A Clustering-Classification Two-Phase Model on Service Module Partition Oriented to Customer Satisfaction

Lu Li, Yun Lin, Xu Wang, Tian Guo, Jie Zhang, Hua Lin, Fuqian Nan

***Abstract*—Service modulation is often implemented to provide customized and standardized service in service industries. And Kano model can help to classify customer requirements in response to rapidly-changing and differential requirements. However, the subjectivity and ambiguity of Kano model may affect the accuracy of the results. By taking account of the customer satisfaction in this paper, a two-phase method based on fuzzy Kano model for partitioning service module is presented. Firstly, an entropy weight method is introduced into the fuzzy Kano model to determine the importance of service requirements. Then fuzzy clustering is utilized to cluster modules based on correlation analysis results of service process. Secondly, an edge transformation model is introduced into Kano model to transfer the fuzzy indifference requirements. Thus a nonlinear programming method considering service time constraints and satisfaction is utilized to reclassify the service modules. A "clustering-classify" two-phase service partition model, in turn, is presented. A typical example such as online shopping logistics service is analyzed to verify the presented method. The results show this method a good validity and feasibility.**

***Index Terms*—Service module, Fuzzy kano model, Fuzzy clustering, Nonlinear programming**

I. Introduction

WITH the continuous development of the service economy, providing customers with satisfied, personalized and standardized service has become the key to enhance customer's experience and enterprise competitiveness. Customer requirement is not only the driving force of service, but also the goal of service. However, the instability of the market and the uncertainty of customer requirement pose a great challenge to the control of the service, which is particularly evident in the online shopping logistics services. China's online shopping logistics business volume reached 31.28 billion in 2016, an increase of 45.7% than last year, and the business income were 397.44 billion yuan, but the number of complaints were as high as 263,000. With the development of the online shopping scale, customer requirement for logistics services continue to upgrade which shows the features of high quality, high frequency, decentralized and multiple categories. Traditional service model was difficult to meet the large-scale, diversified needs. Service modularity makes it possible to break down the service into standard sub-processes and customization sub-processes, and to place the standard sub-processes before the customization sub-processes to achieve maximum flexibility [1]. Mak produced multiple families of products to meet different needs of customers [2]. In the same way, service modularity can achieve the diversity choices and break the traditional organizational boundaries. And it also can improve the organization's agility and flexibility by scheduling, assembling and controlling modular [3]. In conclusion service modularity is an effective way to realize standardization and personalization of service.

Sundbo [4] firstly proposed the concept of service modularity: Divide service into different standard service modules in the process of service design, and provide a variety of service products for the customer through the module selection. The representative research of service module are as follows: Teng [5], Xiao [6] and Ge [7] proposed a modular design method based on Fuzzy Clustering. Seung [8] came up with a service process model based on a sequence using a graph model and object-oriented concepts. Song [9] proposed a modularization approach based on modified service blueprint and fuzzy graph to realize the modularization of product-extension service. Xiong [10] established a service modular approach by coupling matrix. Liu [11] decomposed the product into a number of structural and functional independent service units from the perspective of customer demand and differences of category. Amaya [12] proposed life-cycle model comparing the environmental consequences of different PSS design alternatives. Geum [13] proposed a solid framework for service modularization, by employing and modifying the House of Quality (HoQ) structure in Quality Function Deployment (QFD). In addition, this concept was used in variety fields such as supply chain and library service [14].

The heterogeneity of customer requirements should be taken into account in the design of service modularity to maximize customer satisfaction. Japanese management

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scientist Kano proposed Kano model to elaborate the relationship between customer needs and satisfaction. Most of the studies combination with various methods: Geng [15], Yuan [16] combined Kano with QFD to translate customer requirements into functional attributes of service modules. Chen [17] and Çıkış [18] respectively combined the Kano model with TRIZ and IPA to get the importance of product attributes. Rahmana [19] and Basfirinci [20] used integration of SERVQUAL and KANO Models respectively to help training provider to evaluate trainee satisfaction and examined the service quality attributes of airlines with regard to their effect on customer satisfaction. Wang [21] proposed a hybrid framework that combines fuzzy analytical hierarchy process, fuzzy Kano model with zero-one integer programming to incorporate customer preferences. Some researchers tried to improve Kano model. Chen [22] considered the non-linear relationships in the Kano model. Chen [23] proposed a Kano-CKM model to provide an innovative product development. Lee [24], Meng [25] came up with the fuzzy Kano model based on the uncertainty and fuzziness of customer's perception. Yang [26] proposed a Kano model to reclassify the classification results of Kano model which is based on the degree of importance and customer satisfaction. Zhou and Lee [27] proposed a Lagrangian relaxation-based method to minimize greenhouse gas emissions for green logistics. Recently Das et al. [28] presented a logistics model considering rough interval where they discussed about the complete and rather satisfactory solutions.

