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Unveiling and Evaluating Residential Satisfaction at Community and Housing Levels in China: Based on Large-Scale Surveys

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Abstract

In recent decades, China has witnessed remarkable growth in housing construction, yet housing-related complaints have not declined significantly, highlighting the gap between housing quality and public expectations. Against this background, this study analyzes 32,277 national surveys to unpack residential satisfaction with green-livable communities in China. Entropy and standard-deviation weighting identified 16 priority indicators; artificial neural networks revealed weak direct influence of basic demographics on satisfaction, highlighting non-linear demand patterns. While 65–75% of respondents are satisfied with most attributes, significant city-level gaps persist—Beijing peaks near 90%, Chongqing falls below 50%. Dissatisfaction converges on three domains: infrastructure (parking, barrier-free access), building performance (leakage, noise, thermal defects) and smart systems (security, energy, health monitoring). Residents' improvement priorities have shifted from basic shelter to health safety, smart technology, humanistic care and ecological amenities. A "basic-security + quality-upgrade" strategy is proposed: short-term repairs of common defects, medium-term smart-sustainable upgrades and long-term participatory governance. The findings not only enrich the theoretical framework of community satisfaction research but also provide practical guidance for enhancing community quality and meeting residents' expectations in the context of China's rapid urbanization and housing development.

Keywords: communities and housing; satisfaction; big data mining; data research; regression assessment

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1. Introduction

1.1. Research Background

Since China's reform and opening-up, housing construction has expanded significantly in scale and speed. Urban per capita living space grew from 3.6 m^2 in 1978 to 38.6 m^2 in 2020, rivaling some high-income nations. Demand has evolved from basic needs to a desire for higher-quality, personalized, and diverse housing [1]. Yet, housing-related complaints remain substantial. The China Consumers Association reports that between 2015 and 2019, 30–50% of complaints concerned housing quality, with common issues like water leakage and wall damage. These ongoing problems reveal a gap between housing quality and public expectations, underscoring the need to assess residential satisfaction and improve housing quality.

Researchers are increasingly using satisfaction as a key component in environmental and behavioral studies. This research primarily focuses on two areas: measuring residents' actual satisfaction and studying community performance indicators that affect

satisfaction [2,3]. To gather relevant data, researchers often use two methods: geographic information systems (GIS) analysis or field surveys to collect objective data on housing and community features, such as location and facilities and questionnaire surveys to understand residents' subjective satisfaction and perceptions. By analyzing the relationship between these objective and subjective data, researchers aim to explore the connection between them [4]. Currently, subjective evaluation research dominates both domestic and international studies on residential satisfaction, often relying on questionnaires to collect residents' subjective evaluations of their community environment and satisfaction [5].

Residential satisfaction research, a key part of environmental behavior studies, has evolved from simple causal relationship theories to complex systems cognition [6]. Fried and Gleicher (1961), pioneers in this field, emphasized the importance of residents' subjective evaluations of their living environment over objective factors like sanitary facilities or housing structure [7]. This perspective, supported by evidence linking residential satisfaction to overall quality of life, has gained traction among researchers [8,9]. Influencing-factor analysis has become a major research focus. Alden Speare (1974) used residential satisfaction to predict residential mobility [10]. Theoretically, residential satisfaction is the balance between people's expectations/needs and actual housing conditions. If this balance is disrupted, individuals may adjust their expectations, housing evaluation, or residential status until self-identity is achieved [11]. In the 1980s, the development of cognitive psychology led by Galster to propose the "psychological construct theory" of residential satisfaction. The theory suggests that individuals' psychological expectations are the benchmark for evaluating residential conditions [12]. Due to population differences, subjective perceptions and evaluation standards vary, causing different effects on the same objective attributes. Thus, residential satisfaction research inherently involves both subjective and objective dimensions [13].

Current residential satisfaction research is distinguished by its interdisciplinary nature. Environmental psychology explores the link between spatial perception and emotions, sociology highlights differing housing needs across populations, and behavioral economics examines decision-making biases [14,15]. These developments have shifted satisfaction research from "environmental determinism" to a "human–environment interaction" model, recognizing the mutual influence between humans and their environment. For example, Binay Adhikari [16] found that a walking-friendly environment can boost satisfaction and enhance community belonging by encouraging neighborhood interaction. Methodologically, while questionnaires are common, their limitations are increasingly clear. Pedro et al. used GIS modeling to apply the Leadership in Energy and Environmental Design for Neighborhood Development (LEED-ND) sustainability assessment at the urban scale, identifying key intervention areas in Lisbon. This pioneering approach supports quantitative urban sustainability analysis [17]. Ding et al. employed the analytic hierarchy process for a fuzzy evaluation of urban green building planning, linking planning proportions to specific plots and creating a mathematical model to connect planning indicators [18]. Deng et al. evaluate how to renew the communities to improve the satisfaction of older hospital-adjacent residences while multilevel linear regression, structural equation model and so on are used to measure the satisfaction [19]. Big data technology is also transforming satisfaction research [20,21]. It enables researchers to process large datasets, uncovering patterns missed by traditional methods. Applications include analyzing mobile phone data for spatial usage patterns, energy data for behavior patterns, and online comments for dissatisfaction sources, thus enabling precise satisfaction evaluation. Liu et al. applied the online surveys to identify the urban residents' wellbeing in community cohesion with 301 respondents and structural equation models [22].

As some countries have established their systems to evaluate the quality of communities and housing conditions (showed in Table 1), the development of green communities in China has drawn on international experience while also displaying distinctive local characteristics. In the initial phases of reform and opening up, rapid urbanization resulted in a housing deficit, thereby making efficiency a priority. It is evident that communities constructed during this era frequently exhibited a disregard for environmental quality and humanistic concerns. In the late 1990s, with the implementation of Agenda 21 [23] and the subsequent dissemination of sustainable development concepts, green buildings began to emerge as a policy concern. The publication of the Assessment Standard for Green Buildings in 2006 signaled the advent of a standardized phase in green community construction in China [24]. Subsequent revisions to this standard have continuously strengthened energy conservation and environmental protection requirements and gradually incorporated people-oriented indicators such as health and comfort. Recent national satisfaction surveys have made noteworthy efforts in terms of sample size, indicator design, and data analysis. However, the primary challenges currently confronting the development of green communities in China pertain to the following: a discrepancy between the evaluation indicator system and rapidly evolving lifestyles; an imperfect data sharing mechanism that curtails the application of evaluation results; and inadequate channels for resident participation, which adversely impacts the quality of feedback.

Table 1. The comparison between different assessment systems from different countries.

