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Functional Optimization of Rural House-Sharing Transformation: A Demand-Oriented Approach Using the Refined Kano Model

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Abstract: With the intensification of urbanization across China, the underutilization of rural housing resources has emerged as a pressing socio-economic and spatial challenge. To enhance the efficiency of shared rural housing transformation and support rural revitalization strategies, a data-driven framework was developed to identify and prioritize hierarchical user demand attributes. Demand items were initially derived through an extensive literature review and subsequently refined using a modified Kano model, informed by structured questionnaire surveys. To strengthen attribute prioritization and functional alignment, the Importance-Satisfaction (I-S) model and the Configuration Index Model were employed for triangulated classification. Findings revealed that structural safety (A11) constitutes a highly attractive attribute, exerting a strong influence on user satisfaction when addressed, yet inducing minimal dissatisfaction when absent. Smart home (A4) and green materials (A7) were identified as key quality attributes, essential for functional enhancement and user experience optimization. In contrast, cost-effectiveness (A1) and investment return (A2) were classified as high-value-added attributes, playing a pivotal role in decision-making among economically motivated users. New energy utilization (A8) and green design (A9) were categorized as fundamental, non-negotiable attributes, reflecting evolving sustainability expectations. Meanwhile, cultural inheritance (A15) and cultural display (A17) exhibited characteristics of low-attractiveness attributes, indicating limited influence on user satisfaction. Salvage (A10) emerged as a potential quality attribute with latent user recognition. The resulting demand classification elucidates a structured pathway for functional optimization, offering a robust analytical lens for the adaptive transformation of idle rural properties into shared accommodation assets. The applicability of the refined Kano model in rural spatial redevelopment was thereby validated. By integrating multidimensional user preferences and sustainability considerations, this study contributes an empirically grounded decision-support tool for policymakers, designers, and stakeholders engaged in rural land use regeneration and housing innovation. The proposed framework holds significant implications for the sustainable utilization of dormant rural infrastructure within broader urban-rural integration agendas.

Keywords: Refined Kano model; Shared transformation; Farm house; Rural land use; User requirements analysis

1 Introduction

In recent years, with the deepening implementation of China's rural revitalization strategy, how to improve the rural living environment [1], coordinate the spatial layout of rural areas [2], and enhance farmers' quality of life have become key measures that have attracted widespread attention from all sectors of society. Rural housing renovation, as one of the important measures in practicing the rural revitalization strategy, mainly takes three forms: First, government-led dilapidated house renovations [3] and earthquake-resistant housing projects, whose core goal is to ensure basic housing safety for farmers; Second, house renovations and expansions primarily carried out by farmers themselves, focusing on improving living conditions and enhancing the aesthetics of houses; Third, rural tourism [4] homestay renovations led by social capital participation, which involves revitalizing idle farmhouses to develop special rural industries and promote diversified rural economic development. Although these three renovation models have, to some extent, improved and repaired rural houses, they suffer from issues such as low resource utilization,

outdated renovation methods, and lack of sustainability due to their single-minded focus on participants, hindering the improvement of the rural living environment and the enhancement of the "aesthetic appeal" of rural areas.

The birth of the concept in the sharing economy has brought new methods and approaches to solving traditional renovation models [5]. Integrating the sharing economy concept into house renovations involves coordinating and operating rural housing resources, launching shared renovation projects for farmhouses, and achieving the reuse of idle farmhouses while creating certain economic value. This not only increases farmers' income but also meets urban residents' desire to visit rural areas, get close to nature, and experience rural life, pastoral life, and hometown sentiment [6], promoting integrated urban-rural development. However, during the specific implementation of shared farmhouse renovation projects, a series of issues have emerged, such as whether the functions of the renovated farmhouses are fully [7], how to ensure quality and safety, and unclear responsibility. These problems significantly limit the exploration and sustainable development of shared farmhouse renovations. At the same time, there are still certain knowledge gaps in the current academic research on the transformation of rural houses into shared spaces. On one hand, most existing studies focus on analyzing traditional renovation models, lacking a systematic exploration of the transformation model under the sharing economy concept. On the other hand, specific issues that arise during the transformation process have not yet been addressed with a set of scientific, reasonable, and targeted solutions. Furthermore, the selection of user-oriented design methods in existing research lacks a thorough evaluation of the applicability of the Kano model, failing to adequately highlight its advantages over other methods.

Based on the above issues, this paper takes Lidu Town in Nanchang of Jiangxi Province as a case study. Through field research, questionnaire surveys, and data comparison, it delves into strategies for enhancing the shared transformation of rural houses. It compares and discusses how to scientifically and reasonably design and apply technology to effectively increase the rate of shared transformation of rural houses, thereby promoting the sustainable development of rural house sharing transformation, providing a theoretical basis and practical significance for achieving rural revitalization [8].

This paper will first review the relevant literature, sort out the current situation and challenges of rural house sharing transformation, introduce research methods, discuss through case analysis, put forward specific strategies to improve the quality of rural house sharing transformation, summarize research conclusions, put forward suggestions, and clarify the future research direction.

2 Literature Review

To achieve Chinese-style modernization, it is essential to accelerate the comprehensive revitalization of rural areas. As the process of urban-rural integration accelerates, the number of idle houses in rural areas is increasing, and issues such as relatively low land use efficiency are becoming more prominent [9]. According to statistics, the current area of idle houses in rural China has exceeded several hundred million square meters, with a large amount of land resources not being effectively utilized [10]. The low utilization rate of these resources only manifests as land resource waste [11] in the short term, but looking ahead, the low utilization rate of idle farmhouses and land hinders the expansion of farmers income channels, obstructs county-level urban-rural planning layouts [12], and constrains the development of the rural economy, slowing down the implementation of the comprehensive revitalization strategy for rural areas. In this context, how to activate idle rural houses and land resources [13] has become a focal point of academic and policy circles. This includes, but is not limited to, government-led renovation of dilapidated houses, farmer-initiated self-construction house renovations [14], social capital participation in rural tourism development, exploring regionally distinctive shared housing renovations, promoting the development of urban-rural tertiary industries, and integrating infrastructure and public services. In recent years, various models have emerged for the transformation and utilization of idle rural houses and land. However, these models still face different issues at different stages during their implementation: low resource utilization rates and transformation models. The single mode and insufficient sustainability [15] make it difficult to meet the diversified needs of rural development.

By thoroughly understanding and analyzing the three current forms of rural housing renovation, it is evident that the government-led renovation model, represented by the renovation of dilapidated houses and the Seismic Safety Housing Project [16], aims to ensure basic housing safety for farmers. The improvement of rural housing conditions has enhanced the quality of life for farmers, which has been achieved through policy support and financial investment [17]. However, scholars point out that this model suffers from issues such as uneven resource distribution and a single standard for renovations, making it difficult to meet the diverse needs of farmers.

The self-initiated renovation model by farmers mainly focuses on the renovation and expansion of houses [18], primarily aimed at improving living conditions and enhancing the aesthetic appeal of the buildings. This form of renovation emphasizes the primary role of villagers, with modifications tailored to their actual needs. However, due to the lack of unified planning and professional technical support, the quality of renovations varies widely, making it difficult to achieve economies of scale [19]. To some extent, these two forms of renovation overlook the comprehensive utilization of idle land [20], failing to fully leverage its economic value and leading to resource wastage.