Many scholars have made the qualitative research on service modularity, only little work have been done on quantitative research. The fuzzy clustering method and the structural matrix method were used but few researches take customer requirements into account in quantitative studies. And the granularity of the service module is too large to adapt to the dynamic and personalized customer requirements. In terms of improving Kano model, scholars rarely eliminate the subjectivity and ambiguity of the model at the same time.

Accordingly, this paper presents a quantitative method of partitioning service modules to meet customer personalized requirements. This method aims at partitioning small-granularity service module to overcome the subjectivity and ambiguity of Kano model. Additionally, this paper introduces an online shopping logistics service case, which demonstrates the application of the presented method. Furthermore, this research could serve as a useful guideline to provide personalized services considering the customer requirements.

II. CUSTOMER REQUIREMENTS ANALYSIS BASED ON FUZZY KANO MODEL

The module partition model is constructed to realize the modularization of service and to meet customer personalized requirements. The customer requirement is considered as the starting point. And the "clustering-classification" process is conducted on the basis of service requirement importance calculation. At the same time, this paper puts forward the edge transformation model (ET-M) to classify the service requirement to realize the quantitative calculation of customer satisfaction and the classification of module.

A. Classification of service requirements based on edge transformation model

In traditional classification table, there are five kinds of requirements: attractive requirement, one-dimensional requirement, must-be requirement, indifference requirement and reverse requirement. For the reason that customers will tend to choose indifference requirement, we defined the marginal requirement as fuzzy indifference requirement based on the Kano requirements classification table. the service requirements based on the fuzzy Kano questionnaire are classified which is show in TABLE I and classification matrix

TABLE I
FUZZY KANO QUESTIONNAIRE

requirement	Satisfied	Must be	neutral	Bearable	dissatisfied
achieved	(0.8,1]	(0.6,0.8]	(0.4,0.6]	(0.2,0.4]	[0,0.2]
not achieved	[0,0.2]	(0.2,0.4]	(0.4,0.6]	(0.6,0.8]	(0.8,1]

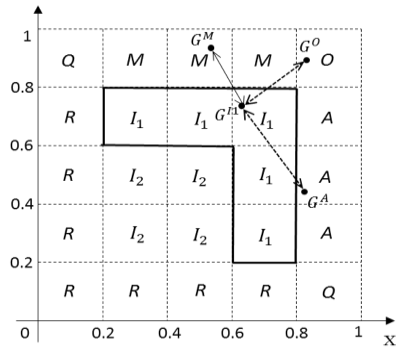

Fig. 1. Classification matrix based on fuzzy Kano.

which is shown in Fig. 1.

The meaning of the letters in Fig. 1 are as follows: A–attractive requirement; O–one-dimensional requirement; M–must-be requirement; I_1–fuzzy indifference requirement; I_2– indifference requirement; R–reverse requirement; Q–problem answer.

The fuzzy indifference requirements are transformed into the corresponding service requirement type to avoid the subjective classification. The transform depends on the average coordinate value distance to A, O and M areas. $G_i(x_i^s, y_i^s)$ represents the evaluation of service requirement F_i from customer $G_i(i=1,2,...,Q)$. x_i^s 、 y_i^s represents the coordinate value of customer evaluation to s ， s means A 、O、M、I_1. G^A 、 G^O 、 G^M 、 G^{I_1} represent the average coordinate of each requirement as shown in TABLE Ⅱ.

TABLE Ⅱ
THE AVERAGE COORDINATE CALCULATION TABLE

Requirement	Quantity	Average coordinate value
A	Q_A	$G^A(\sum_{i=1}^{Q_A} x_i^A / Q_A, \sum_{i=1}^{Q_A} y_i^A / Q_A)$
O	Q_O	$G^O(\sum_{i=1}^{Q_O} x_i^O / Q_O, \sum_{i=1}^{Q_O} y_i^O / Q_O)$
M	Q_M	$G^M(\sum_{i=1}^{Q_M} x_i^M / Q_M, \sum_{i=1}^{Q_M} y_i^M / Q_M)$
I_1	Q_{I_1}	$G^{I_1}(\sum_{i=1}^{Q_{I_1}} x_i^{I_1} / Q_{I_1}, \sum_{i=1}^{Q_{I_1}} y_i^{I_1} / Q_{I_1})$

$$A_{I_1} = \frac{1\Big/\sqrt{(G^{I_1}-G^{A})^2} * I_1}{1\Big/\sqrt{(G^{I_1}-G^{A})^2} + 1\Big/\sqrt{(G^{I_1}-G^{O})^2} + 1\Big/\sqrt{(G^{I_1}-G^{M})^2}}$$
$$O_{I_1} = \frac{1\Big/\sqrt{(G^{I_1}-G^{O})^2} * I_1}{1\Big/\sqrt{(G^{I_1}-G^{A})^2} + 1\Big/\sqrt{(G^{I_1}-G^{O})^2} + 1\Big/\sqrt{(G^{I_1}-G^{M})^2}} \quad (1)$$
$$M_{I_1} = \frac{1\Big/\sqrt{(G^{I_1}-G^{M})^2} * I_1}{1\Big/\sqrt{(G^{I_1}-G^{A})^2} + 1\Big/\sqrt{(G^{I_1}-G^{O})^2} + 1\Big/\sqrt{(G^{I_1}-G^{M})^2}}$$

A_{I_1}、O_{I_1}、M_{I_1} Respectively represent the quantity of A、O、M which are transformed by I_1.

