesthetic attributes of SUV profile

A concise explanation of the meaning of "Aesthetic" in a dictionary introduce "relating to the beautiful as distinguished from the merely pleasing" and "relating to sensuous cognition" (Webster's New International Dictionary, 2002). The

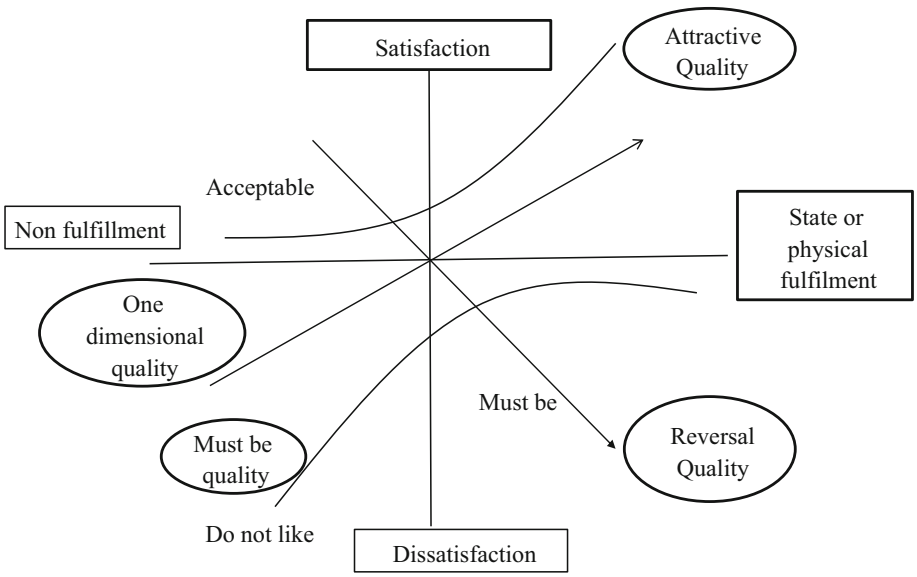

Fig. 5 Kano model of customer satisfaction with Reversal Quality

shape of the product is the primary medium of aesthetic whereas texture, size, material and other visual attributes of aesthetic are also playing an important role for the success of any product in the market. The combinations of all these aesthetic attributes of a product make belief on customer and exert strong feelings. This information makes task (importance attribute) complex or difficult to understand. To make easier the task, all the aesthetic attributes of the product have to be computed on an individual basis or one by one.

In this work, a configuration of an SUV has been selected as an aesthetic quality for the customer's happiness. SUV are known for their robustness and higher off-road abilities. SUV can perform much better on rough roads, hilly areas, snow and at high altitude. Kreuzbauer and Malter (2005) have stated that maximum consumer's decision during purchasing a vehicle depends on aesthetic rather than technical performance/specifications. Aesthetic has become an important issue that should be considered for designing any vehicle. In automotive industries, the role of technological advancement has become less important as compared to the aesthetic attributes in the success of any vehicle in the market (Warell et al. 2006). Ranscombe et al. (2012) have tried to investigate the influence of aesthetic features and brand recognition of vehicles. For the same purpose, they applied a technique to a range of saloon cars and tried to establish the significance and potency of individual aesthetic features. Martínez et al. (2014) have proposed a method for assessing the aesthetic quality of the car by using commercials videos. Hyun et al. (2015) have developed a method of examining brand styles based on product appearance similarity for generations of design alternatives and design trend evaluations for strategic design positioning.

Many attributes are associated with the aesthetic quality for customer satisfaction. To assure the satisfaction of the customer, it is necessary to recognize the importance of aesthetic attributes. A number of aesthetic attributes for customer satisfaction were obtained from literature surveys (Liu 2003; Rashid et al. 2004; Schenknar and Jonson 2000; Pham 1999; Talia and Noam 2004; Yadav et al. 2012, 2013) and have been considered for the study. Eleven aesthetic attributes were selected through the literature survey and discussed with the industry-level product designers to enhance the aesthetic customer satisfaction. These eleven aesthetic attributes are originality, energetic, sport-feeling, modern, aggressive, feminine, youthful, challenging, enjoyable, tough appealing and admiration.

