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Research on Leased Space of Urban Villages in Large Cities Based on Fuzzy Kano Model Evaluation and Building Performance Simulation: A Case Study of Laojuntang Village, Chaoyang District, Beijing

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Abstract: China is in the transition period of urbanization, and the imbalance of land use generated during the original rapid development of megacities still exists, resulting in the preservation of a large number of urban villages in the peripheral areas of cities. Unlike formal housing, these villages are heavily influenced by the confrontation and interweaving between top-down policies of local governments and bottom-up spontaneous construction by local villagers, resulting in a diverse and complex status quo. At the same time, self-built housing in urban villages has become a gathering place for a large number of low-income migrants due to its relatively low rental prices. In terms of the research of urban villages on the current situation of housing, the real needs of users and housing performance are mostly subjective judgments and conclusions. Therefore, the entry point of this paper is the leased space and the leasers, taking Laojuntang Village in Chaoyang District of Beijing as the research object and analyzing its current problems and the real needs of users. This paper adopts an integrated approach of fuzzy Kano model evaluation and building performance simulation. After analyzing the data and discussing the influencing factors, this paper identifies the specific problems and user needs that exist in leased spaces in Laojuntang Village: (1) The architectural performance of leased space is a Must-be Quality, which is the bottom-line requirement and must be improved. (2) The quality of the basic facilities and equipment of the leased space is mostly a One-dimensional Quality, Attractive Quality, and the degree of importance is lower than that of the building performance. (3) The external activity facilities of the leased space are mostly undifferentiated needs, for which the local users are not particularly prominent. (4) The scale and plot ratio of local housing is relatively high, and users are dissatisfied and complaining, which falls under the category of Reverse Quality.

Keywords: leased space of urban village; fuzzy Kano model; user satisfaction; building performance

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1. Introduction

1.1. Research Background

When China's urbanization enters the middle and late stages of development, housing demand will be concentrated mainly in urban agglomerations, especially large urban agglomerations, and the high prices in the central cities of the urban agglomerations will lead to the overflow of part of the housing demand to small and medium-sized cities within the agglomerations [1]. Renting and buying houses are two ways for urban residents to solve their housing needs. For a long time, the commercial housing market has developed rapidly, while the rental market has lagged behind and is not standardized. The problem of low rental quality is more prominent, and the sense of gain of tenants is generally not high. In 2017, the 19th National Congress of the Communist Party of China report explicitly proposed the establishment of a housing system that combines renting and

purchasing ("Ten livelihood Facts revealed in the Report of the 19th National Congress" Xinhua News Agency, Beijing, 21 October 2017 (https://www.gov.cn/govweb/zhuanti/2017-10/21/content_5233556.htm (accessed on 26 December 2023))). The Central Economic Work Conference in 2020 stressed the importance of developing rental housing for housing in big cities, effectively increasing the supply of affordable rental housing, and making every effort to help new citizens and young people ease their housing difficulties (Guiding Opinions of the Ministry of Housing and Urban-Rural Development on the Support of Banks and Insurance Institutions for the Development of Guaranteed Rental Housing, Banking and Insurance Supervision Regulation [2022] No. 5 (http://www.gov.cn/zhengce/zhengceku/2022-02/27/content_5675918.htm (accessed on 26 December 2023))). All these policy documents reflect the fact that the rental market is an inseparable and organic component of the residential market, which requires great attention from the state and the government. Therefore, this paper chooses a very specific presence in the rental market of megacities, namely the leased space of urban villages, whose complexity and differences deserve to be studied.

A key feature of China's urbanization process is the informal growth of villages around cities. Among them, the conceptual basis for urban villages, as a special type of urban housing, is the traditional urban–rural dichotomy of administrative divisions, whereby the city government manages the urban residents, and the townships manage the rural residents. In China, the strict household registration system (hukou system) separates urban and rural populations, which facilitates the functioning of such administrative division [2]. The administrative system of the urban–rural dichotomy gives local villagers the right to develop housing, and they assign homestead and rooms for rent to the floating population [3]. These settlements are often referred to as urban villages.

Meanwhile, in China, urban land is owned by the state, and rural land is owned by village collectives [4]. The State prohibits village collectives from selling rural land directly to land developers, which must be transferred to State ownership through the process of "land expropriation" and then transferred from state representatives to different land developers [5]. The municipal government represented by the state has become the only provider of the real land market [6,7]. The incomplete conversion of housing property rights also makes urban villages become "informal settlements" outside the urban planning laws and regulations [8]. This implies that the social needs and economic interests of vulnerable groups are informality [9]. The reality is indeed that, because the amount of compensation for land expropriation by the state is too low, some villagers choose to refuse to be acquired to retain the land but increase their income by renting out their houses, which is a typical "tile economy" [10,11]. Research has shown that the "tile economy" essentially creates a supply of affordable housing and fills the gap between the demand for and supply of affordable housing [12]. Urban village leased space has almost the same utility as urban housing, and the price is also lower, which is an ideal choice for low-income people.

The existence of urban villages is a special phenomenon under China's urban–rural governance structure and the urban–rural divide. They are located in urban areas and retain the institutional system and collective ownership of the countryside, but in practice, they are excluded from urban governance [13,14]. The management of housing construction in urban villages requires collective construction land approval and planning approval and still fails to effectively regulate the large number of self-built houses. When the spontaneous construction of urban villages is not effectively supervised, the phenomenon of private construction is gradually obvious due to the pursuit of land interests by local house owners, resulting in a more chaotic rental environment. Urbanization and the concentration of the floating population have exacerbated the problem, making many urban villages a gathering place for urban low-income people [15]. A large part of the floating population who are not qualified to live in public rental housing and can hardly afford the high rent of commercial housing can only rent in urban villages, and their residential safety and rights are not guaranteed. These phenomena reflect the rapid transition of socio-economic development from rural to urban areas [16].

However, the development of an urban village is not stable, and the spatial form of an urban village has a history and stages. In the process of urbanization, urban renewal will destroy the old urban village, and the expansion of urban boundaries will produce a new urban village, thus forming the process of spatial suburbanization from the center to the edge [17]. As a result, specific urban villages may disappear in the process of urbanization, but this does not change the affinity between low-income people and urban villages. This feature deserves the attention of relevant policy makers. From the present point of view, the urban village in Beijing has existed for more than 40 years, and the population, space, and industrial structure of the urban village are also changing. Under the current sluggish real estate market and sluggish economic growth, the transformation of urban villages can stimulate investment. But this is not the same as starting "urban village renovation programs" in megacities; instead, local governments should better learn from the lessons of previous renovations. The main residents of the leased space in urban villages are still those with low income and unbalanced employment and housing, and renovation and reconstruction will significantly increase the housing cost and lead to the outflow of people. The densification of space is an inevitable product of the collective system of urban villages, providing a relatively low living space for low-income people and meeting the practical needs of low-income families for reproduction [17]. Therefore, it is an urgent task to accurately excavate the problems existing in the leased space of urban villages and rationally transform urban villages, which is conducive to the stable development of society.

For a study of leased space in urban villages in Beijing, Akinwande found 17 papers that considered the housing supply value chain as it relates to the urban poor in both developed and developing economies around the world [18]. Liu and Ma also reached a similar conclusion by evaluating the tenants of public housing in Beijing before and after relocation [19]. They also emphasized that improved housing conditions and neighborhood relationships can increase resident satisfaction. Liu indicates that there is a serious separation of household workers in Beijing, which is characterized by polarization [20]. On the whole, the imbalance between employment and housing is the most serious and at a low level, which affects the quality of life and subjective well-being of urban residents. Tian pointed out that the development of market-oriented rental housing in megacities is conducive to solving the rental demand of a large floating population, stabilizing the rental housing market price, and achieving work–housing balance to alleviate the problems caused by poverty concentration [21]. Jiang analyzed the leased price of houses in Beijing through the GTWR model and showed that the plot ratio, property cost, green rate, traffic density, public service facilities, and other quantities have a significant impact on the house rental price. Generally speaking, the housing leased prices in Beijing are not randomly distributed in space, there is a positive correlation, and the housing rental prices in neighboring areas have the nature of mutual influence [22]. This also indirectly indicates that improving the leased space of urban villages is conducive to the improvement of housing value and thus contributes to the benign development of the rental market in the surrounding areas. All of these related research efforts have reflected the importance of leased space in urban villages for social development and rental market stability as well as happiness enhancement.

Through the above background analysis and related literature research, we can understand that the development of leased space in urban villages is a specific manifestation of the imbalance of urban development in contemporary China. Local villagers build high-density, self-built houses for economic gain, but this construction activity is subject to the restrictions and requirements of urban governance that come to higher levels of government, for example, policy requirements such as code-compliant buildings, clean streets, and a more secure environment. The current transformation of urban villages is difficult and full of obstacles, and if there is a conflict of interest, some specific transformation methods will be difficult to implement and deviate greatly from the ideal state. This contradictory state of affairs lacks some clear and concrete directions for governance and measures to

address it. At the same time, reviewing the above literature, it can be observed that the academic research related to urban villages has produced some research results, and most of them focus on the economy, household registration system, crowd, policies, and other research, and the research on the housing in urban villages, especially the housing in the leased space, is relatively blank. However, there is a gap in the research on the current situation of leasing space in urban villages and the specific practical needs of the leasers, which is the entry point for our research. Therefore, the research work in this paper helps to enrich the content and field of urban village research, accurately determine the priorities and quantitative indicators of transformation and the actual needs of residents, and provide effective help for future urban construction and policy formulation. The present work is of high research value and deserves further study.

1.2. Study Area

The area selected for this study was Laojuntang Village, Chaoyang District, Beijing, which is located in the south-eastern part of the city and is under the jurisdiction of Shibalidian Township, with a township area of 25.23 square kilometers [23]. The current traffic situation in the area is complex, with several urban ring roads, highways, and railways crossing the township. At present, the region has a total resident population of 124,126, including 37,061 registered residents and 87,065 members of the floating population [23].

The development mode of Laojuntang Village is mainly through the way of renting collective land and houses, and the spontaneous construction is stimulated by the high return of the "tile economy" model. The village is still in the traditional village management mode, and the villagers all live in self-built houses with relatively simple conditions. The infrastructure construction of transportation, water, electricity, and sanitation in the village is imperfect, and the living environment is poor, which belongs to a typical rural–urban fringe area. At the same time, due to the loose management of rental housing, the residence of outsiders is characterized by a small living area per capita, poor environmental conditions, a large transient population, and group renting [24].

1.3. Aims and Questions

Based on this research background, this paper hopes to identify two key research objectives concerning the leased space of urban villages in megacities: (1) Urban villages accommodate a large number of low-income people. What are their practical needs for such a living environment? It is the responsibility of the society, the city, the government, and the relevant researchers and scholars to ensure their basic survival needs. (2) Can there be a prioritization and ranking of the importance of the real and current problems of leased space in urban villages?

In order to achieve the above two research objectives, this paper starts from the leased space of the urban village in Laojuntang Village, Chaoyang District, Beijing, to explore its real problems. It is hoped to accurately determine the housing needs of local tenants, with a view to providing a reasonable theoretical reference for the transformation and upgrading of urban villages in Beijing in the future.

The rest of the paper is as follows: Section 2 mainly introduces the data analysis methods and data sources used in this study of leased space in urban villages and proposes the relevant technical routes. Section 3 analyzes in depth the empirical results of the data generated using the fuzzy Kano model and building simulation techniques and explores the existing status quo problems of leased space and user needs. Section 4 analyzes and discusses the empirical results and the reasons for the status quo problems. Finally, Section 5 summarizes the research of this paper and presents the future improvement routes.

2. Materials and Methods

2.1. Concept and Advantages of Kano Model

In terms of the types of evaluation methods, this paper compares other literature evaluation methods for urban villages, which are mostly subjective or qualitative, with a

large number of subjective factors, and there are certain authenticity problems with the results produced [25,26]. Therefore, this paper adopts a research and evaluation method called the Kano model, which was invented by Noriaki Kano in Japan and focuses on the relationship between the degree of availability of a certain functional requirement of a product and user satisfaction [27]. Initially, the main applications of the Kano model were in product development, marketing, operations management, and other fields [28]. In recent years, some scholars have gradually applied this method to the field of architecture, such as subway space and housing space, and have achieved certain results [29–31]. According to the Kano model, Huang determined the service quality Kano indicators of the Urban Rail Transit Passenger Service Quality that need to be improved significantly [29]. Li used the fuzzy Kano model to calculate the importance of demand and obtained the ranking of priority demand indicators to improve user satisfaction, which provided a reference for space storage design [30]. By using the Kano model, Zhang quantified the types and priorities of public space demand behaviors in subway stations and proposed design strategies for improving the spatial environment quality of subway stations [31]. The above practical cases on the application of the Kano model well reflect the accuracy and effectiveness of the model, which is conducive to the improvement and promotion of the scheme. Therefore, this paper hopes to apply the Kano model to evaluate the leased space and surrounding environment of urban villages in Beijing and determine the importance and priority of urban village governance in the future.