B. Determination of service requirement importance

Delphi method and entropy weight method (EW) are introduced to derive the important weights k_i of service requirement F_i. M experts are invited in the field to evaluate the importance of indicators, w_{ij} represents the importance of F_i evaluation by expert j.

$$b_{ij} = w_{ij} \Big/ \sum_{j=1}^{m} w_{ij}, i = 1,2,3\cdots,n \quad (2)$$

$$B = \begin{Bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ b_{m1} & b_{m2} & \cdots & b_{mn} \end{Bmatrix}$$

For service requirement F_i, the entropy is defined as H_i, k represents Boltzmann constant

$$H_i = -k\sum_{t=1}^{m} f_{ij}\ln f_{ij}, i = 1,2,3\cdots,n \quad (3)$$

$$f_{ij} = b_{ij} \Big/ \sum_{j=1}^{m} b_{ij}, k=1/\ln m \quad (4)$$

The entropy weight of F_i can be defined as:

$$k_i = (1-H_i) \Big/ \sum_{i=1}^{n} H_i, (0 \le k_i \le 1) \quad (5)$$

Taking k_i as the initial weight of service requirement F_i, the Kano model is used to modify the importance of service requirements.

$$Y_i = \sum_{j=1}^{n} d_{ij} / n \quad (7)$$

$$IR_i = (Y_{i1} / Y_{i0})^{1/\theta} \quad (8)$$

$$p_i = k_i \times IR_i \Big/ \sum_{i=1}^{n} k_i \times IR_i \quad (9)$$

Where m_{ij} represents the evaluation of service requirement F_i by customer j (m_{ij}=1,2,3,4,5); Y_{i1}, Y_{i0} represent satisfaction degree of service requirement F_i for a benchmarking enterprise and research enterprise. IR_i is modified rate, θ is Kano factor. The Kano factor value of attractive requirement, one-dimensional requirement, must-be requirement are respectively 2,1,0.5. p_i is the ultimate importance degree of service requirement F_i.

III. Customer Satisfaction-oriented Two Phase Module Partition Model

The two-phase model on service modularity module partition is as follows.

Firstly, to obtain the service requirements index based on the SERVQUAL scale, a classification matrix is proposed to reclassify the customer service requirements. And then puts forward the ET-M to determine the type of service requirements.

Secondly, EW approach is applied to determine the importance of service requirements. The fuzzy Kano model is used to improve the degree of importance.

Finally, a "clustering-classification" two-phase service partition method is presented. Fuzzy clustering analysis is carried out based on the Service flow correlation. Then, the nonlinear programming model is utilized by the satisfaction fitting analysis customer satisfaction degree. Finally, the hierarchical division of modules is realized.

The research framework is shown in Fig. 2.

A. A module clustering model

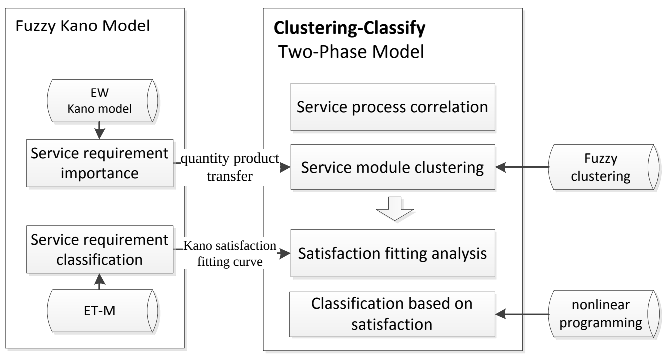

Fig. 2. Research Framework.

The service processes are clustered according to process element identification. The correlation indexes of service process are built based on the weight of service requirements, and then obtain the comprehensive correlation matrix of service process. Finally, the service modules are clustered based on the correlation matrix.

1) Service process correlation analysis

Service blueprint method is used to identify the elements of service process, summarize the service process according to the relevance and continuity. The correlation indexes of service process are constructed as shown in TABLE Ⅲ. The secondary indexes are determined according to the actual service.