Computational problem

In this work, "The aesthetic attribute of SUV profile" has been taken to show the difference in the traditional Kano's model and the combination of Fuzzy theory and Kano model. This problem has been classified into two level or phase: the quality attribute category and the questionnaire.

1. Fuzzy Kano's questionnaire: The design of a questionnaire has been formulated on the basis of Haahti and Yavas (2004) and eleven aesthetic attributes of a SUV have been bringing out through the questionnaire. For the rating of a questionnaire, 312 customers were selected out of which 62% male and 38% female customer were chosen. To achieve the gap between traditional Kano's model and the combination of Fuzzy theory and Kano model, Fuzzy Kano's questionnaire and traditional Kano's ques-

Table 2 Comparison between TKQ and FKQ of 10 customers

Whether the SUV is energetic or not?		Traditional Kano questionnaire					Fuzzy Kano questionnaire				
		Like	Must-be	Neutral	Live-with	Dislike	Like (%)	Must-be (%)	Neutral (%)	Live-with (%)	Dislike (%)
Customer 1	Functional	✓					80		20		
	Dysfunctional				✓					40	60
Customer 2	Functional	✓					100				
	Dysfunctional		✓						10	20	70
Customer 3	Functional		✓				100				
	Dysfunctional			✓					85		15
Customer 4	Functional	✓					90			10	
	Dysfunctional				✓				10	10	80
Customer 5	Functional	✓					80	15	5		
	Dysfunctional					✓				90	10
Customer 6	Functional	✓					100				
	Dysfunctional				✓					20	80
Customer 7	Functional	✓					100				
	Dysfunctional			✓					10	30	60
Customer 8	Functional	✓					90		5		
	Dysfunctional		✓						85	15	
Customer 9	Functional				✓		75		10	15	
	Dysfunctional			✓						10	90
Customer 10	Functional	✓					85		5	10	
	Dysfunctional				✓				15	10	75

tionnaires were prepared for the customer to express their feelings on the aesthetic attribute of SUV profile. The comparison of the individual customer feeling for both functional and dysfunctional questions were compared such as: "If the SUV is energetic how you feel?" that is a functional form of question and "If the SUV is not energetic how you feel?" that is a dysfunctional form of question shown in Table 2.

The comparison between Traditional Kano and Fuzzy Kano has been shown in Table 2, and it has been found out that in Fuzzy Kano's questionnaire, the customer appeared for multi-feeling whereas, in Traditional Kano's questionnaire, the customer has to select only one answer and the other will be ignored. Fuzzy Kano's questionnaire is capable for customer to deliver their ideas, feelings and emotions more efficiently. Even small feeling or ideas of the customer can easily get to know through a Fuzzy Kano's questionnaire.

2. Fuzzy Kano's judgment: According to the rating given by the customers for "energetic" attribute, execution of the Fuzzy Kano's model has been applied for judging the attribute. The actual sample of 312 copies means Fuzzy sample fs = {1,2,3,…,312}. If the question is asked to 'customer 1' that "whether the SUV is energetic or not" then the 'customer 1' belongs to which type of quality attribute, its Fuzzy idea result will be shown with the combination of a functional question (positive) and dysfunctional question (negative) as shown in Table 3. Formulation of quality is required: (0) indicate "Yes" and (1) indicate "No".

$$P = \{1, 0, 0, 0, 0\}$$

$$N = \{0, 0, 1, 1, 1\}$$

It shows that in Traditional Kano model, the customer chose only single alternative out of five alternative whereas, in Fuzzy Kano, the customer chose several alternatives (with percentage) through Fuzzy Kano questionnaire and can be used to convey customer feeling for "energetic" attribute as given below:

$$mP = \{1, 0, 0, 0, 0\}$$
$$mN = \{0, 0, 0.1, 0.2, 0.7\}$$

Use matrix multiplication, mp' $\otimes$ mN will obtain a 5*5 Kano's two-dimensional Fuzzy relation combination 'S' as:

$$S = \begin{bmatrix} 0 & 0 & 0.1 & 0.2 & 0.7 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Table 3 Total level of quality attribute of 10 interviewees