Category	System	Abbr.	Country	Type	Date
Livable	<<Livable Communities: An Evaluation Guide>>	LC	US	Technical Guide	2005
	Livable Housing Design Guidelines	LHDG	Australia	Technical Guide	2017
	<<WELL v2 Building Standard>>	WELL	US	Evaluation standards	2022
	Home Quality Mark 6.0-Technical-Manual	HQM	UK	Evaluation system	2023
Low-carbon	CASBEE for Building (New Construction) Technical Manual	CASBEE-B	Japan	Evaluation system	2014
	LEED v4.1 Residential BD + C Multifamily Homes Guide	LEED	US	Evaluation system	2019
	BREEAM In-Use International Technical Manual: Residential	BREEAM-R	UK	Evaluation system	2020
	ZERO CARBON BUILDING DESIGN STANDARD VERSION 2	ZCBDS	Canada	Construction standards	2022
	Zero Energy Ready Home National Program Requirements	ZEH	US	Construction standards	2023
	PASSIVE HOUSE INSTITUTE	PHI	Germany	Construction standards	2023
	NZCBS Technical Update & Consultation Final v3	NZCBS	UK	Construction standards	2023

1.2. Research Objective and Contribution

Revealing residential satisfaction at community and housing levels and establishing a satisfaction benchmark through extensive survey data is crucial to evaluate residential sustainability, especially for formulating relevant policies. To effectively evaluate the satisfaction of residents in China, the present study has designed and implemented a comprehensive national survey. This initiative, driven by the research objectives of this paper, aims to collect extensive data on various aspects of community that influence residents' satisfaction. The survey has successfully gathered 32,277 valid questionnaires across different regions of China, ensuring a diverse and representative dataset. With the large-scale surveys, we uncover the key factors that significantly impact residents' satisfaction levels. Furthermore, the artificial neural network (ANN) technique has been employed to model the relationships between these factors and satisfaction levels. The

primary objectives of this study are to provide an in-depth understanding of the current state of community satisfaction, to identify the major challenges and shortcomings in existing green communities, and to propose targeted improvement strategies. The insights gained from this study will offer valuable guidance for policymakers, urban planners, and community developers in their efforts to enhance the quality of residential communities and improve the living conditions of residents.

The innovative aspect of this study lies in its use of a large-scale national survey of responses to perceive indicators of residential satisfaction. Through a comprehensive nationwide assessment, it evaluates the current state of satisfaction levels at community and housing levels, identifies key influencing factors and dynamic demands, and establishes a satisfaction benchmark. This is conducive to promoting policies that enhance national residential quality within urban renewal. The academic contribution of the article is its methodological success in integrating standard deviation method, entropy weight method, and ANN models, which reveals patterns in resident demands and provides both data-driven support and concrete strategies for improving community quality, holding significant value for advancing people-oriented, sustainable community development.

2. Materials and Methods

2.1. Survey Questionnaire Design

The design of a survey questionnaire is crucial for collecting sample data and drawing study conclusions. Therefore, this study systematically designs a survey questionnaire by examining domestic and foreign research literature, leveraging prior research experience, and integrating the characteristics of the survey subjects. The questionnaire is structured into three main sections. The first section gathers basic household and residential information, including details such as city of residence, gender, age, family type, occupation, economic status, housing type, floor area, housing layout, and year of construction. The second section assesses community livability satisfaction across six dimensions: natural environment and health, urban facility quality and living convenience, green travel and transport convenience, outdoor livability and comfort, community facility quality and comfort, and community management, security, and safety. This section consists of 30 questions. The third section evaluates construction quality satisfaction across nine dimensions: residential suitability, housing layout and space quality, residential safety and durability, residential safety and health, hygiene and epidemic prevention, long-term performance and quality, kitchen and bathroom facilities and equipment, indoor smart operation and maintenance facilities, and indoor decoration quality. This section includes 45 questions. In total, the questionnaire comprises 15 first-level indicators and 75 s-level indicators, comprehensively covering all aspects of residents' satisfaction with the quality of green and livable communities and housing. The questionnaire design is detailed in Appendix A (Table A1).

The survey used an online questionnaire, which is the most frequently used basic survey method in research. A standardized questionnaire was employed to solicit the opinions of respondents through online research. The employment of anonymity guaranteed the veracity of the questionnaire. A comprehensive online questionnaire was administered and subsequently analyzed to select four exemplary residential communities in each area. The distribution of the online questionnaire occurred from 1 July 2020 to October 2020, resulting in a total of 32,383 collected questionnaires. Of these, 32,277 were determined to be valid, resulting in a validity rate of 99.5%. The questionnaire encompasses 34 provinces, municipalities, and autonomous regions, as well as a number of overseas countries and cities. This survey yielded a substantial amount of data and valuable primary information.

2.2. Basic Data Analysis

2.2.1. Reliability and Validity Tests

The reliability of a scale is defined as the consistency and stability of its measurement results, also known as the scale's reliability. In the context of repeated measurements of the same concept under constant conditions, the absence of variation in the measurement results indicates the reliability of the scale. The Cronbach's alpha coefficient, a widely employed reliability assessment tool, facilitates the identification of internal consistency in questionnaire data [25]. When the Cronbach's alpha coefficient exceeds 0.7, it signifies that the scale's survey data possesses a high degree of reliability. The formula is as follows:

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum S_i^2}{S_x^2}\right) \quad (1)$$

In this context, α represents the reliability coefficient, K denotes the number of test items, S_i^2 denotes the variance of scores on all items across all participants, and S_x^2 denotes the variance of total scores across all participants. The Cronbach's alpha coefficient of the 75 satisfaction indicators was calculated according to the formula. The Cronbach's alpha coefficient of the 32,380 samples prior to screening was 0.995, while the Cronbach's alpha coefficient of the 25,887 samples post-screening, derived from response time and the total score of the 75 indicators, was 0.993. The resultant value is greater than 0.7, indicating that the survey data is highly reliable.

The validity test refers to the process of evaluating whether the results of a questionnaire accurately reflect the intended evaluation outcomes. The most widely employed method for conducting this test is factor analysis. Conversely, if a scale exhibits both high reliability and high validity, it is indicative of its high internal quality. In order to ascertain the suitability of the survey results for factor analysis, the Kaiser–Meyer–Olkin (KMO) test and Bartlett's test can be employed to evaluate the correlation between variables present in the survey results [26,27]. The results of the aforementioned test are displayed in the following Table 2:

Table 2. Validity Test Results of the Survey.

KMO sampling suitability measure		0.996
Bartlett's sphericity test	Approximate chi-square	2,416,514.39
	Degrees of freedom	2775
	Significance	0.000

The KMO test result was 0.996, indicating that the selected influencing factors were strongly correlated and weakly biased. The chi-square value of Bartlett's sphericity test was 2,416,514.39, with a significance of 0.000, which is lower than 0.005. This indicates that the correlation coefficient matrix is not a unit matrix and that there is a correlation between the original variables. The results of the KMO and Bartlett's tests indicate that factor analysis can be conducted on the 75 satisfaction indicators.

2.2.2. Satisfaction Weight Analysis

In this residential satisfaction survey questionnaire, satisfaction was divided into 75 different indicators. The five responses, "very satisfied", "satisfied", "average", "dissatisfied", and "very dissatisfied," were statistically analyzed based on a five-point Likert scale. However, no survey results were available for the evaluation of overall satisfaction. To construct an evaluation model for overall satisfaction based on the 75 indicators and to analyze the relative importance of different indicators on the overall results, this study

introduces two objective weighting methods: standard deviation and information entropy. These methods are used to evaluate the indicators. The standard deviation weight will be utilized as the baseline weight, and the information entropy weight will be employed as the correction weight.

