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Determining the Relative Importance of Quality Dimensions Using the Kano Model and IPA

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⟨Abstract⟩

The Kano model, a two-dimensional quality theory, is widely used as a useful tool for measuring potential customer requirements by utilizing the concept of the Potential Customer Satisfaction Coefficient (PCSC). There is growing evidence that the PCSC, comprising the Potential Satisfaction Coefficient (PSC) and Potential Dissatisfaction Coefficient (PDC) and utilizing Kano's four quality dimensions (A, O, M, and I), can be particularly useful in determining the relative importance of quality characteristics in IPA. Despite prior studies utilizing the PCSC concept for characterizing importance, attempts to determine the relative significance among quality dimensions have been relatively scarce. This study aims to use PCSC and IPA to demonstrate which quality dimension is more significant than the others. The author analysed 32 Kano related articles, encompassing 34 cases, using IPA. The results indicate that the proposed equations are valid for assessing characteristic importance, with O or M is perceived as more important than A or I.

Keywords : The Kano Model, Relative Importance, IPA, Potential Customer Satisfaction Coefficient, Quality Characteristics

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1. Introduction

The Kano model distinguishes the quality dimensions into five categories: Attractive characteristic (A), Must-be characteristic (M), the traditional One-dimensional characteristic (O), Indifferent (I), and Reverse (R). As the Kano model [2][4] is well-accepted in a wide range of academia and industries [11][7][8][3][18][15], there are growing studies that the relative importance among Kano's four quality dimensions (i.e. Attractive, One-dimensional, Must-be, and Indifferent) can be determined using the concept of PCSC (Potential Customer Satisfaction Coefficient. However, it is surprising that attempts to determine the relative significance among quality dimensions have not been widely explored.

The purpose of this study is to develop a standard criterion for relative importance among quality dimensions, namely Attractive (A), One-Dimensional (O), Must-be (M), and Indifferent (I), using PCSC [2] and IPA.

2. The Potential Customer Satisfaction Coefficient (PCSC)

To explore the limitations of the classification method for quality characteristics within Kano's framework, a Kano survey was conducted in June 2020 among 126 students at a competitive college in Korea, utilizing 2 quality characteristics of online learning identified by Song (2013).

Employing mode statistics in the Kano model to classify quality characteristics [2][4] can lead to the oversight of varying intensities within similar quality dimensions. For instance, from Table 1, '1.Accuracy of the content' was identified by 57 respondents (45%) out of 126 as a 'One-dimensional' characteristic, whereas a larger proportion, 85 out of 126 respondents (67%), also perceived '2.Fair evaluation' as 'One-dimensional'. Nonetheless, according to Kano's mode rule, both characteristics were classified as 'One-dimensional'. This instance raises questions about the reliability of Kano's classification outcomes. To address this issue, Berger et al. (1993) introduced the concept of the Potential Customer Satisfaction Coefficient (PCSC), which quantifies the amount of the potential customer satisfaction when expectations are met (i.e. A and O) and potential dissatisfaction when they are not (i.e. M and O), based on Kano's quality dimensions. This coefficient consists of the Potential Satisfaction Coefficient (PSC) and the Potential Dissatisfaction Coefficient (PDC), calculated using equations (1) and (2):

$$PSC_j = \frac{(A+O)}{(A+O+M+I)} \quad (;0 \le PSC_j \le 1) \quad (1)$$

$$PDC_j = -\frac{(M+O)}{(A+O+M+I)} \quad (;-1 \le PDC_j \le 0) \quad (2)$$

where, j = jth quality characteristic (; 1, ..., m)

As shown in Table 1, the PSC and PDC values for '1.Accuracy of the content(0.78, -0.57)' and '2.Fair evaluation(0.73, -0.88)' provide insightful information. Specifically, an