Social capital [21] participation in the development model involves revitalizing idle rural houses for renovation into

countryside bed-and-breakfasts, promoting rural tourism and other specialty industries, advancing the diversification of the rural economy, increasing farmers' income, meeting urban residents' diverse needs for rural life, and fostering integrated urban-rural development. After a long period of adjustment, high renovation costs, a single model, homogenized cultural content [22], and low economic efficiency conversion rates are the pain points that social capital participation in the development model struggles to overcome.

In the existing research on the transformation and utilization of idle rural houses and land, previous ideas and practices have provided valuable theoretical support from different dimensions, aiding in the formulation of relevant policies. Government-led initiatives, farmer self-construction, and social capital participation have led to a series of distinctive transformation models. However, these studies also have limitations: a single perspective due to a single entity, fragmented research on function and quality, and a lack of sustainability considerations. In particular, there is a need for further exploration in areas such as the alignment between user needs and functional design [23], the establishment of a quality evaluation system for transformations, and comprehensive assessments of ecological, economic, and social benefits. On this basis, the perspective of the sharing economy has opened up new pathways for the shared transformation of rural houses. This paper aims to delve into effective strategies for the shared transformation of rural houses from two major dimensions: functional design and quality improvement. By combining field research and case studies, it seeks to provide more comprehensive and in-depth theoretical guidance and practical references for the sustainable utilization [24] of idle rural houses and land.

Under the concept of the sharing economy, transforming rural houses into shared spaces to achieve multifunctional use and value enhancement has become a new trend in the reutilization of idle rural houses and land. By revitalizing idle assets in rural areas, this transformation provides diverse rural living experiences for urban and rural residents, promoting integrated urban-rural development [25]and serving as a crucial component of the rural revitalization strategy. However, issues such as unreasonable functional design and substandard renovation quality are widespread during the process of transforming rural houses. How to shift the focus of rural house renovations from "the surface" to "the essence", ensuring consistency between appearance and substance, is an urgent issue that needs to be addressed in the exploration and discussion of this article.

In past studies on rural transformation and traditional models, while some research has addressed user needs analysis, most have relied on traditional user-centered design methods, lacking a deep application of the Kano model. The Kano model, as a user-centered design approach, can effectively prioritize user needs. By integrating the improved Kano model into a broader participatory rural design framework, it can better meet the diverse needs of farmers and urban residents. Additionally, it can focus on functional design and quality improvement, building a scientific and reasonable evaluation system for transformation quality. This provides comprehensive and in-depth theoretical guidance and practical references for the sustainable use of idle rural houses and land.

This article aims to provide comprehensive and in-depth theoretical guidance and practical references for the sustainable use of idle rural houses and land by focusing on functional design and quality improvement. By applying the modified Kano model to the renovation projects of shared rural houses, it seeks to address the gaps in existing research regarding user needs and functional design alignment, the establishment of a quality evaluation system for renovations, and the assessment of overall benefits. This approach is intended to strongly support the implementation of the rural revitalization strategy.

3 Study Theories and Methods

3.1 Principles of Improved Kano Model Usage

The traditional Kano model [26] is a classic tool for analyzing the relationship between customer needs and product features. It categorizes and prioritizes functions through surveys, helping businesses identify how functions impact customer satisfaction. The requirements are divided into five categories: basic needs, expected needs, attractive needs, no-difference needs, and reverse needs. However, the traditional model has limitations, primarily relying on qualitative analysis without quantitative evaluation, making it difficult to assess the importance of functions, which results in less precise decision-making.

To overcome these limitations, researchers have refined and extended the A-Kano model [27] and the Kano model [28]. The A-Kano model introduces Kano indices (importance index and satisfaction index) and decision support mechanisms (Kano classifier and configuration index), integrating customer satisfaction with producer capabilities to enhance the model's quantitative analysis capabilities. The refinement and expansion of the Kano model further divide the first four categories of attributes into eight, combining the Importance-Satisfaction (I-S) model to more accurately assess requirements.

Based on this, the study proposes a refined Kano model, integrating the quantitative analysis of the A-Kano model and the classification after refining the Kano model. It introduces the Kano index and configuration index, combining them with the I-S model to categorize quality attributes into excellent areas, areas for improvement, excess areas, and carefree areas. This model combines quantitative and qualitative analysis, providing a more comprehensive reflection of the complexity and dynamic changes in requirements. Through the configuration index, it accurately identifies key

requirements, optimizing resource allocation. Building on the first four categories of the traditional Kano model, we refer to relevant studies for deeper classification, expanding it to eight categories: high (low) value-added, high (low) appeal, necessary and critical, and potential and carefree.

In the study, some one-dimensional attributes of higher importance are defined as high-value-added quality attributes, while the rest are low-value-added quality attributes; and from the perspective of attractiveness, they are categorized into high-attractiveness and low-attractiveness quality attributes; to a necessary extent, they are divided into critical and essential and further refined into worry-free and potential quality attributes based on their indifference level. Figure 1 and Table 1 provide an improved explanation of the Kano quality attributes, illustrating the method for redefining quality attributes.

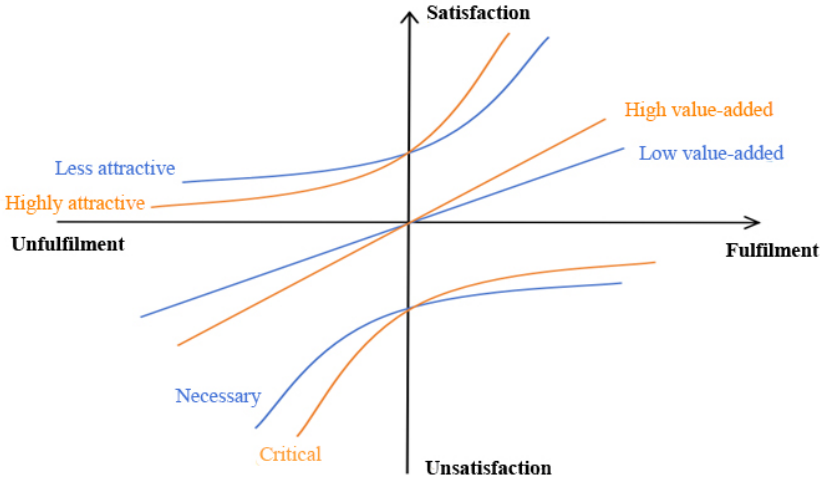

Figure 1. Improved Kano quality attributes

Table 1. Classification of quality attributes of Kano model

Traditional	**Improved**	
One-dimensional properties	High added value	Low added value
Attractiveness	Highly attractive	Low attractive
Necessary to the extent	Critical	Necessary
Indifference	Underlying	Carefree

3.1.1 Kano index number

As a quantitative indicator to measure customer satisfaction and dissatisfaction with specific functional requirements, the Kano index converts customer functional requirements into specific values through data collected by the Kano questionnaire, so as to better understand and prioritize customer needs.