(1) Standard deviation method

Standard deviation, denoted by σ, is the square root of variance and is a fundamental concept in probability statistics [28]. It serves as a measure of statistical distribution, indicating the extent to which data points deviate from the mean. It is a quantitative metric that quantifies the degree of dispersion of a set of data. A substantial standard deviation signifies that the majority of values are significantly distant from the mean. A low standard deviation suggests that the majority of values are closely aligned with the mean. The formula for calculating the sample standard deviation is as follows:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{n-1}} \tag{2}$$

The standard deviation method is a quantitative approach that quantifies the degree of dispersion of data based on standard deviation. It also assigns weights to indicators according to the size of the standard deviation. The formula for calculating the standard deviation weight is as follows:

$$\omega_j = \frac{\sigma_j}{\sum_{j=1}^{n}\sigma_j} \tag{3}$$

(2) Entropy Weight Method

Information entropy is a fundamental concept in information theory, drawing from thermodynamics. It refers to the average amount of information in a system after redundancy has been removed. The Entropy Weight Method (EWM) is predicated on the precepts of information entropy theory, utilizing entropy values to ascertain the degree of dispersion of an indicator [29]. This, in turn, facilitates the determination of the weighting method for each indicator within the system. For a given indicator, a smaller information entropy value indicates greater dispersion of the indicator and greater impact (i.e., weight) of the indicator on the comprehensive evaluation. In the event that all values of an indicator are equivalent, the indicator's effect on the comprehensive evaluation is nullified. The entropy value e_j and weight β_j are calculated as follows:

$$e_j = -\frac{1}{lnm}\sum_{i=1}^{n} p_{ij} ln p_{ij} \tag{4}$$

$$\beta_j = \frac{1-e}{\sum_{j=1}^{m} 1-\mathrm{e}} \tag{5}$$

During the application process, the 75 indicators were converted into numerical values on a five-point Likert scale ranging from "very satisfied," "satisfied," "average," "dissatisfied," and "very dissatisfied," with scores ranging from 5 to 1. First, the standard deviation weight of the 75 indicators is calculated by the Formulas (2) and (3). Subsequently, the data undergoes standardization and translation to ascertain the weight, and the information entropy weight is determined by the EWM according to the Formulas (4) and (5).

2.3. Method for Satisfaction Regression

Backpropagation neural networks are a specific type of neural network characterized by the unidirectional propagation of signals [30]. This model has been utilized since its inception [31], and in this model, neurons receive weighted input signals transmitted from n

neurons in the preceding layer. The total input value is added to the bias, and subsequently, the activation function processes it to yield the neuron's output. The corresponding commonly used sigmoid function is used as the activation function to map a wide range of inputs to the interval (0,1), as demonstrated in Formula (6).

$$sigmoid(x) = \frac{1}{1 + e^{-x}} \tag{6}$$

The integration of numerous neurons within a hierarchical structure constitutes a neural network. In a multi-layer feedforward neural network, a specific number of hidden layers are situated between the input layer and the output layer. The neurons in the input layer receive external inputs, and the neurons in the hidden layer and output layer process the signals and output the results. In this model, each layer of neurons is fully interconnected with the next layer of neurons. There are no connections within the same layer or across layers. The model structure is illustrated in Figure 1.

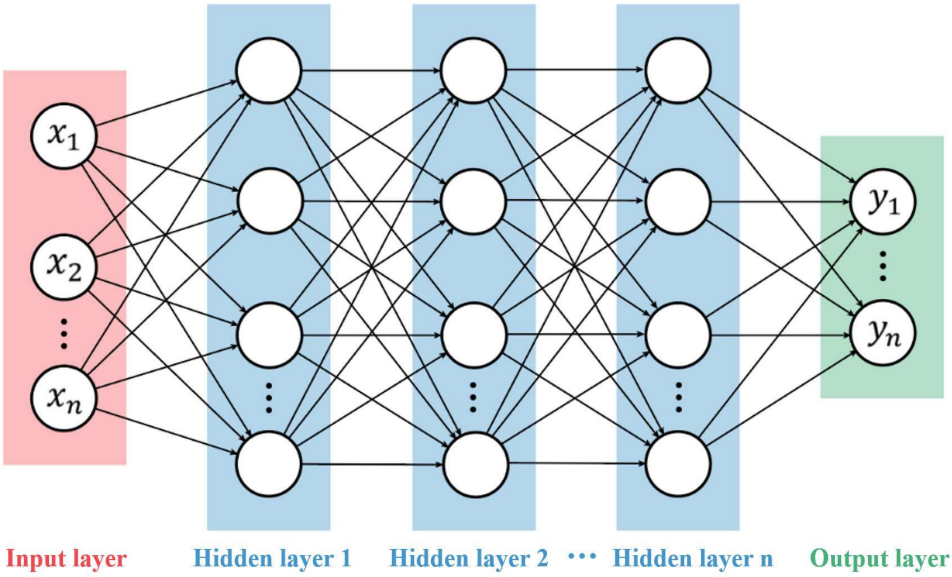


Figure 1. Schematic diagram of the artificial neural network model structure.

Traditional statistical analysis methods (e.g., multiple regression model) can reflect the basic situation of satisfaction, but it is difficult to reveal the nonlinear relationship between independent variables and dependent variables. The research adopts ANN mainly due to its powerful nonlinear modeling capabilities, which can effectively capture the complex multi-dimensional nonlinear relationships and interaction effects between demographic variables and satisfaction. This study employs ANN as a nonlinear regression tool, aiming to explore deeper correlations between demographic variables and satisfaction. First, 75 artificial neural network models were constructed with nine basic information items (gender, age, family type, population, occupation, housing type, housing layout, floor area, and year of construction) as independent variables and 75 satisfaction indicators as dependent variables. Second, an artificial neural network model was constructed and optimized with nine basic information items, and five satisfaction items, for a total of 14 indicators as independent variables. The nine basic information items included gender, age, family type, population, occupation, housing type, housing layout, floor area, and year of construction. The five satisfaction items included Y211 (beautiful streetscape, local characteristics, and cultural harmony), Y212 (proximity to urban open spaces with a lively atmosphere), Y213 (proximity to commercial, cultural, and medical facilities), Y214 (proximity to educational facilities and youth facilities), and Y215 (proximity to elderly

living facilities). The Y201 (natural environment such as parks and green spaces) served as the dependent variable.