The Kano model divides the quality characteristics of products and services into five types: One-dimensional Quality, Attractive Quality, Must-be Quality, Indifferent Quality, and Reverse Quality [32]. Must-be Quality is the customer's basic requirement for the level of functionality and service provided by a product. Customers are dissatisfied when the functional service level does not meet their needs and may not show satisfaction when the functional service level meets their needs. One-dimensional Quality is a demand where customer satisfaction is proportional to the degree of fulfillment of the demand. If such needs are met or performed well, user satisfaction will increase significantly, and vice versa. Attractive Quality is a need that is not overly expected by the user. As the degree of fulfillment of the user's expectations increases, the level of satisfaction rises sharply, but once fulfilled, even if the performance is not perfect, the user shows a very high level of satisfaction. Conversely, even when expectations are not met, customers do not show obvious dissatisfaction. Indifferent Quality means that whether or not the functional service is provided has no impact on user experience and satisfaction. Reverse Quality is a functional service requirement that leads to strong user dissatisfaction. When functional services are provided, user satisfaction will decline.

For the satisfaction of the Kano model, the *Better–Worse* coefficient analysis method is generally used to summarize, and the calculation formula is as follows:

$$Better(SI) = \frac{A + O}{A + O + M + I} \tag{1}$$

$$Worse(DSI) = -(M + O)/(A + O + M + I) \tag{2}$$

where the *Better* coefficient is a positive number, indicating that user satisfaction increases when a feature or service is provided. The larger the value, the more obvious the effect of satisfaction improvement. A negative *Worse* coefficient indicates that user satisfaction decreases when a feature or service is not provided. The greater the absolute value, the more obvious the effect of reducing satisfaction [33].

2.2. Data Source

We conducted a questionnaire survey in Laojuntang Village, Shibalidian Township, Chaoyang District, Beijing, from 18 October 2022 to 15 April 2023, and issued a total of 3 types of questionnaires. The survey was conducted offline to ensure that all respondents filled in as many questions as possible to avoid missing information. At the same time, we

also mapped three local self-built houses in Laojuntang Village and carried out simulation analysis. The sample locations are shown in Figure 1. For the surveying and mapping work of self-built houses in urban villages, we summarized relevant literature [34–39]. It was found that most of the self-built houses in urban villages in Beijing are terraced buildings, while a small number are courtyard buildings with two floors. However, the distance between the buildings is relatively close, especially since the gables between each other are almost attached to each other or share the same gables, resulting in a higher floor area ratio. The interior layout of the building reflects the layout principle of maximizing space utilization, generating the maximum number of rental houses with the minimum traffic area on the plane, and making full use of the original homestead range for vertical growth in the vertical direction. Landlords sell these compartmentalized rental rooms at a profit. The above typical features of urban village architecture also exist in the self-built houses we mapped. Because the survey and mapping time was in the special period of the epidemic situation and the team's energy was limited, we encountered tenants and landlords who refused the survey and mapping requests in many surveys and mapping work. Therefore, mapping the three complete self-built houses is the best result after many requests. Therefore, the selection of these three self-built houses is representative, which can reflect the characteristics of most local self-built houses, and the realistic conditions also limit the number of our surveys.

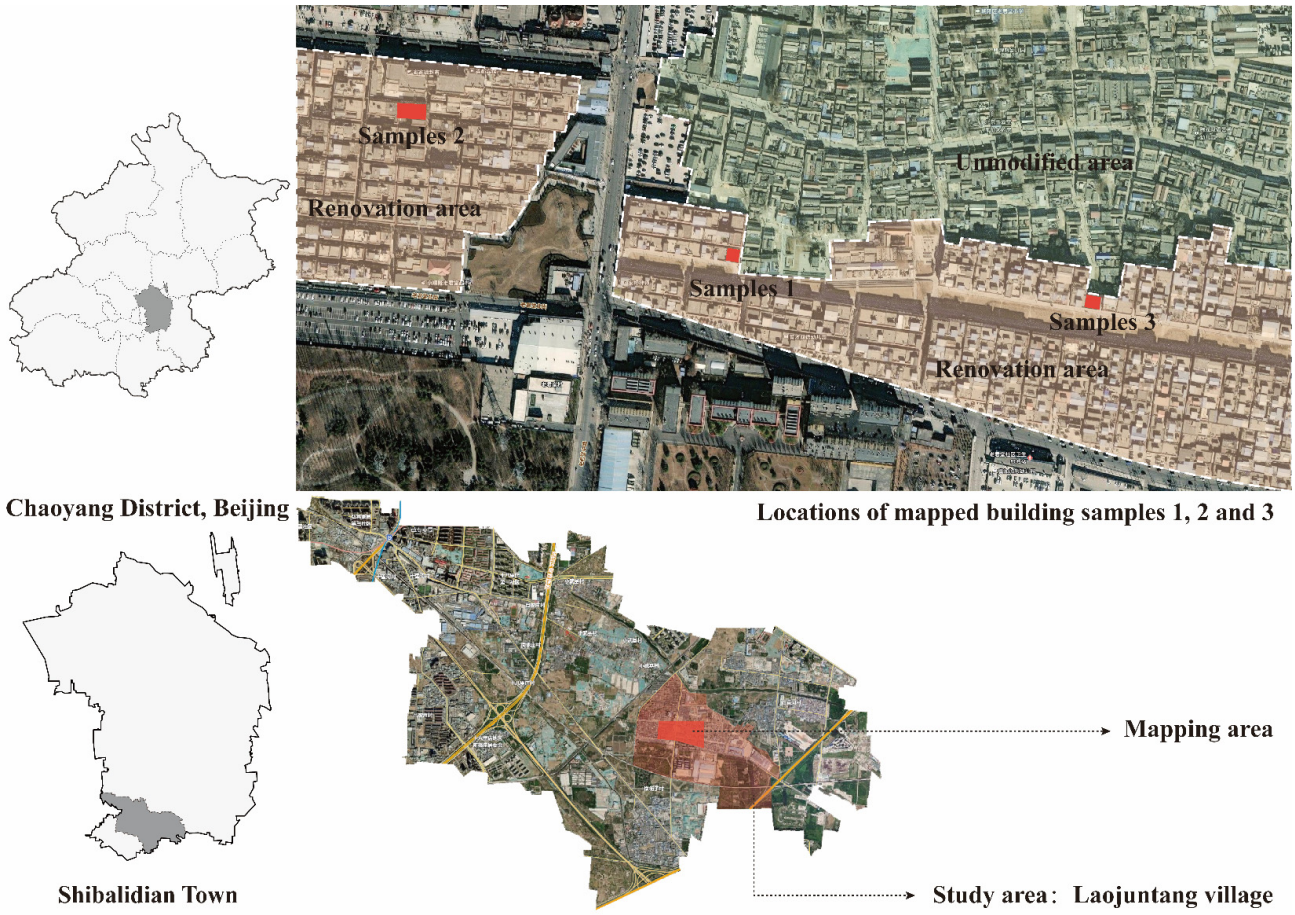

Figure 1. Distribution of locations of mapped building samples 1, 2, and 3 in Laojuntang Village. (Map source: http://www.bigemap.com/ (accessed on 26 December 2023), Administrative district source: http://guihuayun.com/maps/region.php (accessed on 26 December 2023)).

During the preparation of the questionnaire, combined with previous relevant research and field survey and interview information [31,40–43], we selected five categories as first-level demand indicators, each of which contains several second-level demand indicators. The Kano model evaluation system for leased space in Laojuntang Village in Beijing is shown in Table 1. In the data sorting stage of the questionnaire, we will filter out incomplete questionnaires. Finally, we used 243 questionnaire samples for empirical analysis, including 200 Kano model evaluation questionnaires (192 valid), 50 evaluation questionnaires on user satisfaction and the service level of building function (41 valid), and 10 expert evaluation questionnaires on the importance of leased space (10 valid). These demand indicators were determined after consulting the opinions of local residents and relevant experts. Moreover, SPSSAUwas used for reliability analysis. (Reliability analysis is used to measure whether the sample answer results are reliable, that is, whether the sample has real answer scale items; reliability analysis is only used for quantitative data. Cronbach's reliability coefficient (Cronbach's α coefficient value; the same below): if it is above 0.8, then the test or scale reliability is very good; if it is above 0.7, it is acceptable; if it is above 0.6, the scale should be revised without losing its value; if it is below 0.6, the scale needs to be redesigned). It was found that its Cronbach α = 0.903, which demonstrated the rationality of the questionnaire. As for the number of questionnaires, relevant literature shows that the permanent population of the Shibalidian area is 124,126 [23]. Meanwhile, as of June 2020, Shibaridian Township administered 11 communities and 8 administrative villages under its jurisdiction, according to the National Bureau of Statistics of the People's Republic of China (Data source of administrative division: (https://baike.baidu.com/reference/58669387/533aYdO6cr3_z3kATKCCyfmkOi_GN4n6t7OGVOdzzqIP0XOpX5nyFJsm4cMssPBoAkXIvtd2asUf2fygWAFaqq1ZMLVhH-1x1S6pB27dy77k_8Ywm85EopVDXbIWhvHwtkH80CuUgfSI6g (accessed on 26 December 2023)). And Laojuntang Village is a small village belonging to this area, and the population is smaller than that of other large urban villages, so the number of questionnaires is 200–300.

Table 1. Construction of Kano model evaluation system for leased space in Laojuntang Village, Chaoyang District, Beijing.

Tier 1 Demand Indicators	Tier 2 Demand Indicators
(U_1) Basic facilities for leased space	(u_{11}) Leased space area (u_{12}) Number of leased space households (u_{13}) Plot ratio (u_{14}) Reasonability of the house layout (u_{15}) Public space area of houses (u_{16}) Accessible facilities for houses
(U_2) Building performance of leased space	(u_{21}) Ventilation performance of the houses (u_{22}) Closure of doors and windows (u_{23}) Cold protective performance (of houses) in winter (u_{24}) Heat dissipation performance (of houses) in summer (u_{25}) Lighting performance of houses (u_{26}) Number of indoor lighting facilities (u_{27}) Sound insulation performance of walls and floor slabs (u_{28}) Sound insulation performance of windows and doors
(U_3) Equipment quality of leased space	(u_{31}) Anti-noise material quality of houses (u_{32}) Number of lighting and ventilation facilities in the kitchen and bathroom (u_{33}) Quality of kitchen and bathroom electrical equipment (u_{34}) Decoration safety quality of houses (u_{35}) Number of house monitoring facilities (u_{36}) Number of fire-fighting facilities in houses

Table 1. *Cont.*

Tier 1 Demand Indicators	Tier 2 Demand Indicators
(U_4) External space facilities for leased space	(u_{41}) Area of outdoor activity spaces (u_{42}) Number of outdoor sheltering facilities (u_{43}) Number of outdoor alee trees (u_{44}) Number of outdoor green belts (u_{45}) Number of public accessible facilities (u_{46}) Number of public steps
(U_5) External transportation facilities for leased space	(u_{51}) Width of outdoor sidewalks (u_{52}) Outdoor bicycle parking area (u_{53}) Number of bus and metro stations (u_{54}) Number of shared vehicles and parking spots (u_{55}) Number of motor vehicle parking spaces

For each secondary demand indicator, the questionnaire lists two evaluation questions, positive and negative. Each evaluation question will have five comment set options, as shown in Table 2.

Table 2. Evaluation table of Kano model for leased space in Laojuntang Village, Chaoyang District, Beijing.

Demand Indicators	Evaluation Questions	Comment Options				
		Strongly Like	Like	Neutral	Accept Reluctantly	Strongly Dislike
(u_{11}) Leased space area	If there is an increase area, your evaluation is: If there is no an increase area, your evaluation is:					

Through the user's answers to the two questions, the user's opinion can be summarized after analysis. For example, if users answer "like" to a positive question and "dislike" to a negative question for a certain user requirement, then the user considers the requirement as a One-dimensional Quality (O). There are 25 possible outcomes for each need indicator, which are summarized in Table 3.

Table 3. Kano evaluation table.