	M	O	A	I	R	Q
1.	0.12	0.48	0.32	0.08	0	0
2.	0	0.7	0.3	0	0	0
3.	0	0.15	0.85	0	0	0
4.	0.08	0.72	0.18	0.02	0	0
5.	0.02	0.08	0.72	0.18	0	0
6.	0	0.8	0.2	0	0	0
7.	0	0.6	0.4	0	0	0
8.	0	0	0.9	0.1	0	0
9.	0.225	0.675	0.075	0.025	0	0
10.	0.112	0.637	0.212	0.037	0	0

Table 4 Classification of 10 customers common consensus $\alpha \geq 0.4$

	M	O	A	I	R	Q
1.	0	1	0	0	0	0
2.	0	1	0	0	0	0
3.	0	0	1	0	0	0
4.	0	1	0	0	0	0
5.	0	0	1	0	0	0
6.	0	1	0	0	0	0
7.	0	1	1	0	0	0
8.	0	0	1	0	0	0
9.	0	1	0	0	0	0
10.	0	1	0	0	0	0
Frequency	0	7	4	0	0	0

After finding the matrix 'S', the classification of two dimensional aesthetic attributes has been obtained by previous literature, knowledge and skill as shown in Table 1.

Considering to "Whether the SUV profile is energetic?", 'customer 1' has 0.3 (30%) feeling of this subject related to Attractive aesthetic quality attribute while 0.7 (70%) feeling of this issue belonging to One-dimensional aesthetic quality attribute.

$$T = \{0/M\,0.7/O\,0.3/A\,0/I\,0/R\}$$

Following the above steps, views of 312 customers on each aesthetic quality attribute of SUV profile has been obtained. To achieve higher customer satisfaction and identification, the α-cut common consensus standard concept has been used to get Threshold value {Th} α ($\alpha \geq 0.4$). If total aesthetic quality attribute level is higher than α, it will be considered as '1', and if the aesthetic quality attribute level is less than α, then it will be considered as '0' (Table 4).

The Fuzzy Kano model is useful to find the largest identification frequency of quality attribute agreed by the majority. In Fuzzy Kano model, when $\alpha \geq 0.4$, then the highest

Table 5 Comparison of traditional and fuzzy numeric classification

Category	Traditional Kano	Fuzzy Kano ($\alpha \geq 0.5$)	Fuzzy Kano ($\alpha \geq 0.4$)
A	94	138	152
O	116	116	128
M	63	85	96
R	15	12	14
I	24	42	55
Q	0	0	0

Table 6 SI, DI (Fuzzy model), and aesthetic attributes category

Attributes	SI	DI	Fuzzy Kano category($\alpha \geq 0.5$)	Fuzzy Kano category($\alpha \geq 0.4$)	Traditional Kano category
Originality	0.41	0.76	M	M	M
Energetic	0.54	0.50	O	O	A
Sport-feeling	0.63	0.81	M	M	O
Modern	0.67	0.57	O	A	O
Aggressive	0.54	0.65	M	M	M
Youthful	0.69	0.51	A	A	A
Challenging	0.71	0.50	O	O	A
Enjoyable	0.43	0.87	M	M	M
Feminine	0.17	0.07	R	R	R
Tough appealing	0.65	0.69	M	M	O
Admiration	0.31	0.87	M	M	M

response for the quality attribute of 10 customers for a particular quality attribute, "energetic" is "One-dimensional". In other words, seven customers identify or accept the result of "One-dimensional" whereas, in traditional Kano model, the response for the quality attribute of 10 customers is "Attractive". Comparison of traditional Kano's questionnaire, numeric statistics, and Fuzzy Kano's mode for 10 customers has been shown in Table 5 as an example.

