

# Construction and Application of Customer Satisfaction Model with the Service Quality of Last-Mile Delivery in Rural Areas

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*Abstract:* - The backward last-mile delivery infrastructures, the greater difficulties in last-mile delivery due to the scattered residences of rural customers and the lack of logistics professionals in rural areas have emerged as the important factors hindering the improvement of the service quality of last-mile delivery in rural areas. This study combines the classic satisfaction index model and transformation of the SERVQUAL standard scale to draw up the connotations and observation variables of customer expectations, quality perception, perceived value, customer satisfaction, customer complaints and customer loyalty with the service quality of last-mile delivery in rural areas, and takes 460 permanent residents in rural areas as the research objects, then constructs and tests the customer satisfaction model of the service quality of last-mile delivery in rural areas, and deeply analyzes the relationship between customer satisfaction and its influencing factors; by constructing a two-dimensional combination potential of entropy weight-satisfaction average value, the in-depth application of the model is discussed, and at the same time, it provides policy suggestions for local governments, logistics companies and other entities to improve the customer satisfaction with the service quality of last-mile delivery in rural areas.

*Key-Words:* - Last-mile delivery in rural areas, Customer satisfaction, Structural equation model, Two-dimensional combination potential

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## 1 Introduction

With the surge in the number of online shoppers in rural areas, precise last-mile delivery has become a hot topic drawing broad public attention. The service quality of last-mile delivery in rural areas refers to the extent to which logistics companies leverage their last-mile delivery resources (i.e., the product mix consisting of tangible products and intangible services) to meet the explicit or implicit needs of online shoppers in rural areas. It depends largely on the demand side's perception of delivery service at the "real moment" of service contact. Specifically, tangible products include service environment and goods, i.e., the supporting facilities and equipment necessary for service provision, and the goods purchased by the online shoppers in rural areas, while intangible services cover non-quantitative implicit factors such as the confidentiality of personal information, the service attitude of deliverymen, and the quality of complaint handling. The online shoppers

in rural areas are the main customers of logistics companies' last-mile delivery service, and hence their perceived value of the service process and service outcome has emerged as a crucial consideration amid the management innovation of logistics companies.

## 2 Research Summary

### 2.1 Research on the Influencing Factors of Customer Satisfaction in Logistics Services

The academic circles generally believe that the quality of logistics services is a factor that affects their satisfaction, and to a certain extent determines the probability of customers' second choice of services. Hashank R. et al. combined the file data of 260 online retailers and found that in the service quality dimension of logistics, customer satisfaction with logistics quality and cost is directly proportional to their purchase satisfaction and customer retention rate

[1]; Yang, H. et al. found that the core service quality and remedial service quality will have a positive and significant impact on customer satisfaction in the logistics service process [2]; Zuoliang Ye et al. believed that logistics interaction and operation quality will affect customer satisfaction with third-party logistics service providers, thereby affecting customer satisfaction with enterprises [3]; Yaozi He et al. divided the factors that affect the quality of logistics services into information capabilities, distribution capabilities, pre-sales and after-sales services, matching capabilities, and innovation capabilities, through empirical analysis, the above factors have a significant impact on customer satisfaction [4]; Combining the structural equation model, Wensheng Ma established a research model on the relationship between service quality and customer satisfaction in the logistics industry. The results show that the five dimensions of logistics service quality, such as tangibility and reliability, have a positive and significant impact on customer satisfaction [5].

## 2.2 Research on the Measurement and Evaluation of Logistics Service Quality

Foreign research on the measurement and evaluation of logistics service quality is relatively rich, and is mostly based on the perspective of enterprises and customers. Among them, the more classic measurement and evaluation models include: the PDSQ (physical distribution service quality) scale developed by Mentzer extracted three main dimensions of timeliness, availability, and quality from 26 specific items [6]; after that they introduced personnel, process factors and innovatively established the LSQ scale including nine dimensions covering information quality, order release quantity, time, communication quality, etc. and a total of 25 evaluation items [7]; later, Bienstock et al. conducted an empirical test on the PDSQ scale, and improved the new PDSQ scale which increased the measurement items of intangible services accepted by customers [8].

