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VIRTUAL STUDY FOR THE INDIFFERENT ATTRIBUTE OF KANO MODEL

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Abstract- *Kano model is famous for its two dimensional voice capturing capacity. This model is useful for customer needs analysis for product development. Must-be, One-dimensional, Attractive and Indifferent are respectively shown their priority of Kano model in product. Must-be is needed for market entry and one-dimensional for increase the satisfaction. Attractive attribute increase the satisfaction of the consumers, when it is appended, the indifferent attribute does not affect consumer and customer satisfaction in any way. If indifferent attribute keep nil in product, it is better for business, but real life situation threshold number of attribute is present in the product of the business. Indifferent attributes should properly control, otherwise, production cost will be increased. As an example in bicycle, handle shape can be curve or straight or any shape. Handle shape may be indifferent for user. Straight shape handle of bicycle has been studied in this paper for indifferent attributes for determination virtual customer. For this purpose, a survey is done according to Kano model for real life opinion. Fuzzy system is well-designed to determine probability from these opinions. This probability acts as an input of Monte Carlo simulation. This simulation gives a virtual respondent for the indifferent attribute. The validation and efficiency of method is certainly significant for product development team for selection survey sampling than statistical method.*

Keywords: Virtual Study, Indifferent Attribute, Kano Model, Fuzzy System, Probability.

1. INTRODUCTION

Product development cycle that consists of Strategic Goal, Customer Needs Assessment, Product Conceptualization, Product Realization, and Satisfaction. All technical issues of Product Conceptualization and Product Realization are handled after assessing the customer needs for satisfied the consumer [1-3]. Therefore, the success of a product development process (i.e., desired customer satisfaction) is sensitive to the customer needs assessment process. Absolutely how many respondents should be asked to correctly assess for indifferent attribute. If the answer of this question not known beforehand, the product development team might make a decision jeopardizing the subsequent processes of product development. For this purpose, exclusively number of respondents of well known indifferent attribute of bicycle is established from this study. Specified attribute, (i.e. well known indifferent attribute) is used for making standard for determination respondents/ survey sampling, then this standard number or benchmark can be applied for determination others indifferent attribute (unknown) or other attribute [10] [12] by product development team. The purpose of the paper appears to be the use of a Kano model-based customer needs simulation to assure that a contemplated product will serve a useful purpose, and result may be commercially successful. In this paper, a case study is presented for this purpose that may be implemented in the commercial purpose. In this paper also describes a rationale to develop an electronic tool to assist in eliciting customer requirement according to Kano model. For this purpose, the Kano model is study in section 2. Section 3 illustrates the simulation equations. Section 4 explains a case study about the indifferent attribute. Section 5 concludes.

2. Kano Method

The relationship between product attributes, i.e. X-axis and customer satisfaction, i.e. Y-axis defines in Kano model [4], which is shown in Fig.1.

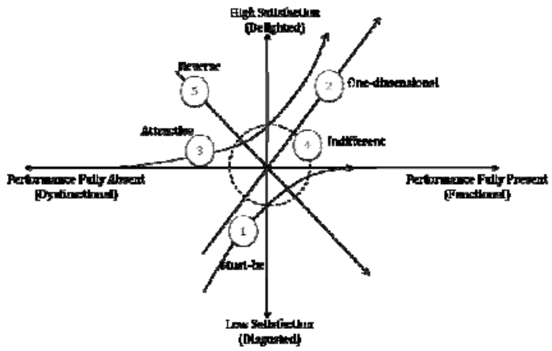

Fig. 1: Kano model

To know whether or not a given attribute is Attractive, Must-be, One-dimensional, Indifferent or Reverse, it is important to fill out a *two-dimensional questionnaire* prepared for each attribute under consideration. One is called *functional answer* (i.e., the answer when the attribute is working/present) and the other is called *dysfunctional answer* (i.e., the answer when the attribute is not working/not present). A respondent needs to answer at the same time both from functional side and the dysfunctional side. The combinations of answers are shown in Table 1.

Table 1: Kano Evaluation

Functional Answer (x_i)	Dysfunctional Answer (y_j)				
	Like	Must-be	Neutral	Live-with	Dislike
Like	Q	A	A	A	O
Must-be	R	I	I	I	M
Neutral	R	I	I	I	M
Live-with	R	I	I	I	M
Dislike	R	R	R	R	Q

A=Attractive, I=Indifferent, M=Must-be, O=One-dimensional, Q=Questionable, and R=Reverse

This method is modified with computer for determination virtual customer for specific indifferent attribute.