Take requirement correlation E2 as an example to elaborate the calculation method. The Delphi method is used to construct the correlation matrix of the service requirement and service process by expert $\gamma_p (p = 1,2,...,P)$.

$$C_{E_2} = \left[\lambda_{ig}\right]_{m\times n}$$

$$v_g^{E_2} = \sum_{i=1}^{m} p_i * \lambda_{ig} \quad (9)$$

TABLE Ⅲ
CORRELATION INDEX OF SERVICE PROCESS

Correlation index	Relationship description
Functional correlation (E1)	Whether to participate in the same function
Requirement correlation (E2)	Whether to participate in the same requirement
Physical correlation (E3)	Whether the occurrence time is related Whether in the same or similar place Is there a public resource Whether there is a common service personnel
Management correlation (E4)	Whether the relevant personnel configuration Complexity of management

Where λ_{ig} is the strength of correlation between service requirement $F_i(i=1,2,...,m)$ and service process $O_g(j=1,2,...,n)$. $\lambda_{ig}=0,1,3,6,9$ (1 indicates weak correlation, 3 is general correlation, 6 is strong correlation, 9 is inseparable, 0 is irrelevant). $v_g^{E_2}$ is the weight of service process O_g under the influence of service requirement.

The correlation matrix of service process is influenced by the service requirement. The matrix is calculated by employing quantity product formula.

$$D_{E_2}=\left[\omega_{(g,l)}\right]_{n\times n}$$

$$\omega_{(g,l)}=\begin{cases}1, & g=l\\ \dfrac{1}{\omega}\sum_{i=1}^{m}p_i\cdot\lambda_{ig}\cdot\lambda_{il}, & g\neq l\left(\omega=\max\limits_{g\neq l}\left(\left|\sum_{i=1}^{m}p_i\cdot\lambda_{ig}\cdot\lambda_{il}\right|\right)\right)\end{cases} \tag{10}$$

$\omega_{(g,l)}$ represents the degree of association between service processes which numbered g、$l(1\le g\le n,1\le l\le n)$.

The correlation matrix Y_{E_2}、Y_{E_3} and Y_{E_4} are calculated under the influence of functional factors, physical factors and management factors. And then the weighted correlation matrix Y_E is calculated：

$$Y_E=\mu_{E_1}Y_{E_1}+\mu_{E_2}Y_{E_2}+\mu_{E_3}Y_{E_3}+\mu_{E_4}Y_{E_4} \tag{11}$$

$$v_g=\mu_{E_1}v_g^{E_1}+\mu_{E_2}v_g^{E_2}+\mu_{E_3}v_g^{E_3}+\mu_{E_4}v_g^{E_4} \tag{12}$$

r_{gl} is the comprehensive degree of service process O_g、$O_l(1\le g\le n,1\le l\le n)$. v_g is the comprehensive weight of service process. $\mu_E=(\mu_{E_1},\mu_{E_2},\mu_{E_3},\mu_{E_4})$ is the weight matrix of the influence index which is scored by Delphi approach , and $\mu_{E_1}+\mu_{E_2}+\mu_{E_3}+\mu_{E_4}=1$.

2) Fuzzy clustering of service process

Fuzzy clustering approach clusters the service processes into service module according to the principle of strong coupling and weak coupling principles.

Suppose that there are n service processes in the set:

$$sp=\left\{sp_1,sp_2,...,sp_n\right\}$$

The service processes are affected by service requirement, function, physics, and management factors. So, based on the above analysis, the comprehensive correlation matrix of any two service processes is shown as follows:

$$Y_E=\left[r_{gl}\right]_{n\times n}=\begin{bmatrix}r_{11} & r_{12} & \cdots & r_{1n}\\ r_{21} & r_{22} & \cdots & r_{2n}\\ \vdots & \vdots & \ddots & \vdots\\ r_{n1} & r_{n2} & \cdots & r_{nn}\end{bmatrix}$$

Where $0\le r_{gl}\le 1(g,l=1,2,...,n)$.

The minimum fuzzy equivalent matrix is constructed from the fuzzy similarity matrix by the transitive closure method which can be explained by:

$$R^*=R^{2^\sigma}=R\circ R\circ\cdots\circ R,\text{where }\sigma\le\log_2(n-1) \tag{13}$$

where R^* is minimum fuzzy equivalent matrix； R is transitive closure “∘ ”is Zadeh operator $\wedge\vee$,if $R^{2^{\sigma-1}}=R^{2^\sigma}$, then $R^*=R^{2^\sigma}$

R^* is solved according to the comprehensive correlation matrix Y_E. The appropriate threshold λ is selected according to the granularity of the service module to get the service process clustering.

B. A module classification model

The modules are classified after clustering the service processes considering the impact of customer satisfaction. Take the service time as constraint and find a service process classification scheme to maximize customer satisfaction based on the satisfaction fitting analysis.

1) Quantitative customer satisfaction analysis

A quantitative Kano model is used to analyze customer satisfaction [29]. Fit the customer satisfaction fitting curve (S-F curve) to obtain the formula of service requirement realization and customer satisfaction： $s_i=af(x_i)+b$. The curve is shown in Fig. 3.