(1) Importance Index: Here, the average score for functional issues and non-functional issues is calculated to determine the importance index of each functional requirement. Functional refers to positive scores, while non-functional refers to negative scores. The importance index indicates the impact of the functional requirement on overall customer satisfaction. A higher value suggests that the functional requirement is more important to the customer r_i, X_i, Y_i. The specific form of the formula is shown in Figure 2.

$$\mathrm{r}_i = \sqrt{X_i^2 + Y_i^2} \tag{1}$$

(2) Satisfaction Index: The satisfaction index is obtained by calculating the angle between customer satisfaction and dissatisfaction with functional requirements. The satisfaction index reflects the relative level of customer satisfaction and dissatisfaction with functional requirements. An angle closer to 0 degrees indicates that the absence of functional requirements would lead to customer dissatisfaction, but the presence of these requirements does not significantly enhance customer satisfaction; an angle closer to 90 degrees indicates that the presence of functional requirements would greatly increase customer satisfaction, However, the lack of these requirements has little impact on customer satisfaction. See Figure 3 for the detailed formula.

$$a_i = \arctan\left(\frac{Y_i}{X_i}\right) \tag{2}$$

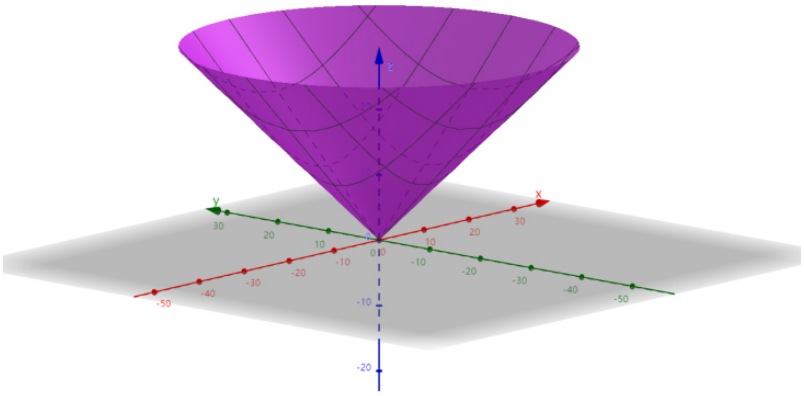

Figure 2. Formula of importance index

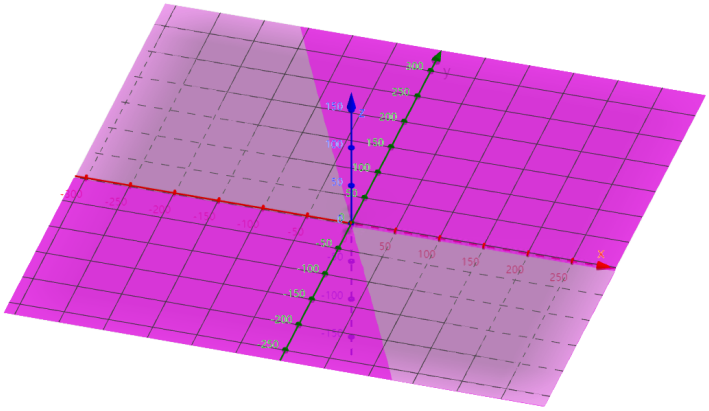

Figure 3. Formula of satisfaction index

3.1.2 Configuration index: p_i

The configuration index is a quantifiable metric derived from the Kano Index (which includes the Importance Index and Satisfaction Index). It is used to evaluate the priority of each functional requirement in product configuration, reflecting the relative importance of these requirements in meeting customer needs. The introduction of this metric aims to address the shortcomings of traditional Kano models in supporting engineering design decisions. By assigning a configuration index to each functional requirement, companies can more effectively determine the priority of functional requirements during the product design process, thereby optimizing product configuration and enhancing market competitiveness and customer satisfaction. See Figure 4 for the formula.

$$p_i = \frac{2}{\pi}(1 - a_i) \cdot r_i \tag{3}$$

p_i is the configuration index of functional requirements.

a_i is the satisfaction index of functional requirements, which indicates the relative level of customer satisfaction and dissatisfaction with functional requirements.

r_i is the importance index of functional requirements, indicating the impact of the functional requirements on the overall customer satisfaction.

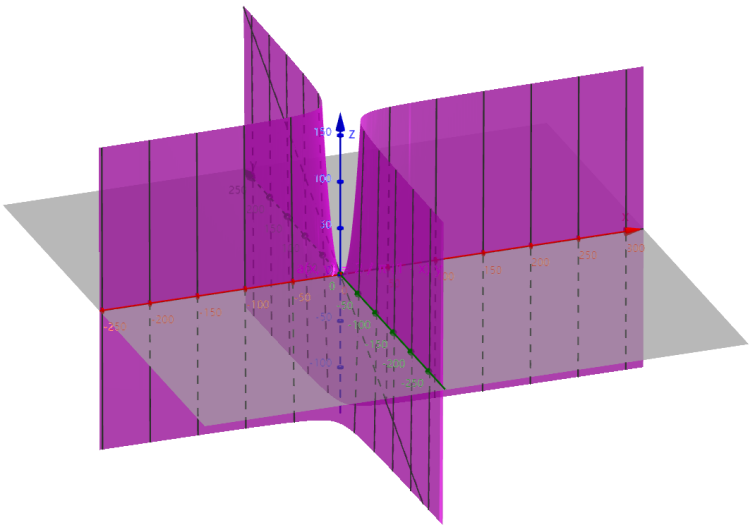

Figure 4. Configuration index formula diagram

The configuration index is proportional to the importance index, meaning the greater the impact of functional requirements on customer satisfaction, the higher the configuration index. The configuration index is inversely proportional to the satisfaction index, meaning the closer the functional requirements are to essential attributes (smaller angle), the lower the configuration index; the closer the functional requirements are to attractive attributes (larger angle), the higher the configuration index.

3.1.3 Demand attribute classification

We first classify the quality attributes of requirements according to the importance index and satisfaction index, and set reasonable thresholds for the importance index and satisfaction index. First, calculate the median and average value of the two indexes to understand the general category of each requirement, and then modify the threshold to make the classification of requirements more uniform and reasonable.

At the same time, in the refined Kano model, we combine the traditional classification method with the configuration index. By partitioning the configuration index, different partitions correspond to different requirements and quality attributes, so as to achieve the classification results. The correlation between quality attributes and configuration index is shown in Table 2.

Table 2. Correlation between quality attributes and configuration index

No.	Quality Attribute Categories	Quality Attribute Description
1	High attractiveness	The configuration index is very high,and customers' satisfaction has improved significantly.
2	Low attractiveness	The configuration index is relatively low, and the improvement of customers' satisfaction is not obvious.
3	High value-added attributes	The configuration index is high, and the customers' satisfaction with these attributes increases in direct proportion to their importance.
4	Low value-added attributes	The configuration index is low, and the improvement of customers' satisfaction with these attributes is not proportional to their importance.
5	Key attributes	The configuration index is very high, and customers are very satisfied with and important to these attributes.
6	Necessary attributes	The configuration index is relatively high, and customers are more satisfied with and important to these attributes than key attributes.
7	Inherent nature	The configuration index is moderate, and customers' satisfaction and importance of these attributes are relatively high, but may not be fully recognized at present.
8	The carefree attributes	The configuration index is low, and customers have low satisfaction and importance to these attributes.