3. SIMULATION EQUATIONS

Simulation method is formulated in the following way by using Monte Carlo simulation principle [5-12].

Inputs:

$\boldsymbol{E} = (E_1, \ldots, En)$ //Event Vector

$\boldsymbol{Pr(E)} = (Pr\ (E_1), \ldots, Pr\ (E_n))$ //Event Probability Vector

$\boldsymbol{N}$ //Number of Trials

Calculate:

$CPr\ (E_i) = Pr\ (E_1) + \ldots + Pr\ (E_i),\ i=1,\ldots,\ n$ //Cumulative Probability of Events

For $j=1,\ldots, N$

Do $r_j \in [0, 1]$ //r_j is a random number in the interval [0, 1]

If $r_j \leq CPr\ (E_1)$ *Then* $S_j = E_1$

Otherwise

For $i=2,\ldots, n$

If $CPr\ (E_{i-1}) < r_j \leq CPr\ (E_i)$ *Then* $S_j = E_i$

A stopping rule is applied for the Monte Carlo Simulation, than the cumulative probability of the last event *Sn* is 1, *i.e.* $CPr\ (Sn) = 1$; then automatically stop the simulation. The proposed simulation process is following:

Step 1: Choices of FA and DFA of unknown customer, *FA, or DFA* $\in$ *{Like (L), Must-be (M), Neutral (N), Live-with (LW), Dislike (D)}*

Step 2: Generate a set of random inputs

Step 3. Simulation of dysfunctional answer of customer independently

Step 4. Simulation of functional answer of customer independently

Step 5. Simulation of customer evaluation by using combination of FA and DFA

According to step 2, a set of random inputs has been generated by using the formula=RAND () in a cell of Microsoft office Excel.

4. VIRTUAL RESPONDENTS DETERMINATION

A case is considered in Fig. 2 for virtual respondents determination. According to Fig.2, there is a questionnaire regarding a product (bicycle) attribute (handle is straight in shape). It is well-known answer of a respondent would be “must-be” from functional side (i.e., the bicycle handle should straight in shape) and “must-be” from dysfunctional side (i.e., the bicycle handle should straight in shape). This combination of answer (must-be, must-be) yields an “Indifferent” attribute according to Kano Evaluation Table 1. In reality, respondents exhibit a rather fuzzy behavior and sometimes answer different than the expectation. For example, see the frequency of the answers of 27 respondents shown in Fig.2. As a result, some respondents answer makes the attribute “Indifferent” some others make it “Attractive” and so on. This raises a fundamental question that is how many respondents should be requested to know for certain that the specified attribute is an Indifferent attribute or not.

This question can be answered using the method .The first step is to input the probability vectors of functional answers and dysfunctional answers determine the probability vectors of functional/ dysfunctional answers the following procedure can be used.

As it is seen from the case shown in Fig.3, from functional side, the respondents are “quite-likely” to choose “Like”, “some-likely” to choose “Must-be, Neutral and Live-with” and “less-likely” to choose “Dislike”. On the other hand, from the dysfunctional side, the respondents are “quite-likely” to choose “Live-with” “some-likely” to choose “Dislike and Neutral” and “less-likely” to choose “Like and must-be”. Although both cases must-be should be become “quite-like”, where in functional answer must be becomes some-likely, and dysfunctional side becomes “must-be” unexpected less-likely.