Two values of quality attribute 'α' have been selected for the study and these are 0.5 and 0.4. If we are using the value of α as 0.5, the percentage of accepting a particular attribute will be increase and the percentage of selecting other alternatives will be decreased. In this case, the customer will be able to select only one attributes, but in the case of $\alpha = 0.4$, the possibilities of selecting more than one alternative will be increased because the customer can give 40% weightage to two different attributes. Therefore, under $\alpha \geq 0.4$ standard, the result will be accepted by the majority. The aesthetic attribute of SUV profile has been compared in traditional Kano's questionnaire and Fuzzy Kano's questionnaire with SI, DI of Fuzzy mode have been shown in Table 6.

In this work, aesthetic attributes of SUV profile have been categorized into several traditional Kano classes and Fuzzy Kano that makes customer satisfaction or dissatisfaction due to the fulfillment or non-fulfillment of each aesthetic attribute of SUV profile.

Different Kano categories have been found by traditional Kano model for several attribute of SUV profile as shown in Table 7 and Fig. 6.

By applying the Fuzzy Kano model, it has been found that there is a change in the category of few attributes and these few attributes are energetic, sport feeling, challenging and tough appealing as show in Table 8 and Fig. 7.

In this study, the highest self-stated importance has been given to must-be attribute by the customers. The adjusted improvement ratio has been calculated by function discussed by Chaudha et al. (2011) and proposed approach has been used to calculate the SI and DI by adding the reversal attribute to the denominator because Reversal is also a quality attribute which affects the customer demand in the different manner as shown in Table 9. Distinct Kano class decides the value of 'k', which can get by DI–SI plot (Tontini 2003). The value of 'k' may be -1 for reversal attribute because reversal attribute is vice versa of one-dimensional attribute. Here it can be clearly found that Must-be characteristics have less Relative Importance if the Self Stated Importance is higher.

Table 7 The traditional Kano classification of aesthetic attribute

Attributes	A	O	M	R	I	Total	Category
Originality	72	56	184	0	0	312	M
Energetic	90	80	77	0	64	312	A
Sport-feeling	54	143	110	0	5	312	O
Modern	94	116	63	15	24	312	O
Aggressive	101	70	134	0	7	312	M
Youthful	134	83	79	0	16	312	A
Challenging	120	102	56	2	32	312	A
Enjoyable	36	101	172	0	3	312	M
Feminine	42	13	11	218	28	312	R
Tough appealing	93	111	106	0	2	312	O
Admiration	36	61	213	0	2	312	M