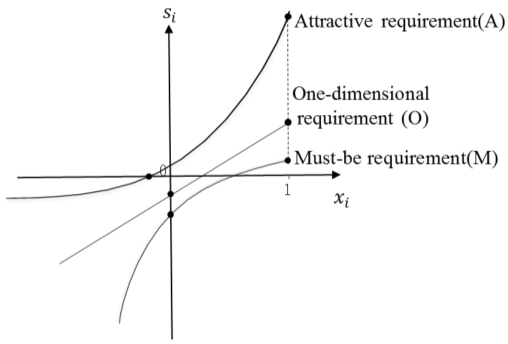

Fig. 3. Customer satisfaction fitting curve.

Calculate the coordinate values of two points $(1,CS_i)$, $(0,NS_i)$ in the curve . Where CS_i and NS_i are the satisfaction and dissatisfaction with F_i from Kano model. s_i is the ordinate of customer satisfaction with F_i, x_i is the realization degree of F_i; a and b represent the parameters of the curve.

$$CS_i=\frac{f_A+f_O}{f_A+f_O+f_M+f_I} \tag{14}$$

$$NS_i=-\frac{f_M+f_O}{f_A+f_O+f_M+f_I} \tag{15}$$

The expression of attractive, one-dimensional and must-be S-F curves are $s_i=a_1e^{x_i}+b_1$, $s_i=a_2x_i+b_2$, $s_i=a_3(-e^{-x_i})+b_3$. The parameter values are as follows：

$$a_1 = \frac{CS_i - NS_i}{e-1}, b_1 = -\frac{CS_i - eNS_i}{e-1} \quad (16)$$

$$a_2 = CS_i - NS_i, b_2 = NS_i \quad (17)$$

$$a_3 = \frac{e(CS_i - NS_i)}{e-1}, b_3 = \frac{eCS_i - NS_i}{e-1} \quad (18)$$

S-F curve fitting function are expressed as：

$$s_i = \begin{cases} \frac{CS_i - NS_i}{e-1} e^{x_i} - \frac{CS_i - eNS_i}{e-1} & (A) \\ (CS_i - NS_i)x_i + NS_i & (O) \\ -\frac{e(CS_i - NS_i)}{e-1} e^{-x_i} + \frac{eCS_i - NS_i}{e-1} & (M) \end{cases} \quad (19)$$

2) Classification model of service process

The service time is treated as constrain and customer satisfaction is treated as the goal to select the basic process. And then the One-dimensional processes are selected in the remaining processes. Finally, the charm processes remain.

Must-be process classify model:

$$\max \sum_{i=1}^{m_1} -p_i \frac{e(CS_i - NS_i)}{e-1} e^{\sum_{g=1}^{n} T_g \cdot v_g \cdot \lambda_{ig} / \sum_{g=1}^{n} v_g \cdot \lambda_{ig}} + \frac{eCS_i - NS_i}{e-1} \quad (20)$$

s.t.

$$\sum_{g=1}^{n} T_g > 0$$

$$48 < \sum_{g=1}^{n} D_g T_g \le 60$$

$$T_g = \begin{cases} 1, \text{service process } O_g \text{ is chosen} \\ 0, \text{ else} \end{cases}$$

One-dimensional process classify model:

$$\max \sum_{i=1}^{m_2} p_i (CS_i - NS_i) \left(\sum_{g=1}^{n} T_g \cdot v_g \cdot \lambda_{ig} / \sum_{g=1}^{n} v_g \cdot \lambda_{ig} \right) + NS_i \quad (21)$$

s.t.

$$\sum_{g=1}^{n} T_g > 0$$

$$\sum_{g=1}^{n} D_g T_g \le 48$$

$$T_g = \begin{cases} 1, \text{service process } O_g \text{ is chosen} \\ 0, \text{ else} \end{cases}$$

Where m_1 is the quantity of basic service requirement, $i = (1, 2, ..., m_1)$; m_2 is the quantity of expected service requirement, $i = (1, 2, ..., m_2)$; D_g is the time of O_g ;T_g is 0-1 variable that indicates whether the service process is selected .

IV. Case Analysis

Y company is a famous logistics enterprise which mainly provides online shopping logistics services. The dynamic and uncertainty of online shopping, the rapid expansion of the market scale, posed a great challenge to the logistics services. To meet the individual needs of customers, take Y company as an example, to study the modularization of online shopping logistics service.

Based on the SEVERQUAL scale, related literature and the characteristics of online shopping logistics, 27 customer service requirements are constructed, as shown in TABLE Ⅳ.