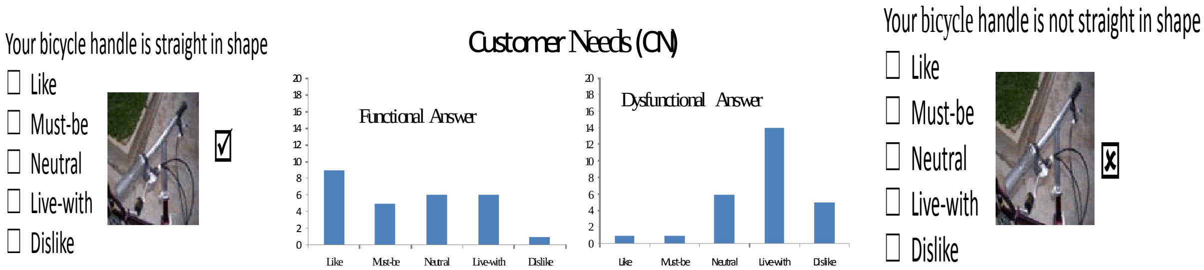

Fig.2: The questionable sampling in Survey

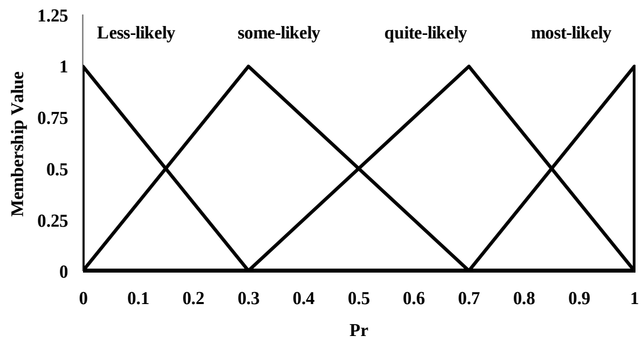

Fig. 3: Defining linguistic likelihoods by fuzzy numbers

These linguistic likelihoods ("most-likely", "some-likely", "less-likely", and so on) can be transformed into numerical probability using fuzzy logic. Ullah and Tamaki, 2011**[13]** have afforded a fuzzy logic method, which is used here. Figure 3 illustrates the fuzzy numbers defining the linguistic likelihoods "most-likely", "quite-likely", "some-likely", and "less-likely."

From the linguistic likelihoods shown in Fig.3, the average value and lower and upper limits of are determined using centroid method [**14**] and α-cuts at α=0.5, respectively. The results are shown in Table 2.

Table 2. Numerical probability of linguistic likelihoods

Linguistic likelihoods	Pr		
	Lower limit	Upper limit	Average
most-likely	0.85	1	0.9
quite-likely	0.5	0.85	2/3
some-likely	0.15	0.5	1/3
less-likely	0	0.15	0.1

Table 3 shows the probabilities of functional answers for average and worst-case scenarios. For average scenario the average probabilities of linguistic likelihoods (shown in Table 2) are used. These probabilities are normalized to calculate crisp probabilities shown in 4-th column in Table 3. For worst-case scenario, the lower limit of most-likely is used and upper limits of quite –likely, some-likely and less-likely are used. These limits are normalized to calculate the crisp probabilities for worst-case scenarios, as shown in last column in Table 3.

Table 3. Probabilities of functional answers for average and worst-case scenarios.

		Average Scenario		Worst -case Scenarios	
Functional Answer	Linguistic likelihoods	Average probability	Crisp probability	Upper/lower limits of probability	Crisp probability
Like	quite-likely	0.666	0.37733711	0.85	0.34
Must-be	some-likely	0.333	0.188668555	0.5	0.2
Neutral	some-likely	0.333	0.188668555	0.5	0.2
Live-with	some-likely	0.333	0.188668555	0.5	0.2
Dislike	less-likely	0.1	0.056657224	0.15	0.06

Similarly the probabilities of dysfunctional answers for average and worst-case scenarios are determined and listed in Table 4.

Table 4. Probabilities of dysfunctional answers for average and worst-case scenarios.

		Average Scenario		Worst -case Scenarios	
Dysfunctional Answer	Linguistic likelihoods	Average probability	Crisp probability	Upper/lower limits of probability	Crisp probability
Like	less-likely	0.1	0.065274151	0.15	0.069767442
Must-be	less-likely	0.1	0.065274151	0.15	0.069767442
Neutral	some-likely	0.333	0.217362924	0.5	0.23255814
Live-with	quite-likely	0.666	0.434725849	0.85	0.395348837
Dislike	some-likely	0.333	0.217362924	0.5	0.23255814

The results shown in Tables 3-4 provides two sets probabilities of functional/dysfunctional answers. These probabilities are illustrated in Fig. 4. Using these probabilities a study has been carried out to determine the minimum number of respondents to conclude whether or not an attribute is Indifferent. Figure 5 shows results for average scenario. As observed from Fig. 5, for 25 respondents there is overlap among the probabilities of Indifferent and Attractive. This means that using the results of 25 respondents it is not reliable to conclude that the attribute is an Indifferent attribute. For the case of 50 respondents still there is an overlap between the probabilities of Indifferent and Attractive. On the other hand, when 100 respondents are used, the overlap disappears and this trend remains more or less the same for more respondents (e.g., compares the results of 100 respondents and 200 respondents shown inFig.5).