Domestic scholars have also proposed evaluation or measurement indicators of logistics service quality from different research perspectives. Jian Xu et al. comprehensively used Analytic Hierarchy Process, SEVEQUAL and other methods to construct a logistics enterprise service quality evaluation index system from the three perspectives of enterprise service performance, service process, and service capability [9]; Yaoli Zhang combined small-scale B2C and C2C online shopping, used process analysis to find out 38 contact points with customers in their logistics services, and then distributed questionnaires to small merchants with signing experience, six representative factors that affect the quality of online shopping logistics services are sorted out, including

delivery service level, order-taking service level, ability to fulfill orders correctly, timeliness, information service capacity and price [10]; Fang Lu used empirical research and analysis to regard availability, utility, and interactivity as the three most important dimensions of logistics service quality [11].

The above studies provided useful ideas for the research on the customer satisfaction with the service quality of last-mile delivery in rural areas, but there are still some shortcomings: firstly, the research on e-commerce logistics and distribution in rural areas is still at the stage of preliminary discussion, and related research is mainly limited to the difficulty of logistics distribution and countermeasures; there are few studies on the evaluation index system to measure the quality of last-mile delivery in rural areas, some studies also directly used the results of previous studies, the established index system generally has the characteristics of being too complicated and poor in practicability, moreover, it mostly focused on single-index simple weighting processing, lacking a multi-index linkage measurement system, and seldom used certain evaluation methods to conduct comprehensive evaluation research. Secondly, related satisfaction surveys only focused on the comparison of results and cause analysis, and didn't provide methods for how to use the survey results; there is little research on the relationship between variables and the evolutionary law, and it is impossible to intuitively understand the causal relationship between variables, the lack of verification of the rationality of the model leads to poor effectiveness of the research results.

Based on the analysis of the current status of last-mile delivery in rural areas, this study takes the rural online shopping consumer groups in Fujian Province as the research object, and uses the structural equation modeling method to design a customer satisfaction model of the service quality of last-mile delivery in rural areas, and empirically analyzed the relationship between customer satisfaction and its influencing factors; a two-dimensional combination potential of entropy weight-satisfaction average value was constructed to deepen the application of the satisfaction model; finally, it provides policy recommendations for local governments, logistics companies and other multi-agents to improve the customer satisfaction with the service quality of last-mile delivery in rural areas.

## 3 Status of Last-Mile Delivery in Rural Areas

### 3.1 Backward Last-mile Delivery Infrastructures in Rural Areas

The infrastructures in rural areas lag far behind those in urban areas, especially the transportation infrastructures. The narrow and rugged roads in some rural areas make it difficult for vehicles to pass through, and hence a well-functioning transportation network cannot be formed, not to mention door-to-door delivery. Rural customers sometimes have to pick up the goods purchased online at the package pickup point, the fact of which greatly hampers the enthusiasm of rural customers to shop online and compromises the safety and timeliness of the goods purchased online [12].

### 3.2 Greater Difficulties in Last-mile Delivery Due to the Scattered Residences of Customers

The vast population and scattered residences in rural areas have brought about two major challenges to last-mile delivery: 1) it's difficult to plan consistent delivery routes, making delivery time-consuming and labor-intensive; and 2) the costs of delivery remains high as the number of packages to be delivered to rural customers is still at a low level.

### 3.3 Lack of Logistics Professionals in Rural Areas

In rural areas, a large number of young people have left home to work in cities, therefore leading to a severe shortage of qualified logistics professionals and making it difficult to carry out effective last-mile delivery.

Taking the online shoppers in the rural areas of Fujian Province as the research subjects, this study uses the structural equation modeling (SEM) to design a customer satisfaction model for measuring the service quality of last-mile delivery in rural areas, and empirically analyzes the relationships between the satisfaction of online shoppers in rural areas and satisfaction-affecting factors, thereby informing efforts made by logistics companies to build an efficient last-mile delivery system.

## 4 Research Hypotheses and Model Establishment

### 4.1 Initial Model and Research Hypothesis

Building upon the American Customer Satisfaction Index (ASCI), this study has designed a customer satisfaction model for measuring the service quality of last-mile delivery in rural areas. This model takes the expectations of rural customers, quality perceived by rural customers and value perceived by rural customers as the premise latent variables, and takes customer satisfaction, customer complaints and customer loyalty as the result latent variables. The

initial model and research hypotheses are shown in Figure 1 and Table 1 .