Demand Indicators		Dysfunctional Form of the Question				
		Strongly Like	Like	Neutral	Accept Reluctantly	Strongly Dislike
Functional form of the question	Strongly like	Q	A	A	A	O
	Like	R	I	I	I	M
	Neutral	R	I	I	I	M
	Accept reluctantly	R	I	I	I	M
	Strongly dislike	R	R	R	R	Q

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

User satisfaction and service level of building function evaluation questionnaire: The survey is divided into 2 main parts, all of which use a 1–5 Likert scale to express the numerical changes. The first part is to investigate the current user satisfaction and the improved user satisfaction. In order to better express the changes in user satisfaction, we used a 1–5 Likert scale to express the satisfaction values, where S_0 represents the current satisfaction of n users with a demand indicator, and S_1 represents the improved satisfaction of n users with a demand indicator. The second part is to investigate the current building functional service level and the improved building functional service level. P_0 represents the evaluation of the current functional service level of a demand indicator by n users, and P_1 represents the evaluation of the improved functional service level of a demand indicator by n users, as shown in Table 4.

Table 4. Evaluation table of user satisfaction and service level of building function in the leased space in Laojuntang Village, Chaoyang District, Beijing.

Demand Indicators	Evaluation Questions	Comment Options				
		Very satisfied	Fairly satisfied	Neither	Fairly dissatisfied	Very dissatisfied
(u_{11}) Leased space area	(S_0) Current user satisfaction (S_1) User satisfaction after improvement					
		Excellent	Very good	Fair	Poor	Very poor
	(P_0) Current service level of building function (P_1) Service level of building function after improvement					

Expert evaluation questionnaire on the original importance of leased space: The original importance level represents the value level of a functional attribute, and users may not be able to clearly identify the original importance level of a demand indicator. Therefore, this research referred to the opinions of 10 experts and scholars in the field of architecture. The Likert scale of grades 1–5 is also used to express the change in the value of the original importance level W_0 [33], as shown in Table 5.

Table 5. Evaluation table of original importance of leased space in Laojuntang Village, Chaoyang District, Beijing (expert scoring table).

Demand Indicators	Comment Options				
(u_{11}) Leased space area	Very important	Fairly important	Neither	Fairly unimportant	Very unimportant

2.3. Data Analysis

The Kano model's assessment of a building's functional services from the user's perspective is influenced by the contrast between the user's expected requirements and the fulfillment of actual needs [44,45]. The original methodology for the Kano model evaluation has been continuously improved, mainly to eliminate inaccuracies in the model's assessment of user needs for categorization [46,47]. Therefore, it is essential to understand customer needs as accurately as possible, and this is where the methodology of this study will be improved.

The fuzzy Kano model introduces the membership function on the basis of the traditional Kano model to improve the satisfaction evaluation method of the traditional method. When designing a questionnaire with the traditional Kano model, five definite options are set for the positive and negative questions of each demand item to express satisfaction. This method ignores the situation where users give uncertain answers due to complex and changeable psychology. Therefore, the fuzzy Kano model uses [0, 1] to express user satisfaction with a certain demand, as shown in Table 6, which is more in line with the user's real evaluation of thinking habits and more suitable for real-life uncertainty problems [30].

The technical route of this evaluation and analysis of urban village leased space is mainly divided into two parts: fuzzy Kano model evaluation and building performance simulation, as shown in Figure 2.

Table 6. Comparison of traditional Kano model questionnaire and fuzzy Kano model questionnaire.

Traditional Kano Model Questionnaire					
Demand Indicators	**Strongly Like**	**Like**	**Neutral**	**Accept Reluctantly**	**Strongly Dislike**
Functional form of the question	✔				
Dysfunctional form of the question					✔
Fuzzy Kano Model Questionnaire					
Demand Indicators	**Strongly Like**	**Like**	**Neutral**	**Accept Reluctantly**	**Strongly Dislike**
Functional form of the question	0.625	0.23	0.08	0.06	0.005
Dysfunctional form of the question	0.01	0.01	0.16	0.18	0.65

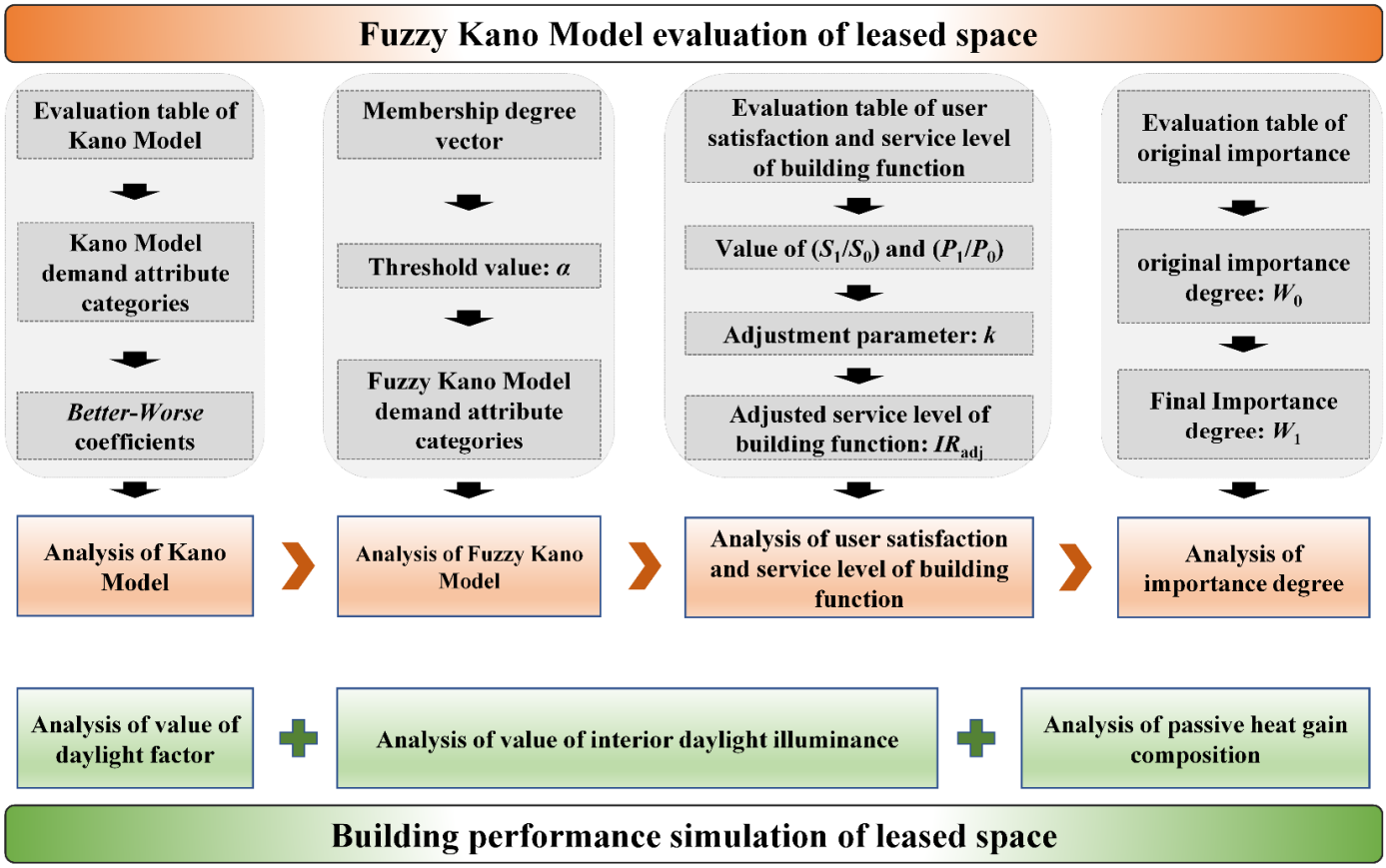

Figure 2. Technology roadmap for fuzzy Kano model evaluation and building performance simulation.

The first part of the technical route: leased space demand index data analysis. Based on the calculation of Formulas (1) and (2), we continue with six specific steps, which are as follows:

1. Constructing a fuzzy relationship matrix.

Taking the u_{11} demand index as an example, we assume that the matrix of the building providing a certain functional service element is F, and the matrix of the building not providing a certain functional service is D. The values in each matrix are derived from the membership values of five evaluation criteria options. Then, F = [0.63 0.23 0.08 0.06 0.01], and D = [0.01 0.01 0.16 0.18 0.65]. Next, the principle of fuzzy relationship is used to carry out the fuzzy transformation of F and D matrices [44], to obtain the fuzzy evaluation matrix S (retained to 3 decimal places) for a certain evaluation index, i.e., Formula (3):

$$S = F^T D = \begin{bmatrix} 0.006 & 0.006 & 0.097 & 0.110 & 0.403 \\ 0.002 & 0.002 & 0.036 & 0.041 & 0.148 \\ 0.001 & 0.001 & 0.013 & 0.015 & 0.054 \\ 0.001 & 0.001 & 0.009 & 0.010 & 0.037 \\ 5.425 \times 10^{-5} & 5.425 \times 10^{-5} & 0.001 & 0.001 & 0.003 \end{bmatrix} \quad (3)$$

By comparing the values in matrix S with Table 3, we can get a preliminary result on the classification of fuzzy Kano attributes for this evaluation indicator. The membership degree values of each demand attribute are $t_M = s_{25} + s_{35} + s_{45} = 0.24$, $t_O = s_{15} = 0.40$, $t_A = s_{12} + s_{13} + s_{14} = 0.21$, $t_I = 0.13$, $t_R = 0.01$, and $t_Q = 0.01$ (reserved to 2 decimal places). Therefore, the membership vector T of the demand attribute of the service element u_{11} of this function can be obtained, namely

$$T = \left(\frac{M}{0.24} \frac{O}{0.40} \frac{A}{0.21} \frac{I}{0.13} \frac{R}{0.01} \right) \quad (4)$$

2. Determination of the value of the threshold α.

We can see that the membership degree vector T simultaneously possesses five demand attributes, M, O, A, I, and R. In order to select more accurate data, we introduced a judgment variable α value—a threshold value—and screened five attributes of the membership degree vector T of each demand index again [30]. Choosing different α values to categorize the demand attributes will produce completely different results [33]. For example, taking $\alpha = 0.25$, the customer demand attribute vector T = (0, 1, 0, 0, 0, 0, 0) for that quality element. Therefore, for that demand indicator (u_{11}), the demand attribute of its fuzzy Kano is One-dimensional Quality (O).

3. Methods for improving user satisfaction and the service level of building function.

The study of combing [48–50] found that the representation of the relationship between user demand satisfaction and the service level of building function in the fuzzy Kano model can be unified from the approximation by a functional expression, i.e., $S = f(k, P)$, where k denotes the fuzzy Kano model demand indicator attribute's adjustment parameter [50]. In general, the better the service level of building function (P) provided by a building, the higher the satisfaction (S) it will bring to its users. Changes in the value of k will also be reflected in the demand attributes of the fuzzy Kano model, where we use ΔS to denote the magnitude of change in user satisfaction and ΔP to denote the magnitude of change in the service level of building function provided by the building. For the convenience of study, we assume that the functional relationship between $\Delta S/S$ and $\Delta P/P$ is linear, and the adjustment parameter k is introduced here to represent the linear relationship between the two, namely

$$\Delta S/S = k(\Delta P/P) \quad (5)$$

By integrating Formula (5), the approximate function expression $S = f(k, P)$ can be converted as follows [49,50]:

$$S = cP^k \quad (6)$$

where c is a constant. Let S_0 and S_1 represent the current user satisfaction degree and the improved user satisfaction degree, respectively; P_0 and P_1 represent the current service level of building function and the improved service level of building function, respectively; then, the relationship formula between the improvement rate of the user satisfaction degree and the improvement rate of the service level of building function can be derived:

$$S_1/S_0 = cP_1^k/cP_0^k = (P_1/P_0)^k \quad (7)$$

4. Determination of the value of the adjustment parameter k.

The value of k can be obtained by Formula (7), such as in Formula (8).

$$k = log_{P_1/P_0}{}^{S_1/S_0} \tag{8}$$

Therefore, in order to get the value of k, it is necessary to get the values of S_0, S_1, P_0, and P_1 collected in Table 4, as shown in Formulas (9) and (10).

$$S_0 = \sum_{i=1}^{n} s_{0i}, S_1 = \sum_{i=1}^{n} s_{1i} \tag{9}$$

$$P_0 = \sum_{i=1}^{n} p_{0i}, P_1 = \sum_{i=1}^{n} p_{1i} \tag{10}$$

By substituting Formulas (9) and (10) into Formula (8), we get

$$k = \log_{\sum_{i=1}^{n} p_{1i}/\sum_{i=1}^{n} p_{0i}} \sum_{i=1}^{n} s_{1i} / \sum_{i=1}^{n} s_{0i} \tag{11}$$

5. Determination of the adjusted improvement factor IR_{adj}.

According to the value of adjustment parameter k of each demand indicator obtained from Formula (11), let IR_0 be the improvement coefficient of user satisfaction ($IR_0 = S_1/S_0$). We can derive the IR_{adj} [50]:

$$IR_{adj} = (IR_0)^{1/k} \tag{12}$$

In this case, IR_{adj} is the rate of improvement that a building must make in order to achieve the level of satisfaction desired by its users [44].