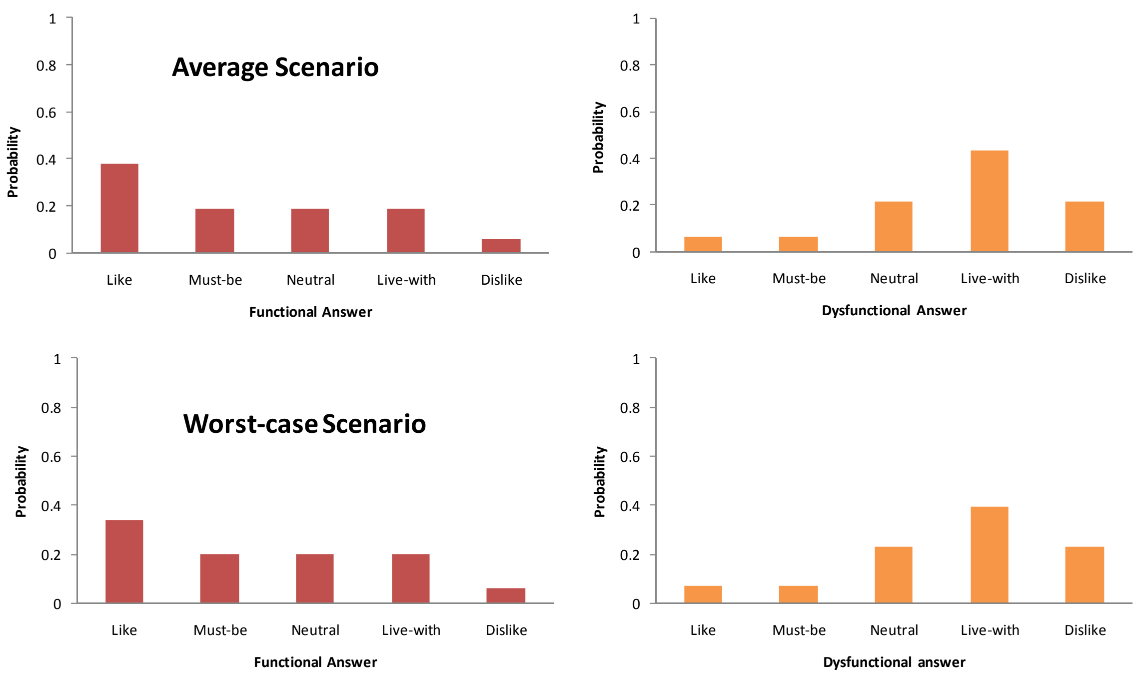

Fig.4: Probabilities of functional/dysfunctional answers for two scenarios

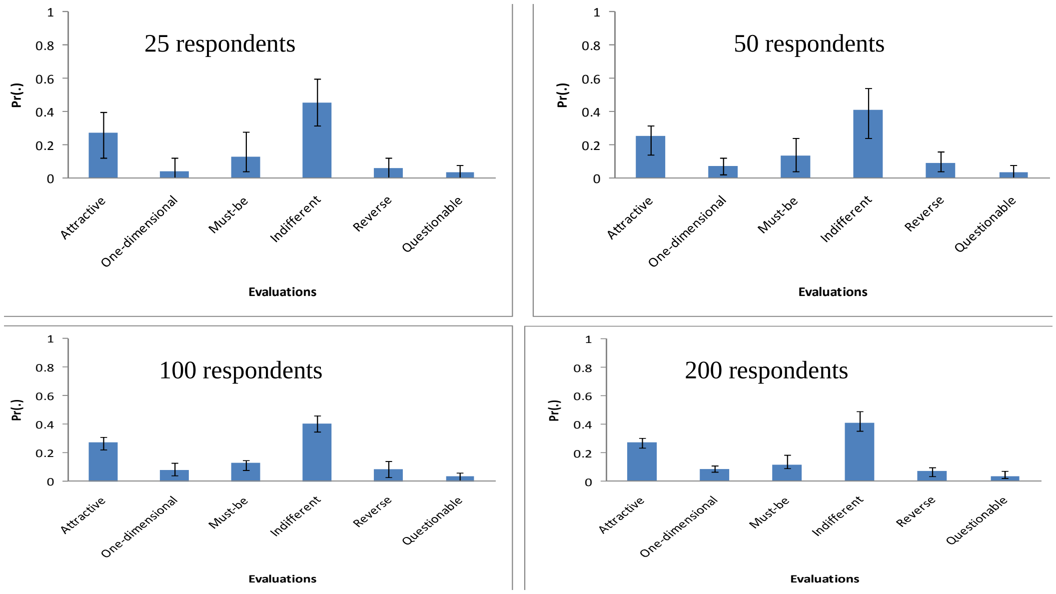

Fig. 5: Number of respondents versus Kano Evaluation for average scenario

Therefore, at least answer from 100 respondents should be collected to determine that an attribute is an Indifferent attribute. What if the other set of probabilities (probabilities for worst-case scenario) is used? Figure 6 shows the results for the case. In that case 25 respondents it is not reliable to conclude that the attribute is an Indifferent attribute. For the case of 50 respondents still there is an overlap between the probabilities of Indifferent and Attractive. On the other hand, when 100 respondents are used, the overlap appears also in the worse case. This means that there is tie between Indifferent and Attractive, there should be considered an Indifferent attribute. Otherwise Attractive probability should have been much higher than that of Indifferent.