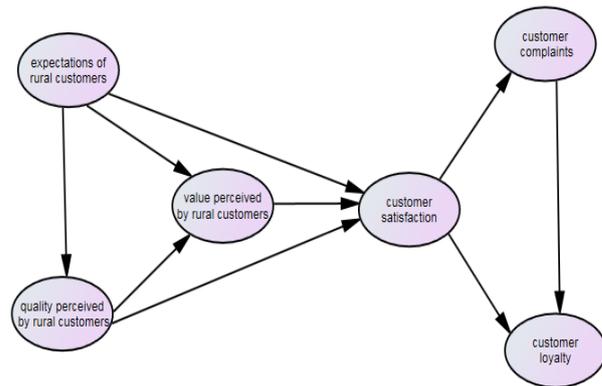


Fig.1 Initial customer satisfaction model for measuring the service quality of last-mile delivery in rural areas

Table 1. Research hypotheses for the initial model

SN	Research Hypotheses
H1	Customer expectations have a positive impact on customer satisfaction
H2	Customer perceived quality has a positive impact on customer satisfaction
H3	Customer perceived value has a positive impact on customer satisfaction
H4	Customer expectations has a positive impact on customer perceived value
H5	Customer perceived quality has a positive impact on customer perceived value
H6	Customer perceived value plays a mediator role between customer expectations and customer satisfaction
H7	Customer perceived value plays a mediator role between customer perceived quality and customer satisfaction
H8	Customer satisfaction has a positive impact on customer complaints
H9	Customer satisfaction has a positive impact on customer loyalty
H10	Customer complaints has a positive impact on customer loyalty

### 4.2 Variables

Based on the results of existing foreign studies and the results of empirical research relating to other industries, this study identified the connotations of the latent variables in the initial model. Among them, customer expectations refer to the expectations that customers have before accepting the last-mile delivery service; customer perceived quality refers to the actual feelings of customers after receiving the last-mile delivery service, and can be measured from five aspects with the aid of SERVQUAL scale, this study uses the entropy weight method (EWM) to calculate the weights of the corresponding items and the scores

for tangibles, reliability, responsiveness, assurance, and empathy [13]. The customer perceived value can be measured by the gap between the expected service quality and the perceived service quality [14]. Customer satisfaction is directly affected by customer expectations and the degree to which they are satisfied [15]. Customer satisfaction could help reduce customer complaints, customers often express their complaints through formal complaints and informal complaints that influence the choices of others [16]. As a combination of customers' awareness and behavior, customer loyalty can be measured from two aspects: intention to recommend and intention to purchase again [17], satisfied customers would make a long-term purchase commitment to a certain brand or company. The latent variables are measured by the liker 5-level scoring method, as shown in Table 2.

Table 2. Connotations of latent variables and observable variables in the model

Latent Variables	Observable Variables
Customer expectations F1	1.You expect the courier company to provide a service that makes you very satisfied (X1)
	2.You expect the delivery service of the courier company to be fast and timely (X2)
	3.You expect the delivery service of the courier company to be precise (X3)
	4.You expect the courier company to ensure that the goods are delivered in good condition (X4)
	5.You expect that the courier company could keep providing higher quality last-mile delivery service and become an industry model (X5)
	6.You expect a more convenient way of package pickup (X6)
Customer perceived quality F2	7. Tangibles [X7]
	8. Reliability [X8]
	9. Responsiveness [X9]
	10. Assurance (X10)
	11. Empathy [X11]
Customer perceived value F3	12.The delivery service is worth its corresponding price (X12)
	13.Customers' time and mental costs (X13)
Customer satisfaction F4	14.How satisfied are you with the delivery service of the courier company (X14)
	15.To what extent can the delivery service of the courier company meet your expectations (X15)
Customer complaints	16.Cost-effectiveness of the last-mile delivery service (X16)

F5	17.Satisfaction with dispute handling (X17)
Customer loyalty F6	18. Possibility of choosing again (X18)
	19.Possibility of recommending to others (X19)
	20. Acceptable price increase (X20)
	21.Possibility of long-term cooperation (X21)

### 4.3 Questionnaire

This study takes permanent rural residents with online shopping experience in Fujian Province as the research subjects. The questionnaires distributed to these research subjects consist of two parts: 1) basic personal information, including gender, age, monthly frequency of online shopping, etc.; and 2) items related to the 6 latent variables and scored using the 5-point Likert scale. The specific items were designed with reference to previous research and the SERVQUAL scale, as shown in Table 3 through Table 8 [18].