6. Determination of the final importance degree of the demand indicator W_1.

According to the data collected in Table 5, w_{0i} ($I = 1, 2, 3, \ldots n$) represents the evaluation results of 10 experts on a certain demand indicator, that is, the original importance W_0 of this demand indicator [51], which can be obtained as follows:

$$W_0 = \sum_{i=1}^{n} w_{0i} \tag{13}$$

In addition, the improvement factor IR_{adj} after the adjustment of the service level of building function obtained by Formula (12) is multiplied by original importance W_0, namely

$$W_1 = W_0 \cdot IR_{adj} \tag{14}$$

According to Formula (14), the final user demand importance W_1 and priority ranking can be obtained.

Through the multi-level operation process of 14 formulas, we can use this set of data statistics to assess the current situation of the leased space in Beijing Laoguntang Village more scientifically, accurately find out the housing problems, and carry out reasonable qualitative and quantitative analyses. Finally, we can put forward the final importance degree and improvement priority with high credibility based on the data operation, i.e., the priority of the relevant departments for the transformation of the leased space of the urban villages and the degree of the transformation in the future.

For the second part of the technical route, building performance simulation, we adopted Ecotect Analysis software. Ecotect Analysis software is an efficient building thermal, optical, and acoustic analysis software. It uses the finite difference method to divide the analysis plane into multiple analysis units according to the user's needs by using the grid to analyze each node. The software can analyze the lighting of the model through the meteorological information parameters imported by the user based on the solar

radiation intensity, building thermal parameters, etc. It is simple to use, fast to calculate, and highly visual.

First of all, the preliminary preparation for thermal property analysis is performed. According to the field mapping, we set the building materials in Ecotect as brick and mortar materials, mainly including Brick Masonry Medium (specific heat capacity 836.80, thermal conductivity 0.711), Concrete cinder (specific heat capacity 656.90, thermal conductivity 0.355), and Plaster building (specific heat capacity 1088.00, thermal conductivity 0.431), so as to simulate more realistically the thermal property of self-built houses in urban villages. Then, we also simulate the living habits of the leasers: since the area of each leased space is different, we set the living area of each person to 10 square meters, and combined with the actual research, we can determine the number of people living in each room. Next, we set up a timetable (8:00–18:00, when the renter is out of work, and no one is in the room; 18:00–8:00, when the renter is in residence and resting, and there are people in the room). The meteorological data of Beijing are imported to simulate the real climate environment. In this paper, the hourly typical meteorological year data are derived from the "Special Meteorological Database for China Building Thermal Environment Analysis" of Tsinghua University. Finally, the system mode of heating, ventilation, and air mediation is set to be a mixed-mode system because it is in the Beijing area, and the house will be collectively heated in winter.

Secondly, the preliminary preparation for the analysis of the daylight factor and interior daylight illuminance is performed. In the process of investigation, we found that the local rental space is generally LED energy-saving lamps or incandescent lamps (lamp power of about 20 watts). Secondly, the lowest point of the Windows of the three self-built houses we surveyed is generally 1.5 m above the indoor floor, which is mainly set in order to protect the privacy of tenants in such a high density of self-built houses. Because the envelope structure will have a relatively large impact on the lighting, the non-matching size of the grid is used. The size of the analysis grid for each sample is as follows: Sample No. 1 (2470 × 1750 mm size, 40 compartments in the × direction, 30 compartments in the y direction, 1 layer is 1500 mm high from the ground plane, and 2 layers are 4500 mm high from the ground plane); Sample No. 2 (30,927 × 10,450 mm size, 55 compartments in the × direction, 20 compartments in the y direction, 1 layer 1500 mm above the ground plane, 2 layers 4500 mm above the ground plane); Sample No. 3, 1 layer and 2 layers (13,300 × 8438 mm size, 20 compartments in the x direction, 16 compartments in the y direction, 1 layer 1500 mm above the ground plane, 2 layers 4500 mm above the ground plane); Sample No. 3, 2 layers (13,300 × 8438 mm size, 30 compartments in the × direction, 2 0 compartments in the y direction, 3 layers 7500 mm above the ground plane). Finally, according to the characteristics of daylight climate in the Beijing area, the system is set as a Class III daylight climate region. In addition, based on the characteristics of the Class III daylight climate region and "the China Building Lighting Design Standard" (GB50033-2013 version) [52] ("the China Building Lighting Design Standard" (GB50033-2013 version): the bedrooms, living rooms (halls), and kitchens of residential buildings should have direct lighting; the lighting of bedrooms and living rooms (halls) of residential buildings shall not be lower than the standard value of lighting of lighting class IV, the value of the daylight factor of side lighting shall not be lower than 2.0%, and the indoor natural light illuminance shall not be lower than 300 lux. (https://www.mohurd.gov.cn/gongkai/zhengce/zhengcefilelib/201301/20130105_224720.html (accessed on 26 December 2023)), we set the units in the Data and Scale: the Minimum value of daylight factor is 2.00%. The Minimum value of interior daylight illuminance is 300 lux. Therefore, we establish a model in Ecotect Analysis according to the mapping results and calculate the daylight factor and interior daylight illuminance of local houses by choosing daylight and artificial light modes as the standard.

3. Results

This section is based on the empirical results derived from the research methodology and data in Section 2, and the main results focus on the in-depth analysis of relevant qualitative and quantitative information about leased space in Laojuntang Village, Beijing. This information is reasonably accurate after we surveyed 233 local renters and 10 experts in the field of architecture, as well as mapping three local self-built houses on the ground. Therefore, it can more scientifically reflect the real feelings of local leasers about the leased space and also provide a large number of reference bases for subsequent deeper analysis and discussions.

3.1. Demand Type and Satisfaction Analysis of Kano Model

According to the calculation results of Formulas (1) and (2), we can get the type of each demand and its *Better–Worse* coefficient statistics of the Kano model for the leased space of Laojuntang Village, as shown in Table 7.

Table 7. *Better–Worse* coefficients of Kano model for leasing space in Laojuntang Village, Chaoyang District, Beijing.

No.	Kano Demand Attribute Categories	*Better* Coefficient	*Worse* Coefficient
u_{32}	M	0.51	−0.51
u_{33}	M	0.43	−0.48
u_{35}	M	0.43	−0.45
u_{42}	M	0.41	−0.45
u_{11}	O	0.62	−0.65
u_{24}	O	0.60	−0.64
u_{23}	O	0.59	−0.67
u_{25}	O	0.57	−0.64
u_{21}	O	0.55	−0.68
u_{22}	O	0.55	−0.61
u_{28}	O	0.53	−0.66
u_{31}	O	0.50	−0.57
u_{27}	O	0.50	−0.63
u_{54}	A	0.49	−0.48
u_{53}	A	0.47	−0.45
u_{52}	A	0.40	−0.37
u_{26}	I	0.49	−0.49
u_{14}	I	0.45	−0.48
u_{34}	I	0.44	−0.48
u_{36}	I	0.40	−0.41
u_{41}	I	0.39	−0.37
u_{44}	I	0.37	−0.35
u_{43}	I	0.36	−0.35
u_{16}	I	0.33	−0.35
u_{45}	I	0.32	−0.35
u_{15}	I	0.32	−0.38
u_{51}	I	0.29	−0.36
u_{46}	I	0.27	−0.32
u_{55}	I	0.09	−0.12
u_{13}	R	0.14	−0.02
u_{12}	R	0.07	−0.03

Moreover, based on the statistical results of the *Better–Worse* coefficient, with the *Better* coefficient as the horizontal axis, the absolute value of the *Worse* coefficient as the vertical axis, and the mean (0.42, −0.44) as the quadrant threshold [53], we establish a scatter plot of the *Better–Worse* coefficient matrix to classify and prioritize the 31 demand indicators in terms of their quadrant positions, as shown in Figure 3. Therefore, the priority of each demand indicator can be seen by the *Better–Worse* coefficient value.

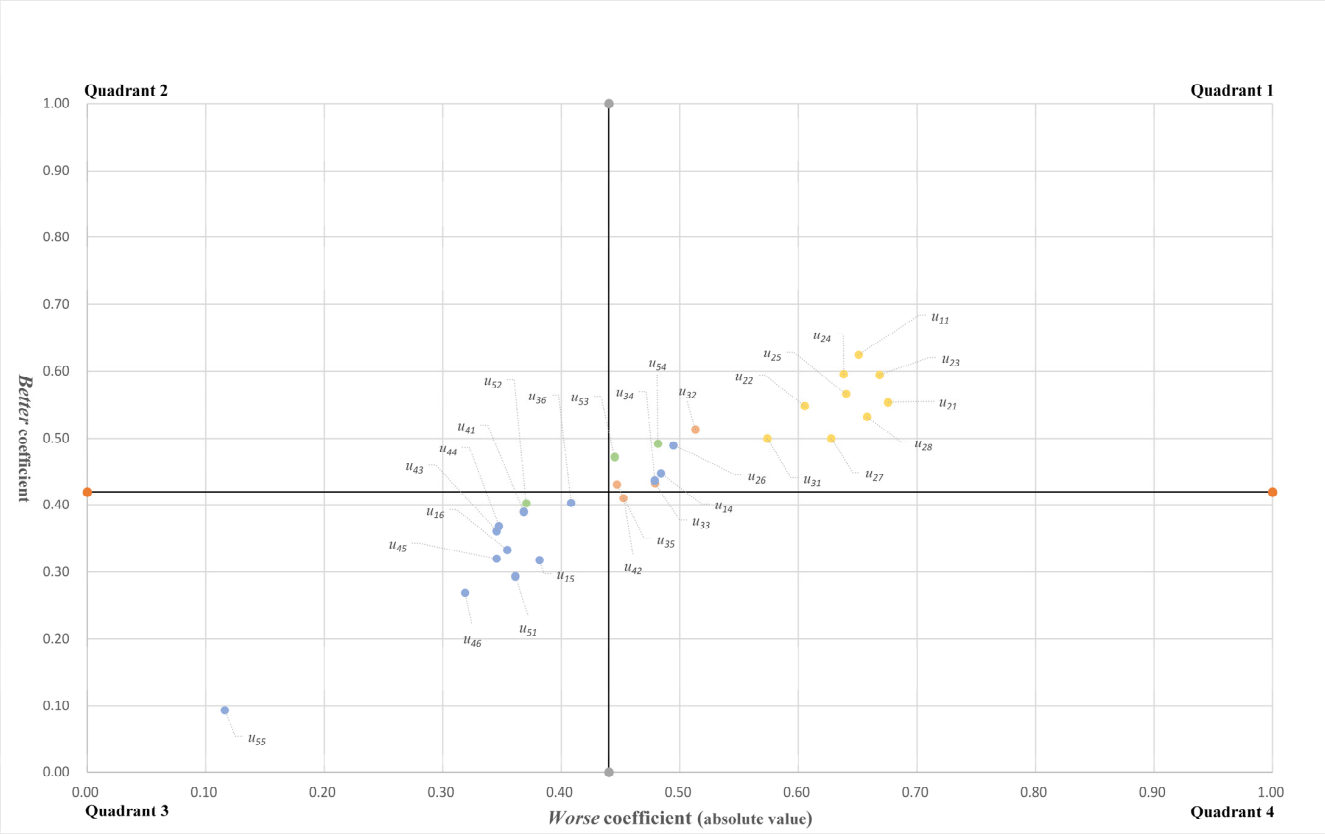

Figure 3. Scatter plot of *Better–Worse* coefficient matrix of Kano model for leased space in Laojuntang Village, Beijing.

Based on the data results in Table 7 and Figure 3, we can find the following information.

Quadrant 1: The One-dimensional Quality. Belonging to the first quadrant are u_{11} (belonging to U_1), u_{24}, u_{23}, u_{25}, u_{21}, u_{22}, u_{28}, u_{27} (belonging to U_2), and u_{31} (belonging to U_3). The absolute values of the *Better* coefficient value and *Worse* coefficient of these nine demand indicators are high, which indicates that it is important and urgent. It is a competitive attribute of quality, and every effort should be made to satisfy the user's One-dimensional Quality.

Quadrant 2: The Attractive Quality. Belonging to the second quadrant are u_{54}, u_{53}, and u_{52} (belonging to U_5). These three demand indicators have a high value of the *Better* coefficient and a low absolute value of the *Worse* coefficient, which indicates that it is important but not urgent.

Quadrant 3: The Indifferent Quality. Belonging to the third quadrant are u_{14}, u_{15}, u_{16} (belonging to U_1), u_{26} (belonging to U_2), u_{34}, u_{36} (belonging to U_3), u_{41}, u_{44}, u_{43}, u_{45}, u_{46} (belonging to U_4), u_{51}, and u_{55} (belonging to U_5). The low value of *the Better* coefficient and the low absolute value of the *Worse* coefficient for these 13 demand indicators indicate that they are unimportant and non-urgent and that these function points are those that the users do not care about.