It is hypothesized that the model will learn universally applicable rules during training, thereby ensuring that the conclusions drawn are applicable to the majority of residents. Nonetheless, in view of the model's advanced learning capabilities, there is a possibility that it may interpret the attributes of the training samples as universal characteristics of all samples. This may result in overfitting due to a reduction in the model's generalizability [32]. In order to circumvent the issue of overtraining to the greatest extent possible, it is imperative to disassociate the training set from the testing set to assess the generalization capability of the model. When the R2 of the training set data increases with training and the R2 of the testing set begins to decrease, learning should be stopped in a timely manner to alleviate the problem of overfitting [33], as illustrated in Figure 2.

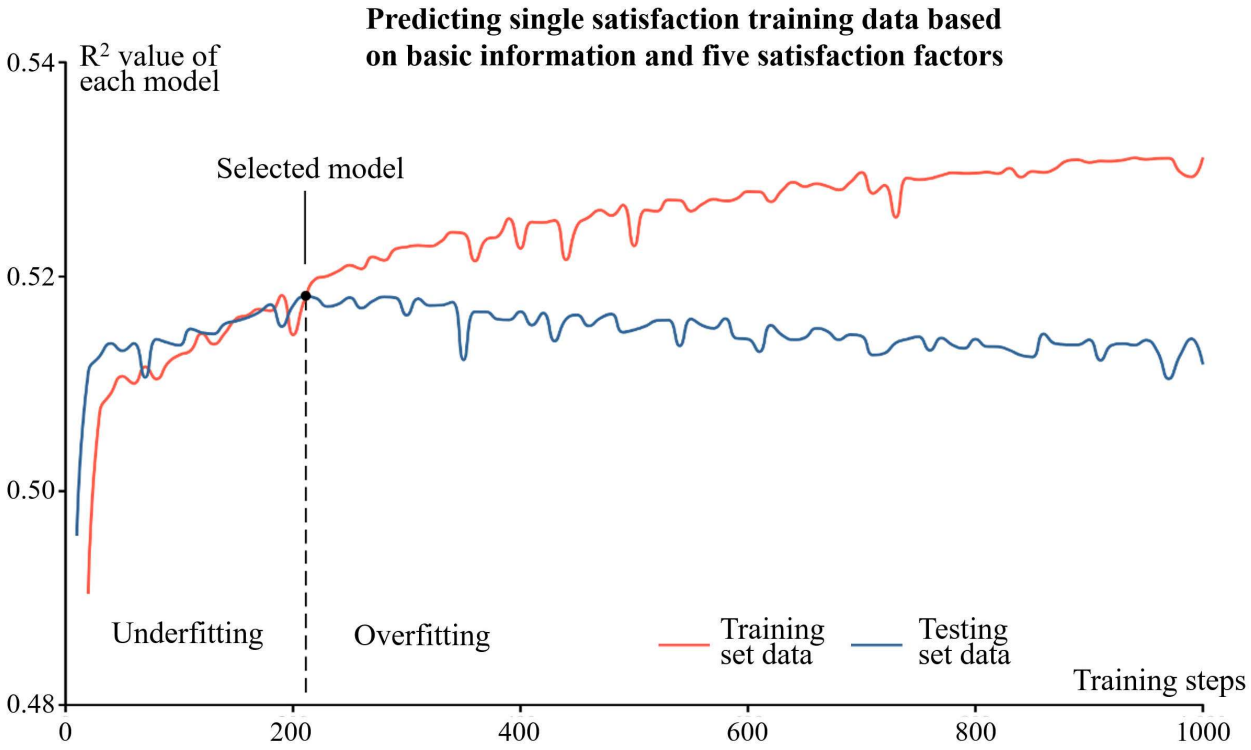


Figure 2. Schematic diagram of the relationship between training steps and R^2 value.

In this study, we employed a training set and testing set ratio of 4:1, based on actual experience. When the error of the testing set continued to increase or when training reached a specific number of steps, the training was halted and the hyperparameters and weights with the lowest testing set error were recorded [34]. The primary optimization methodologies employed for BP networks encompass enhancements to learning algorithms and modifications to network architecture. The number of nodes in the input layer (14) and the number of nodes in the output layer (1) correspond to the independent and dependent variables, respectively. The design of the hidden layer affects the network's capacity, generalization capability, learning speed, and output performance. Given the network's capacity for generalization, it is imperative to ascertain the optimal values for the number of hidden layers and neurons in each layer [35]. In this study, we adopted the grid search method for model parameter tuning. Grid search is a systematic and exhaustive optimization technique that explores the predefined multidimensional parameter space to identify the best hyperparameter combination [36]. The parameter ranges were carefully selected based on domain expertise and relevant literature to ensure an effective and

rational search process [37]. The parameters tuned include the number of hidden layers, units within each hidden layer, activation functions, and optimization algorithms, which directly impact the network's capacity, generalization ability, and convergence speed. This exhaustive search was complemented with early stopping criteria and train-test separation strategies to prevent overfitting and enhance the model's generalization capability.

Regarding model validation and future improvements, this study controlled the overfitting of the model through methods such as separating the training set from the test set and the early stop strategy, and initially verified that the model has a certain generalization ability. Moreover, the research focus is not merely on satisfaction prediction, but rather on leveraging ANN's fitting regression capabilities to explore the impact of input features on satisfaction.

2.4. The Innovation of the Proposed Methods

Concluded from above, this study proposes an innovative integrated approach that combines big data mining techniques and artificial neural network (ANN) models to systematically evaluate resident satisfaction in China's green and livable communities. First, we utilized big data mining to process and analyze 32,277 valid questionnaires from diverse regions and community types across the country. This approach overcomes the limitations of traditional satisfaction studies in terms of data scale and geographic coverage, revealing macro-level distribution patterns and key factors influencing community satisfaction. Second, the innovation in the methodology lies in its use of an ANN model with dual-weighting method—standard deviation weighting and entropy weighting—to quantify the importance of satisfaction indicators. Additionally, we optimized the model's hyperparameters and structure through grid search and introduced an early stopping strategy to prevent overfitting, thereby more accurately capturing the complex nonlinear relationships between satisfaction and resident characteristics.

3. Results

3.1. Descriptive Results of Survey

Initially, the minimum values of the response times were processed, as illustrated in Figure 3. The sample sizes for the four response time intervals are 2512 (7.76% of the total sample size), 11,016 (34.02% of the total sample size), 24,948 (77.05% of the total sample size), and 30,516 (94.24% of the total sample size), respectively. As illustrated in Figure 3, when excluding the minimum values of response times, 20 s or 50 s can be used as the threshold. Among the participants, 346 individuals had a response time of less than 20 s, while 580 individuals had a response time of less than 50 s. These two groups accounted for 1.07% and 1.80% of the total sample size, which was 32,380. Given the temporal requirements for the completion of 75 questions, the 580 samples with a response time of less than 50 s were excluded from the analysis.

Subsequently, an analysis was conducted on the maximum values of response times. As illustrated in Figure 4, the distribution of response times appears to approximate a Poisson distribution, characterized by long tails. As illustrated in Figure 4a, the raw data set exhibits a maximum response time of approximately 60,000 s, with the tail data points being too dispersed to be readily discernible. Consequently, the interval was modified to range from 0 to 10,000 (as depicted in Figure 4b).