Table 3. Items related to the latent variable of customer expectations

Q5	You expect the courier company to provide a service that makes you very satisfied
Q6	You expect the delivery service of the courier company to be fast and timely
Q7	You expect the delivery service of the courier company to be precise
Q8	You expect the courier company to ensure that the goods are delivered in good condition
Q9	You expect that the courier company could keep providing higher quality last-mile delivery service and become an industry model
Q10	You expect a more convenient way of package pickup

Table 4. Items related to the latent variable of customer perceived quality

Variables	Items	Weight
Tangibles	Q11 The basic service facilities at the package pickup point are complete	0.099
	Q12 The deliverymen have neat clothing and appearance	0.143
	Q13 It's easy to pick up the package from where you live	0.291
	Q14 The pickup points of different courier	0.217

		companies are close to each other	
Reliability	Q15	No area is omitted by the delivery service	0.250
	Q16	The goods delivered by the courier company are correct	0.198
	Q17	There is no omission of the goods delivered by the courier company	0.131
	Q18	The delivery destinations are correct	0.119
	Q19	The goods delivered by the courier company are in good condition	0.123
	Q20	The outer packaging of the goods delivered by the courier company is intact	0.163
	Q21	The courier company is reliable in delivery	0.121
	Q22	The courier company can deliver the goods within the specified time	0.145
	Q23	The courier company can provide real-time information about my packages	0.239
	Responsiveness	Q24	You expect the courier company to respond to your complaints in time
Q25		The deliverymen won't be too busy to service your needs immediately	0.405
Assurance	Q26	Deliverymen's proficiency in workflow	0.287
	Q27	The confidentiality of your personal information during the delivery process	0.390
	Q28	The deliverymen are very polite	0.323
Empathy	Q29	The deliverymen can promptly communicate with you on the status of the goods being	1.000

		delivered	
Table 5. Items related to the latent variable of perceived value			
	Q30	The delivery service is worth its corresponding price	
	Q31	Less time and mental costs in handling the logistics formalities	
Table 6. Items related to the latent variable of customer satisfaction			
	Q32	How satisfied are you with the delivery service of the courier company	
	Q33	To what extent can the delivery service of the courier company meet your expectations	
Table 7. Items related to the latent variable of customer complaints			
	Q34	Cost-effectiveness of the last-mile delivery service	
	Q35	Your satisfaction with the courier company's handling of disputes	
Table 8. Items related to the latent variable of customer loyalty			
	Q36	Possibility of choosing again	
	Q37	Possibility of recommending to others	
	Q38	Acceptable price increase	
	Q39	Possibility of long-term cooperation	

## 5 Discussion

### 5.1 Reliability Test of the Model

A total of 541 questionnaires were distributed to permanent residents in rural areas and 460 valid questionnaires were recovered. SPSS 20.0 was used to find that the Cronbach's Alpha coefficient of the reliability subscale of each latent variable in the questionnaire was above 0.7, and that the Cronbach's Alpha coefficient of the whole scale reached 0.968, indicating that this scale is highly reliable. Therefore, the 6 latent variables and 21 observable variables in the initial model  $M_1$  were retained [19].

### 5.2 Model Testing and Adjustment

AMOS 7.0 was used to test and correct the initial model  $M_1$  (Figure 2), with significance test results of relevant parameters shown in Table 9. When the corresponding P values are all greater than 0.1, it's deemed that the corresponding path coefficients are not significantly different from zero at 90% confidence. Therefore, the four paths of  $F1 \rightarrow F3$ ,  $F1 \rightarrow F4$ ,  $F2 \rightarrow F4$  and  $F5 \rightarrow F6$  are removed. By further

adjusting and simplifying model  $M_1$ , model  $M_2$  was obtained, as shown in Figure 3.