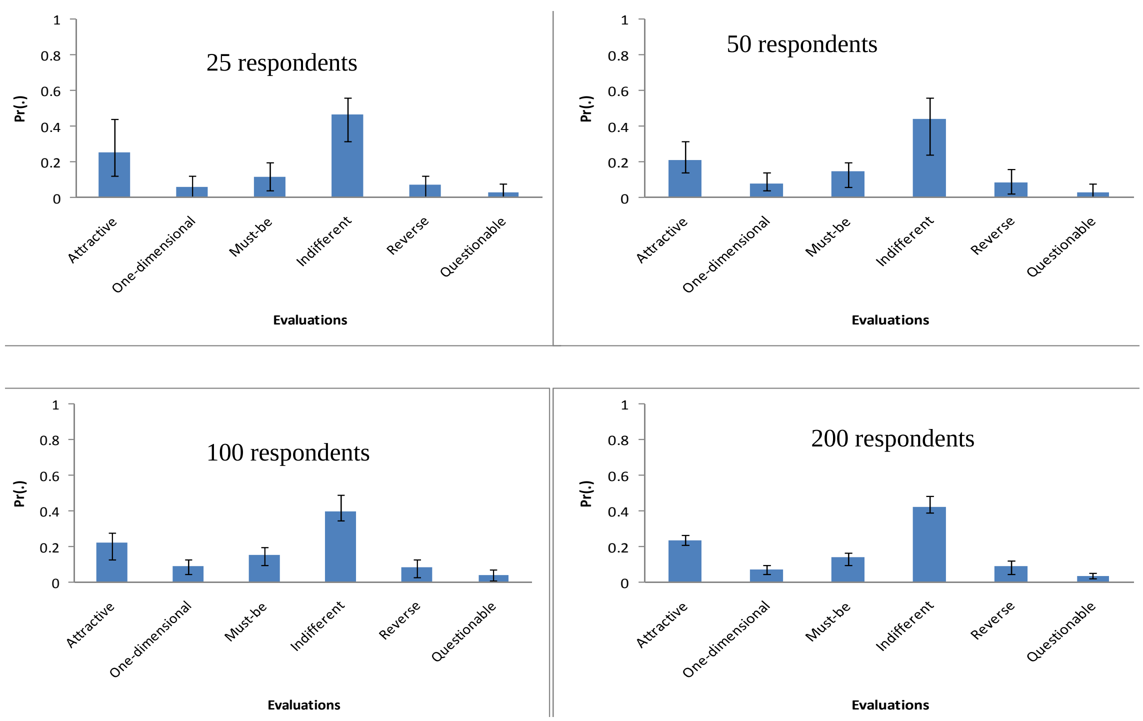

Figure 6: Number of respondents Versus Kano Evaluations for worst case scenario

According to the above results it can be completed that if the answers of at least 100 respondents should be considered an Indifferent attribute. This working standard can be used as a guideline while distinguishing an Indifferent attribute from others in all kinds of products.

5. CONCLUSION

This proposed method is definitely efficient and effective for selection survey sampling using computer for indifferent attribute selection. The presented customer needs assessment system can assist a product development team by providing an answer to the question: the minimum number of interviewees necessary to provide good estimates whether or not an attribute is Indifferent, Must-be[15], Attractive[10], One-dimensional[16], and Reverse [12] attribute in accordance with Kano Model. In particular, it is found that at least 100 respondents should be asked to determine whether or not an attribute is an Indifferent attribute. This method is configured and setting from existing Kano evaluation method, thus, there is no consideration the customer demographic factors, psychographic factors with this computation. User friendly computer system may be developed with consideration all demographic and psychographic factors for commercial success. In spite of, this computer method can better role than traditional statistical method. Besides, in practical case, gathering responses from 100 respondents could be quite difficult and may be also costly. In any case, gathering so many responses entails obvious costs. Thus, a company can be reduced costs, only uses 20 respondents instead of 100 respondents through using this method and also obtained product attributes. Through this case study examines the problem of obtaining reliable opinions from respondents, but such reliable opinions collection on the production development process is not easy job, even questionnaire making, collection opinions from customers and then process for finding product attribute are also time consuming, costly, yet, many times , it is impossible to access many potential customer.

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