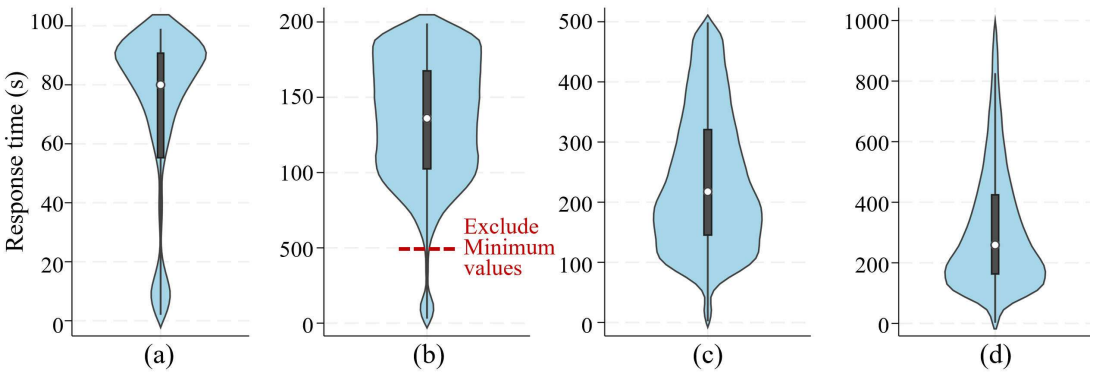


Figure 3. Violin plot of response time for satisfaction survey questionnaire: (**a**) response time between 0–100 s; (**b**) response time between 0–200 s; (**c**) response time between 0–500 s; (**d**) response time between 0–1000 s.

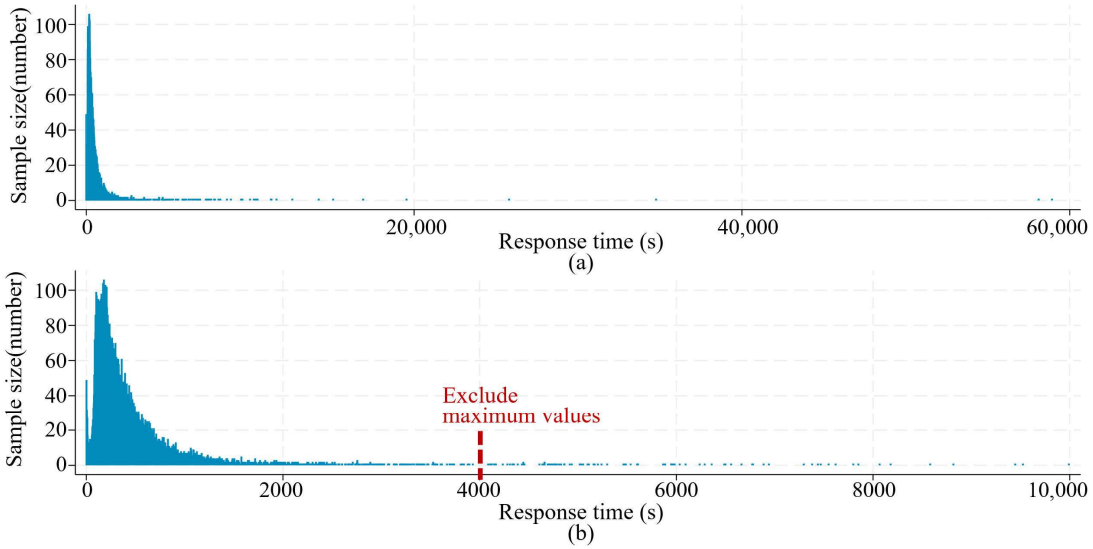


Figure 4. Overall distribution of response times for satisfaction survey questionnaire: (**a**) response time between 0–60,000 s; (**b**) response time between 0–10,000 s.

As illustrated in Figure 4b, the minimum values of the response times for the initiation of the test are considerably higher than the remaining values. Subsequent to the exclusion of these minimum values, the aggregate distribution of response times exhibited greater consistency with the characteristics of a Poisson distribution. The tail data that extends beyond 4000 s is characterized by its considerable length and broad dispersion. A total of 107 samples surpassed 4000 s, yet these constituted a mere 0.33% of the overall sample size. In the course of processing the maximum values, 107 samples with response times that exceeded 4000 s were excluded.

Figure 5 provides further evidence that validates the rationality of the response time processing. The sample sizes of the three response intervals depicted in Figure 5a, Figure 5b, and Figure 5c are 31,800, 31,693, and 31,420, respectively. As illustrated in Figure 5c, even after excluding values greater than 2000 s during the processing of maximum values, a significant number of outliers remain at the tail. This indicates that the response time distribution does not adhere to a normal distribution, and the tail data is extensive and relatively continuous. Consequently, it is not necessary to further exclude values based on 4000 s. This finding aligns with the results presented in Figure 4, thereby substantiating the analytical observations.

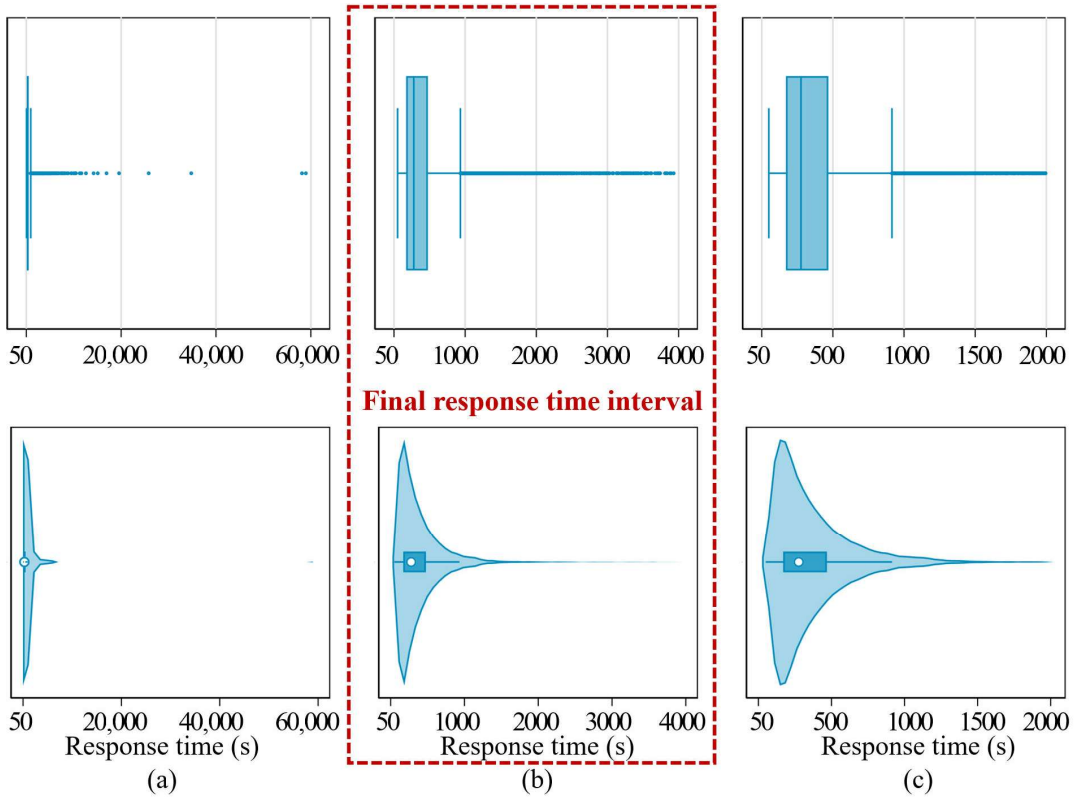


Figure 5. Box plot and violin plot of response times for satisfaction survey questionnaire: (**a**) response time between 50–60,000 s; (**b**) response time between 50–4000 s; (**c**) response time between 50–2000 s.