Quadrant 4: The Must-be Quality. Belonging to quadrant 4 are u_{32}, u_{33}, u_{35} (these three requirements belong to the equipment quality U_3 of the leased space), and u_{42} (belonging to U_4). These four demand indicators have a low value of the *Better* coefficient and a high absolute value of the *Worse* coefficient, which indicates it is unimportant but urgent. This situation also indicates that the demand indicators belonging to this quadrant are the most basic needs, which are the things that the users believe the leased space is obliged to do and which need to be given great attention.

There are u_{13} and u_{12} that belong to the Reverse Quality (belonging to U_1). Although these two demand indicators are not represented in the scatterplot, they also reflect the

aversion of local leased space users to the volume ratio and number of houses that are too highly dense, a situation that also requires the governmental part to strengthen the regulation and remediation of the number and density of leased space in the subsequent governance.

At the same time, in product development, the order of functional priorities is generally M > O > A > I > R [42]. However, when practically considering the current situation and future improvement direction of leased space in Beijing's urban villages, the improvement of the One-dimensional Quality and Attractive Quality can also improve the satisfaction and happiness of the leasers, and the quality attributes of the houses themselves and the surrounding traffic situation in Beijing's leasing market are also important concerns of the leasers. Therefore, we believe that it is important to prioritize the Must-be Quality, One-dimensional Quality, and Attractive Quality according to the actual situation, so as to improve the leased space in Beijing's urban villages in a more scientific and reasonable way.

3.2. Demand Type Analysis of Fuzzy Kano Model

We used the data collected from the 192 Kano model questionnaires and combined them with the knowledge of the membership degree vector in Fuzzy Mathematics to convert the Kano model into a fuzzy Kano model. Calculated according to Formulas (3) and (4), the membership degree vector about each demand indicator of the fuzzy Kano model was obtained as shown in Table 8.

Table 8. Statistics of the membership degree vector for the lease space in Laojuntang Village, Chaoyang District, Beijing.

No.	Membership Degree Vector (*T*)					
	M	**O**	**R**	**A**	**I**	**Q**
u_{11}	0.24	0.40	0.01	0.21	0.13	0.01
u_{12}	0.01	0.00	0.60	0.03	0.34	0.02
u_{13}	0.01	0.00	0.21	0.05	0.15	0.03
u_{14}	0.26	0.22	0.01	0.23	0.28	0.00
u_{15}	0.24	0.12	0.02	0.20	0.41	0.01
u_{16}	0.23	0.12	0.01	0.22	0.42	0.01
u_{21}	0.29	0.37	0.01	0.18	0.14	0.01
u_{22}	0.27	0.33	0.00	0.21	0.17	0.01
u_{23}	0.27	0.40	0.00	0.19	0.13	0.01
u_{24}	0.25	0.37	0.01	0.21	0.14	0.01
u_{25}	0.27	0.36	0.01	0.20	0.15	0.01
u_{26}	0.25	0.24	0.01	0.25	0.25	0.01
u_{27}	0.30	0.31	0.01	0.18	0.18	0.01
u_{28}	0.30	0.35	0.00	0.18	0.16	0.01
u_{31}	0.28	0.29	0.00	0.21	0.21	0.01
u_{32}	0.25	0.26	0.00	0.25	0.23	0.00
u_{33}	0.27	0.21	0.00	0.23	0.30	0.00
u_{34}	0.26	0.21	0.01	0.23	0.29	0.00
u_{35}	0.24	0.19	0.01	0.10	0.13	0.01
u_{36}	0.24	0.17	0.00	0.24	0.35	0.00
u_{41}	0.22	0.14	0.01	0.25	0.38	0.00
u_{42}	0.26	0.19	0.01	0.23	0.32	0.00
u_{43}	0.22	0.13	0.00	0.24	0.41	0.00
u_{44}	0.21	0.13	0.01	0.24	0.41	0.00
u_{45}	0.23	0.11	0.00	0.21	0.44	0.00
u_{46}	0.21	0.08	0.04	0.18	0.47	0.02
u_{51}	0.25	0.11	0.00	0.19	0.45	0.00
u_{52}	0.22	0.15	0.01	0.25	0.37	0.01
u_{53}	0.23	0.21	0.00	0.26	0.29	0.00
u_{54}	0.24	0.24	0.01	0.26	0.26	0.01
u_{55}	0.09	0.01	0.15	0.08	0.66	0.02

According to the data results in Table 8, we can find that the membership degree vector T for each item contains the degree of affiliation of six demand attributes, and these values are dynamically changing. This data phenomenon also illustrates the lack of consideration of data dynamics changes in the traditional Kano model qualitatively and the lack of quantitative data proof [54].

However, most of the values of the membership degree vector reflected in Table 8 are small, and we believe that the method of taking the value of α directly according to the previous studies is not reasonable and will affect the determination of each demand attribute of the fuzzy Kano model. Therefore, we use comparative analysis to determine the value of the threshold α [42]. Firstly, α takes the value range of $\alpha \in [0.05–0.70]$, respectively, for comparative analysis and illustration. Due to the large amount of data and cumbersome processing, this paper omits the calculation process of this part and only gives the final classification results at each confidence level and studies them against the demand attributes identified in Table 7, as shown in Table 9.

Table 9. Comparison of demand attribute categories of Kano model and fuzzy Kano model.

No.	Kano Demand Attribute Categories	Fuzzy Kano Demand Attribute Categories													
		α = 0.70	α = 0.65	α = 0.60	α = 0.55	α = 0.50	α = 0.45	α = 0.40	α = 0.35	α = 0.30	α = 0.25	α = 0.20	α = 0.15	α = 0.10	α = 0.05
u_{11}	O	/	/	/	/	/	/	O	O	O	O	M	M	M	M
u_{12}	R	/	/	R	R	R	R	R	I	I	I	I	I	I	I
u_{13}	R	/	/	/	/	/	/	/	/	/	/	R	I	I	A
u_{14}	I	/	/	/	/	/	/	/	/	/	M	M	M	M	M
u_{15}	I	/	/	/	/	/	/	I	I	I	I	M	M	M	M
u_{16}	I	/	/	/	/	/	/	I	I	I	I	M	M	M	M
u_{21}	O	/	/	/	/	/	/	/	O	O	M	M	M	M	M
u_{22}	O	/	/	/	/	/	/	/	/	O	M	M	M	M	M
u_{23}	O	/	/	/	/	/	/	O	O	O	M	M	M	M	M
u_{24}	O	/	/	/	/	/	/	/	O	O	M	M	M	M	M
u_{25}	O	/	/	/	/	/	/	/	O	O	M	M	M	M	M
u_{26}	M	/	/	/	/	/	/	/	/	/	M	M	M	M	M
u_{27}	O	/	/	/	/	/	/	/	/	M	M	M	M	M	M
u_{28}	O	/	/	/	/	/	/	/	O	M	M	M	M	M	M
u_{31}	M	/	/	/	/	/	/	/	/	/	M	M	M	M	M
u_{32}	M	/	/	/	/	/	/	/	/	/	M	M	M	M	M
u_{33}	M	/	/	/	/	/	/	/	/	I	M	M	M	M	M
u_{34}	M	/	/	/	/	/	/	/	/	/	M	M	M	M	M
u_{35}	M	/	/	/	/	/	/	/	/	/	M	M	M	M	M
u_{36}	I	/	/	/	/	/	/	/	I	I	I	M	M	M	M
u_{41}	I	/	/	/	/	/	/	/	I	I	A	M	M	M	M
u_{42}	M	/	/	/	/	/	/	/	/	I	M	M	M	M	M
u_{43}	I	/	/	/	/	/	/	I	I	I	I	M	M	M	M
u_{44}	I	/	/	/	/	/	/	I	I	I	I	M	M	M	M
u_{45}	I	/	/	/	/	/	/	I	I	I	I	M	M	M	M
u_{46}	I	/	/	/	/	/	I	I	I	I	I	M	M	M	M
u_{51}	I	/	/	/	/	/	I	I	I	I	M	M	M	M	M
u_{52}	A	/	/	/	/	/	/	/	I	I	A	M	M	M	M
u_{53}	A	/	/	/	/	/	/	/	/	/	A	M	M	M	M
u_{54}	A	/	/	/	/	/	/	/	/	/	A	M	M	M	M
u_{55}	I	/	I	I	I	I	I	I	I	I	I	I	I	I	M

According to the comparative statistics in Table 9, firstly, it is taken into account that there should be a good match with the original Kano model demand attribute categories, and secondly, there should not be a lack of excessive data information. Therefore, based on the consideration of these two factors, we finally determined that the fuzzy Kano model demand attribute category generated when the threshold value $\alpha = 0.25$ is relatively realistic.

Comparing the demand attribute categories of the fuzzy Kano model ($\alpha = 0.25$) with the traditional Kano model, we can find the following changes: the seven demand indicators on building performance from u_{21}, u_{22}, u_{23}, u_{24}, u_{25}, u_{27}, and u_{28} changed from the One-dimensional Quality to the Must-be Quality, reflecting that the building performance of the leased space in the actual situation is very important and needs to be urgently enhanced. Both model evaluations highlight the importance of building performance, which is also a major concern for the government and local village councils in the subsequent management of urban villages. The transformation of u_{14} from the Indifferent Quality to the Must-

be Quality reflects renters' demands for unreasonable housing layouts. For example, the bathrooms and kitchens of many houses during our research were windowless, and there were a certain number of stairwells, with extremely unreasonable layouts, so a reasonable adjustment of the layout structure of the houses is necessary for the leased space in Laoguntang Village. The shift of u_{41} and u_{51} from the Indifferent Quality to the Attractive Quality indicates that their importance is increasing and also reflects renters' attitudes toward outdoor activity space and neighboring transport; that is, they will be satisfied if the transport situation can be improved, and if it is not, they will only be compelled by the reality of the situation, and they will not be very disappointed. Based on the realities of Beijing's urban planning (Articles 38, 40, and 41 of the Urban and Rural Planning Law of the People's Republic of China provide that the siting and location of construction projects for township and village authorities, township and village enterprises and institutions, new market towns, new rural areas, and farmers' residences in the city must be examined and approved by the competent administrative department for urban and rural planning and that construction land-use planning permits, construction project planning permits, or rural construction planning permits must be issued before construction is allowed to proceed (https://www.beijing.gov.cn/zhengce/zhengcefagui/201905/t20190522_60899.html (accessed on 26 December 2023))), the realization of these two demand indicators will meet great resistance.

Explanation of missing data: We believe that the reason why u_{13} shifted from the Reverse Quality to missing data can be seen from the membership degree vector in Table 8, where the degree of affiliation of the item demand R (0.21) and I (0.15) is higher for this indicator, and the other attributes are almost 0 and are all less than 0.25, reflecting the high dissatisfaction of this indicator, so the indicator cannot be identified as demand attributes. At the same time, we relate this indicator to the R (0.60) and I (0.34) of u_{12}, and we can find that the R and I of these two demand indicators are extremely high when compared with other demand indicators. Therefore, when all the other demand indicators can be identified as demand attribute categories, but only the data of this indicator are missing, this special situation also precisely shows that the local renters are extremely dissatisfied with the status quo of the over-density of the housing stock and have almost no favorable opinion, which leads to a very low level of satisfaction and a very high level of dissatisfaction with the data of this demand indicator, as well as the data filled in the indicator of u_{12}, and therefore leads to the situation of the very low values of M, O, and A as well as the lack of the attributes of the indicator of the demand.

3.3. Satisfaction and Importance Analysis of Fuzzy Kano Model

Based on the results of data operations in Tables 8 and 9, we can accurately determine the various demand attribute categories of leased space in Laojuntang Village, which is a reasonable qualitative conclusion. Based on this, we find that the different demand indicators under the same fuzzy Kano model attributes need to further address the quantitative issues, i.e., the degree of satisfaction, the degree of functional services, and the degree of importance of future improvement of the different demand indicators under the same attribute category, in order to deepen the science and accuracy of the fuzzy Kano model from the quantitative perspective, which is also conducive to the practical use of the local leased space governance.

This subsection is divided into two main parts for empirical analysis. We combine the data from Table 4 with Formulas (9) and (10) to obtain Table 10.

