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From Vacancy to Vitality: NIMBY Effects, Life Satisfaction, and Scenario-Based Design in China's Repurposed Residential Spaces

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Abstract

With the ongoing advancement of urbanization in China, a disparity has arisen between population demands and the allocation of community resources, resulting in a persistent increase in residential vacancy rates. The integration of service facilities into vacant residential spaces has enabled functional housing transformations. This study analyzes three typical types of communities in Xi'an to examine these transformations, identifying distinct types and patterns across five scenarios, which include social, health, leisure, cultural, and educational contexts. Through structured questionnaires and in-depth interviews, we collected data on residents' life satisfaction and NIMBY (not in my backyard) perceptions. Applying a NIMBY index algorithm, we quantified characteristics and identified root causes. The results demonstrated that leisure scenarios most significantly affected satisfaction, while social scenarios showed the highest NIMBY index. Using an ordered logistic regression model, we determined key NIMBY factors influencing satisfaction across scenarios, revealing their differential impact mechanisms. Drawing on the findings, we investigated coordination mechanisms between the transformations of residential spaces and the needs of residents. Based on this analysis, the research objective was to explore how vacant housing can integrate service facilities while mitigating NIMBY effects and meeting resident needs. Proposed strategies include hierarchical facility allocation, NIMBY mitigation measures, and spatial planning optimization, ultimately adapting to diverse lifestyles and housing demands.

Keywords: NIMBY effects; life satisfaction; functional transformation; repurposed residential spaces; community vitality

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1. Introduction

Over the past two decades, the urbanization rate in China has risen from approximately 40% to around 67% [1]. The influx of a large rural population into urban areas has resulted in increased demand for housing [2]. In response, local governments have relied on land finance to enhance their fiscal capacity, while real estate developers have pursued aggressive strategies characterized by high levels of debt and rapid turnover. Homebuyers have increasingly regarded properties as instruments for value preservation and appreciation, often purchasing multiple houses and leaving them vacant in anticipation of future price increases. This behavior has contributed to market overvaluation and the misallocation of resources [3]. A survey conducted by the Beike Research Institute in 2022 revealed that the

average housing vacancy rate in 28 major and medium-sized cities in China was 12%, a figure that is considered relatively high [4].

In the context of contemporary urban development in China, a notable social phenomenon has emerged: the integration of daily living facilities within residential buildings. Essential amenities, including community canteens, convenience stores, and grocery shops, are increasingly being incorporated on the ground floors of residential complexes, thereby addressing the "last-mile" needs of residents [5]. Additionally, small nursing stations have been established within these buildings to cater to the demands of an aging population, while technology-driven amenities such as smart parcel lockers, unmanned retail shelves, and shared gyms further enhance the convenience for residents. This trend is primarily driven by multiple factors, including policies promoting the 15 min life circle, increasing demands for enhanced quality of life, and limited urban land resources [6,7]. It signifies a transformation of vacant residential spaces into functional living areas, serving as a beneficial strategy within China's urbanization process to refine community services and optimize spatial efficiency [8]. As China's urban development shifts from a phase dominated by expansion through new construction to one that emphasizes the renewal of existing stock [9], the diversification of functions within underutilized building spaces may emerge as a new normal [10]. Consequently, communities with a substantial amount of vacant residential space are likely to become key targets for deeper exploration and more efficient utilization of idle spatial resources in the future [11].

"Existing residential spaces within communities" refers to those areas that have been completed and are currently in use as part of the urban development. While their fundamental functions remain operational, certain challenges, such as prolonged vacancies in some spaces, may result in diminished community vitality, a lack of resident engagement, and insufficient service functions. In contemporary China, only a limited number of residential areas have undergone centralized transformation. Representative examples include Tianzifang [12] and Jianyeli [13] in Shanghai, both of which have successfully transformed their original residential functions into comprehensive zones that integrate cultural tourism, commercial activities, and office spaces. However, such transformations are often characterized by high costs, extended timelines, and challenges in recouping investments, rendering them exceptional cases. A more prevalent trend involves the commercial transformation of existing residential spaces. For example, in urban residential areas, one can observe phenomena such as nail salons located directly across from residences and script-killing venues situated above them [14]. To some extent, this type of functional transformation can enhance the development of community life circles, address residents' basic and quality consumption needs in daily life at close range, achieve a degree of self-sufficiency, optimize the utilization of spatial resources, and bolster the community's supply resilience.

In recent years, studies on community service facilities in China have emphasized various aspects, including planning and layout, supply–demand matching [15], intelligent transformation [16], and policy mechanisms [17]. Additionally, these studies have integrated pressing social issues such as urban renewal, aging populations, and child-friendly initiatives [18,19]. Those studies predominantly explored four main areas. First, some studies have analyzed the optimization of spatial planning as informed by the 15 min life circle concept, utilizing geographic information systems (GIS) and big data technologies to assess the accessibility and equity of community facilities and highlight deficiencies in their configuration [20,21]. Second, certain studies have examined supply–demand dynamics amid shifting population structures, analyzing utilization rates of and user satisfaction with scarce facilities such as eldercare and childcare centers [22,23]. They have uncovered a paradoxical coexistence of facility underuse and unmet demand, highlighting systemic allocation inefficiencies. Third, a few studies have explored intelligent transformation

pathways, including Internet of Things (IOT) management platform implementation and virtual service solutions [24]. Additionally, studies have innovated policy innovation mechanisms, emphasizing that spatial retrofitting and multistakeholder governance are crucial for enhancing facility efficiency [17]. Globally, scholars have begun exploring the practice of vertical living. Yeang emphasized the potential of three-dimensional service distribution (e.g., retail, healthcare, and public amenities embedded in mid-levels or rooftops) to enhance accessibility while mitigating land scarcity. Empirical evidence from Asian cities such as Hong Kong and Singapore demonstrated the efficacy of state-mandated vertical facility allocation models. However, unresolved challenges persist, including socioeconomic stratification and elevator-dependent mobility, which constrain equitable access to vertically integrated services. While recent advances have leveraged space syntax and mobility big data to quantify connectivity, a critical gap remains in systematically linking microscale facility design within residential buildings to macroscale urban sustainability outcomes.

In 2023, the National Development and Reform Commission proposed the implementation of a construction project for embedded service facilities within urban communities, specifically targeting the public spaces of these communities. Despite existing studies on the planning of community service facilities, two significant research gaps persist. First, the majority of the literature has focused on the configuration of public space facilities, leaving a void in systematic research on embedded service facilities within residential buildings. Second, these studies have predominantly emphasized static spatial analysis and lacked consideration of the dynamic evolution of needs. This study addresses these gaps by constructing a three-dimensional analytical framework of "life scenario–satisfaction–NIMBY effect", thereby not only filling the research void concerning embedded facilities in residences but proposing a novel paradigm for the functional transformation of residential space in response to residents' needs.