3.2 Importance-Satisfaction (I-S) model

By analyzing the importance and satisfaction of customers to each attribute, the I-S model [29] usually represents a two-dimensional coordinate system, with the horizontal axis representing the importance and the vertical axis representing the satisfaction. The attributes are divided into four regions according to these two dimensions,as shown in Figure 5.

(1) Excellent region (high investment, high investment): These attributes are very important to customers and customers are very satisfied with their current performance. In order to maintain high customer satisfaction, these attributes can be maintained or fine-tuned to avoid excessive investment and waste of resources.

(2) Areas to be improved (high-intensity finance, low cost): These are important to customers, but they have attributes of dissatisfaction with their current performance (deco). Prioritize improving these attributes to enhance customer satisfaction. To ensure that the performance of these attributes meets or exceeds customer expectations, we will invest more resources and effort.

(3) Excess areas (low importance, high satisfaction): Attributes that are not important to the customer but are very satisfactory to the customer for their current performance. Consider whether it is necessary to reduce the investment in these attributes to save resources and costs. However, be careful not to overcut them, so as not to affect the overall satisfaction of the customer.

(4) Unimportant attributes (low importance, low satisfaction): These attributes are not very important to customers, and they are currently unsatisfactory. Generally, there is no need to pay much attention to or invest in these attributes, as their impact on overall customer satisfaction is minimal. Unless these attributes become important in the future, they can be given secondary importance.

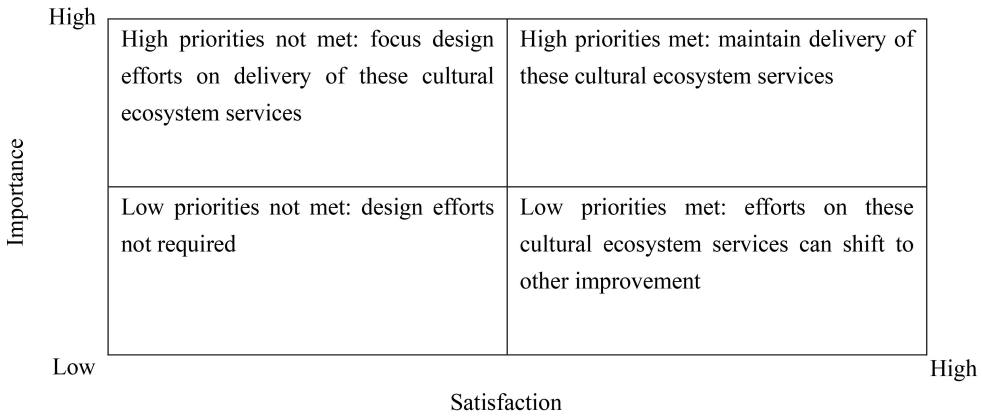

Figure 5. I-S model diagram

3.3 SWOT Analysis

SWOT analysis [30] is a method for analyzing a company's competitive position and is one of the fundamental analytical methods in marketing. It analyzes the company's internal strengths and weaknesses (Weaknesses) based on its resources, as well as external opportunities and threats (Threats), then selects appropriate strategies. SWOT analysis helps companies formulate corresponding development strategies, plans, and countermeasures, conducting a thorough and comprehensive analysis of themselves and contributing to the positioning of their competitive advantages. When performing SWOT analysis, it is necessary to objectively recognize the company's strengths and weaknesses, distinguish between the current state and future prospects, consider all aspects comprehensively, and compare with competitors to find suitable advantages in the overall analysis.

3.4 Questionnaire Survey Method

The questionnaire survey method [31] is an empirical research approach that systematically collects user needs and preferences. It involves distributing pre-designed questionnaires to respondents, who then fill them out. The collected data is then processed to obtain the required information. This method can be primarily divided into closed-ended and open-ended questionnaires, used for both qualitative and quantitative research. It aims to understand the perspectives, attitudes, and needs of respondents, making it suitable for various fields such as sociology and psychology. The survey methods include face-to-face, telephone, online, and other forms of questionnaire completion.

In this study, we used the questionnaire method to collect data. The questionnaire design included a series of questions designed to evaluate the transformation of rural houses into shared houses. We selected residents in Lidu

Town in Nanchang of Jiangxi Province as the subjects of the survey, and distributed the questionnaires by means of field distribution.

The composition of this questionnaire mainly includes questions, an introduction, questions and answers, as well as a conclusion. Among these, the questions and answers form the main structure of the questionnaire. The design of the questions should be based on the survey outline and actual circumstances. The first half typically collects basic information about the respondents, while the second half gathers their opinions and responses. A well-designed set of questions and answers can enhance the quality of the questionnaire. During the development process, it is essential to clarify the research objectives and target population, construct a theoretical framework, design the questionnaire structure, and develop the questions and answers. Before the actual survey, a pre-test of the questionnaire is also necessary to assess its reliability and validity. In this study, the questionnaire design adheres to the principles of simplicity, neutrality, and comprehensiveness. It uses a five-point Likert scale [31, 32] to quantify user satisfaction and importance regarding the demand for shared rural housing renovation through positive and negative options.

3.5 Reliability and Validity Assessment

Reliability and validity [33] are key indicators for assessing the quality of questionnaires. Reliability refers to the consistency, reliability, or homogeneity of measurement results. It can be divided into internal reliability and external reliability. Internal reliability indicates whether a set of questions in a survey measures the same concept, i.e., how consistent these questions are with each other. External reliability refers to the degree of consistency when the same questionnaire is repeatedly measured on the same subject at different times. The most commonly used method to measure reliability is the Cronbach's alpha (Cronbach's alpha):

$$\alpha = \frac{N}{N-1}\left(1 - \frac{\sum_{i=1}^{N}\sigma_i^2}{\sigma_t^2}\right) \tag{4}$$

N: The total number of items in the scale;
σ_i^2: The variance of question i;
σ_t^2: The variance of the total score.

Its value is usually between 0 and 1. If the reliability coefficient of the scale is above 0.9, it indicates that the scale has good reliability; if between 0.8 and 0.9, it indicates acceptable reliability; if between 0.7 and 0.8, it indicates that revision is needed; if below 0.7, the questionnaire may need to be redesigned.

Validity testing refers to the examination of the effectiveness of a questionnaire. In simpler terms, it aims to determine whether the designed items are reasonable and can effectively reflect the research objectives of the researcher. The purpose of validity analysis is to assess whether the research items can effectively measure the variables that the researcher intends to measure. Common types of validity analysis include content validity analysis and structural validity analysis. Content validity analysis evaluates the applicability of questionnaire items in measuring related concepts, i.e., the rationality of item design. Structural validity analysis, on the other hand, examines the correspondence between measurement items and measured variables, with methods including exploratory factor analysis and confirmatory factor analysis.