According to the user satisfaction data in Table 10, the larger the value of S_0, the more satisfied they are with the current status of the need, and vice versa. Moreover, the value of the column of S_0 is increasing from top to bottom, reflecting that the current status of the first few demands is very bad; for example, the current satisfaction values of the seven demand indicators, u_{23}, u_{24}, u_{27}, u_{21}, u_{28}, u_{31}, and u_{35}, are all less than 2.00, which is lower than the other demand indicators. As a result, we find that the physical properties of the house itself and the experience of living in it are of great concern to the user. Secondly, a

larger value of S_1 indicates a greater need for greater improvement in the future to achieve the desired level of satisfaction. We can find that the values in the S_1 column do not differ much from each other, and they are all in the range of [3.32–3.88]; that is, the attitude is between "Fairly satisfied" and "Neither", so we think that the renters lack confidence in the expected improvement of the leased space and have an average attitude toward whether the leased space and its surrounding conditions can be improved in practice.

Table 10. Summary of user satisfaction and service level of building function for leased spaces in Laojuntang Village, Chaoyang District, Beijing.

Summary of User Satisfaction (Sorted by the Value of S_1/S_0)				**Summary of Service Level of Building Function (Sorted by the Value of P_1/P_0)**			
No.	S_0	S_1	S_1/S_0	**No.**	P_0	P_1	P_1/P_0
u_{23}	1.88	3.85	2.05	u_{21}	1.83	3.76	2.05
u_{24}	1.90	3.83	2.01	u_{23}	1.85	3.78	2.04
u_{27}	1.88	3.76	2.00	u_{28}	1.76	3.46	1.97
u_{21}	1.90	3.76	1.97	u_{22}	1.90	3.68	1.94
u_{28}	1.93	3.76	1.95	u_{24}	1.90	3.63	1.91
u_{22}	2.00	3.80	1.90	u_{27}	1.85	3.49	1.88
u_{31}	1.93	3.66	1.90	u_{31}	1.83	3.39	1.85
u_{35}	1.98	3.56	1.80	u_{32}	1.98	3.56	1.80
u_{25}	2.12	3.76	1.77	u_{35}	1.95	3.49	1.79
u_{32}	2.17	3.73	1.72	u_{16}	2.12	3.71	1.75
u_{36}	2.12	3.56	1.68	u_{25}	2.15	3.71	1.73
u_{34}	2.12	3.49	1.64	u_{54}	2.24	3.88	1.73
u_{33}	2.24	3.63	1.62	u_{51}	2.32	3.98	1.72
u_{53}	2.34	3.73	1.59	u_{34}	2.05	3.51	1.71
u_{54}	2.44	3.88	1.59	u_{36}	2.00	3.39	1.70
u_{52}	2.44	3.78	1.55	u_{52}	2.27	3.85	1.70
u_{13}	2.39	3.68	1.54	u_{14}	2.10	3.51	1.67
u_{26}	2.54	3.88	1.53	u_{15}	2.22	3.71	1.67
u_{14}	2.37	3.61	1.53	u_{53}	2.34	3.90	1.67
u_{51}	2.49	3.76	1.51	u_{26}	2.39	3.95	1.65
u_{12}	2.29	3.44	1.50	u_{33}	2.22	3.66	1.65
u_{16}	2.46	3.71	1.50	u_{42}	2.32	3.80	1.64
u_{42}	2.51	3.73	1.49	u_{13}	2.24	3.61	1.61
u_{15}	2.49	3.66	1.47	u_{41}	2.44	3.93	1.61
u_{11}	2.49	3.63	1.46	u_{46}	2.29	3.68	1.61
u_{41}	2.59	3.76	1.45	u_{45}	2.41	3.85	1.60
u_{43}	2.71	3.85	1.42	u_{43}	2.49	3.95	1.59
u_{44}	2.83	3.95	1.40	u_{12}	2.17	3.41	1.57
u_{46}	2.63	3.68	1.40	u_{11}	2.39	3.66	1.53
u_{45}	2.73	3.76	1.38	u_{44}	2.68	3.93	1.46
u_{55}	2.73	3.32	1.21	u_{55}	2.59	3.49	1.35

A similar situation of satisfaction data in Table 10 also occurs in the building functional service level data. The larger the value of P_0, the higher the functional service level of the demand, resulting in higher user satisfaction with it, and vice versa. Moreover, the value of the column of the current service level of building function is increasing from top to bottom, reflecting that the functional service level of the previous indicators is lower; for example, the current functional service level of the nine demand indicators u_{21}, u_{23}, u_{28}, u_{22}, u_{24}, u_{27}, u_{31}, u_{32}, and u_{35} are all less than 2.00, which is lower than that of the other demand indicators, and this leads to the fact that the corresponding current value of user satisfaction is lower, which well explains the reason for the change in the value of satisfaction. Therefore, we believe that it is particularly important to improve the physical properties of the house, and its impact on the life of the user is very great. At the same time, the greater the value of P_1, the greater the room for improvement of this demand indicator, and the poorer the current service level, and vice versa. We found that the value of P_1 is

highly similar to that of the S_0, which is in the range of [3.32–3.98]. This means that the attitudes are between "Very good" and "fair", with a neutral attitude toward the need for future improvement of the leased space.

These evaluation results from local leaseholders also reflect that the transformed urban village space may not be fully suited to the needs of the local residents. At the same time, in the process of urban village management, the process of transformation also involves the personal interests of local residents. When there is a conflict of interest, some specific transformation methods will be difficult to implement and will have a greater discrepancy with the ideal state. Local residents have also experienced this transformation and upgrading process and also understand that the implementation of urban village transformation is difficult and obstructive. Therefore, based on the above two explanations, we believe that local residents maintain a neutral or even skeptical attitude toward their satisfaction with the improvement of leased space in urban villages, as they are not sure whether urban village renovation will be suitable for their real lives, nor are they sure whether urban village renovation will be implemented in real terms.

At the same time, we analyzed the value of S_1/S_0 and P_1/P_0. When the former value is larger and the latter is smaller, the larger the ratio of the two, the higher the importance of the evaluation index and the higher the priority of future improvement, so the more it reflects the factors of concern to the local leaseholders. We can find that u_{23}, u_{24}, and u_{27} have more than two points in the evaluation score of S_1/S_0, and u_{23} and u_{21} have more than two points in the evaluation score of P_1/P_0. Therefore, for the cold-proofing performance, heat dissipation performance, lighting performance, and acoustic performance of the leased space, the local government needs to strengthen the relevant governance and improvement work in the future transformation of urban villages.

The second part is to calculate the adjusted improvement coefficient IR_{adj} of the service level of building function for each demand indicator according to Formula (12) and to obtain the final importance degree W_1 of each demand indicator of the fuzzy Kano model according to Formula (14), as shown in Table 11.

According to the statistical results of the data in Table 11, the original importance degree W_0 reflects the importance ranking of the 10 experts and scholars in the field of architecture for each demand indicator of the leased space in Laoguntang Village, Beijing. Among them, u_{23}, u_{28}, u_{27}, u_{22}, u_{24}, u_{31}, u_{21}, u_{25}, u_{35}, u_{34}, u_{33}, u_{36}, u_{32}, u_{53}, u_{11}, and u_{26}, the W_0 of these 16 demand indicators is greater than 4.00, which belongs to the range of "Fairly important" to "very important", indicating the importance that experts attach to the three main demand aspects of building performance, equipment quality, and basic facilities in leased spaces. This is also consistent with the results of the previous analysis, that is, the renovation and upgrading of leased space in urban villages should pay more attention to the physical performance and living experience of the housing itself. Then, for u_{14}, u_{12}, u_{13}, u_{54}, u_{52}, u_{16}, u_{55}, and u_{41}, the W_0 of these eight demand indicators is at [3.17–3.83], which is between "Neither" and "Fairly important", indicating that the experts have a neutral attitude toward the basic facilities and external transport facilities of the leased space. If these two aspects can be upgraded and improved, it is still meaningful for the leased space of urban villages, but in reality, it is still a difficult obstacle. For example, according to Beijing's relevant policies (Article 32 of the Urban Planning Law of the People's Republic of China: for the construction of new buildings, extensions, and alterations of buildings, structures, roads, pipelines, and other engineering facilities within an urban planning area, an application must be submitted to the administrative department for urban planning with the relevant approval documents, and the administrative department for urban planning shall issue a construction project planning permit in accordance with the planning and design requirements set forth in the urban plan. The construction unit or individual may apply for the commencement of work only after obtaining the construction project planning license and other relevant approval documents (https://zyk.bjhd.gov.cn/jbdt/auto4539_51835/auto4539_56157/auto4539/auto4539_56160/201810/t20181002_3243221.shtml (accessed on 26 December 2023))), the rectification of the size and plot ratio of rental housing requires

the control of the relevant authorities and involves the interests of the collective land, so it is difficult to reduce or increase the number of households and the plot ratio. The W_0 of the remaining seven demand indicators is [2.50–2.83], which is between "Neither" and "Fairly unimportant", indicating that the experts are skeptical of the facilities for external activities in the leased space. Because renters in Beijing's urban villages need to spend time traveling to save on living costs, long hours of work and commuting take up their living time, and leased space is only a place for them to take a break, so the attention paid to the external facilities is not as important as it should be.

Table 11. Summary of fuzzy Kano model and importance degree for leased spaces in Laojuntang Village, Chaoyang District, Beijing (sorted by the value of W_1).

No.	Fuzzy Kano Demand Attribute Categories	k	$1/k$	IR_0	IR_{adj}	W_0	W_1	Rank
u_{23}	M	0.99	1.01	2.04	2.05	4.83	9.92	1
u_{28}	M	1.02	0.98	1.97	1.95	4.50	8.77	2
u_{27}	M	0.91	1.10	1.88	2.00	4.33	8.67	3
u_{22}	M	1.03	0.97	1.94	1.90	4.50	8.56	4
u_{24}	M	0.93	1.08	1.91	2.01	4.00	8.05	5
u_{31}	M	0.96	1.04	1.85	1.90	4.17	7.91	6
u_{21}	M	1.06	0.95	2.05	1.97	4.00	7.90	7
u_{25}	M	0.96	1.04	1.73	1.77	4.33	7.67	8
u_{35}	M	0.99	1.01	1.79	1.80	4.17	7.51	9
u_{34}	M	1.08	0.92	1.71	1.64	4.50	7.40	10
u_{33}	M	1.04	0.96	1.65	1.62	4.50	7.29	11
u_{36}	I	1.02	0.98	1.70	1.68	4.33	7.27	12
u_{32}	M	1.09	0.92	1.80	1.72	4.17	7.16	13
u_{53}	A	1.10	0.91	1.67	1.59	4.17	6.64	14
u_{11}	O	1.12	0.89	1.53	1.46	4.50	6.57	15
u_{26}	M	1.18	0.84	1.65	1.53	4.00	6.12	16
u_{14}	M	1.22	0.82	1.67	1.53	3.83	5.85	17
u_{12}	I	1.12	0.90	1.57	1.50	3.83	5.75	18
u_{13}	/	1.10	0.91	1.61	1.54	3.67	5.65	19
u_{54}	A	1.18	0.85	1.73	1.59	3.50	5.57	20
u_{52}	A	1.21	0.83	1.70	1.55	3.33	5.17	21
u_{16}	I	1.37	0.73	1.75	1.50	3.33	5.02	22
u_{55}	I	1.54	0.65	1.35	1.21	3.83	4.65	23
u_{41}	A	1.28	0.78	1.61	1.45	3.17	4.60	24
u_{42}	M	1.25	0.80	1.64	1.49	2.83	4.21	25
u_{51}	M	1.31	0.76	1.72	1.51	2.67	4.03	26
u_{15}	I	1.33	0.75	1.67	1.47	2.67	3.92	27
u_{43}	I	1.31	0.76	1.59	1.42	2.67	3.80	28
u_{44}	I	1.14	0.88	1.46	1.40	2.67	3.72	29
u_{45}	I	1.47	0.68	1.60	1.38	2.67	3.67	30
u_{46}	I	1.41	0.71	1.61	1.40	2.50	3.50	31

Based on the analysis of the original importance W_0, we can obtain the final importance degree W_1, with u_{23} housing winter thermal performance ranking first in importance. We believe that in the cold winter, the renter can live in a better-insulated room, which is a bottom-line requirement and also the most basic housing guarantee for "Beijing drifters". If even this safeguard requirement is not met, how can an urban village leased space be considered a compliant housing unit? However, through field mapping combined with building simulation techniques, we found that in reality, many rental rooms do not meet such bottom-line requirements (see the discussion in Section 3.4 for more details). Secondly, observing the top 15 of the final importance degree ranking, we can find that essentially all of them are concerned with the three main aspects of building performance, equipment quality, and external transport facilities of the leased space. In this way, the final importance

degree ranking can determine the priority of urban village leased space renovation and upgrading methods, and improve the living security for the leasers.