Therefore, this study addresses three core research questions. (1) When analyzing the functional transformation of existing residential spaces in communities, how can service facilities embedded in renovated vacant housing be systematically classified in a manner that is scientifically robust, practically applicable, and community-adaptive? (2) What are residents' satisfaction levels and not-in-my-backyard (NIMBY) perceptions toward different types of functional scenario transformations? What key factors drive NIMBY effects, and how do their differential impact mechanisms influence satisfaction? What interrelationships and interaction mechanisms exist between these factors? (3) Based on understanding resident attitudes and impact mechanisms, how can functional transformations of vacant housing and facility-embedding strategies be scientifically and effectively planned and implemented to maximize resident satisfaction while minimizing NIMBY conflicts?

This study breaks through the paradigm of the "planar living circle" and conducts a spatial analysis of the community in the vertical dimension, that is, focusing on the impacts generated by different types of facilities within residential spaces. It incorporated the psychological level of people (satisfaction, NIMBY effect), the behavioral pattern level (frequency of use), and the physical level of space (scenario distribution) into the analytical framework to explore the future adaptation mechanisms of embedded residential facilities. Based on the existing functionally transformed residential spaces, their usage scenarios were categorized into five types. It then employed scenario simulation methods to gain insights into the demand characteristics of stakeholders concerning the integration of service facilities into residential buildings. Finally, the study utilized satisfaction evaluations and NIMBY analysis to assess the usage experiences of different stakeholders with these facilities. By combining an ordered logit model, the paper explored the usage model for

integrating residential service facilities from the perspective of reducing NIMBY sentiment to enhance user satisfaction.

2. Materials and Methods

2.1. Study Area

Xi'an, a metropolis with a population of approximately 13.08 million, faces significant challenges in accommodating its growing population. The demand for land for residential, commercial, industrial, and public facilities is pressing. However, as urban expansion begins to slow and available construction land becomes increasingly limited, there is a need to transition from traditional incremental expansion to a more strategic approach focused on urban renewal. This new approach emphasizes enhancing functionality, optimizing layouts, and improving supporting infrastructure. The suburbs, serving as a transitional zone between urban and rural areas, possess underutilized spatial resources and attract far fewer residents than the urban center, resulting in a higher number of vacant homes. Directing urban renewal efforts towards these vacant residential spaces in the suburbs and repurposing them for multifunctional uses can effectively address deficiencies in the development of life circles. This study aims to conduct a thorough investigation in the suburbs of Xi'an, categorizing existing communities into three types: composite functionality quality community (CFQ-community), basic-guarantee-type traditional Community (BGT-community), and monofunctional resettlement community (MR-community). Three typical communities were selected as research sites, namely Phase 1 of Vanke City, Wanjing Lizhiwan Community, and Lujiawan Community. The distribution of research locations is shown in Figure 1.

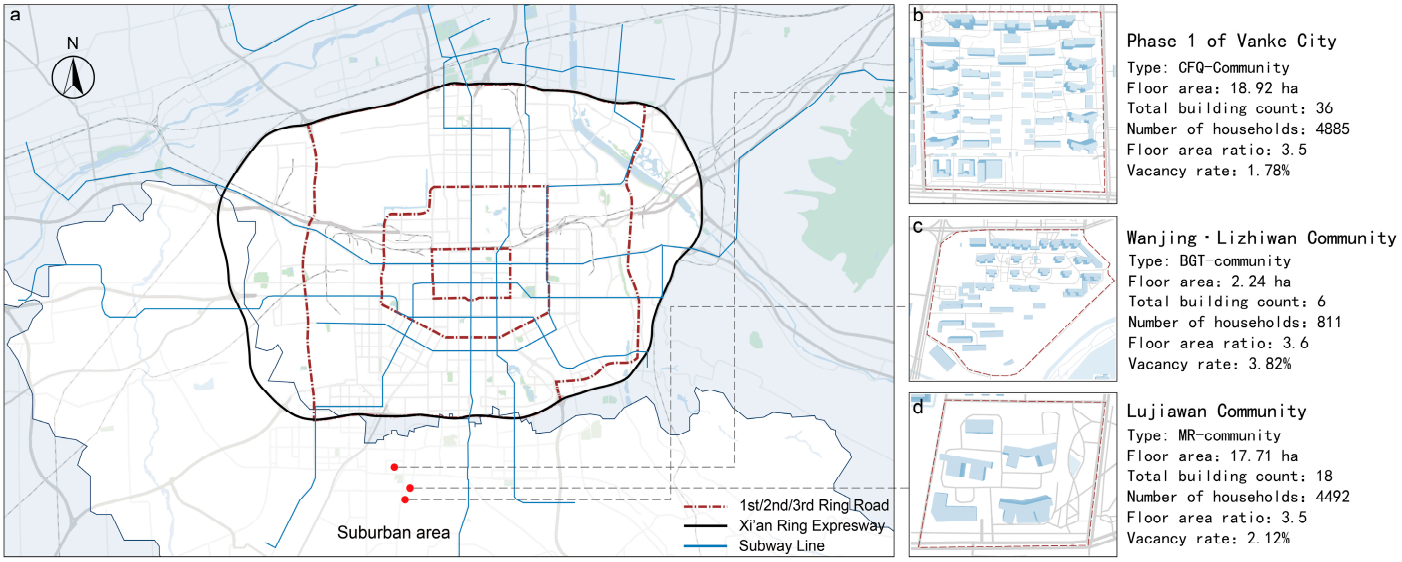


Figure 1. Spatial distribution and characteristics of sample communities. (**a**): Typical community location in the suburbs of Xi'an; (**b**): Phase 1 of Vanke City; (**c**): Wanjing Lizhiwan Community; (**d**): Lujiawan Community.

2.2. Data Collection

2.2.1. Indicators

Satisfaction. Assessment of the satisfaction of various stakeholders within the community was conducted through surveys to evaluate whether their daily needs and emotional experiences were fulfilled in the space, as well as their attitudes and opinions regarding the multifunctional use of existing residential areas [25,26]. This process can be characterized as a shift from spatial considerations to emotional responses [27]. Since residents and mer-

chants are the primary beneficiaries of the multifunctional use of these residential spaces, this study primarily focused on analyzing the perspectives of these two groups. Data on residents' satisfaction with the use of multifunctional residential spaces were gathered using a questionnaire scoring system, while merchants' satisfaction was assessed through interviews. The measurement method employed in this study was a Likert five-point scale, where 1 indicated very dissatisfied, 5 indicated very satisfied, and any missing scenario was assigned a score of 0 points [28].