4 Research Process on Prioritization of Vacant Housing Demand Items

4.1 Identification of the Needs for Sharing Rural Housing

4.1.1 Determination of questionnaire requirements

During the conduct of this study, we adopted a multi-faceted and comprehensive approach to data collection and analysis, ensuring both breadth and depth of information. First, the research team utilized the globally renowned academic resource platform–Web of Science (WOS) database, employing specific keyword combinations and search criteria to comprehensively and systematically retrieve literature related to home renovation.

At the same time, in order to better grasp the current housing design market trends and consumer preferences, we visited the Archcollege website, which is a high-quality platform for architects around the world, with a lot of cutting-edge architectural design concepts and practice cases. We sorted out some of the more satisfactory elements of housing design.

In addition, considering the particularity and policy orientation of idle house renovation under the rural revitalization strategy, we obtained a large number of relevant policy documents and research reports from the Chinese Academy of Natural Resources Economics. Based on collecting extensive literature and market information, the research team further conducted field investigations, delving into rural areas to engage in face-to-face communication and interviews with local residents. They thoroughly understood their actual needs and expectations regarding the renovation of idle farmhouses and provided specific suggestions and recommendations for the renovation work. Through meticulous observation and in-depth exchanges, we summarized 17 potential needs of local users for the

renovation of idle farmhouses, which were detailed and organized, numbered A1-A17. These needs cover many aspects, providing rich and specific data support for our subsequent research, ranging from economic benefits and convenience to green practices, safety, and cultural significance. User requirements can be seen in Table 3.

Table 3. User requirements indicators

Demand Nature	Requirement	Demand Coding	Requirements Description	Literature Reference
Economic efficiency	Cost-effectiveness	A1	The renovation cost is within the budget and the cost performance is pursued.	[34]
	Investment return	A2	The renovated houses can bring economic benefits, such as renting and operating B&Bs.	[35]
	Subsidy policy	A3	Use government subsidies or tax incentives to reduce the cost of renovation.	[36]
Convenience	Smart home	A4	The interior electrical appliances of the house are intelligent and convenient to use.	[37]
	Tending	A5	The structure and facilities of the house are easy to maintain, reducing long-term maintenance costs.	[38]
	Convenient transportation	A6	The house should be convenient for transportation after renovation.	[39]
Green attributes	Green materials	A7	Use environmentally friendly and energysaving materials to reduce energy consumption.	[40]
	New energy utilization	A8	Reduce energy consumption during house renovation.	[41]
	Green design	A9	Use green building design, such as natural lighting, rainwater collection system, etc.	[42]
	Salvage	A10	Use recyclable materials to reduce construction waste.	[43]
Safety	Structural safety	A11	Ensure that the structure of the house is stable and meets building safety standards.	[44]
	Fire-protection standard	A12	Meet fire protection requirements and be equipped with necessary firefighting facilities.	[45]
	Security facilities	A13	Install anti-theft doors and Windows, and monitoring system to improve security.	[46]
	Healthy environment	A14	Use non-toxic and harmless decoration materials to ensure the health of residents.	[47]
Culture	Cultural inheritance	A15	Preserve and restore architectural elements of historical and cultural value.	[48]
	Local characteristics	A16	Integrate local cultural characteristics, such as the use of local traditional building materials and decoration.	[49]
	Cultural display	A17	Some houses are transformed into special buildings, such as folk museums and cultural centers.	[50]

4.1.2 The investigation process

In this study, a comprehensive approach was adopted, integrating field research, literature review, and questionnaire surveys to ensure a thorough and in-depth methodology. First, we referred to relevant literature on the Kano model and developed a Kano questionnaire about the demand for shared renovation of idle rural houses. This accurately measured and quantified various indicators of local residents' needs for the renovation of idle rural houses, providing a reliable basis for subsequent research analysis.

In March 2024, the research team conducted a field survey in Lidu Town, Jinxi County, Nanchang, Jiangxi Province, China. Lidu Town boasts unique geographical conditions and abundant natural resources, including fertile land suitable for agricultural production and rich water and forest resources that strongly support local residents' livelihoods and economic development. In terms of economic development, Lidu Town stands out significantly. Its medical device industry and liquor industry have become the two major pillars of the local economy, enjoying high

recognition and competitiveness in the market. Moreover, Lidu Town has achieved remarkable success in e-commerce, with local enterprises promoting their specialty products to national and even global markets through e-commerce platforms, further driving rapid economic growth.

Especially, a certain proportion of idle rural houses in Lidu Town provides rich practical scenarios and potential market space for shared renovation of farmhouses. Examining the dual needs of residents and tourists, the favorable conditions of Lidu Town offer us convenience. Through conducting research in Lidu Town, we hope to develop a replicable model for rural revitalization, providing valuable references for other regions.

During the field research, our team members visited residents' homes in the jurisdiction, engaging in face-to-face communication with them. We provided detailed explanations of the purpose and significance of this survey to the residents, patiently answered their questions, and guided them through the completion of the survey questionnaire. In this way, we collected a large amount of firsthand data on local residents'views on existing vacant houses and their expectations for renovation, which will provide valuable data support for our subsequent research and analysis.

During the research process, members conducted a comprehensive visit and recorded the existing idle houses in Lidu Town. During the visits, each member observed the architectural structure and appearance of the existing idle houses, and meticulously documented information such as their geographical location, surrounding environment, and ownership. These records provide a direct basis for understanding the current status of idle houses in the town and serve as important references for subsequent reconstruction planning and design.

While conducting field research, the project team also collected a large amount of existing research findings and practical cases by reviewing the current status of idle house renovations, relevant policies for rural revitalization, academic studies, and news reports. Through in-depth analysis of these materials, they gained a more precise understanding of the development direction and key points of shared renovation of idle farmhouses, providing strong theoretical support and practical guidance for feasible renovation plans in the next phase.

4.1.3 Reliability and validity analysis of questionnaire

The statistical results of the questionnaires' reliability and validity parameters are shown in Table 3. The positive and negative Cronbach's α coefficients for the economic, convenience, greenness, and safety needs all fall between 0.756 and 0.845, which is generally considered an acceptable level of reliability, indicating that the questionnaire has good internal consistency. The KMO values for both positive and negative items are greater than 0.6, meeting the requirements. Additionally, the Bartlett's test values for both positive and negative items are less than 0.001, suggesting that the data is suitable for factor analysis. These data indicate that this questionnaire has high quality and is appropriate for subsequent statistical analysis and research. The results of questionnaire data analysis are shown in Table 4.

4.2 Use of Refined Kano Model

This study is based on the refined Kano model, collecting customer needs through a Kano questionnaire. The survey was conducted both offline and online simultaneously, resulting in a total of 256 completed questionnaires. Among these, 18 were invalid, leaving 238 valid responses, with an effective rate of 92.97%. The valid questionnaires were statistically analyzed, revealing a balanced gender distribution, diverse age range, broad occupational diversity, and income levels: the number of male and female samples is nearly equal, covering ages from teenagers to seniors, spanning various occupations including students, corporate employees, government or public institution staff, and others. Monthly incomes range from no income to high-income levels. Notably, the sample includes a significant proportion of middle-aged individuals aged 18-45 and middle-income groups earning between 5,000-8,000 yuan per month, reflecting their active participation and representativeness in society. Overall, the questionnaire data demonstrates a certain level of breadth and representativeness, providing a comprehensive reflection of the perspectives and needs of different social groups.