3.4. Building Performance Simulation Analysis of Leased Spaces in Urban Villages

After mapping three self-built houses at different locations (see Figure 1), we analyze the physical properties of these houses through building simulation technology (this paper adopts Ecotect Analysis 2011 version software), so as to prove the accuracy and reasonableness of the fuzzy Kano model in a more realistic way. We simulated the thermal property and value of interior daylight illuminance properties of the local self-built house using Ecotect Analysis, as shown in Table 12, Figures 4 and 5.

Table 12. Annual passive heat gain data of self-built houses in Laojuntang Village, Chaoyang District, Beijing (all visible heat areas, 1 January to 31 December).

Sample Number	Losses/ Gains	Category					
		Fabric	Sol-Air	Solar	Ventilation	Internal	Inter-Zonal
Sample 1, 1st floor	Losses	41.40%	0.00%	0.00%	47.40%	0.00%	11.10%
	Gains	3.20%	9.80%	12.80%	3.90%	70.30%	0.00%
Sample 1, 2nd floor	Losses	42.60%	0.00%	0.00%	46.80%	0.00%	10.60%
	Gains	3.30%	10.00%	13.00%	3.90%	69.80%	0.00%
Sample 2, 1st floor	Losses	49.80%	0.00%	0.00%	40.10%	0.00%	10.00%
	Gains	3.70%	14.80%	13.00%	3.20%	65.20%	0.00%
Sample 2, 2nd floor	Losses	59.70%	0.00%	0.00%	39.80%	0.00%	0.40%
	Gains	3.70%	12.40%	11.50%	2.70%	69.20%	0.50%
Sample 3, 1st floor	Losses	74.50%	0.00%	0.00%	20.80%	0.00%	4.70%
	Gains	6.80%	34.40%	16.00%	2.10%	40.60%	0.10%
Sample 3, 2nd floor	Losses	67.70%	0.00%	0.00%	31.80%	0.00%	0.40%
	Gains	5.10%	19.50%	17.20%	2.60%	54.90%	0.70%
Sample 3, 3rd floor	Losses	63.80%	0.00%	0.00%	35.70%	0.00%	0.50%
	Gains	5.10%	17.90%	18.00%	3.10%	55.10%	0.80%

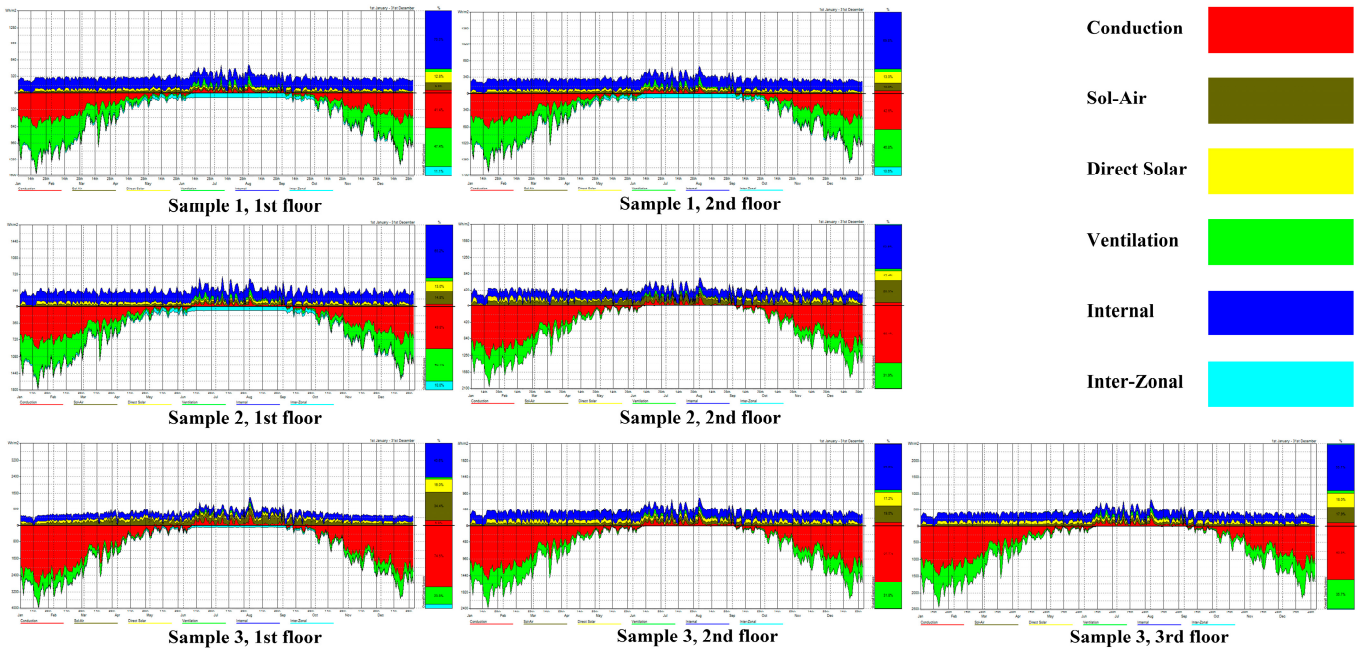

Figure 4. Passive heat gain composition of the sample throughout the year (all visible heat areas). The legend description is in the upper right corner.

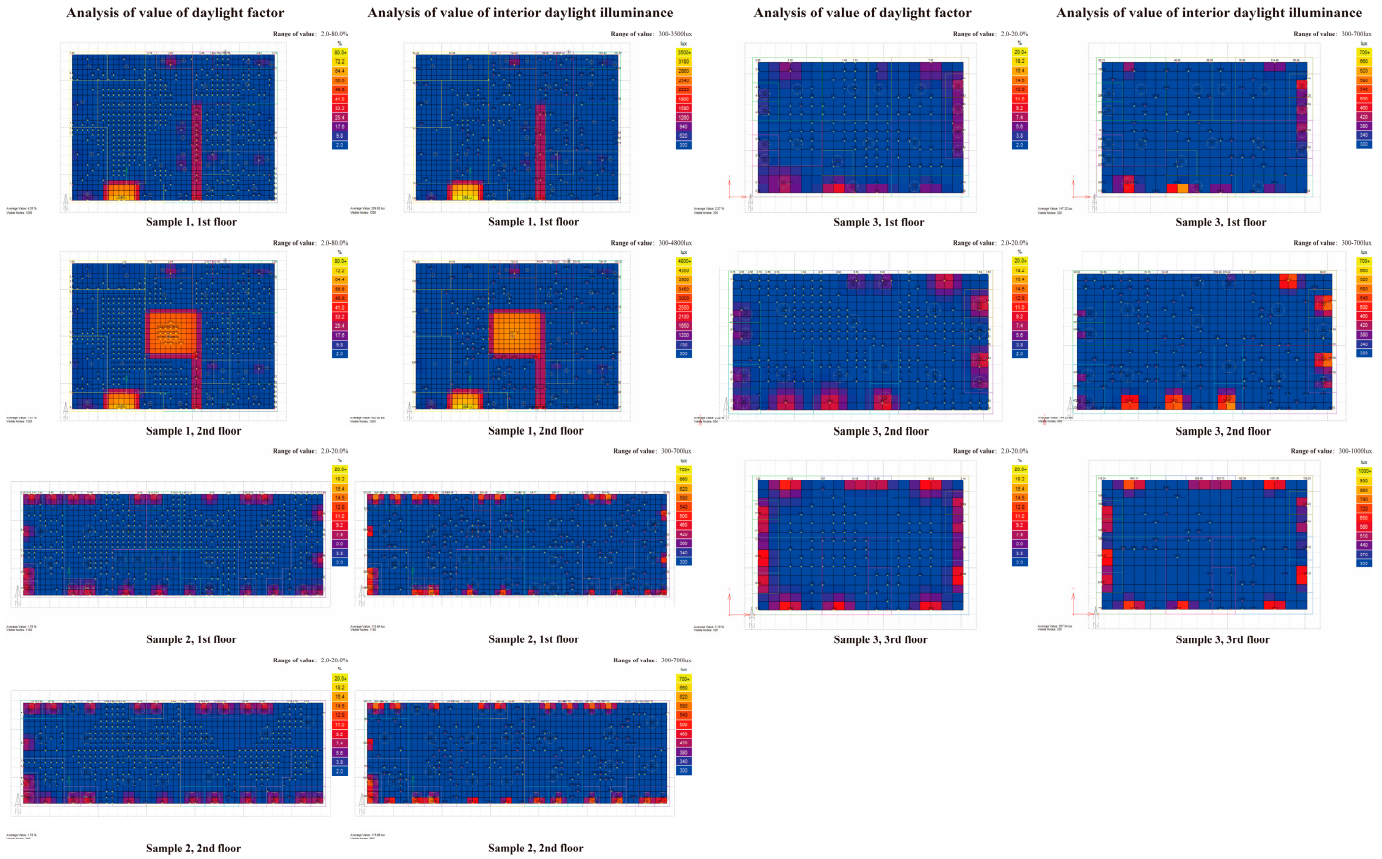

Figure 5. Analysis of value of daylight factor and value of interior daylight illuminance for samples 1, 2, and 3 (all visible heat areas).

For the thermal property of the self-built house, combining the simulation information in Table 12 and Figure 4, we find that in the annual cycle, the heat of the self-built house mainly comes from direct solar radiation (solar), internal heat of the house, air-conducted heat (sol-air), and a small amount of heat gain from ventilation (ventilation), and its heat gain performance is average compared to the heat loss performance. However, the heat dissipation of the self-built houses deserves our attention. And their structural heat loss (fabric, the red area in Figure 3) is very serious. For example, the structural heat loss of each floor of Sample No. 1 reaches 41.40% and 42.60%, respectively, the structural heat loss of each floor of Sample No. 2 reaches 49.80% and 59.70%, respectively, and the structural heat loss of each floor of Sample No. 3 reaches 74.50%, 67.70%, and 63.80%, respectively. Structural heat loss in Samples 2 and 3 accounted for almost the majority of the heat transfer. This shows that structural heat loss has a very unfavorable effect on the construction of houses. Especially in the cold Beijing winter, a large amount of heat inside the house is conducted to the outside, which, on the one hand, leads to an increase in the heating demand and fails to save resources. On the other hand, the living experience of the renters is highly unsatisfactory, emphasizing the necessity of meeting these fundamental heating requirements in future urban village renovations. This most basic heating requirement is necessary to meet. Similarly, the ventilation and heat loss performance of the three samples is also very serious, which is not conducive to thermal insulation and aggravates the reduction in the indoor temperature of the leased space in winter, resulting in great dissatisfaction among occupants and more consumption of winter heating resources.

According to Figure 5 and the lighting analysis of the three self-built houses, combined with the China Building Lighting Design Standard (GB50033-2013version), we found that the average value of the daylight factor of the interior of the one-story building of Sample No. 1 is 4.2%, and the average value of interior daylight illuminance is 209.92 lux, and the values of the two-story building are 7.57% and 492.06 lux, which indicates that Sample

No. 1 meets the specification requirements as a whole. However, the value of the daylight factor of the rooms in the west, east, and north locations of their building ranges from 0.21% to 1.91%, and the value of interior daylight illuminance is also in the range of 10.79–187.47 lux, which is much lower than the overall average. The open spaces on the south and central sides make the values of the daylighting analyses significantly higher, resulting in better overall lighting levels, but the spaces in the two locations happen to be the rooms where the homeowners themselves reside, and the lighting levels in all the other leased spaces are still far from meeting the specification requirements.

The average value of the daylight factor of the interior of the one-story building of Sample No. 2 is 1.78%, and the average value of interior daylight illuminance is 115.84 lux, and the values of the two-story building are 1.78% and 115.96 lux, respectively, which indicates that the overall lighting level of Sample No. 2 is poor and does not meet the specification requirements. The Sample 2 building maximizes rental income by separating small leased space as much as possible within the limited site area, resulting in extremely poor lighting conditions in each small leased space including the landlord's room. Only the locations around the perimeter of the building near the windows and doors have slightly better lighting conditions, while most of the other spaces have a value of the daylight factor ranging from approximately 0.14 to 1.97 percent and the value of interior daylight illuminance ranging from 18.83 to 98.41 lux.