Not-In-My-Backyard (NIMBY). The term NIMBY stands for the public's opposition to certain facilities that, while offering social benefits, may have adverse effects on local communities. Examples of such facilities include waste treatment plants, nuclear power stations, and chemical plants. Individuals who display NIMBY attitudes often hold strong environmental values. This concept first appeared in the United States during the 1980s to characterize the opposition of community residents to the establishment of unwelcome facilities in their neighborhoods [29].

In this study, the NIMBY measurement was applied to assess the impact of service facilities within residential buildings on residents. The intensity of the NIMBY effect, which is a latent variable, cannot be measured directly. However, it can be assessed indirectly through residents' language, behavior, and feedback to the external environment [30]. Thus, this study utilizes residents' acceptance levels of diversified development within community residential spaces as a metric for assessing the NIMBY effect in residential areas. Building upon the established perceived risk scale, the significant influencing factors are categorized into four dimensions: comfort, security, sense of belonging, and spatial perception [31], as shown in Table 1.

Table 1. Measurement indicators of NIMBY effect.

Dimensions	NIMBY Effect Content	NIMBY Effect Indicators
Comfort	Noise pollution	Noise pollution
	Garbage pollution	Garbage pollution
Security	Risk of personal safety and property damage	Safety risks
	Fire safety hazards	Fire safety hazards
Belonging	Neighborhood relationships	Neighborhood relationships
	Timely responsiveness of the property to residents' questions	Response to residents' issues
	Information is available on important matters for the community	Information accessibility
Spatial fairness	Respect from business and industry	Sense of respect
	Accessibility to various facilities	Facilities accessibility
	Public space encroachment	Public space encroachment

The present study employed a positive evaluation method, specifically acceptance, to assess residents' willingness to have a particular facility established within their residential building [31]. Responses were scored on a 5-point scale ranging from "very unwilling" (1 point) to "very willing" (5 points). To avoid the potential distortion of accurate assessments of NIMBY differences caused by extreme responses, this paper utilized the weighted scoring method proposed by Li to derive a NIMBY index [32]. This index served as a tool for evaluating the magnitude of the NIMBY effect associated with various service facilities located within residential buildings. The calculation formula is expressed as follows:

$$V_i = \frac{\alpha_4 \times 4 + \alpha_5 \times 5}{\alpha_1 \times 1 + \alpha_2 \times 2 + \alpha_3 \times 3 + \alpha_4 \times 4 + \alpha_5 \times 1} \times 100$$

where V_i represents the NIMBY index, α_1 represents the number of people who are "very willing", α_2 represents the number of people who are "willing", α_3 represents the number of people who are "neutral", α_4 represents the number of people who are "unwilling", and α_5 represents the number of people who are "very unwilling".

2.2.2. Survey Method and Sample Size

This study utilized a combination of questionnaire surveys, field research, and in-depth interviews to conduct its investigation. The questionnaires collected data from community residents regarding the current usage of service facilities integrated within existing residential spaces. This included their satisfaction with these facilities, frequency of use, assessment of NIMBY sentiments related to their use, evaluation of the reasons behind these sentiments, and characteristics of future demand for embedded service facilities. The field interviews aimed to capture the attitudes and views of various stakeholders in the community regarding embedded service facilities, as well as the impact of these facilities on community life.

It should be emphasized that during the survey, residential spaces with embedded service facilities were subjected to architectural assessment. Some of the spaces underwent minor nonstructural modifications, such as non-load-bearing partitions, but none of these alterations changed the overall structure of the existing residential spaces, which remained in regular use. During interviews with property managers, it was mentioned that regular safety inspections and fire drills would be arranged for these spaces. The five types of functional spaces summarized in this study are all derived from these successfully implemented cases, and their structural adaptability was verified through actual use.

The questionnaire survey was conducted using a random sampling method in the community park, resulting in a total of 284 questionnaires distributed and 276 valid responses collected. Among the respondents, females represented a higher proportion at 59.78%. The family structure was predominantly nuclear, comprising 55.07% of the sample, while single-person households made up 14.86% and extended families accounted for 30.07%. Regarding age distribution, individuals under 20 years old represented 10.14%, those aged 20–35 accounted for 22.83%, respondents aged 36–50 made up 54.71%, and those over 50 constituted 12.32%. The specific demographic details of the respondents are categorized by community, as shown in Table 2.

Table 2. Statistical table of respondent demographics.

Respondent Demographics	CFQ-Community (Vanke City Phase 1 Community)	BGT-Community (Wanjing Lizhiwan Community)	MR-Community (Lujiawan Community)
Sample size	90	94	92
Gender	Male (40.00%) Female (60.00%)	Male (40.43%) Female (59.57%)	Male (40.23%) Female (59.78%)
Age	<20 (8.89%) 20–35 (23.33%) 36–50 (62.22%) >50 (5.56%)	<20 (11.70%) 20–35 (19.15%) 36–50 (55.32%) >50(13.83%)	<20 (9.78%) 20–35 (26.09%) 36–50 (46.74%) >50 (17.39%)
Family structure	Nuclear family (60.00%) Single-person (25.56%) Extended family (14.44%)	Nuclear family (53.19%) Single-person (11.70%) Extended family (35.11%)	Nuclear family (50.00%) Single-person (7.61%) Extended family (42.39%)
Income/year (thousand CNY)	<50 (3.33%) 50–100 (18.56%) 100–200 (54.22%) >200 (23.89%)	<50 (11.93%) 50–100 (34.67%) 100–200 (42.34%) 200 (11.06%)	<50 (16.78%) 50–100 (45.32%) 100–200 (31.73%) >200 (6.17%)

2.2.3. Sampling Characteristics in the Three Types of Communities

Based on the various functional attributes of existing residential spaces, repurposed spaces can be classified into social, leisure, health, cultural, and educational scenarios based on their usage contexts. Statistical analysis of questionnaire data revealed that over 40% of residents reported the presence of multifunctional use in their buildings. The adaptive reuses of residential spaces in the three types of communities each showcased varying levels of functional diversification. A total of 24 residential units, representing 0.5% of the overall residential area, were repurposed in the Vanke City Phase 1 Community, a composite functionality quality community. These units were spread across all floors. The converted spaces included 17 different functional categories, with a primary focus on leisure activities, followed by educational and health-related uses. Examples of these facilities include convenience stores, reading rooms, and fitness centers. By contrast, the Wanjing Lizhiwan Community, a traditional community of the basic guarantee type, is located within a school district. It converted 13 residential units, which represented 0.2% of the total residential spaces, primarily in low- to mid-rise areas. At time of study, these newly transformed multifunctional spaces served eight different purposes, with a strong emphasis on educational activities, including after-school childcare programs, extracurricular interest classes, and beauty and wellness studios. In Lujiawan Community, a resettlement community, 22 residential spaces, accounting for 1.3% of the total residential area, were repurposed for specific functions, primarily within low-rise buildings. Although these transformed spaces covered 14 different functional categories, their multifunctional diversity was still somewhat restricted. The predominant uses focused on leisure and social activities, including health and wellness services, beauty and wellness shops, and convenience stores. A detailed breakdown of functional distributions and respondent demographics across these communities is provided in Table 3.