According to the relevant data collected by the questionnaire, corresponding calculations are made. First of all, the Kano index is considered to calculate the average score of functional problems and non-functional problems. On the basis of the average score, the satisfaction index and importance index of each requirement item are calculated, and the results are shown in Table 5.

According to the importance index and satisfaction index obtained, we draw the I-S model of demand items. We use the median of the two indices as the coordinate origin to divide the data obtained from demand items into four regions, and the nature of demand items is divided as shown in the Figure 6. The corresponding results of each region are shown in Table 6.

Table 4. Reliability and validity analysis of questionnaire

Demand Nature	Request Content		Reliability Analysis		Factor Analysis			
			Cronbach α Coefficient		KMO Price		Bartlett Spherical Test Value	
			Forward Direction	Opposite Direction	Forward Direction	Opposite Direction	Forward Direction	Opposite Direction
Economic efficiency	Cost-effectiveness	A1	0.781	0.805	0.696	0.713	< 0.001	
	Investment return	A2						
	Subsidy policy	A3						
Convenience	Smart home	A4	0.756	0.773	0.686	0.699		
	Tending	A5						
	Convenient transportation	A6						
Green attributes	Green materials	A7	0.842	0.845	0.816	0.818		
	New energy utilization	A8						
	Green design	A9						
	Salvage	A10						
Safety	Structural safety	A11	0.838	0.803	0.810	0.800		
	Fire-protection standard	A12						
	Security facilities	A13						
	Healthy environment	A14						
Culture	Cultural inheritance	A15	0.807	0.777	0.713	0.697		
	Local characteristics	A16						
	Cultural display	A17						

Table 5. Kano index table

Demand Coding	Average Score for Functional Problems	Average Score for Nonfunctional Problems	Key Indicators (r_i)	Satisfaction Index (a_i)
A1	3.866	2.181	4.438	1.044
A2	3.861	2.185	4.437	1.056
A3	3.828	2.113	4.372	1.071
A4	3.824	2.223	4.423	1.057
A5	3.895	2.118	4.433	1.069
A6	3.920	2.038	4.418	1.073
A7	3.895	2.168	4.458	1.068
A8	3.870	2.126	4.415	1.063
A9	3.870	2.122	4.413	1.064
A10	3.832	2.084	4.362	1.091
A11	3.920	2.332	4.561	1.065
A12	3.861	2.130	4.410	1.066
A13	3.840	2.097	4.375	1.073
A14	3.874	2.193	4.452	1.056
A15	3.777	2.097	4.320	1.034
A16	3.845	2.034	4.349	1.084
A17	3.710	2.055	4.241	1.067

Table 6. I-S model requirements results

Region	Demand Coding
Excellent area	A5, A6, A7
Areas for improvement	A1,A2, A4, A11, A14
A carefree zone	A8, A9, A15
Surplus areas	A3, A10, A12, A13, A16, A17

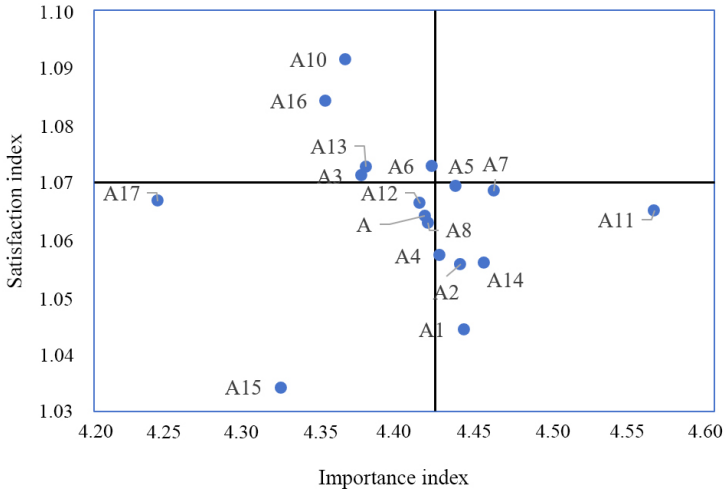

Figure 6. I-S model results diagram

Based on the results of the importance index and satisfaction index, as well as the I-S model, we select the median of these two indices as the threshold for classifying quality attributes of requirements. However, the resulting classification is overly concentrated in one category, leading to unclear delineation of requirement properties. We then reset the threshold to ensure that requirement attributes are relatively evenly distributed across the eight quality attributes. The revised importance thresholds are: High Importance>4.45; Medium Importance 4.35-4.45; Low Importance <4.35. The satisfaction thresholds are: High Satisfaction>1.07; Medium Satisfaction 1.05-1.07; Low Satisfaction <1.05. These thresholds were optimized based on classification balance: the traditional three-category method (high/medium/low) requires each category to account for about 30-40%, but the original median led to a high importance ratio of 58%. We adjusted the threshold accordingly, using the percentile method: Importance: High (27%) / Medium (46%) / Low (27%); Satisfaction: High (24%) / Medium (28%) / Low (48%). Ultimately, when forming an 8-category combination, each category is controlled within a reasonable range of 5%-15%.

The classification results obtained below the threshold are shown in Table 7. In the classification of quality attributes obtained using a single importance index and satisfaction index, there are certain issues: using only two dimensions-importance and satisfaction-for classification may fail to fully reflect the complex impact of quality attributes on customer satisfaction and loyalty. Setting thresholds for importance and satisfaction can be somewhat subjective, and different threshold settings can lead to different classification results. How to select appropriate thresholds to ensure the reasonableness and effectiveness of the classification is a challenge. Moreover, single-dimensional analysis may fail to identify these potential improvement opportunities.

Table 7. Initial mass property classification

Kano Attribute	Requirement Item Code
High value-added quality attributes	A1, A2, A7, A14
Low value-added quality attributes	A15, A17
Highly attractive quality attributes	A5, A6, A10, A13
Low attractive quality attributes	A16
Necessary quality attributes	not have
Key quality attributes	A11
Potential quality attributes	A3, A8, A9, A12
Carefree quality attributes	not have

We adopt the refined Kano model by integrating the configuration index proposed in the A-Kano model. By partitioning the configuration index, we achieve the effect of categorizing quality attributes. Its advantages include: combining importance and satisfaction indices to reflect customers' overall preferences and expectations for a particular attribute. Classifying through the configuration index allows for a more comprehensive consideration of customers' overall evaluation of attributes, not just single satisfaction or importance. Through classification using the configuration index, different types of attributes (such as high attractiveness, high value-added, key, etc.) can be given attention. Therefore, we use the configuration index with the satisfaction index, and the importance index with the Kano quality attribute classification, based on data distribution and descriptive statistics for categorization.

The configuration index reflects the possibility of including specific functional requirements when considering

customer satisfaction and producer capacity. Therefore, we combine the configuration index with Kano quality attributes to rank the priority of corresponding requirements. The ranking results are shown in Table 8.