Table 1. The Kano's classification results

No.	Quality Characteristics*	Kano's results	PSC	PDC	A		O		M		I		R		S		Total
1	Accuracy of the content	O	0.78	-0.57	41	(0.33)	57	(0.45)	14	(0.11)	13	(0.10)	0	(0.00)	1	(0.01)	126
2	Fair evaluation	O	0.73	-0.88	6	(0.05)	85	(0.67)	24	(0.19)	9	(0.07)	1	(0.01)	1	(0.01)	126

*The 2 quality characteristics of online learning were adopted from Song (2013)

unfair evaluation is likely to cause more dissatisfaction (PDC=-0.88) compared to the dissatisfaction caused by an inaccurate content (PDC=-0.57), even though both are classified as 'one-dimensional' characteristics.

3. Relative Importance Using the PCSC Concept

Customer-perceived importance often depends on both the delight when a characteristic is provided and the disappointment when it is absent [16]. Kano's paired positive and negative questions assist in effectively measuring these inherent satisfactions and dissatisfactions. Here, dissatisfaction caused by poor quality can be prevented by measuring PDC, and satisfaction derived from good quality can be maximized by measuring PSC. Consequently, the Relative Importance (RI) of a characteristic should be formulated as a function of both PSC (Potential Size of Satisfaction) and PDC (Potential Size of Dissatisfaction), and calculated as follows:

$$RI_j = PSC_j + |PDC_j| \quad (0 \le RI_i \le 2,\ 0 \le PSC_i \le 1,\ 0 \le PDC_i \le -1) \qquad (3)$$

where, j = jth quality characteristic (; 1, ..., m)

4. Research Method

4.1 Data Collection

To identify the more important quality dimensions, the author extracted data on Kano results as exemplified in Table 1 and the direct importance and satisfaction, encompassing 32 peer-reviewed Kano related articles listed in the ISI (Institute for Scientific Information) and a total of 621 characteristics. The data published in each article were downloaded using the subscription service of the affiliated universities, and for journals not covered by the service, the university's Full Document Delivery Service (for 7 articles) was utilized for extraction.

4.2 Data Analysis

This study analyzes the distribution of Kano's quality dimensions either within individual IPA quadrants or across combined quadrants (see Fig. 1). Firstly, the 'relatively more important area' could be defined by combining 'I. Concentrate Here' with 'II. Keep Up The Good Work,' whereas the 'relatively less important area' might be

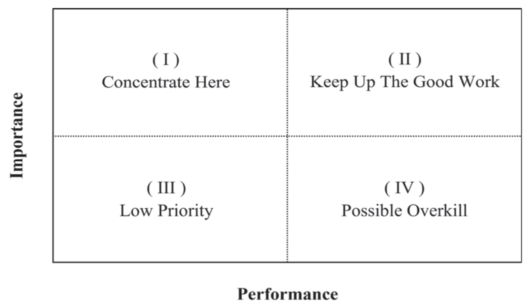

Fig. 1 Importance-Performance Analysis [9]

Ⅰ. Concentrate Here: urgent improvement is necessary, as the characteristics that customers perceive as important are currently underperforming.
Ⅱ. Keep Up The Good Work: effective performance management is needed for gaining and retaining loyal customers, as it ensures that the characteristics important to them are performed satisfactorily.
Ⅲ. Low Priority: managers show no interest in this area.
Ⅳ. Possible Overkill: efforts can be reallocated to other quadrant(s) since the performance of characteristics deemed less important is already satisfactory.

composed of 'III. Low Priority' and 'IV. Possible Overkill.' Secondly, the frequency data within each single IPA quadrant is symbolized. For example, regarding Quadrant I ('Concentrate Here'), Con_A represents the frequency of attractive characteristics, Con_O the frequency of one-dimensional characteristics, Con_M the frequency of must-be characteristics, and Con_I the frequency of indifferent characteristics.