3.2. Satisfaction Results from Survey

Preliminary data interpretation of the "satisfaction" evaluation at the "community" and "housing" levels was conducted based on the responses to the questionnaire. In the satisfaction evaluation, responses indicating "very satisfied" and "relatively satisfied" were combined into a single category of "satisfied". Similarly, responses indicating "dissatisfied" and "very dissatisfied" were combined into a single category of "dissatisfied". The results are presented in Figures 6 and 7 (more information can be found in Appendix B, Figures A1–A15). For "natural ecological environments such as parks and green spaces", "satisfied" was selected by 75.9%, "average" by 17.8%, and "dissatisfied" by 6.0%; for "sewage discharge and water pollution, garbage and waste pollution", "satisfied" was selected by 71.6%, "average" by 20.5%, and "dissatisfied" by 7.7%; for "air pollution and air quality", "satisfied" was selected by 73.2%, "average" by 20.1%, and "dissatisfied" by 6.9%; for "emergency shelters for safety and disaster prevention in the surrounding area", "satisfied" was selected by 71.9%, "average" by 20.9%, and "dissatisfied" by 7.8%. For "noise from road traffic", "satisfied" was selected by 68.4%, "average" by 20.7%, and "dissatisfied" by 10.5%. For "configuration standards for indoor water supply and drainage, heating and air conditioning, ventilation, gas, and electrical equipment", "satisfied" was selected by 71.4%, "average" by 22.5%, and "dissatisfied" by 6.1%. For "indoor finishing standards and configuration level of kitchen and bathroom facilities", "satisfied" was selected by 70.6%, "average" by 23.3%, and "dissatisfied" by 6.1%; for "thermal insulation and heat retention, sunlight exposure, and ventilation", "satisfied" was selected by 72.4%, "average" by 21.4%, and "dissatisfied" by 6.15%. For "floor area size", "satisfied" was selected by 73.1%, "average" by 21.4%, and "dissatisfied" by 5.52%; for "floor plan layout and functional use of space", "satisfied" was selected by 73.1%, "average" by 21.64%, and "dissatisfied" by 5.3%.

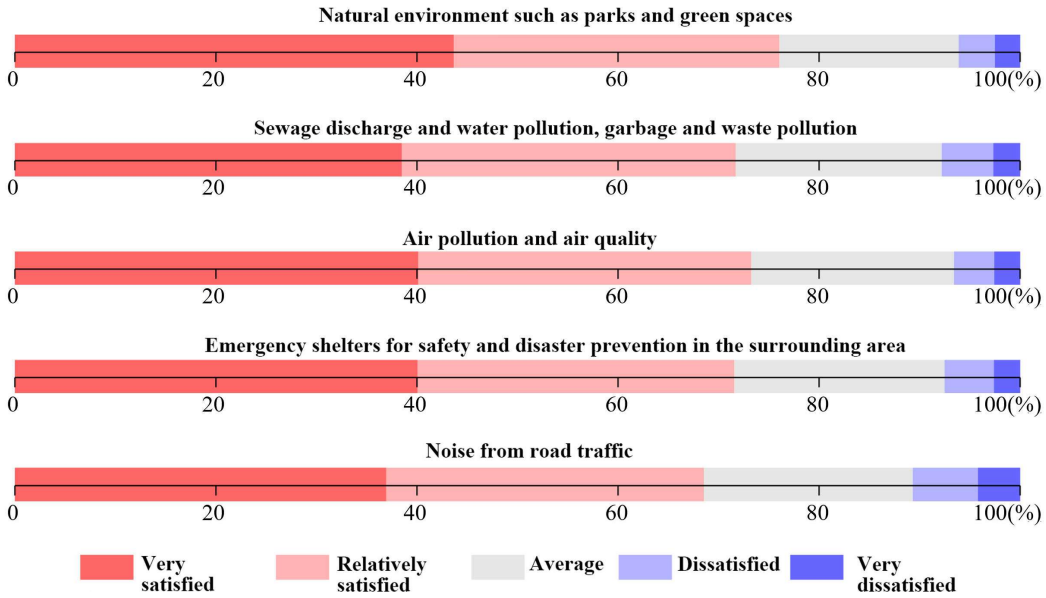


Figure 6. Satisfaction with natural ecology and environmental health indicators.

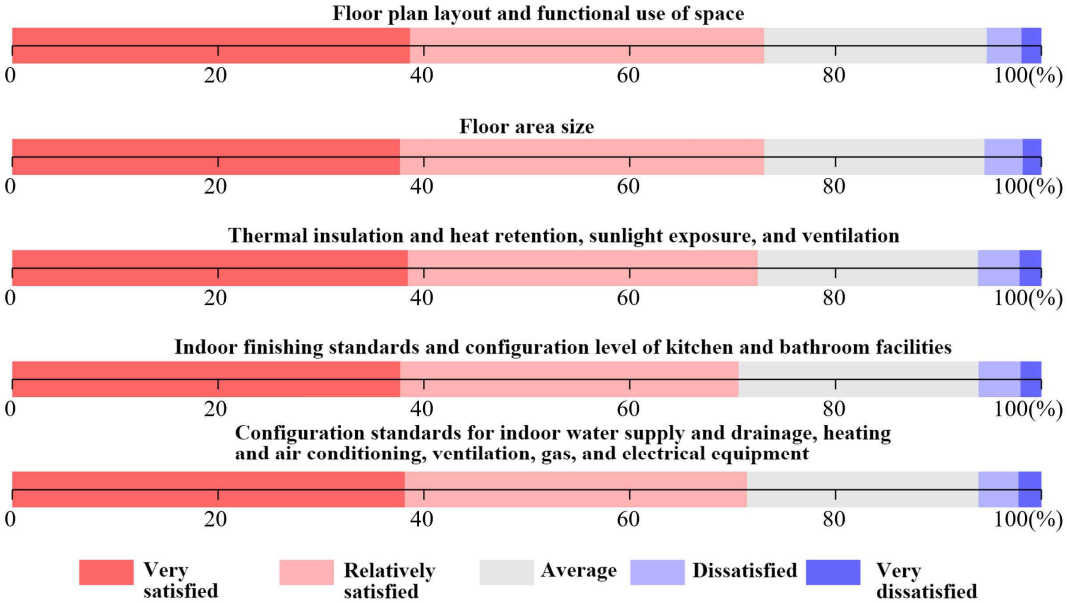


Figure 7. Satisfaction with applicable performance and living quality indicators.