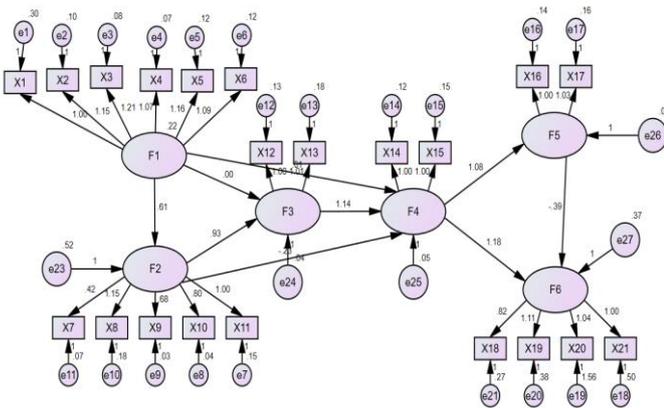


Fig.2 Coefficient estimation and test results of model  $M_1$

Table 9. Parameter significance test results of model  $M_1$

Variable path	Estimate	C.R.	P
F1→F2	0.609	7.204	***
F2→F3	0.931	26.608	***
F1→F3	0.003	0.066	0.947
F3→F4	1.141	3.973	***
F1→F4	0.010	0.201	0.841
F2→F4	-0.226	-0.838	0.402
F4→F5	1.075	28.907	***
F4→F6	1.184	1.733	0.083
F5→F6	-0.393	-0.630	0.529

Testing the goodness-of-fit of model  $M_2$ : As shown in Table 10, among the absolute fit, incremental fit and parsimonious fit indices of model  $M_2$ , more than half of the indices fit, indicating good overall fitness and pointing to the fact that the optimized model  $M_2$  is a better one [20].

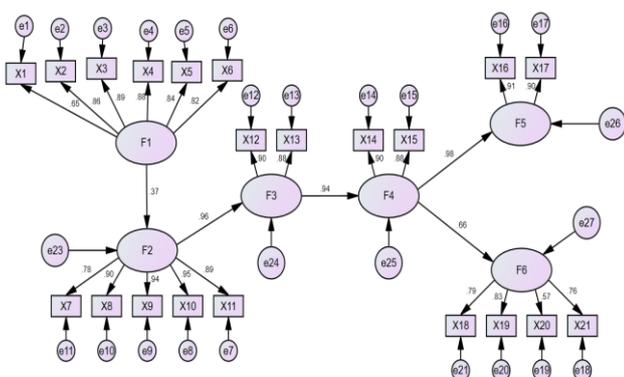


Fig.3 Coefficient estimation and test results of optimized model  $M_2$

Table 10. Fit indices for the optimized model

Statistical test	Fitting criteria or thresholds	Test results	Goodness of Fit
<b>Absolute Fit Indices</b>			
CMIN /DF	P>0.05 (not up to the significant level)	2.785 (P=0.000)	Reference index
RMR	<0.05	0.038	Yes
RMSEA	<0.08	0.062	Yes
SRMR	<0.05	0.0511	No
GFI	>0.9	0.904	Yes
AGFI	>0.9	0.88	No
CN	>200	512.36	Yes
<b>Incremental Fit Indices</b>			
NFI	>0.95	0.946	No
RFI	>0.90	0.938	Yes
IFI	>0.95	0.965	Yes
TLI	>0.95	0.960	Yes
CFI	>0.95	0.965	Yes
<b>Parsimonious Fit Indices</b>			
PNFI	>0.50	0.829	Yes
PCFI	>0.50	0.845	Yes

### 5.3 Empirical Result Analysis and Inspiration

The relationships and the interactions between factors affecting customer satisfaction with the service quality of last-mile delivery in rural areas can be observed via the changes in the standardized path coefficients of each variable in the optimized model  $M_2$ , as shown in Table 11.

Firstly, it can be seen from the results of significance that the research hypotheses H1, H2, and H4 are not valid, and other hypotheses are supported, that is, the direct paths from customer expectations and customer perceived quality to customer satisfaction is not significant, and the path from customer expectations to customer perceived value is not significant. The path coefficients of "customer expectation", "customer perceived quality" and "perceived value" on "customer satisfaction" are 0.332, 0.902 and 0.938, which reflect the influence of various factors influencing customer satisfaction with the service quality of last-Mile delivery in rural areas to a certain extent. Among them, "perceived value" has the greatest impact. As the scale of online shopping in rural areas continues to expand, the number of logistics services contacted by rural customers has also continued to increase, they have long-term and stable expectations for the basic service quality of various express logistics companies. In the environment of increasingly fierce competition in logistics services, it is not obvious that logistics companies expect to

improve customer satisfaction by adjusting customer expectations, They should pay more attention to the stable output of service quality, allow customers to produce more accurate expectations, gradually narrow the gap between expected quality and perceived quality, and pay attention to changes in the price of logistics services and the spiritual cost of customers waiting for logistics procedures to improve perception value, then improve customer satisfaction.