Significant differences in the frequencies of Kano's quality dimensions as allocated across IPA quadrants are calculated using a statistical paired t-test method with SPSS version 25 for Windows. To apply the paired t-test, the basic assumption of normality was tested using the Shapiro-Wilk test. The results showed that, for most pairs (e.g., Keep_Good vs. Poss_Over: p=0.322), the p-value was greater than 0.05, indicating that the assumption of normality was satisfied. Each of the 34 cases is compared (i.e., 34 times) in pairs for the frequency of Kano quality dimensions (A, O, M, I) classified in each IPA category(see Table 2). For example, if the number of one-dimensional characteristics classified as in Quadrant II is significantly greater than those in Quadrant III at a 1% significance level, denoted as 'Kee_O 〉 Low_O with p 〈 0.01**'. Similarly, the study uses the notation 'Con & Kee_O 〉 Low & Pos_O with p 〈 0.01**' when the frequency of one-dimensional characteristics plotted in quadrants I & II (relatively more important area) is significantly greater than those in quadrants III & IV (relatively less important area).

5. Results of Relative Importance Among Quality Dimensions

As can be seen in Table 2, the Kano's categorization results of 32 selected articles (34 cases; 621 characteristics), indicate that 211 characteristics (34%) were classified as one-dimensional, representing the highest, followed by 175 must-be (28%), 157 attractive (25%), and the least 78 as indifferent (13%) at the time of the survey. In addition, one-dimensional characteristics (45% = 95/211) and must-be characteristics (41% = 71/175) were most commonly seen in Quadrant II, while attractive (37% = 58/157) and indifferent (66% = 51/77) characteristics appeared most frequently in Quadrant III. The statistical results of Kano's dimensions within IPA quadrants are summarized as follows (see Table 3):

Table 2. Results of Kano's classification in IPA

Case	Case	No. of Chars.	Sum				IPA with Kano results															
							Concentrate Here				Keep up the Good work				Low Priority				Possible Overkill			
							← The area of high importance →								← The area of low importance →							
			A	O	M	I	A	O	M	I	A	O	M	I	A	O	M	I	A	O	M	I
C1	Website design	12	5	3	4	0	0	0	1	0	1	1	1	0	4	0	0	0	0	2	2	0
C2	Home delivery service	30	3	12	14	1	1	2	5	0	0	3	3	0	1	0	2	1	1	7	4	0
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
C34	Smartphone	21	4	8	7	2	0	3	2	0	0	3	5	0	0	1	0	2	4	1	0	0
Sum		621	157	211	175	78	33	46	37	2	30	95	71	6	58	31	36	51	36	39	30	19

Table 3. P-value results of Kano's quality dimensions in each IPA quadrants

	Mean(order)	S.D.	Con_A [0.97]	Con_O [1.35]	Con_M [1.09]	Con_I [0.06]	Kee_A [0.89]	Kee_O [2.79]	Kee_M [2.09]	Kee_I [0.18]	Low_A [1.71]	Low_O [0.91]	Low_M [1.06]	Low_I [1.50]
Con_A	0.97(10)	1.058	1											
Con_O	1.35(5)	1.412		1										
Con_M	1.09(7)	1.311			1									
Con_I	0.06(16)	0.239	0.000**	0.000**	0.000**	1								
Kee_A	0.89(12)	1.250				0.001**	1							
Kee_O	2.79(1)	2.683	0.001**	0.004**	0.002**	0.000**	0.001**	1						
Kee_M	2.09(2)	2.667	0.033*		0.026*	0.000*	0.030*		1					
Kee_I	0.18(15)	0.459	0.000**	0.000**	0.001**		0.006**	0.000**	0.000**	1				
Low_A	1.71(3)	2.082	0.015*			0.000**	0.020*	0.046**		0.000**	1			
Low_O	0.91(11)	1.583				0.004**		0.001**	0.035*	0.015*		1		
Low_M	1.06(8)	1.953				0.006**		0.002**	0.030*	0.019*			1	
Low_I	1.50(4)	1.942				0.000**		0.011*		0.000**				1
Pos_A	1.06(8)	1.391				0.000**		0.002**		0.002**				
Pos_O	1.15(6)	1.941				0.002**		0.000**		0.008**				
Pos_M	0.88(12)	1.343				0.002**		0.001**	0.005**	0.010**				
Pos_I	0.56(14)	0.927		0.001**	0.037*	0.003**		0.000**	0.004**	0.026*	0.008**			0.006**