A attractive, *O* one-dimensional, *M* must-be, *I* indifferent, *R* reversal

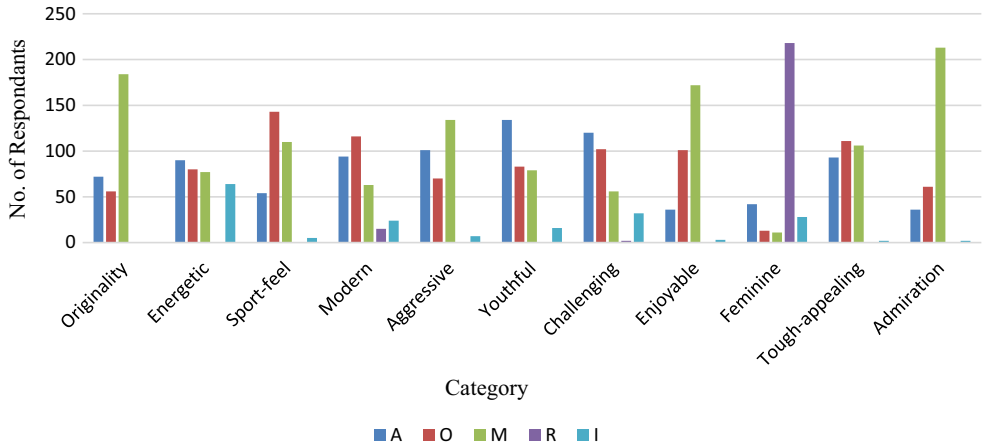

Fig. 6 Traditional Kano classification of aesthetic attribute

Discussion

In this work, the result of the study on "Aesthetic attribute of good SUV profile" depicts that for a particular aesthetic attribute most customers do not have only individual sentiment but also have various sentiments with the difference. Therefore, the traditional Kano model questionnaire is unsatisfactory as the only a single response is choosing by the customer under complex decision environment. Traditional numeric classification is convenient in the calculation and very easy to solve, but the result of classification is unable to obtain half agreement. In Fuzzy Kano model, the response of customer is agreed and accepted by majority by using α-cut standard. Different quality attribute classification can be obtained by adjustment of the α-cut standard. Based on Berger et al. (1993) CS Coefficient, a Reversal characteristic has been introduced to calculate the SI & DI because Reversal is also a quality characteristic which affects the customer requirements in a different manner. These new SI & DI can describe those requirements that really bring differentiation to the aesthetic attribute of SUV profile. It can also identify those requirements that are unfavorable to the customers, and therefore can bring dissatisfaction to customer expectation with the fulfillment of that particular Reversal characteristic.

The paper also describes a function of Adjusted Improvement Ratio in which the value of 'k' can be taken as − 1 for Reversal characteristics as Reversal characteristics are the vice versa of One-dimensional characteristics. This proposed approach has been proved very useful to identify the user demands in a more desirable way and can help to enhance the level of customer satisfaction in a modified way.

Sensitivity analysis has been performed by varying the number of respondents. In the presented study, sensitivity analysis has been performed at five levels i.e. (0%, 10%, − 10%, + 20%, − 20%). In the first level, the number of respondents has not been changed. In the second and third levels, 10% increment and decrement have been done in the attribute have a maximum number of respondents and the

Table 8 The fuzzy Kano classification of aesthetic attribute ($\alpha \geq 0.4$)

Attributes	A	O	M	R	I	Total	Category
Originality	78	42	192	0	0	312	M
Energetic	97	102	82	0	31	312	O
Sport-feeling	80	64	165	0	3	312	M
Modern	122	73	92	11	14	312	A
Aggressive	69	91	143	0	9	312	M
Youthful	116	97	83	4	12	312	A
Challenging	74	121	88	3	26	312	O
Enjoyable	72	78	161	0	1	312	M
Feminine	36	18	32	209	17	312	R
Tough appealing	77	110	117	0	8	312	M
Admiration	56	48	205	0	3	312	M

A attractive, *O* one-dimensional, *M* must-be, *I* indifferent, *R* reversal

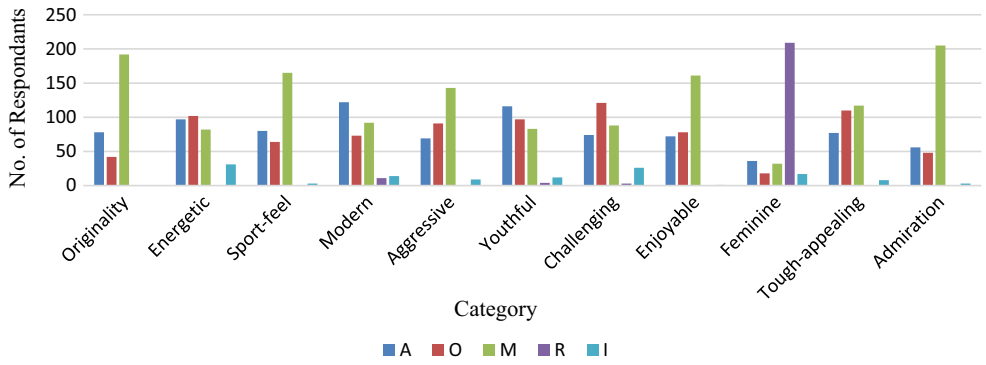

Fig. 7 Fuzzy Kano classification of aesthetic attribute

same number of respondents have been added to the other attributes according to their percentage contribution in total summation of the respondent. Similarly, at the fourth and fifth level, 20 increments and decrement has been done in the attribute have a maximum number of respondents and the same number of respondent have been added to the other attributes according to their percentage contribution in total summation of the respondent.