The average value of the daylight factor of the one-story building of Sample No. 3 is 2.27%, and the average value of interior daylight illuminance is 147.32 lux; the values of the two-story building are 2.22% and 144.02 lux, and the values of the three-story building are 3.19% and 207.54 lux. This indicates that the overall lighting level of Sample No. 3 shows an upward trend along with the increase in the building's height, and the value of the daylight factor of Sample No. 3 meets the specification requirements but has a lower value. However, the value of interior daylight illuminance does not meet the specification requirements and has a low value. The lighting status quo of Sample 3 reflects that the building height has a weak significance in improving the lighting level of self-built houses and does not have a substantial improvement in the living experience of the renters. But in the rental market, the house owner can use the gimmick of the advantage of the height of the building to win the trust of the renters to increase the rent of the three-story and two-story houses in order to obtain more profits. (The reality of leased space reflects Beijing's unique economic and policy characteristics. From an economic point of view, these rooms that do not comply with the building code are mainly a way for housing owners to save costs and increase the number of rentals in exchange for more revenue. That is why public spaces such as foyers, atriums, and courtyards seldom appear, which also reflects the fact that housing owners do not care about the living comfort and reasonableness of the leased space but only about profit. At the same time, in the process of pursuing the interests of homeowners, the local policy in Beijing also has relevant policy restrictions on self-built houses on rural collective land (in principle, the area of the base of a villager's house shall not exceed 75 percent of the area of the house base, and the height of the eaves of a house (calculated from the plane of the base of the house) shall not exceed 7.2 m). The vertical downward projection and steps of the house from all directions (including dripping) should be controlled within the boundaries of the house base (https://www.beijing.gov.cn/zhengce/zhengcefagui/202008/t20200811_1979059.html (accessed on 26 December 2023))). These policies lead the landlords to add more houses in the limited space and at the same time compress the area of leased space.

4. Discussion

The above empirical results show that the improvement of building performance, equipment quality, and external transport facilities in the leased space of urban villages is the main demand of local renters. Therefore, the main content of this section discusses the reasons for the current situation of leased space in Beijing's urban villages from three aspects: the leasing market, the household registration system, and social security.

4.1. Imbalanced Rental Market and Prices Reduce the Level of Leasers' Living Needs

Firstly, the imbalance of the leasing market in Beijing limits living options for leasers. The imbalance in the leasing market mainly includes problems such as unequal rights and obligations of the leasing parties, disorderly market order, and insufficient relevant regulations and policies. However, according to China's relevant laws (Article 2 of the Interpretation of the Supreme People's Court on Several Issues Concerning the Specific Application of the Law in Hearing Cases of Disputes over Urban Housing Lease Contracts: a lease contract concluded between a lessor and a lessee in respect of a house that has not been granted a planning permit for the construction project or that has not been constructed in accordance with the provisions of the planning permit for the construction project shall be null and void (https://flk.npc.gov.cn/detail2.html?ZmY4MDgxODE3OTlkZjQwMDAxNzliMDhlYWZjODE3NmU= (accessed on 26 December 2023))), there is a certain number of non-compliant rooms in leased spaces in urban villages, which means that it is often difficult to protect the rights of renters in the event of civil disputes. Moreover, leased spaces in urban villages are generally unable to produce a written housing lease contract, which makes the rights of renters not effectively protected. The leaseholder is still a weak party, and the rights and obligations of both parties to the lease are imbalanced. Once their leaseholder residence rights are infringed upon and cannot get timely and effective protection, they will face greater economic losses [55].

Then, the great imbalance between income and expenditure forces low-income people to choose leased spaces in urban villages. Although there are many illegal disadvantages of leased space in urban villages, there are still a large number of low-income people who choose to live there. According to [56], it was found that the mobile population in Beijing is mainly employed people in lower-paying jobs. As rents and agency fees are higher in civilian residential neighborhoods and are mostly shared by many people, leased spaces in urban villages are mostly with separate kitchens and bathrooms, water, and electricity and are freer to enter and exit. These market factors have resulted in the choice of some leasers who have limited consumption levels and are not willing to share a room. They have to choose urban villages that are farther away from their workplace to save living costs. As a result, their demand for subways, buses, and bicycles will be extremely strong, which is also the focus of Beijing's future governance and transformation of urban villages. If this can be improved, we believe it will greatly enhance the well-being of workers in Beijing. Furthermore, this also indicates that the leased space prices have a predominant influence on the spatial organization of residents' daily lives.

Last but not least, the high-intensity working pace in Beijing also greatly reduces the living demand of leasers. According to our survey, a large number of local renters choose to work in Beijing to accumulate experience and wealth, and their work occupies most of their time, and they live in their rented houses from 18:00 to 8:00 every day. Therefore, their rented rooms are no more than temporary shelters, and they seldom have the energy or time to pay attention to factors outside the room. They are more concerned about the comfort of living in the indoor space, such as protection from cold in winter, heat dissipation in summer, and better sound insulation.

Therefore, we can understand that the leased space in urban villages is a kind of living object that the renters have no choice but to choose due to the real economic factors, and the demand for leased space in such a situation is also a basic need.

4.2. Strict Household Registration and Social Security System Ignorance of the Housing Rights of Renters

Migrant workers still lack a greater degree of security in living in Beijing, which is closely related to the city's strict household registration and social security system. The inability to obtain Beijing household registration for a long period of time will inevitably lead to a lack of effective protection of the rights and interests of renters and an increase in the rate of emigration of the floating population. Compared to other megacities, Beijing has implemented the strictest hukou control policy. Public services and social policies in Beijing

are commonly linked to the household registration system, and it is progressively more difficult for the floating population to settle in the city. Because urban low-income people mostly work in the informal sector [57], they do not benefit from government interventions such as tax breaks and supply-side subsidies, and demand-side subsidies are limited.

Low-income people in Beijing also suffer from unfair treatment in the distribution of public resources. In the process of urbanization, capital shows a tendency to concentrate in the central area first, which leads to the expulsion of labor from the inner city to the peripheral area [58]. In this process, rich public resources are always gathered in the city center area, and low-income people are always forced to stay away from urban resources. In this way, the floating population may face unfavorable conditions in terms of the various public resources they need. Research suggests that illegitimate tenancy status may prevent low-income tenants from accessing public services, forcing half or more of them to choose to stay in semi-formal rural housing when they cannot afford to pay the rent of formal housing [59]. Urban villages are a source of low-cost housing in megacities, providing living conditions that are usually lower than those recognized by the government [60,61], but they satisfy those with less access to resources with lower rental prices and living costs and allow these people to maintain a basic working life in the city. This comes at the cost of poorer housing conditions. The study shows that the floating population sometimes works in Chinese cities and appropriately gives up their rights to non-life-threatening social welfare transactions such as health care and children's education [62]. This is a particular status quo for low-income people in megacities [52,63].

In the light of the above discussions and analyses, we believe that it is an important and urgent task to solve the current problems of leased space in Beijing's urban villages and to more accurately meet the needs of local residents. However, economic and policy factors constrain the improvement of leased space in Beijing's urban villages, such as the need to improve the leasing market by optimizing legal rules and law enforcement, the need to improve transport conditions in coordination with Beijing's urban planning and construction, the need for housing renovation to create new conflicts of interest and conflicts between people and land, and the difficulty in realizing social security for leasers due to the constraints of the household registration system. Moreover, combining the empirical results of the fuzzy Kano model data, we also find that the occupants of Beijing's urban village leased space are more concerned about the goodness of their own sense of living experience and that the external space and facilities have less impact on them, which further suggests that the leasers have less dependence on the leased space and less dependence on the city of Beijing; that is, they do not have a sense of belonging. So much so that in reality most renters will eventually leave Beijing after accumulating wealth and experience in the city and move to other cities or places of origin [63]. This is a very real social phenomenon, and Beijing's leased space reflects the dilemma and uncertain future of low-income people in contemporary megacities. We believe that changing this phenomenon requires long-term and arduous efforts.

5. Conclusions

Through the use of the fuzzy Kano model with the empirical results produced by building performance simulation and the discussion of the influencing factors, this paper reveals that the main problems and user needs that exist in the leased spaces of Laoguntang Village are as follows: (1) The architectural performance of the leased space is poor, which is the most concerned by local leasers and belongs to the Must-be Quality. Specifically, the thermal property and lighting conditions of the leased space do not meet the requirements of the relevant norms, making the leased space's cold-proofing performance in winter, heat dissipation performance in summer, ventilation performance, and indoor light environment all very poor, which seriously reduces the satisfaction and sense of well-being of the leasers and is in urgent need of renovation and upgrading. (2) The poor quality of basic facilities and equipment in leased spaces is manifested in such problems as too small a housing area, too many illegal structures, and the poor quality of housing materials and facilities, mostly

belonging to the One-dimensional Quality and Attractive Quality, which are less important than the performance of the building. (3) The facilities for external activities in the leased space are poor, mostly the Indifferent Quality. In particular, the local traffic conditions are more complex, with multiple high-speed roads and urban ring roads arranged here, leading to congestion during peak periods of pedestrian flow. And there are fewer metro stations and bus stops in the neighborhood, which are linearly distributed and unable to form a network-type traffic layout, which is not conducive to the travel of local residents. However, this Indifferent Quality is difficult to transform and upgrade in a short period of time, and the possibility of improvement is low, so the local users are not particularly prominent in their demand. Laojuntang Village is a typical "tile economy" development model, with a high building scale and plot ratio that makes residents dissatisfied. (4) This status quo is a special phenomenon arising from the imbalance between economic development and housing supply and demand in contemporary Beijing, and it is a problem that requires a great deal of policy support and economic assistance to solve, so the users fall under the Reverse Quality category, reflecting an attitude of helplessness.

In summary, these user needs with clear priority and importance illustrate that the application of this research methodology is feasible in this research object and field, generating accurate and scientific data and results and providing scientifically sound references for subsequent governance work.

In addition, we believe that the results of this study will also have a positive impact on urban planning and policy making. First, for the urban planning of Beijing, urban villages generally exist in the green isolation areas of the first and second roads in Beijing. The green isolation areas were originally intended to limit the excessive development of the city, but in fact, they spontaneously produced the gathering places of urban villages. Therefore, from this research results that renters have a needy and reluctant attitude toward transportation improvements, it can be seen that it is more important to prioritize the urban planning level to propose a reasonable arrangement of transportation routes and increase the number of public service facilities. Moreover, the research results also found that the local rental space organization model is relatively homogeneous and closed and lacks public space. The concept of the "Living Circle Residential Area" is also proposed in the 2018 "Urban Residential Area Planning and Design Standards", which is conducive to enhancing residents' sense of belonging and promoting social integration. Future urban planning should also address the issue of building living areas in the "living circle" of urban villages, so as to enhance the sense of well-being of low-income people. Second, for Beijing's policy formulation, the transformation of urban villages is characterized by a distinct government-led approach. The findings of this paper indicate that the building performance of leased space is of most concern to local renters and is the Must-be Quality. The focus of rental space in urban villages remains on ensuring that low-income people can have a place to live that meets the Must-be Quality. This requires that the government should pay attention to the relevance and practicability of its policies in the governance of urban villages. Although it is now entering a new phase of large-scale transformation of urban villages, transformation does not mean elimination. On the contrary, policy making should provide renters with more low-cost basic space and affordable healthy housing. Otherwise, when exclusionary remodeling allows these non-households to lose their population elsewhere, it will not be conducive to the operational development of the city.

From a longer perspective, for the future development of leased space in Beijing's urban villages, we hope that there are three ways to solve the problem as follows: First, through negotiation between the government, local village committees, and housing owners, the local leasing market should be regulated, and the quality of housing and the living environment in leased space should be upgraded, so that leased space can be transformed from a survival space to a living space, and the satisfaction and happiness of residents can be increased. This is the first and foremost task for improvement. Second, the government should strengthen cooperation with village collective organizations and social capital to

increase the construction of public rental housing, so that the original informality of leased space in urban villages can be transformed into compliance under the supervision of the government, which will contribute to the efficient governance of urban villages. Third, improving the inequality of access to social benefits and resources caused by the household registration system may be helpful in stimulating tenants to settle in megacities, such as allowing children to attend community schools.

In addition, in future research work, this paper can still be further refined and improved from two aspects. First, the research method is still limited. At present, this paper mainly evaluates, simulates, and analyzes urban villages from the perspective of the leased space, which focuses more on solving the problem of housing space in practice and lacks the comprehensive development of urban village rental space from the aspects of macro planning, policy mechanism, and multi-party cooperation. This part of the research still needs to be improved. Second, the research object of this paper is Laojuntang Village, which is only a part of several urban villages. There are still many different types of urban villages in Beijing, and each type of urban village has high research value, which can explore different transformation paths, such as government-led, developer-led, and village-collective-led. We hope that in future research work, we can further improve the transformation path and development form of the leased space of urban villages. This thesis tries to start the discussion, hoping to arouse the attention of the academic circle so as to encourage more and deeper research achievements.

Although the road to the future governance of leased space in Beijing's urban villages is long and arduous, we believe that it can be gradually improved through economic assistance, policy support, multi-party negotiation, industrial transformation, and other paths. We also sincerely hope that more research can focus on the survival of low- and middle-income people in megacities and that their rights and interests can be improved, which is also an important path to social justice. At the same time, we will also pay continuous attention to the changes in the leased space and tenants in urban villages and carry out regular questionnaire surveys and return visits, so as to contribute to better social governance.

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