Table 3. Statistical table of residential functional conversion.

Residential Functional Conversion	CFQ-Community (Vanke City Phase 1 Community)	BGT-Community (Wanjing Lizhiwan Community)	MR-Community (Lujiawan Community)
Number of Residential functional conversion	24	13	22
Percentage of Residential functional conversion	0.5%	0.2%	1.3%
Distribution of Residential functional conversion	Distributed across all floors	Distributed from the lower to middle floors	Located on lower floors
Primary scenarios formed	Leisure	Education	Leisure and society

2.3. Ordered Logistic Model

Resident satisfaction was assessed using a five-point Likert scale, which exhibited distinct ordinal characteristics. In contrast to the traditional multinomial logistic regression model, the ordered logistic regression model (OLRM) was utilized to identify the key factors influencing satisfaction across different scenario types, as it more effectively accommodated the ordinal relationships inherent in the independent variables. Consequently, five separate OLRMs were constructed using the SPSS software (version 27.0, IBM Corp., Armonk, NY, USA). These models incorporated ten types of NIMBY perceptions as independent variables, and resident satisfaction levels were measured across five distinct scenario categories, leisure, health, education, social, and cultural, serving as the dependent variables. This methodological approach aimed to identify the critical NIMBY factors that influenced satisfaction, thereby providing an empirical foundation for effectively addressing resident

concerns regarding service facilities embedded within residential areas. The findings are intended to guide demand-oriented urban renewal and retrofitting initiatives. The general form of the constructed model is expressed as follows:

$$log\left(\frac{P(Y_k \leq j|\ X)}{P(Y_k > j|\ X)}\right) = \theta_{kj} - \sum_{i=1}^{10} \beta_{ki} X_i,\ j = 1, 2, 3, 4$$

where Y_k is satisfaction with the k-th scenario (k ∈ {Leisure, Health, Education, Society, Culture}); j is the satisfaction level threshold (4 points in total); θ_{kj} is the j-th truncation threshold for the k-th scenario; X_i represents the 10 independent variables of NIMBY effect (I = 1, . . ., 10); and β_{ki} is the regression coefficient of the independent variable in the category k-th scenario [33].

3. Results

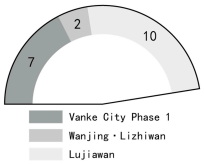
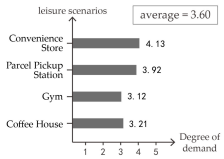
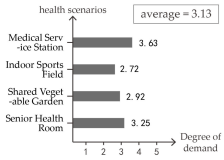
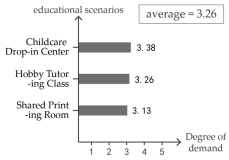
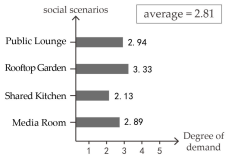
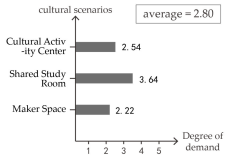
3.1. Usage Characteristics of Residential Space After the Facilities Were Integrated

The analysis of interview and experimental data revealed that residents exhibited a preference for activity places within residential buildings, primarily driven by enhanced accessibility compared with life circles. The research further revealed significant variations in residents' usage patterns across different community scenarios. Leisure scenarios (e.g., convenience stores, parcel stations) ranked first with three to five weekly visits, meeting rigid daily demands through high-frequency essential services. Social scenarios (e.g., communal lounges, rooftop gardens) followed at three weekly visits, reflecting pursuits of life quality and social interaction. The usage frequencies of health and education scenarios were nearly identical, primarily serving elderly and adolescent populations with approximately two visits per week. In contrast, cultural facilities were a low-frequency option (just one weekly visit) because of fast-paced lifestyles, highlighting the marginalized status of cultural activities in community life. In short, the frequency of residents' use of community facilities followed a decreasing pattern: basic services were used the most, quality-enhancing facilities came second, and spiritual needs were least prioritized. This reflects that residents pursued higher-level spiritual enjoyment only after their basic living needs were met.

During the process of integrating service facilities into residential spaces, residents' demands also exhibited multidimensional differentiation characteristics. In the leisure scenario, the demand for convenience stores was the highest, with an average value of 4.13, followed by coffee shops and express delivery stations, indicating that the layout of infrastructure is a basic requirement for meeting quality of life. In the educational scenario, the demand for childcare centers was the highest, suggesting that residents expect the community to provide family support services, especially for dual-income families who need external help to take care of their children to alleviate parenting pressure. In the health scenario, the demand for medical service stations was the highest, with an average value of 3.63, while the demand for indoor sports venues and senior activity rooms were 2.72 and 3.25, respectively, indicating that residents' needs for a healthy lifestyle vary across different age groups. The demand for social and cultural scenarios was relatively lower, with rooftop gardens and shared study rooms at 3.33 and 3.64, respectively. Overall, residents' demands gradually decreased from leisure scenarios that provide basic living services to educational, health, and social scenarios, with cultural needs being relatively the least demanded. Moreover, the relatively high demand for health-related services among residents, as opposed to the less frequent demand for social and cultural services, fundamentally reflects a divergence in the hierarchy of their needs. Health-related facilities directly address essential requirements for safe survival, such as the emergency functions

of medical stations and the daily protection afforded by age-friendly modifications. These facilities are indispensable and urgently required in the field. Furthermore, the sample attributes indicated a relatively high proportion of middle-aged and elderly individuals. Given the objective reality of physiological decline, this demographic tends to prioritize health-related issues. In contrast, social and cultural facilities correspond to higher-level needs for belonging and self-actualization, the utilization of which is constrained by factors such as leisure time and economic cost. This also indicates that the configuration of facilities must adhere to the progressive principle of "basic survival needs → higher-order spiritual needs." The specific usage patterns of these five living scenarios by community residents are illustrated in Table 4.

Table 4. Statistical table of community residents' usage patterns for five types of living scenarios.