3.3. Determination of Satisfaction Weights

During the application process, the 75 indicators were converted into numerical values on a five-point Likert scale ranging from "very satisfied", "satisfied", "average", "dissatisfied", and "very dissatisfied", with scores ranging from 5 to 1. First, the standard deviation weight of the 75 indicators is calculated by the formula in Section 2.2.2. Subsequently, the data undergoes standardization and translation to ascertain the weight, and the information entropy weight is determined by the EWM according to the Formulas (4) and (5) in Section 2.2.2. The results of the weights calculation for the 75 indicators are shown in Table 3 below:

Table 3. Results of weight calculation for 75 indicators.

Major Indicators	Sub-Indicators	Standard Deviation Weight	Information Entropy Weight
Y20	Y201	0.0132	0.0124
	Y202	0.0136	0.0140
	Y203	0.0134	0.0131
	Y204	0.0136	0.0139
	Y205	0.0147	0.0180
Y21	Y211	0.0130	0.0120
	Y212	0.0130	0.0120
	Y213	0.0131	0.0126
	Y214	0.0131	0.0126
	Y215	0.0139	0.0150
Y22	Y221	0.0136	0.0140
	Y222	0.0135	0.0138
	Y223	0.0132	0.0129
	Y224	0.0136	0.0142
	Y225	0.0139	0.0151
Y23	Y231	0.0130	0.0119
	Y232	0.0131	0.0122
	Y233	0.0135	0.0136
	Y234	0.0147	0.0182
	Y235	0.0138	0.0144
Y24	Y241	0.0139	0.0146
	Y242	0.0135	0.0137
	Y243	0.0128	0.0119
	Y244	0.0140	0.0154
	Y245	0.0136	0.0142
Y25	Y251	0.0132	0.0127
	Y252	0.0134	0.0131
	Y253	0.0136	0.0143
	Y254	0.0135	0.0139
	Y255	0.0135	0.0139
Y30	Y301	0.0127	0.0116
	Y302	0.0127	0.0115
	Y303	0.0130	0.0124
	Y304	0.0131	0.0125
	Y305	0.0131	0.0126
Y31	Y311	0.0128	0.0118
	Y312	0.0128	0.0118
	Y313	0.0127	0.0113
	Y314	0.0134	0.0132
	Y315	0.0135	0.0137
Y32	Y321	0.0126	0.0109
	Y322	0.0127	0.0114
	Y323	0.0130	0.0121
	Y324	0.0134	0.0134
	Y325	0.0132	0.0131
Y33	Y331	0.0144	0.0173
	Y332	0.0134	0.0132
	Y333	0.0130	0.0123
	Y334	0.0136	0.0141
	Y335	0.0128	0.0120

Table 3. *Cont.*

Major Indicators	Sub-Indicators	Standard Deviation Weight	Information Entropy Weight
Y34	Y341	0.0126	0.0111
	Y342	0.0130	0.0121
	Y343	0.0131	0.0126
	Y344	0.0131	0.0126
	Y345	0.0132	0.0130
Y35	Y351	0.0130	0.0122
	Y352	0.0131	0.0128
	Y353	0.0131	0.0127
	Y354	0.0131	0.0127
	Y355	0.0132	0.0129
Y36	Y361	0.0140	0.0153
	Y362	0.0139	0.0149
	Y363	0.0139	0.0149
	Y364	0.0139	0.0152
	Y365	0.0140	0.0155
Y37	Y371	0.0130	0.0122
	Y372	0.0131	0.0127
	Y373	0.0131	0.0127
	Y374	0.0132	0.0131
	Y375	0.0134	0.0133
Y38	Y381	0.0136	0.0145
	Y382	0.0132	0.0133
	Y383	0.0138	0.0149
	Y384	0.0135	0.0139
	Y385	0.0132	0.0132

The specific values of the 75 items of satisfaction will vary under the two calculation methods, but the magnitude of change will be synchronized. Consequently, these values will either increase or decrease in unison. The areas with higher satisfaction weights are those that residential users are more concerned about, as reflected in significant changes in their evaluation of current living quality. Consequently, a substantial proportion of users have expressed discontent with the prevailing circumstances. However, it is noteworthy that contemporary technological advancements have the potential to address these concerns. Conversely, a substantial proportion of users have expressed satisfaction with the present state of affairs regarding this issue. According to the classification of communities and residences, there are five and 11 items with a weight difference ratio (i.e., the percentage by which the weight value exceeds the smallest weight value) greater than 25%, as demonstrated in Table 4 (ranking of weight differences at the community level). The 16 aforementioned sub-items have been identified as the target characteristics for enhancing housing performance and residential satisfaction.

Table 4. Ranking of weight differences at the community level.

Sub-Indicator No.	Information Entropy Weight	Weight Difference Ratio	Sub-Indicator No.	Information Entropy Weight	Weight Difference Ratio
Y234	0.0182	52.9%	Y364	0.0152	39.4%
Y205	0.0180	51.3%	Y362	0.0149	36.7%
Y244	0.0154	29.4%	Y363	0.0149	36.7%
Y225	0.0151	26.9%	Y383	0.0149	36.7%
Y215	0.0150	26.1%	Y381	0.0145	33.0%

Table 4. *Cont.*

Sub-Indicator No.	Information Entropy Weight	Weight Difference Ratio	Sub-Indicator No.	Information Entropy Weight	Weight Difference Ratio
Y331	0.0173	58.7%	Y334	0.0141	29.4%
Y365	0.0155	42.2%	Y384	0.0139	27.5%
Y361	0.0153	40.4%	Y315	0.0137	25.7%

3.4. Satisfaction Regression

First, the ANN models were constructed with nine basic information items (gender, age, family type, population, occupation, housing type, housing layout, floor area, and year of construction) as independent variables and 75 satisfaction indicators as dependent variables. Following a series of experiments, the optimal structure of the model was determined to be three hidden layers, each comprising five neurons, in conjunction with the Sigmoid activation function. Following the determination of the optimal combination of hyperparameters, the model determination coefficient R^2, which exhibited the strongest generalization capability, was obtained in the training. The model's fitting quality is determined by the coefficient R^2, which ranges from 0 to 1. R^2 indicates the proportion of the dependent variable variability that can be explained by the model. The closer R^2 is to 1, the better the model's fitting capability. The results obtained from the neural network model are presented in Table 5. The highest R^2 value recorded was 0.133, and the average value was 0.107, suggesting that the independent variables did not adequately align with the dependent variable. In consideration of the aforementioned data, it can be determined that a direct correlation between the fundamental information variables and satisfaction is not evident. The complexity of satisfaction's explanation through basic information is also noteworthy.