TABLE Ⅳ
CUSTOMER REQUIREMENT INDEX

Requirement attribute	No.	Customer service requirement
Service product requirement	F1	Accurate and timely delivery
	F2	Complete and clear documents
	F3	Cargo safety
	F4	Safety packaging
	F5	Quick response
	F6	Fast response to claims
	F7	Fast response to complaints
Information requirement	F8	Order monitoring
	F9	Information availability
	F10	Information accuracy
Cost requirement	F11	Reasonable freight
	F12	Multiple payment methods
Convenience requirement	F13	Pickup convenient
	F14	Convenient equipment operation
	F15	Simple procedure of Pickup
	F16	Smooth communication channels
Individual requirement	F17	Flexible dispatching location
	F18	Time flexibility
	F19	Booking pickup
	F20	Insured transportation
	F21	Key customer visits
	F22	Installation service
Empathic requirement	F23	friendly attitude
	F24	Professional staff
	F25	Logistics personnel neat
	F26	Good reputation
	F27	High level of enterprise management

A total of 200 Kano questionnaires were issued in which 168 were valid. The service requirements are classified based on ET-M, and the type of service requirements are translated by using equation (1). The final distribution is shown in TABLE Ⅴ. Taking six service requirements as an example, the contrast between classification of Kano model and the classification after the edge transformation is shown in Fig. 4. Finally, there were eight service requirements transferred into other type of requirements, providing more data for subsequent analysis. For example, F_2、F_{15}、F_{20} are transferred into M which means they are must-be requirements. The lack of these services will greatly affect customer satisfaction

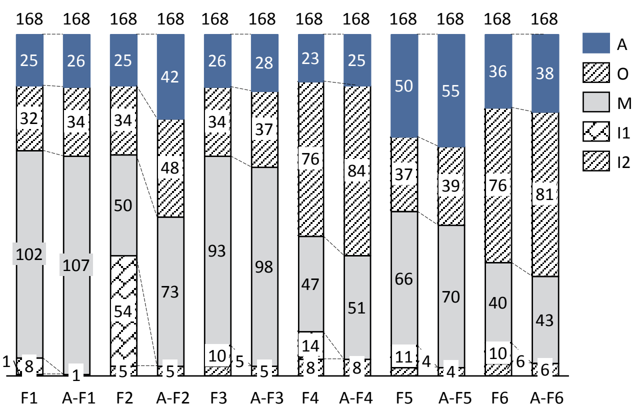

Fig. 4. Comparison of results before and after transformation.

The online shopping logistics service processes are deconstructed by service blueprint. The process of receiving, processing, transportation and delivery are identified then the delivery process is taken as an example as shown in Fig.5.

TABLE Ⅴ
EVALUATION RESULTS OF SERVICE PROCESS

Requirement	A	O	M	I	Q	R	type	CS	DS
F1	26	34	107	1	0	0	M	0.36	-0.84
F2	42	48	73	5	0	0	M	0.53	-0.72
F3	22	43	98	5	0	0	M	0.39	-0.84
F4	25	84	51	7	1	0	O	0.65	-0.80
F5	55	39	70	4	0	0	M	0.56	-0.65
F6	38	81	43	6	0	0	O	0.71	-0.74
F7	35	51	72	10	0	0	M	0.51	-0.73
F8	48	70	45	5	0	0	O	0.70	-0.68
F9	54	39	57	26	0	0	M	0.55	-0.62
F10	62	29	66	11	0	0	M	0.54	-0.57
F11	37	80	51	0	0	0	O	0.70	-0.78
F12	91	28	39	10	0	0	A	0.71	-0.40
F13	35	79	51	3	0	0	O	0.68	-0.77
F14	63	35	60	9	1	0	A	0.58	-0.57
F15	48	40	68	12	0	0	M	0.52	-0.64
F16	39	38	87	4	0	0	M	0.46	-0.74
F17	75	63	25	5	0	0	A	0.82	-0.52
F18	76	54	35	3	0	0	A	0.77	-0.53
F19	74	48	39	7	0	0	A	0.73	-0.52
F20	46	41	67	13	0	0	M	0.52	-0.65
F21	40	27	24	71	1	5	I	0.40	-0.30
F22	63	40	44	21	0	0	A	0.61	-0.50
F23	39	46	78	5	0	0	M	0.51	-0.74
F24	40	30	86	12	0	0	M	0.42	-0.69
F25	52	55	47	15	0	0	O	0.63	-0.60
F26	45	75	30	18	0	0	O	0.71	-0.63
F27	74	35	38	19	0	2	A	0.65	-0.43

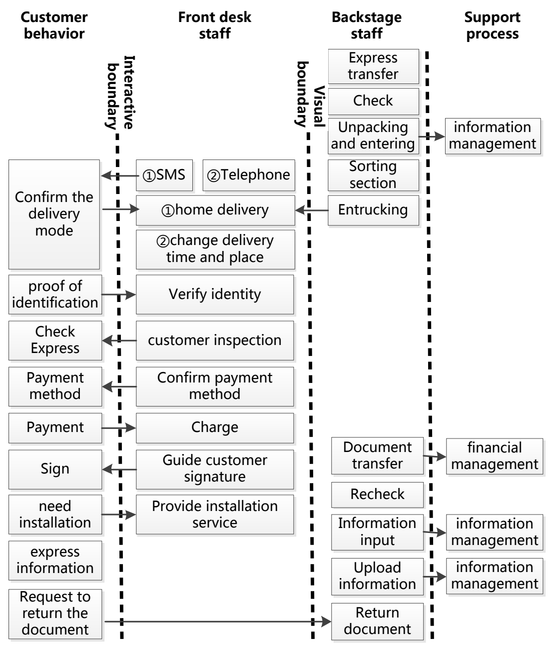

Fig.5. Delivery process service blueprint.