Scenarios	Content	Picture	Frequency of Use	Quantity (Unit)	Degree of Demand
Leisure	Convenience Store Parcel pickup station Gym Coffee house		3–5 times/week		
Health	Medical service station Indoor sports field Shared vegetable garden Senior health room		2 times/week		
Education	Childcare drop-in center Hobby tutoring class Shared printing room		2 times/week		
Society	Public lounge Rooftop garden Shared kitchen Media room		3 times/week		
Culture	Cultural activity center Shared study room Maker space		1 times/week		

3.2. Satisfaction and NIMBY in Housing Functional Transformation

3.2.1. Life Satisfaction of Community Residents

The analysis of residents' satisfaction with their living scenarios can be approached from two dimensions: First, at the population level, significant variations in life satisfaction existed across demographic groups. Men showed slightly higher satisfaction than women in all scenarios, though gender differences remained small. Younger individuals (<20 years) reported the highest social satisfaction, while middle-aged groups (36–50 years) showed lower health and education satisfaction. Older adults (>50 years) preferred leisure scenarios, with cultural satisfaction consistently low across all ages. This likely reflects child-rearing responsibilities increasing expectations for educational services. Single-person households, without such demands, reported higher education satisfaction. Both nuclear and extended

families exhibited higher leisure satisfaction but lower education satisfaction compared with single-person households. This discrepancy likely stemmed from the additional responsibility of child-rearing in family units, which creates higher expectations for educational facilities. In contrast, single-person households, unburdened by such responsibilities, engage more freely in educational activities and thus report higher satisfaction due to fewer demands on these services. Income levels revealed an inverse trend—as income rose, satisfaction across most scenarios tended to decline. Lower-income individuals, whose basic needs are less consistently met, derived greater fulfillment from leisure activities, resulting in the highest leisure satisfaction scores. Meanwhile, higher-income groups rated all scenarios at or below 3 points, suggesting they may have transitioned to Maslow's "higher-level needs", where standardized community services fail to meet their elevated expectations for quality and personalized experiences [34]. Notably, cultural satisfaction remained universally low, indicating potential deficiencies in community cultural offerings. While demographic factors influenced satisfaction patterns, this consistent cultural dissatisfaction warrants particular attention for improvement.

Second, at the scenario level, the leisure scenario stood out as the most satisfactory dimension with a score of 3.47, which was attributed to the abundance of leisure facilities and activities that effectively met the residents' needs for relaxation. In contrast, the cultural scenario received a score of only 1.98, primarily due to a lack of cultural activity richness, insufficient cultural facilities, and inadequate cultural atmosphere creation. The observed discrepancy between the relatively low demand for cultural services and their corresponding dissatisfaction scores stems primarily from two interrelated factors. First, the provision of cultural facilities in these communities followed a top-down approach, with property managers and developers determining programming without substantive resident participation, resulting in a mismatch between the formal cultural offerings (e.g., static reading rooms) and residents' actual preferences for participatory, event-based activities (e.g., seasonal festivals and workshops). Second, our methodological approach—while rigorous—may have amplified dissatisfaction due to the scoring system's treatment of missing facilities (assigned 0), which disproportionately affected cultural spaces given their frequent absence. Additionally, cultural demand exhibits a "latent-temporal" pattern, where residents may not prioritize these services daily but experience acute dissatisfaction when seasonal or communal needs (e.g., Lunar New Year events) go unmet. Specific satisfaction ratings for different scenarios among different groups in the three types of communities are shown in Table 5.

Table 5. The life satisfaction of residents in the community undergoing housing functional transformation.

	Type of Housing Functional Transformation				
	Leisure	**Health**	**Education**	**Society**	**Culture**
Male	3.40 (1.24)	2.96 (0.97)	3.14 (0.79)	2.43 (1.02)	1.76 (1.12)
Female	3.28 (0.86)	2.87 (0.93)	3.17 (0.96)	2.32 (1.09)	1.69 (0.75)
Under 20 years old	3.47 (0.62)	3.24 (0.51)	2.98 (1.07)	3.58 (1.15)	2.17 (1.51)
Aged 20–35 years old	3.63 (0.43)	3.12 (0.68)	3.07 (1.01)	3.73 (0.57)	1.95 (0.65)
Aged 36–50 years old	3.75 (0.78)	2.87 (0.56)	3.16 (1.13)	3.56 (0.69)	1.76 (1.23)
Over 50 years old	3.66 (0.27)	2.74 (0.53)	3.25 (1.37)	3.47 (1.56)	2.31 (0.98)
Nuclear family	3.18 (1.21)	2.06 (0.97)	3.08 (1.53)	2.44 (0.67)	1.63 (1.79)
Single-person	3.24 (0.82)	2.48 (0.34)	3.25 (1.42)	2.04 (1.24)	2.15 (1.32)
Extended family	3.52 (0.47)	2.11 (0.69)	3.21 (1.37)	2.53 (0.46)	1.94 (1.13)
Income blow 50 [1]	3.74 (0.37)	2.85 (0.56)	3.22 (0.48)	2.88 (0.79)	2.27 (0.58)
Income from 50 to 100 [1]	3.65 (0.21)	2.62 (0.72)	3.13 (0.88)	2.54 (0.62)	1.95 (1.19)

Table 5. *Cont.*

	Type of Housing Functional Transformation				
	Leisure	**Health**	**Education**	**Society**	**Culture**
Income from 100 to 200 [1]	3.62 (0.21)	2.49 (0.67)	3.32 (1.03)	2.56 (0.40)	2.09 (0.85)
Income over 200[1]	3.02 (0.76)	2.61 (0.59)	3.06 (0.59)	2.72 (0.92)	2.06 (1.08)
Total sample	3.60 (1.42)	2.37 (1.53)	3.16 (0.83)	2.40 (1.11)	1.90 (0.79)

Notes: [1] unit is thousand CNY per year. Data are presented as mean value (standard deviation).

3.2.2. NIMBY and Housing Functional Transformation in Community

This study conducted an in-depth analysis of the assessment scores for various sense of nuisance in five scenarios of community residential spaces, as shown in Table 6, aiming to identify the fundamental reasons for the sense of nuisance in these five types of scenarios. First, residents' concerns about "noise pollution" were the most prominent in general, followed by "fire safety hazards" and "public space encroachment", which all may have adverse effects on the residents' quality of life and the overall environment of the community. Second, during the integration of leisure scenarios into the residential space, residents were most concerned about the issues of "noise pollution" and "public space encroachment", while garbage pollution and "fire safety hazards" were the most worrying issues in the health scenarios. In the education scenarios, the issues of "noise pollution", "public space encroachment", and "risk of personal safety and property damage" were the most critical factors affecting the residents' living experience. For the social scenarios, "whether the property responds promptly to residents' questions" and "whether it is respected by the industry's businesses" were the most concerned aspects by the residents. "Noise pollution" and "whether the property responds promptly to residents' questions" were the most critical reasons affecting the cultural scenarios.