For performing Sensitivity Analysis, two attributes have been taken (Originality and Energetic) and Sensitivity Analysis has been performed at five levels i.e., (0%, 10%, − 10%, + 20%, − 20) and has been shown in Tables 10, 11. The category of originality attribute does not changed in any of the five levels because the category of the attribute is more dominating. The category of energetic attribute gets changed at 2 levels i.e., (− 10% & − 20%) because two categories are very close to each other, this means that there is a requirement of further information. In that case below approach can be used to identify the category of attribute (Berger et al. 1993).

If (one dimension + attractive + must be) > (indifferent + reversible + questionable).
Then maximum category is (one dimensional, attractive, must be)
Else maximum category is (indifferent, reversible, and questionable).

The presented work deals with a technique that converts the customer voice into product designs. This approach will be helpful for the product designer, industrial designer and researchers for designing a product according to customer's needs or requirements. With the help of this approach, the product designers can easily categories the customer requirements and integrate those requirements into a final product design that helps to achieve the higher customer satisfaction and attraction.

Table 9 Final importance of requirements with integrated approach

Attributes	SSI	Grade (Fuzzy)	m	Our car profile	C-1	C-2	Target	IR	AIR	AI	RI
Originality	4.56	M	0.76	2	2	3	3	1.50	1.98	9.03	0.63
Energetic	3.72	A	0.54	3	4	2	5	1.66	3.17	11.79	0.91
Sport-feeling	4.11	O	0.81	4	3	3	4	1.00	1.81	7.44	0.48
Modern	4.25	O	0.67	4	3	4	4	1.00	1.67	7.10	0.44
Aggressive	4.72	M	0.65	3	2	3	4	1.33	1.70	8.02	0.53
Youthful	4.53	A	0.69	2	3	2	4	2.00	2.60	11.78	0.91
Challenging	3.78	A	0.71	2	3	4	3	1.50	3.35	12.66	1
Enjoyable	4.69	M	0.87	3	4	3	4	1.33	1.81	8.49	0.58
Feminine	2.03	R	0.17	2	2	3	3	1.50	1.28	2.60	0
Tough appealing	4.37	O	0.69	4	5	4	5	1.25	2.11	9.22	0.65
Admiration	4.33	M	0.87	2	3	3	4	2.00	2.73	11.82	0.91

SSI self-stated importance, *C-1* competitor 1, *C-2* competitor 2, *IR* improvement ratio, *AIR* adjusted importance ratio, *AI* adjusted importance, *RI* relative importance

Table 10 Sensitivity Analysis

	A	O	M	R	I	Total	Category
Originality (0%)	78	42	192	0	0	312	M
Originality (+10%)	66	35	211	0	0	312	M
Originality (−10%)	90	49	173	0	0	312	M
Originality (+20%)	53	29	230	0	0	312	M
Originality (−20%)	103	55	154	0	0	312	M
Energetic (0%)	97	102	82	0	31	312	O
Energetic (+10%)	92	112	78	0	30	312	O
Energetic (−10%)	102	92	86	0	32	312	A
Energetic (+20%)	88	122	74	0	28	312	O
Energetic (−20%)	106	82	90	0	34	312	A

Table 11 Sensitivity Analysis, Change in category

Attributes	0%	+10%	−10%	+20%	−20%
Originality	M	M	M	M	M
Energetic	O	O	A	O	A

Concluding remarks and scope of future work

1. A reversal attribute is introduced for the calculation of SI and DI because reversal attribute is also a quality attribute which affects the customer requirement.
2. The presented work defines a function of Adjusted Improvement Ratio in which the value of 'k' can be taken as − 1 for Reversal characteristics.
3. Limitations: The major limitation of this research is that it may be difficult to apply this approach to a totally new product which is not already introduced in the market. In such conditions, customers will be unaware of different aspects of the product and survey results will be irrelevant. The results of the study are specific to the particular geographic area and the particular segment of the population.
4. Recommendation for further authors: For further researchers, a Kano model can be integrated with Fuzzy AHP and TOPSIS method, so that we can able to find out which criterion is most important and which is least.

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