Secondly, by further analyzing the effect of customer perceived quality on customer satisfaction, it can be seen that there are gaps between the indirect effects of the five elements of customer perceived quality on customer satisfaction. Specifically, the indirect effects of tangibles, reliability, responsiveness, assurance and empathy transmitted to customer satisfaction through customer perceived value are 0.71, 0.81, 0.85, 0.86 and 0.81 respectively, indicating that among the elements of customer perceived quality that affect customer satisfaction, assurance has the strongest indirect effect, while intangibles have the weakest indirect effect. Based on the questionnaire items, in the case of limited resource input, adopting a differentiation strategy based on the development characteristics of the five dimensions will be an important way for local governments, logistics companies and other participating entities to improve the quality of customer perception.

For example, in terms of logistics talent supply, local governments should introduce relevant policies to attract highly educated talents to join the rural logistics and distribution industry; logistics companies should regularly train their deliverymen, place emphasis on reflections, improvements and skills updates, and test the competency of deliverymen through irregular assessments, so as to build a professional service team and provide customers with outstanding services. By narrowing the gap between service commitments and realities, as well as between the perceived quality and the expected quality, the logistics companies will be able to effectively improve the satisfaction of online shoppers in rural areas. in terms of advancing infrastructure construction, local governments should take the initiative to invest in the construction of distribution resources, which can be leased for use by logistics enterprises; logistics companies should make full use of social logistics resources in all aspects of rural distribution, such as using public transportation resources as transportation tools and public facilities resources as distribution nodes. Logistics companies can share distribution resources to reduce the idleness of logistics resources and improve the economic benefits of rural distribution.

Finally, in terms of the post-factors of customer satisfaction, "customer satisfaction" has a significant

positive impact on "customer loyalty". From the customer's point of view, they only need to be satisfied with this logistics service, but from the perspective of logistics companies, "customer satisfaction" is not enough, what the company needs is "customer loyalty", and satisfaction must be transformed. From the perspective of the path coefficient, the impact of "customer satisfaction" on "customer loyalty" is as high as 0.663, and customer satisfaction is the main influencing factor of customer loyalty.

Table 11. The direct effect, indirect effect and total effect among the latent variables in the model (standardized results)

	F1	F2	F3	F4
F2	0.368***	-	-	-
(Direct effect)	(7.24)	-	-	-
(Indirect effect)	-	-	-	-
(Total effect)	0.368	-	-	-
F3	-	0.961***	-	-
(Direct effect)	-	(27.55)	-	-
(Indirect effect)	0.354	-	-	-
(Total effect)	0.354	0.961	-	-
F4	-	-	0.938***	-
(Direct effect)	-	-	(26.33)	-
(Indirect effect)	0.332	0.902	-	-
(Total effect)	0.332	0.902	0.938	-
F6	-	-	-	0.663***
(Direct effect)	-	-	-	(12.94)
(Indirect effect)	0.22	0.598	0.622	-
(Total effect)	0.22	0.598	0.622	0.663
F5	-	-	-	0.981***
(Direct effect)	-	-	-	(28.90)
(Total effect)	0.325	0.885	0.920	0.981

Note: "\*\*\*\*" means it's significant at the level of 0.01. The figure in brackets refers to the corresponding C.R. value (t value). The parameters given in the table are all standardized parameters, and the direct effect is the path coefficient in the model.

## 5.4 Deepening Application of the Two-dimensional Combination Potential of Entropy Weight-Satisfaction Average Value

In order to enhance the application effect of the comprehensive evaluation model of customer satisfaction, this study adopts K-means clustering algorithm to cluster the satisfaction average value and entropy weighting result of the evaluation variables of customer perceived quality, and divides them into two regional levels. The average value of satisfaction is taken as the horizontal axis, the entropy weight is taken as the vertical axis, and the horizontal and vertical axes intersect at (4.14, 0.07), the plane is divided into four quadrants. According to the different characteristics of the quadrants, the analysis matrix is divided into four types of potential regions. Local governments, logistics companies and other entities should adopt differentiated development models and strategies for service elements in different quadrants. The details are shown in Figure 4.