Table 6. NIMBY effect evaluate scores and NIMBY index statistics table in five types of scenarios.

NIMBY Effect Index	Leisure	Health	Education	Society	Culture	Evaluate Scores	Rank
Noise pollution	2.57	3.12	2.64	3.22	2.37	2.78	①
Garbage pollution	4.25	2.98	4.37	4.28	4.36	4.05	⑩
Safety risks	3.92	3.32	2.97	3.58	3.66	3.49	⑥
Fire safety hazards	3.28	3.15	3.11	3.45	3.02	3.20	②
Neighborhood relationships	4.03	3.19	3.35	4.23	3.14	3.59	⑦
Response to residents' issues	3.41	3.83	4.06	2.79	2.95	3.41	⑤
Information accessibility	3.29	4.27	4.13	3.57	3.73	3.80	⑧
Sense of respect	4.14	3.98	4.21	3.02	4.28	3.93	⑨
Facilities accessibility	3.39	3.30	3.22	3.18	3.26	3.27	④
Public space encroachment	3.27	3.56	2.84	3.23	3.44	3.27	③
NIMBY index	10.91	14.63	23.18	61.36	41.52		

Survey data indicated significant hierarchical disparities in NIMBY effects across various functional scenarios within community residential spaces. The social activity scenario exhibited the highest NIMBY intensity, with an index score of 61.35, followed by cultural, educational, and health scenarios. In contrast, the leisure scenario demonstrated the lowest index score of 10.91, indicating the highest level of public acceptance.

3.3. Ordered Logistic Model Results

The ordered logistic regression analysis utilized ten dimensions of the NIMBY effect as independent variables and residents' satisfaction across five categories of scenarios (leisure, health, education, social, and cultural) as ordinal dependent variables, yielded significant

findings, as shown in Table 7. The results revealed the differentiated impacts of NIMBY effect on satisfaction with multifunctional spaces. Multicollinearity diagnostics confirmed variable independence (specific data are shown in Appendix A).

Table 7. Results of the ordered logistic regression models.

	Leisure		**Health**		**Education**		**Society**		**Culture**	
Dependent variable threshold	Beta	OR	Beta	OR	Beta	OR	Beta	OR	Beta	OR
Satisfaction ≤ 1	−2.50 ***	0.08	−3.10 ***	0.05	0.38 ***	0.06	0.42 ***	0.04	0.37 ***	0.07
Satisfaction ≤ 2	−1.20 ***	0.30	−1.60 ***	0.20	0.30 ***	0.27	0.33 ***	0.22	0.29 ***	0.33
Satisfaction ≤ 3	0.80 **	2.23	0.50	1.65	0.26 *	1.82	0.28	1.49	0.28 **	2.01
Satisfaction ≤ 4	2.50 ***	12.18	2.20 ***	9.03	0.32 ***	8.17	0.36 ***	9.97	0.31 ***	7.39
Argument										
Noise pollution	−0.82 ***	0.44	−0.25	0.78	−0.58 **	0.56	−0.20	0.82	−0.15	0.86
Garbage pollution	−0.41 **	0.66	−1.05 ***	0.35	−0.20	0.82	−0.35 *	0.70	−0.50 **	0.61
Safety risks	−0.30 *	0.74	−0.49 **	0.63	−0.35 **	0.71	−0.38 **	0.68	−0.13	0.84
Fire safety hazards	−0.20 *	0.82	−0.90 ***	0.41	−0.15	0.86	−0.18	0.84	−0.10	0.90
Neighborhood relationships	0.65 ***	1.92	0.40 **	1.49	0.50 **	1.65	1.35 ***	3.86	0.55 **	1.73
Response to residents' issues	0.35 **	1.42	0.73 ***	2.08	0.30 *	1.35	0.54 **	1.72	0.40 **	1.49
Information accessibility	0.28 *	1.32	0.25 *	1.28	0.60 **	1.82	0.30 *	1.35	0.85 ***	2.34
Sense of respect	0.40 **	1.49	0.35 *	1.42	0.92 ***	2.51	0.45 **	1.57	0.78 ***	2.18
Facilities accessibility	1.20 ***	3.32	0.45 **	1.57	0.35 *	1.42	0.25 *	1.28	0.62 **	1.86
Public space encroachment	−0.75 ***	0.47	−0.30 *	0.74	−0.25 *	0.78	−0.77 ***	0.46	−0.30 *	0.74
χ^2 (df = 10)	125.6 ***		158.3 ***		98.7 ***		142.8 ***		115.4 ***	
Nagelkerke R^2	0.35		0.41		0.28		0.39		0.31	
Test of parallel lines	$p = 0.12$		$p = 0.09$		$p = 0.21$		$p = 0.11$		$p = 0.15$	

Notes: * $p \leq 0.05$; ** $p < 0.01$; *** $p < 0.001$.

The leisure scenario model unequivocally demonstrated residents' prioritization of spatial functional effectiveness in recreational environments. Its results revealed that facilities accessibility (β = 1.20 ***, OR = 3.32) exerted a statistically significant positive effect, while public space encroachment (β = −0.75 ***, OR = 0.47) produced a substantive negative impact. Whether the spatial functions can be guaranteed and utilized effectively was the most crucial factor to decide the satisfaction of the leisure scenario. The health scenario model highlighted the inherent high demand of residents for community health safety. Specifically, a strong inhibitory effect of garbage pollution (β = −1.05 ***, OR = 0.35) indicated that the occurrence ratio of residents' satisfaction maintaining a higher level was significantly reduced by 65% when there was a risk of garbage pollution. Given the vulnerability of the multifunctional transformation scenario to disease transmission in a residential environment, targeted risk mitigation strategies are indispensable. The educational scenario model reflected residents' urgent demand for stakeholder engagement mechanisms related to their interests. The results showed that sense of respect (β = 0.92 ***, OR = 2.51) was the main influencing factor of the educational scenario in residential areas, with a 151% increase in satisfaction associated with a one-unit improvement in respect level. The improvement of respect sense had a very strong driving effect on promoting drastic increases in satisfaction grade. The results of the social scenario model affirmed that spatial design is the foundation for cultivating social capital to enhance interaction opportunities. Neighborhood relationships (β = 1.35 ***, OR = 3.86) produced the strongest positive effect, with a one-unit enhancement in harmony level associated with a 286% increase satisfaction

odds. A good neighborhood relationship or social atmosphere was the most critical driving force to enhance satisfaction with social scenarios. The results of the cultural scenario model showed that optimization of accessibility of community information (β = 0.85 ***, OR = 2.34) was a main positive predictor, with a one-unit improvement in transparency associated with a 134% increase in satisfaction odds. The current lack of accessibility of information constituted the main limiting factor for the improvement of the satisfaction level with the cultural scenario.