Table 8. Demand attributes

Kano Attribute	Requirement Item Code
Highly attractive quality attributes	A11
Key quality attributes	A4, A7
High value-added quality attributes	A1, A2
Necessary quality attributes	A8, A9
High value-added quality attributes	A12, A13
Low attractive quality attributes	A15, A17
Potential quality attributes	A10
Carefree quality attributes	A16

Table 9. Conversion of required functions

Demand Nature	Demand Coding	Functional Requirements (FRs)	Functional Requirements Description
Economic efficiency	A1	Budget optimization and renovation plan	Detailed cost budget and revenue forecast are carried out in the design phase
	A2	Value-added residential space design	Add extra living or commercial space
	A3	Policy-driven energy saving transformation	Use government subsidies for energy conservation
Convenience	A4	Intelligent system integration	Intelligent lighting, intelligent security, intelligent home appliance control and other systems integration
	A5	Easy to maintain design	In the design, the easy inspection of the structure, the easy replacement of facilities and so on are considered
	A6	Traffic convenience design	Reasonable traffic flow line design, sufficient parking space configuration and so on
Green attributes	A7	Application scheme of environmental protection materials	Choose renewable or recyclable building materials such as bamboo or recycled steel.
	A8	New energy integration system	Install solar water heaters or wind power equipment.
	A9	Green building design concept	Design a well-lit window layout and install a rainwater collection system.
	A10	Construction waste recycling program	Recycled materials are used in the construction process,
Safety	A11	Measures to enhance structural stability	Strengthen the structure of the house
	A12	Fire safety system configuration	Install smoke detectors, fire alarm systems and fire doors.
	A13	Security monitoring and antitheft system	Install security doors, window bars and surveillance cameras.
	A14	Healthy living environment guarantee	Use low VOC (volatile organic compounds) coatings and non-toxic building materials.
Culture	A15	Protection of historical and cultural elements	Restore or preserve architectural features of historical value
	A16	Local cultural characteristics are integrated	Integrate local cultural elements into the design, such as using local tiles or murals.
	A17	Renovation of cultural display space	Part of the space will be transformed into a cultural display area

After prioritizing the requirements, we can better understand which needs should be allocated resources to first, thus clarifying which functions should be given priority in the transformation process. This transformation process first helps clarify the products' goals and expected functions, converting users' abstracts or vague wishes, preferences, and issues into specific, actionable functional requirements, ensuring that the development team has a clear understanding of the products' purpose. At the same time, functional requirements provide clear work guidance for design and development teams, effectively promoting communication and collaboration within the team. In situations with limited resources, prioritizing functional requirements in conjunction with customer needs ensures

that the “key points” of customer needs are addressed and improved, helping to anticipate and assess potential risks and challenges during implementation, allowing for timely adjustments to improvement strategies and measures. Additionally, functional requirements provide standards for quality testing and validation, closely aligning with user needs. This ensures that the product meets expectations while also helping to define the unique selling points and market positioning of the ”house product” after the shared rural housing transformation, ensuring its replicability, sustainability, and upgradability, providing a basis for continuous improvement of the “house product”. In other industries, clarifying functional requirements also helps ensure that product development complies with specific regulations and standards. At the same time, during the product design phase, clearly defined functional requirements can be used to estimate and control operating costs, preventing cost increases later on. In summary, translating customer needs into functional requirements is key to ensuring high-quality and effective product development processes and ultimately making the final product competitive in the market.

To delve into the cutting-edge dynamics and practical needs in the field of housing reconstruction, we adopted a multi-dimensional information collection strategy. First, we systematically reviewed academic literature related to housing reconstruction by querying the WOS database. We also referred to Archcollege, a professional platform of the School of Architecture, which aggregates the latest news and best practices from the global architectural community. To ensure our research aligns with policy guidance, we obtained relevant policy documents from the China Institute of Natural Resources Economics (Chinese Academy of Natural Resources Economics). Through this multi-channel information gathering and analysis, we transformed the functional requirements for housing reconstruction into clear points. The results are shown in Table 9.

5 Findings

This study designed and distributed the Kano questionnaire, collecting 256 responses, of which 238 were valid, with an effective rate of 92.97%. Through statistical analysis of the questionnaire data, the average scores for functional issues and non-functional issues of each requirement item were calculated, leading to the determination of the importance index (r_i) and satisfaction index (a_i) for each requirement item. Based on the calculated importance index and satisfaction index, the I-S model was used to classify the requirement items. Using the median values of importance and satisfaction as the origin, the requirement items were divided into four regions: Excellent Region, Improvement Region, No Worries Region, and Excess Region. The results show that A5 (tending), A6 (convenient transportation), A7 (green materials), and other requirements are located in the excellent area, indicating that these requirements are very high for customer satisfaction and importance, and should be maintained; and A1 (cost-effectiveness), A2 (investment return), A4 (smart home) are in the area to be improved, indicating that these requirements are highly important to customer satisfaction and importance, but currently underperform and need to be prioritized for improvement.

This study introduces a refined Kan model for quality attribute classification, further refining the requirement categorization. By setting thresholds for importance and satisfaction, requirements are subdivided into eight categories of quality attributes: high added value, low added value, high attractiveness, low attractiveness, critical, necessary, potential, and worry-free. For example, A11 (structural safety) is classified as a critical quality attribute, A4 (smart home) and A7 (green materials) are classified as high-attractiveness quality attributes. This classification method not only considers the importance of requirements, but also combines customer satisfaction and expectations for requirements, making demand classification more refined and reasonable.

Due to the fact that the satisfaction-importance index cannot comprehensively reflect the overall response to demand items, this study further introduces a configuration index to prioritize these items. The configuration index integrates the importance index and the satisfaction index, reflecting customers overall preferences and expectations for a particular attribute. By categorizing through the configuration index, we can more comprehensively consider customers comprehensive evaluations of attributes, rather than just single satisfaction or importance. Thus, we obtain demand item A11 (structural safety) as a high-attractiveness quality attribute with a high configuration index, which is the key factor to attract customers. It should be ensured to achieve high quality first; requirement items A4 (smart home) and A7 (green materials) are key quality attributes, which have a great impact on customer satisfaction. Its stability and reliability must be ensured; requirement A1 (cost-effectiveness) and A2 (investment return) belong to the high value-added quality attribute, which can significantly improve customer satisfaction and needs to be optimized. Demand item A8 (new energy utilization) and A9 (green design) is a necessary quality attribute and the basic element to meet customer needs. It should be ensured that it meets certain standards; requirement A12 (fire-protection standard) and A13 (security facilities) belong to the low value-added quality attribute, which has limited effect on the improvement of customer satisfaction. It can be moderately invested under the premise of meeting the basic requirements; requirements A15 (cultural inheritance) and A17 (cultural display) belong to the low attractiveness quality attribute, which has weak attraction to customers and can be considered as a secondary factor; Demand item A10 (Salvage) is a potential quality attribute with certain development potential and can be used as the direction of future improvement; requirement A16 (local characteristics) belongs to carefree quality attributes, which have little

impact on customer satisfaction and can be regarded as secondary concerns.