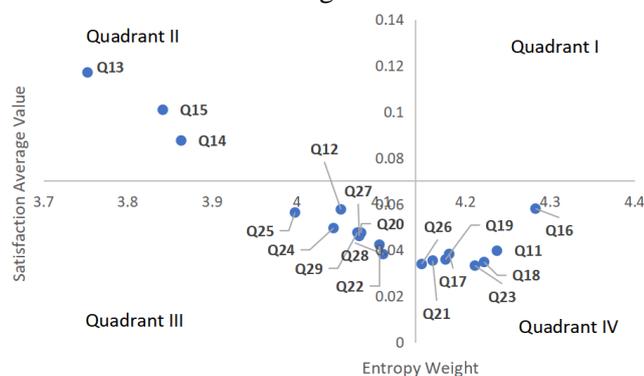


Fig.4 Diagram on the two-dimensional combination potential of entropy weight-satisfaction average value

Quadrant I is the continued maintenance area characterized by high relevance and high importance. Currently, no service elements have fallen into this zone. Quadrant II is a key area for improvement characterized by low relevance and high importance covering three service elements of Q13, Q14 and Q15, the degree of customer satisfaction with its service and the importance of the index are in an imbalanced state; regarding the service elements in this area, relevant entities should adopt the strategy of "active connection and priority improvement", and appropriately tilt resources to speed up the improvement of the service quality of the area elements to meet customer needs. Quadrant III is a low priority area characterized by low relevance and low importance, covering 8 service elements including Q12, Q20, Q22, Q24, Q25, Q27, Q28, and Q29. In the case of limited resources, relevant entities should adopt the strategy of "continuous attention and key breakthroughs" for the service elements in the region, and pay attention to the changes in customer expectations for indicators in the region, prioritize the development of system function

enhancement projects with great resource potential, and break the low degree of relevance in order to produce breakthrough effects. Quadrant IV is an intensive development area characterized by high relevance, low importance, and covering the remaining service elements. It has obvious oversupply phenomenon, but it is also an important factor affecting the popularity and brand of distribution services. For the service elements in this area, relevant entities should adopt the strategy of "integrate innovation and transfer resource" to gradually improve the resource allocation efficiency of the elements in the area, and on the basis of maintaining the overall strength of services, timely referral of some resources to the service elements of Quadrant II.

## 6 Conclusion

The value judgment of rural netizens on the process of last-mile delivery service in rural areas and the degree of achievement of the result goal has become an important link in the management innovation of the government, logistics enterprises and other entities to improve the quality of terminal distribution service.

Firstly, This study draws on the ASCI and SERVQUAL standard scale to design the customer satisfaction model with the service quality of last-Mile delivery in rural areas taking the expectations of rural customers, quality perceived by rural customers and value perceived by rural customers as the premise latent variables, and taking customer satisfaction, customer complaints and customer loyalty are the result latent variables. It takes 460 permanent residents in rural areas as the research objects, then constructs and tests the customer satisfaction model and deeply analyzes the relationship between customer satisfaction and its influencing factors. Empirical results showed: there are different key factors affecting the customer satisfaction with the service quality of last-mile delivery in rural areas. Among the premise factors of customer expectations, customer perceived quality and customer perceived value, customer expectations have an indirect effect on customer satisfaction through customer perceived quality and perceived value, and there are gaps between the indirect effects of the five elements of customer perceived quality on customer satisfaction, with assurance having the strongest indirect effect and intangibles having the weakest indirect effect. customer satisfaction is the main influencing factor of customer loyalty.

Secondly, in the case of limited resource input, adopting differentiated strategies based on the development characteristics of the five dimensions will be an important way for local governments, logistics companies and other entities to improve the customer perceived quality, customer satisfaction and customer loyalty. Local government and logistics companies can gradually improve customer satisfaction with the service

quality of last-mile delivery services in rural areas by catering to the actual needs of rural customers, revving up infrastructure construction, ensuring the confidentiality of customer information, further improving and optimizing the delivery routes, strengthening the training of employees, and improving the professional services of delivery.

Finally, in order to enhance the application effect of the satisfaction model, multi-agents should adopt differentiated development models and strategies for the characteristics of quality perception service elements in different combination potential areas, including continued maintenance areas, improved key areas, lower priority areas, and intensive development areas.

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#### Author contribution

Yuh-jen Cho conceived idea; Lin Xue performed the data analysis and wrote the paper; Shu-rong Huang and Zhe-peng Yang collected the data and revised the paper.

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