4. Dicussion

4.1. A Dynamic Comparison with Other Cities

Utilizing questionnaires and in-depth interviews, this study revealed that the functional transformation of residential buildings in Xi'an was predominantly characterized by a market-driven approach, lacking explicit policy standards.

The facilities embedded in residential spaces were primarily commercial in nature. Different types of communities have given rise to differentiated commercial ecosystems. The Wanjing Lizhiwan community, located within a high-quality school district, attracted a large number of after-school childcare services and interest training institutions to set up shop in residential buildings, forming a cluster of educational services. In contrast, high-end communities such as the first phase of Vanke City are more likely to feature high-end fitness studios and coffee book bars that cater to a quality lifestyle. The Lujiawan community, being a relocation community, was primarily populated with small convenience stores and barbershops that meet daily necessities. Through in-depth interviews with 27 merchants operating in repurposed residential units, a consistent economic rationale emerged: the significantly lower rental costs compared with street-level commercial spaces constituted the primary driver for business viability. Operating within a residential building can save about 10–15% in rental costs compared with street-level storefronts. This cost advantage provides a space for small businesses to survive. Most of the merchants within the community were residents of the community itself. They chose to operate within the community for family reasons, such as the convenience of taking care of the elderly and children in the family or the need to earn some additional income to subsidize household expenses even if they did not have formal employment. Interviews with the property management revealed that there were at time of study no clear requirements for the admission of embedded facilities within residential buildings. Management measures identified include regular fire safety training for merchants and scheduled safety inspections. No major issues had been encountered in the management process so far.

This phenomenon may exemplify a form of "grassroots innovation" in the functional transformation of residential spaces in China, contrasting sharply with the "policy-first" model observed in first-tier cities such as Shanghai. According to the Shanghai Residential Property Management Regulations, owners of specific housing units intending to alter the use of their properties must adhere to laws, regulations, and management agreements and obtain unanimous consent from owners with vested interests before submitting an application to the district housing management department for approval [35]. This mandatory approval process may mitigate the likelihood of conflicts related to the transformation. A notable instance of residential space functional transformation in Shanghai is Tianzifang [12], one of the few residential areas that has undergone a concentrated transformation. The "residential-to-nonresidential" transformation in Tianzifang necessitates strict adherence to the approval process, with unauthorized modifications potentially deemed illegal. For example, in 2018, certain merchants were required to rectify their operations because of incomplete procedural compliance [36]. In contrast, the market-driven transformation in Xi'an, while partially addressing residents' high-frequency demands (with a satisfaction

level of 3.60 for leisure-related scenarios), has led to heightened conflicts due to the absence of policy-based mediation. For instance, it was found that some community residents strongly opposed the functional transformation of residential spaces, generally perceiving that such transformations alter the original living environment and may cause issues such as noise and litter, thereby disrupting community life and causing numerous inconveniences. Shanghai could resolve some conflicts at the planning stage through regulation-based pre-intervention, whereas Xi'an's "transform-first-and-govern-later" model incurred higher negotiation costs (with a satisfaction level of only 2.78 for noise-related issues). However, this also underscores the unique research value of residential transformation in Xi'an during the current stage of market-driven organization.

Compared with international examples, the model of embedded service facilities in residential buildings in Xi'an is similar to the concept of the "vertical city." [37] Buildings integrate multiple functions, such as living, working, and leisure, reflecting the efficient use of urban space. In terms of facility layout, Xi'an's residential complexes use unoccupied housing to embed service amenities that suit inhabitants' fundamental needs. In contrast, international vertical communities, such as Peruri88 in Indonesia, divide the areas needed for urban life vertically by stacking functions such as food production, retail, workplaces, healthcare, and housing to create a complete living chain within a single building [38]. In terms of functional variety, the embedded service facilities in Xi'an's residential structures vary according to the community type. For example, the Lizhiwan Community investigated in this research provided mostly educational services, whereas the Lujia Bay Community focused on recreational activities. International vertical communities, on the other hand, serve a broader range of services that are closely related. For example, Singapore's HDB (Housing and Development Board) has developed a highly standardized functional configuration model for vertical communities [39]. The void deck, a government-led community service carrier, merges fundamental livelihood activities, such as preschool centers, elder activity stations, basic medical clinics, and community police stations, into eight types of standardized facilities. The Housing Development Act's obligatory standards ensure that all HDB estates receive a consistent level of public services. Xi'an has adopted a market-driven strategy for its construction and operating models. On the other hand, multinational vertical communities are primarily built and run by developers. For instance, the Interlace, a social housing project in Singapore, was designed and built by developers with government subsidies. Its operation emphasizes resident participation. Similarly, in Germany's WagnisArt project [40], future users collectively participate from the design stage, and residents have the power to decide the appearance of public courtyard areas and the rooftop gardens.

It should be emphasized that the above cross-city comparison is based on the model induction in the literature rather than a strict empirical comparison. Future research can verify the hypothesis by collecting data related to other cities.

4.2. Measures for Embedding Service Facilities in Residential Spaces

4.2.1. Layered and Categorized Facility Allocation

The integration of an analysis of residents' spatial usage requirements with an evaluation of NIMBY characteristics suggests that systematically incorporating service facilities within residential buildings—tailored to the specific needs of residents and organized by layers and categories—will establish an optimal model for future communities [41]. The ground floors, designed for high accessibility, will prioritize leisure activities and include essential services with high frequency, such as convenience stores and parcel stations. This arrangement will ensure easy access for residents on upper floors while facilitating merchant operations and equipment maintenance. The middle floors will feature

health-oriented spaces, including medical service stations and age-friendly facilities. These facilities are designed to address both emergency situations and routine healthcare needs for elderly residents as well as individuals of all age groups. The lower-middle floors will accommodate educational facilities, such as childcare centers and classes based on specific interests, thereby providing convenient and reliable solutions for dual-income families. Rooftop spaces will be transformed into social scenarios featuring gardens and shared kitchens. Adding some green plants and rest areas to create a tranquil and comfortable atmosphere for social interaction. The vacant top floors will be designated for cultural spaces, such as shared reading rooms and activity centers, fostering serene environments conducive to learning and productivity.