intra-single quadrant

Notes: *Difference in frequencies is significant at 0.05 level (two-tailed), ** Significant at 0.01 level (two-tailed)

1) Intra-single quadrant IPA results

'I. Concentrate Here': one-dimensional characteristic emerged as the most frequent (average 1.35 per case). This frequency is marginally higher than that of must-be characteristics (1.09) and attractive characteristics (0.97), but it is statistically significantly higher than indifferent characteristics (0.06) with $p < 0.01^{**}$. Consequently, in this IPA area, the order of frequency can be represented as 'O (1.35), M (1.09), A (0.97) > I (0.06)'.

'II. Keep Up The Good Work': 'O (2.80), M (2.09) > A (0.88) > I (0.18)' with $p < 0.01^{**}$ or $p < 0.05^{*}$ and (Kee_O ≠ Kee_M with $p = 0.329$).

'III. Low Priority': 'A (1.71) > O (0.91)' with $p = 0.04^{*}$ (one-tailed) and (Low_A ≠ Low_I with $p = 0.674$; Low_A ≠ Low_M with $p = 0.249$).

'IV. Possible Overkill': 'O (1.15) > I (0.56)' with $p = 0.03^{*}$ (one-tailed) and (Pos_O ≠ Pos_A with $p = 0.838$; Pos_O ≠ Pos_M with $p = 0.463$).

2) Inter-single quadrant IPA results

'II. Keep Up The Good Work' vs. 'I. Concentrate Here': Kee_O > Con_O with $p = 0.00^{**}$; Kee_M > Con_M with $p = 0.01^{*}$ (one-tailed).

'II. Keep Up The Good Work' vs. 'III. Low Priority': Kee_O > Low_O with $p = 0.00^{**}$; Kee_M > Low_M with $p = 0.03^{*}$ (one-tailed)'; Low_I > Kee_I with $p = 0.00^{**}$; Low_A > Kee_A with $p = 0.02^{*}$.

'II. Keep Up The Good Work' vs. 'IV. Possible Overkill': Kee_O > Pos_O with $p = 0.00^{**}$; Kee_M > Pos_M with $p = 0.01^{**}$.

'III. Low Priority' vs. 'IV. Possible Overkill': Low_I > Pos_I with $p = 0.01^{**}$; Low_A > Pos_A with $p = 0.06$ (one tailed).

'III. Low Priority' vs. 'I. Concentrate Here': Low_I > Con_I with $p = 0.00^{**}$; Low_A > Con_A with $p = 0.02^{*}$.

'IV. Possible Overkill' vs. 'I. Concentrate Here': Pos_I > Con_I with $p = 0.00^{**}$

Based on the results of both intra- and inter-analysis, it can be concluded that the one-dimensional and must-be characteristics are predominantly distributed in 'II. Keep up the good work', with a significance level of either 1% or 5%.

The Kano results for the combined IPA quadrants, distinguishing between areas of greater importance (Quadrants I and II) and lesser importance (Quadrants III and IV), facilitate direct identification of the quality dimensions deemed more significant by customers, and are summarized as follows:

1) Intra-combined Quadrants results: Quadrants I & II and Quadrants III & IV

In Quadrants I & II, designated as more important area, the frequencies of one-dimensional and must-be characteristics are statistically significantly higher compared to the frequencies of attractive and indifferent characteristics in the same quadrants (i.e., 'O, M > A > I'), as seen in Table 4. To be