The importance of service requirements is determined by using equations (2) −(8)：

$k_i = (0.053, 0.036, 0.051, 0.034, 0.045, 0.040, 0.044, 0.036, 0.041, 0.043, 0.037, 0.032, 0.048, 0.037, 0.034, 0.036, 0.044, 0.041, 0.036, 0.036, 0.020, 0.034, 0.034, 0.033, 0.019, 0.030, 0.026)$

$p_i = (0.063, 0.026, 0.042, 0.028, 0.055, 0.040, 0.065, 0.029, 0.061, 0.064, 0.033, 0.020, 0.043, 0.023, 0.041, 0.067, 0.032, 0.034, 0.026, 0.028, 0.024, 0.051, 0.049, 0.012, 0.027, 0.019)$

The elements of four service processes are broken down and then summarized to obtain 44 online shopping logistics service processes which are shown in TABLE Ⅵ.

TABLE Ⅵ
LOGISTICS SERVICE FLOW CHART

No.	Service process	No.	Service process
1	Receiving preparation	23	Automatic sorting
2	Receive and check information	24	Manual sorting
3	Scheduling logistics personnel	25	Make transportation plan
4	Packet service	26	Vehicle scheduling
5	Inspection Express	27	Route optimization
6	Provide safe packaging	28	Air transportation
7	Weighing charge	29	Train transportation
8	Labeling and marking	30	Vehicle transportation
9	Provide operational guidance	31	Order monitoring
10	Insured transportation	32	Pre preparation
11	Marketing activities	33	Express receipt
12	Shift handover	34	Sorting section treatment
13	Information input	35	Receiving SMS
14	Upload information	36	Receiving method coordination
15	Automatic address matching	37	Provide home delivery service
16	Goods classification	38	Change of time and place
17	Sealed delivery	39	Verify recipient
18	Loading shipment	40	Recipient payment
19	Pick up stand-by	41	collection on delivery
20	Unloading	42	installation service
21	Acceptance signature	43	Return document
22	Routing list	44	Service quality improvement

The secondary indexes of online shopping logistics services are built based on literature search and research to analyze the correlation of online shopping logistics service process. Indexes are shown in TABLE Ⅶ.

The correlation degree of service process is solved under the influence of service requirement by using equations (10) - (11). And then find out the correlation degree of service process under the influence of other first grade indexes. Finally, the comprehensive correlation matrix is obtained (Intercept some of the results).

$$Y_E=\begin{bmatrix} 1 & 0.085 & 0.1 & 0.355 & 0.1 & 0.122 & 0.535 & 0.122 & 0.2 & 0.125 \\ & 1 & 0.632 & 0.835 & 0.086 & 0.158 & 0.012 & 0.453 & 0.028 & 0.138 \\ & & 1 & 0.822 & 0.146 & 0.108 & 0.217 & 0.008 & 0.156 & 0.266 \\ & & & 1 & 0.586 & 0.523 & 0.985 & 0.634 & 0.32 & 0.125 \\ & & & & 1 & 0.686 & 0.256 & 0.158 & 0.085 & 0.368 \\ & & & & & 1 & 0.425 & 0.852 & 0.245 & 0.234 \\ & & & & & & 1 & 0.126 & 0.017 & 0.25 \\ & & & & & & & 1 & 0.135 & 0.215 \\ & & & & & & & & 1 & 0.25 \\ & & & & & & & & & 1 \end{bmatrix}$$

TABLE Ⅶ
CORRELATION INDEX OF ONLINE SHOPPING LOGISTICS SERVICE PROCESS

	Correlation index	Secondary index
E1	Functional correlation	Packing /Machining Warehousing services Transportation service Delivery service Handling service Information service Customer service
E2	Requirement correlation	service requirements in TABLE Ⅳ
E3	Physical correlation	time space Logistics resources Service personal
E4	Management correlation	Management relevance Management complexity

The fuzzy clustering analysis is carried out by using the comprehensive correlation matrix. Then, the service modules are clustered by using MATLAB software to solve the model. The value of threshold λ is 0.65.The results are shown in TABLE Ⅷ.