According to the classification of quality attributes and the priority ranking of functional implementation obtained from the configuration index, in order to better meet customer needs and achieve the goal of sharing rural houses, this study believes that the following functions should be given priority: First, for the demand item A of high attractive quality attributes11 (structural safety), measures to enhance the stability of the structure, such as strengthening the structure of the house to ensure the safety of the house, are the key factors to attract customers. Secondly, for the requirement item A of key quality attributes A4 (smart home) and A7 (green materials), intelligent systems and environmental protection materials should be integrated respectively to meet customers high expectations for intelligence and environmental protection. Then, for the demand items A of high value-added quality attributes A1 (cost-effectiveness) and A2 (investment return), it is necessary to design budget optimization and renovation plan and value-added living space design to improve the cost performance and investment return rate of the renovation. In addition, it is necessary to meet the requirements of quality attributes A8 (new energy utilization) and A9 (green design) should implement new energy integration systems and green building design concepts, such as the installation of solar equipment, the design of natural lighting, good window layout, etc., to meet customers demand for green energy saving. For low value-added quality attribute requirements A12 (fire-protection standard) and A13 (security facilities), fire safety systems and security monitoring and anti-theft systems should be configured to ensure basic security. For the low attractiveness quality attribute requirement A15 (cultural inheritance) and A17 (cultural display), historical and cultural elements can be integrated into the renovation to protect and display the cultural space, so as to enhance the cultural value of rural houses. Potential quality attribute requirement A10 (Salvage) can be achieved through construction waste recycling programs that convert waste into resources. Finally, the need for worry-free quality attributes item A16 (local characteristics) Local cultural features can be appropriately integrated into the design, such as using locally distinctive tiles or murals, to enhance the local character of rural houses. By prioritizing and implementing specific measures for these functions, it is possible to more effectively meet the needs of different quality attributes, improving the overall quality and customer satisfaction of shared rural house renovations.

6 Conclusions and Proposals

6.1 Research Conclusions

This study is based on a refined Kano model, conducting an in-depth analysis of the functional requirements for rural housing sharing transformation and prioritizing them. By combining configuration indicators with quality attributes, it clarifies the emphasis on various needs during the transformation process and the order of achieving these priorities. All needs have been categorized. The research findings indicate that a refined Kano model can effectively identify and quantify customer needs, providing a scientifically sound and reasonable design basis for rural housing sharing transformation.

The application of the refined Kano model in requirement analysis, through the introduction of configuration metrics and the I-S model, has to some extent overcome the limitations of the traditional Kano model, more comprehensively reflecting the complexity and dynamic changes in customer needs. The quantitative analysis capability of the model has been significantly enhanced, enabling accurate identification of key requirements, optimizing resource allocation, and ensuring a high degree of alignment between design modifications and customer needs. For example, A11 (structural safety) is a highly attractive quality attribute, its priority is the highest, indicating that ensuring the safety and stability of the house structure is the key factor to attract customers in the transformation of rural housing sharing. And A1 (cost-effectiveness) and A2 (investment return) are high value-added quality attributes, they should also be optimized to improve the cost performance and economic benefits of transformation.

In addition, the refined Kano model breaks down customer needs into specific functional requirements, providing design and development teams with clear work objectives. For structural safety requirements, it proposes enhancing functionality through structural stability; for green design requirements, it suggests implementing specific functional needs such as new energy integration systems and green building design concepts. The process of transforming from requirements to functions helps clarify product goals and features, facilitates team communication and collaboration, and enhances the efficiency and market competitiveness of product development.

6.2 Proposals

This study makes an in-depth discussion on the improvement of function and quality of rural house sharing transformation based on the refined Kano model, and puts forward suggestions for the optimization of the refined Kano model and further rural house transformation.

In practical applications, the thresholds for importance and satisfaction should be dynamically adjusted based on specific circumstances. It is recommended to regularly collect user feedback, taking into account market changes and evolving user needs, to re-evaluate and optimize these thresholds, ensuring the accuracy and timeliness of the classification results. In addition to the dimensions of importance and satisfaction, other evaluation indicators, such as user loyalty and market competitiveness, should also be considered.

In addition to the dimensions of importance and satisfaction, other evaluation indicators can be introduced, such as user loyalty and market competitiveness. The higher the comprehensive degree of multi-dimensional evaluation of demand items, the greater their contribution to product success, and the richer the decision support information provided. In the model, user profiles are integrated, and based on the characteristics and preferences of each user profile, demand items are analyzed differently, with their importance assessed separately, and targeted improvement strategies are formulated. An intelligent and refined Kano model analysis tool is developed using big data and artificial intelligence, which collects, processes, and analyzes data to enhance the efficiency and accuracy of the model, while reducing the complexity and errors of manual operations.

The renovation of rural houses should also focus on the coordination between single and multiple functions. In addition to achieving individual functions, it is important to ensure the integration and synergy among these functions. Furthermore, a user feedback mechanism should be established to regularly collect users' experiences and suggestions for improvement after the renovation. Based on user feedback, adjustments and optimizations can be made to the renovation plan.

By paying attention to the behavioral habits and changing needs of users, we plan functional upgrades in advance. We encourage local community residents to participate throughout the renovation process, including demand research, design, construction supervision, and operation management. This approach aims to build and share community rural housing renovation projects, enhancing residents' sense of belonging and responsibility towards these projects, and improving their sustainability and social recognition.

When renovating farmhouses, the integration of these houses with the surrounding natural and social environments is a crucial factor that cannot be overlooked. It is essential to enhance ecological protection, adapt to local conditions, and create projects that are both environmentally friendly and culturally relevant. These projects should also incorporate the local social and cultural heritage, aiming to promote the integrated development of urban and rural areas and advance the construction of an integrated urban-rural system. In addition to the farmhouse homestay operation model discussed in this article, other economically beneficial models for farmhouses can be explored, such as farmhouse cafes, clubhouses, reading rooms, and exhibitions of farmhouse agricultural products. These models should cater to multiple dimensions and needs, improving the mechanisms that connect farmers and broaden their income sources, thus providing more practical paths and examples for the development of the rich farmer industry.

After the renovation of rural houses is completed, a long-term maintenance and update mechanism will be established. The responsibility for the income from the houses will be shared by all parties involved. A regular maintenance plan will be established based on the characteristics of the house facilities to ensure their long-term stable operation. Additionally, the functions of the houses will be updated and upgraded according to market changes and technological advancements.

The research findings indicate that, despite the refined Kan model's advantages in demand analysis and functional design, its application still faces certain limitations. For instance, the model's complexity increases the difficulty of data collection and analysis, especially when dealing with multi-dimensional evaluation indicators. Continuous user feedback and market monitoring are essential for the dynamic adjustment mechanism of the model. Moreover, the model's applicability is influenced by regional and cultural differences, necessitating validation and adjustments in different regions and cultural contexts. In the long term, the refined Kan model holds significant theoretical and practical value in the transformation of rural housing for sharing. Its strengths in demand analysis and functional design enable it to meet the diverse needs of rural housing transformations across different regions. Moving forward, this model can be applied to cross-regional rural housing transformation projects, ensuring its adaptability through localized adjustment mechanisms.

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Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflict of interest.

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