Table 4. P-value results of Kano's quality dimensions in combined IPA quadrants

	Mean(order)	S.D.	Con&Kee_A	Con&Kee_O	Con&Kee_M	Con&Kee_I
Con&Kee_A	1.853(7)	1.861	1	-	-	-
Con&Kee_O	4.147(1)	3.341	0.002**	1	-	intra-combined quadrant
Con&Kee_M	3.176(2)	3.380	-	-	1	
Con&Kee_I	0.235(8)	0.554	0.000**	0.000**	0.000**	1
Low&Pos_A	2.765(3)	2.652	0.017*	0.047*	-	0.000**
Low&Pos_O	2.059(4)	2.386	-	0.000*	-	0.000**
Low&Pos_M	1.941(6)	3.015	-	0.007**	0.025*	0.004**
Low&Pos_I	2.059(4)	2.411	-	0.001**	-	0.000**

Notes: * Difference in frequencies is significant at 0.05 level (two-tailed), ** Significant at 0.01 level (two-tailed)

specific, Con & Kee_O 〉 Con & Kee_A with p = 0.00**; Con & Kee_O 〉 Con & Kee_I with p = 0.00**; Con & Kee_M 〉 Con & Kee_A with p = 0.04* and Con & Kee_M 〉 Con & Kee_I with p = 0.00** , while Con & Kee_O ≠ Con & Kee_M with p = 0.28.

In Quadrants III & IV, designated as the less important area, there are no significant differences in the frequencies among quality dimensions. However, the attractive characteristic is the most observed, ranking third globally, as indicated in Table 4.

2) Inter-combined Quadrants results: Quadrants I & II vs. Quadrants III & IV.

The frequencies of must-be and one-dimensional characteristics in Quadrants I & II are statistically significantly higher than those in Quadrants III & IV. Specifically, Con & Kee_M 〉 Low & Pos_M with p = 0.03*; Con & Kee_O 〉 Low & Pos_O with p = 0.00**. However, Con & Kee_O is not statistically significantly different from Con & Kee_M, with p = 0.28. Conversely, attractive and indifferent characteristics appear more frequently in Quadrants III & IV than in Quadrants I & II: Low & Pos_A 〉 Con & Kee_A with p = 0.02**; Low & Pos_I 〉 Con & Kee_I with p = 0.00**. Nonetheless, there is no significant difference between Low & Pos_A and Low & Pos_I, with p = 0.26.

From the results conducted using IPA framework, it is evident that must-be and one-dimensional characteristics are perceived as more important than attractive and indifferent characteristics, concisely denoted as 'O, M 〉 A, I'.

6. Conclusion

This study demonstrated that consumers perceive one-dimensional and must-be characteristics as more important than attractive and indifferent characteristics (i.e., 'O, M 〉 A, I') through IPA.

The findings of this study align with the asymmetric relationship between characteristics performance and overall satisfaction, as described in prospect theory [5], which examines the magnitude of dissatisfaction (loss) and satisfaction (gain). Additionally, these findings are consistent with the negative and positive effects of word-of-mouth [12].

The PCSC approach using Kano's results enhances the applicability of the Kano model, as it can be integrated into various frameworks such as the IPA or Importance- Satisfcation (I-S) model (Yang, 2003), the priority model for improvement by Bacon (2003), and the diagonal model [13]. It is particularly useful in QFD, as it considers both the results of characteristic importance and Kano's classification results simultaneously [6][10[17].

It is necessary to conduct a systematic verification process to determine whether the characteristic-level importance calculation results using Equation (3) of this study align with the relative importance results of the Kano quality dimensions (A, O, M, I). For this purpose, follow-up research is required to develop and validate an importance calculation formula that differentially considers the relative weights of PSD and PDC in Equation (3) proposed in this study. For example, in the case of safety products like chemical agents, PSD is expected to be relatively more important, whereas for value-added products like unexpected events in restaurants, PSC is likely to be more significant.

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