TABLE Ⅷ
CLUSTERING RESULTS OF SERVICE PROCESS

Modular	Service process
Information module	2、11、13、14、25
Data analysis module	3、15、22、26、27、31
Client module	4、6、7、8、21、35、36、37、39、40
Transceiver module	1、12、16、17、18、32、33、34
Transport module	28、29、30
Sorting module	19、20、21、23、24
Personality module	9、10、11、41、42、43、44

The service process time D_g is obtained by investigating, and the weight of service process is calculated by using equations (9) and (12). The results are as follows:

$$D_g=(0.5, 0.17, 0.25, 2.5, 1, 0.5, 0.17, 0.17, 0.25, 0.17, 0.33, 4.5, 4, 2, 0.17, 1.5, 2, 1, 0.5, 1, 1.5, 0.33, 0.75, 3.5, 1.5, 0.25, 0.25, 10, 17, 28, 0.25, 0.5, 1.5, 0.67, 1, 0.17, 2.5, 0.33, 0.17, 0.25, 0.25, 0.33, 0.25, 0.17)$$

$$v_g=(0.035, 0.052, 0.068, 0.058, 0.015, 0.02, 0.019, 0.014, 0.02, 0.01, 0.008, 0.013, 0.038, 0.014, 0.025, 0.021, 0.011, 0.011, 0.004, 0.008, 0.009, 0.015, 0.019, 0.013, 0.019, 0.012, 0.014, 0.012, 0.008, 0.007, 0.031, 0.048, 0.033, 0.015, 0.026, 0.038, 0.059, 0.058, 0.012, 0.012, 0.009, 0.025, 0.012, 0.032)$$

Service modules are classified by using equations (20)−(21). Lingo11.0 software is used to solve the model. Finally, the online shopping logistics service modules are obtained and the results are shown in TABLE Ⅸ.

TABLE Ⅸ
ONLINE SHOPPING LOGISTICS SERVICE MODULES

	Must-be process	One dimensional process	Attractive process
Information module	2、11、13、14、25		
Data module	3、22、26	15、27、31	
Client module	4、6、7、8、21、35、37	36、38、40	39
Transceiver module	1、12、16、17、18、32、33、34		
Transport module	30	29	28
Sorting module	19、20、21、24	23	
Personality module	10	9、41	11、42、43、44

In traditional Kano model, online shopping logistics service can be divided into several modules. By using two phase model, it was clarified into seven modules. Each module consists of three classes. An accurate service can be combined by these smaller–sized modules which can meet customer requirements better. As shown in Fig.6.

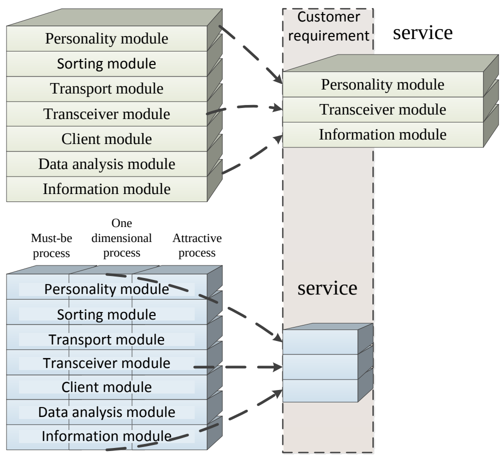

Fig.6. Service portfolio configuration.

Taking the sorting module as an example, the indispensable processes such as pick up stand-by, unloading, acceptance signature are divided into the must-be process. But for the reason that automatic sorting is an effective process to improve customer satisfaction, it was divided into the one-dimensional process.

Each module can be replicated and outsourced because of the independent and versatile characteristics. With the development of logistics alliance, this part of the business can be transferred to other logistics enterprises. The clustering module partition is beneficial to the management, organization and resource analysis within the module. Modular implementation is more conducive to the allocation of resources

The divided modules provide the guidance for service design and can be used to select the configured service that can meet personalized customer requirements farthest. Differentiated services are provided by combining must-be process, one dimensional process and attractive process, and also provide decision support for modular configuration.

In addition, the results of the service module can be dynamically upgraded with the development of society, the progress of technology, continuously improved business service levels and customer demand. Some attractive requirements may be transformed into must-be requirements and new requirements will arise. In this way, the dynamic changes provide a guarantee for differentiated, low-cost services.

V. CONCLUSION

Service modularity is the key to realize service standardization and customization. This paper constructed the "clustering-classification" two-phase partitioning model to obtain service module based on the fuzzy Kano model. The contributions of this article are as follows :(1)EW and fuzzy Kano model are used to determine the importance service requirement considering subjectivity of Kano model.(2)Due to the fuzzy and indiscriminate demand, a classification matrix diagram and ET-M are presented to eliminate the fuzziness of the Kano model and improve the decisional of Kano model. Reclassify the fuzzy indifference requirement according to the average coordinate value of customer evaluation. In this way, the classification results are more reasonable. (3) The two-phase model on service module partition is presented to reduce the granularity of the model and to meet the flexibility requirements. Firstly, the service processes are clustered based on considering the impact of requirement index, function index, physics index and management index. Then, a nonlinear programming considering suitable service time and maximize customer satisfaction is conducted to classify the service module.

This paper proved the validity and feasibility of the method through the modularization of the online shopping service of Y enterprise. The next step will consider the randomness and the correlation between modules in the process of partitioning the service modules, and improve the accuracy of the division model by eliminating the autocorrelation between modules. And resource allocation will be focused on in the future.

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