4.2.2. Mitigating the NIMBY Effect

In the integration of diverse living scenarios within residential buildings, it is imperative to comprehensively address residents' concerns related to NIMBY issues through systematic optimization of spatial planning and the implementation of smart technologies. Noise pollution, which is often the most significant concern, can be effectively managed through a zoning strategy that concentrates noise-generating facilities on designated floors. This approach should be supplemented with soundproofing materials, noise-reducing equipment, and time-restricted usage policies to mitigate disturbances [42]. Embedding compact fire stations and smart surveillance within buildings addresses emergency requirements while minimizing spatial occupation. The implementation of retractable and concealable facility designs, paired with clear spatial signage, can effectively alleviate residents' concerns regarding the encroachment on communal areas. Additionally, regular safety education and fire drills serve to further reduce potential risks [43]. Fostering community relationships necessitates the development of thoughtfully designed interactive spaces and the implementation of standardized operational protocols. The establishment of themed shared activity areas, complemented by reservation systems, encourages positive interactions among neighbors. Additionally, evaluations of merchant services and mechanisms for resident feedback foster mutual accountability, thereby enhancing environmental quality and strengthening residents' sense of belonging and respect within the community. Environmental hygiene management combines technological innovations with the promotion of responsible behaviors. The implementation of smart waste disposal systems and monitored recycling stations effectively mitigates pollution at its origin. The seamless incorporation of waste-sorting facilities into building service areas ensures both functionality and cleanliness. These initiatives, in conjunction with ongoing environmental education, foster the establishment of sustainable management practices [44].

The primary focus of this approach is to highlight the synergy between spatial design and management protocols, with the aim of adapting residential buildings to address NIMBY conflicts. It is essential to prioritize high-impact issues such as noise control and safety, followed by the implementation of phased optimizations. This cost-effective and targeted strategy enhances the living standards within the community, ultimately fostering a harmonious ecosystem for residents, merchants, and property management entities.

4.3. Limitations

This study has several limitations that warrant further discussion. First, in terms of research methodology, the study primarily relied on case analyses of three typical communities in Xi'an. The relatively limited sample coverage may not fully reflect variations in residential space renovation across different regions and urban development stages. Future research could expand the sample scope to include more city types for comparative analysis. Second, at the technical level, the study insufficiently explored the feasibility of structural

modifications to residential spaces. The renovation of existing residential buildings inevitably encounters constraints, primarily in terms of spatial diversity and adaptability. Because of the rigid designs and structures of current residential buildings, achieving flexible and versatile spatial layouts during renovations is challenging. This, to some extent, restricts the diversification of residential space functions. Third, regarding economic sustainability, the study did not thoroughly evaluate the long-term operational cost–benefit balance of renovation projects. Particularly for market-oriented service facilities, their commercial sustainability requires a more systematic economic analysis. Last, domestic policies and regulations still have certain gaps, lacking clear guidance and supportive measures to promote and standardize the functional conversion of residential spaces. This makes the practical implementation of such conversions difficult to achieve.

These limitations highlight the need for more in-depth future research, including expanding sample sizes, strengthening interdisciplinary collaboration, deepening economic feasibility analyses, and proposing more effective measures to address the issue of high vacancy rates in existing residential spaces.

5. Conclusions

This study aimed to investigate the feasibility and optimization strategies for integrating service facilities into existing residential spaces within the context of urbanization in China. The objective was to address the challenges of high vacancy rates and resource misallocation while simultaneously catering to the diverse needs of residents for living service facilities. Through empirical research conducted in three representative communities in Xi'an, the findings indicated that residents' demands for various functional scenarios exhibited significant stratification characteristics. The study introduces an innovative strategy for vertically stratifying service facilities within residential buildings: commercial services are designated for the ground floor, health and educational facilities occupy the middle layers, and cultural spaces are situated on the top floor. Furthermore, this study revealed that residents' satisfaction was influenced by multiple factors, including the accessibility of facilities, the effectiveness of community governance, and the NIMBY phenomenon, which encompasses concerns such as safety risks and spatial equity. The significance of this study is further underscored by its establishment of an analytical framework that encompasses "demand classification–spatial adaptation–NIMBY governance." Practically, it offers a functional compound transformation model aimed at the renewal of current urban residential spaces. Looking ahead, the implementation of intelligent management systems and resident cogovernance mechanisms have the potential to enhance spatial utilization efficiency and bolster community resilience. This research holds considerable reference value for advancing high-quality urbanization development.

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Appendix A

Appendix A.1

Multicollinearity diagnostics revealed no significant concerns among the independent variables. All variance inflation factor (VIF) values ranged from 1.27 (facilities accessibility) to 2.15 (safety risks), well below the critical threshold of 5. Corresponding tolerance statistics varied between 0.47 and 0.79, exceeding the 0.2 acceptability criterion. The mean VIF of 1.56 further confirmed the absence of substantial multicollinearity, satisfying the ordinal regression model's independence assumptions.

Table A1. Multicollinearity test results for NIMBY effect variables.

Dependent Variable Threshold	Tolerance	VIF
Noise pollution	0.65	1.54
Garbage pollution	0.61	1.64
Safety risks	0.47	2.15
Fire safety hazards	0.71	1.41
Neighborhood relationships	0.74	1.35
Response to residents' issues	0.73	1.37
Information accessibility	0.77	1.30
Sense of respect	0.72	1.39
Facilities accessibility	0.79	1.27
Public space encroachment	0.68	1.47

Appendix A.2

The five ordinal logistic regression models all passed the overall significance test ($\chi^2(10) = 98.7\sim158.3$, $^*p^* < 0.001$), among which the health scenario model had the best fit (Nagelkerke $R^2 = 0.41$, AIC = 826.3) and the education scenario model, the weakest ($R^2 = 0.28$, AIC = 943.2). All models met the parallel line assumption ($^*p^* > 0.05$), which supported the establishment of proportional advantage. The AIC/BIC ranking (health < social < leisure < cultural < education) was consistent with the pseudo-R^2 results, indicating that the neighbor-avoidance variable had the strongest explanatory power for health satisfaction, while there may be unobserved moderating variables in the educational scenario.

Table A2. Goodness-of-fit statistics for ordered logistic regression models.

Fit the Indicator	Leisure	Health	Education	Society	Culture
χ^2 (df = 10)	125.6 ***	158.3 ***	98.7 ***	142.8 ***	115.4 ***
−2 log likelihood	852.6	798.3	915.2	810.5	882.1
Cox and Snell R^2	0.31	0.37	0.24	0.35	0.27
Nagelkerke R^2	0.35	0.41	0.28	0.39	0.31
McFadden R^2	0.18	0.22	0.14	0.20	0.16
AIC	880.6	826.3	943.2	838.5	910.1
BIC	948.2	893.9	1010.8	906.1	977.7
Parallel line test χ^2	15.2	17.8	12.5	16.4	14.1
Parallel line test *p*-value	0.12	0.09	0.21	0.11	0.15

Notes: *** $p < 0.001$. All models estimated with 10 degrees of freedom.

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