Table 5. Fitting results of artificial neural network model for estimation of satisfaction with basic information.

Independent Variables: 9 Basic Information Items					
Group	**Dependent Variable**	**R^2**	**Group**	**Dependent Variable**	**R^2**
Y20	Y201	0.1095	Y32	Y321	0.1068
	Y202	0.1106		Y322	0.1111
	Y203	0.0946		Y323	0.1134
	Y204	0.1053		Y324	0.1065
	Y205	0.0899		Y325	0.1177
Y21	Y211	0.0891	Y33	Y331	0.0893
	Y212	0.0848		Y332	0.0936
	Y213	0.0664		Y333	0.0995
	Y214	0.0721		Y334	0.1228
	Y215	0.0866		Y335	0.1100
Y22	Y221	0.0643	Y34	Y341	0.1184
	Y222	0.0738		Y342	0.1212
	Y223	0.0739		Y343	0.1165
	Y224	0.0915		Y344	0.1277
	Y225	0.0898		Y345	0.1230
Y23	Y231	0.1020	Y35	Y351	0.1199
	Y232	0.1102		Y352	0.1134
	Y233	0.0971		Y353	0.1167
	Y234	0.1127		Y354	0.1219
	Y235	0.1143		Y355	0.1199

Table 5. *Cont.*

Independent Variables: 9 Basic Information Items					
Group	**Dependent Variable**	**R^2**	**Group**	**Dependent Variable**	**R^2**
Y24	Y241	0.1025	Y36	Y361	0.1305
	Y242	0.0969		Y362	0.1331
	Y243	0.0756		Y363	0.1206
	Y244	0.1007		Y364	0.1087
	Y245	0.0816		Y365	0.1169
Y25	Y251	0.1091	Y37	Y371	0.1156
	Y252	0.1134		Y372	0.0963
	Y253	0.1163		Y373	0.1097
	Y254	0.1040		Y374	0.1166
	Y255	0.1120		Y375	0.1190
Y30	Y301	0.1067	Y38	Y381	0.1049
	Y302	0.1157		Y382	0.1130
	Y303	0.1114		Y383	0.1050
	Y304	0.1130		Y384	0.1159
	Y305	0.1210		Y385	0.1103
Y31	Y311	0.1147			
	Y312	0.1227			
	Y313	0.1254			
	Y314	0.1050			
	Y315	0.1169			

The training results of the model with varying activation functions are presented in Table 6. Specifically, the activation function column contains two activation functions, indicating that other activation functions are employed for the input layers and hidden layers in the model. The Sigmoid activation function is utilized for the output layer. Furthermore, the employment of the sigmoid activation function in the output layer has been demonstrated to enhance the model's performance in comparison to the utilization of the identical activation function. This phenomenon may be attributed to the utilization of 0–1 normalization by the model, resulting in a parameter range that aligns with the activation function value range. This alignment has been observed to enhance the model's performance to a certain extent.

Table 6. Training results for different activation functions.

Activation Function	Optimal Hidden Layers	Optimal Number of Neurons	Optimal R^2
sigmoid	3	8	0.5187
relu	1	14	0.5185
relu, sigmoid	1	5	0.5195
elu	2	10	0.5167
elu, sigmoid	3	14	0.5199
leakyrelu	1	14	0.5171
leakyrelu, sigmoid	1	10	0.5208
tanh	3	10	0.5176
tanh, sigmoid	2	14	0.5201

4. Discussion

This study surveyed community and housing satisfaction nationwide and obtained several important findings. Preliminary findings from the survey indicate that Chinese residents as a whole hold a generally positive sentiment towards their residential environment. At the community and housing levels, the satisfaction survey revealed that 20 of the 30 secondary indicators and six of the primary indicators received a "very satisfied"

or "relatively satisfied" rating of over 70%. The remaining 10 indicators all exceeded 65% (Figure 8). At the housing level, 36 of the 45 secondary indicators and nine of the primary indicators had satisfaction rates exceeding 68%, with the remaining nine exceeding 65% (Figure 9). This result is indicative of the substantial advancements made in China's housing construction following the implementation of reform and opening-up.

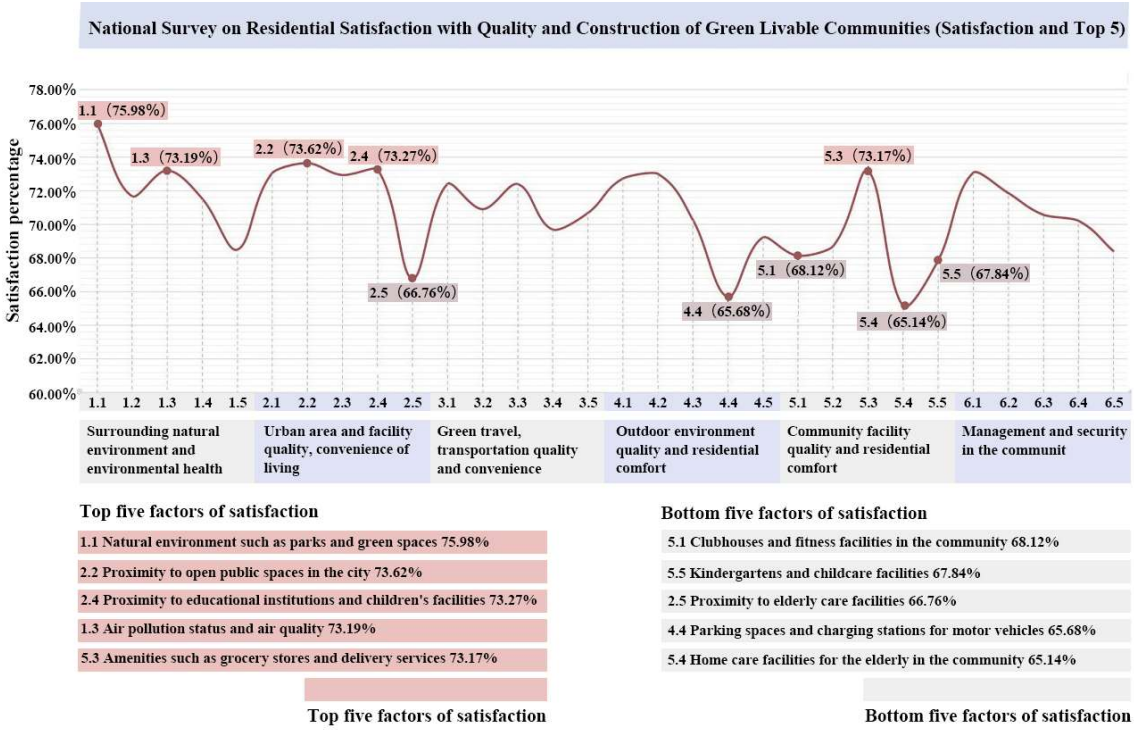


Figure 8. National Survey on Residential Satisfaction with Quality and Construction of Green Livable Communities (Satisfaction with Communities and Top 5).

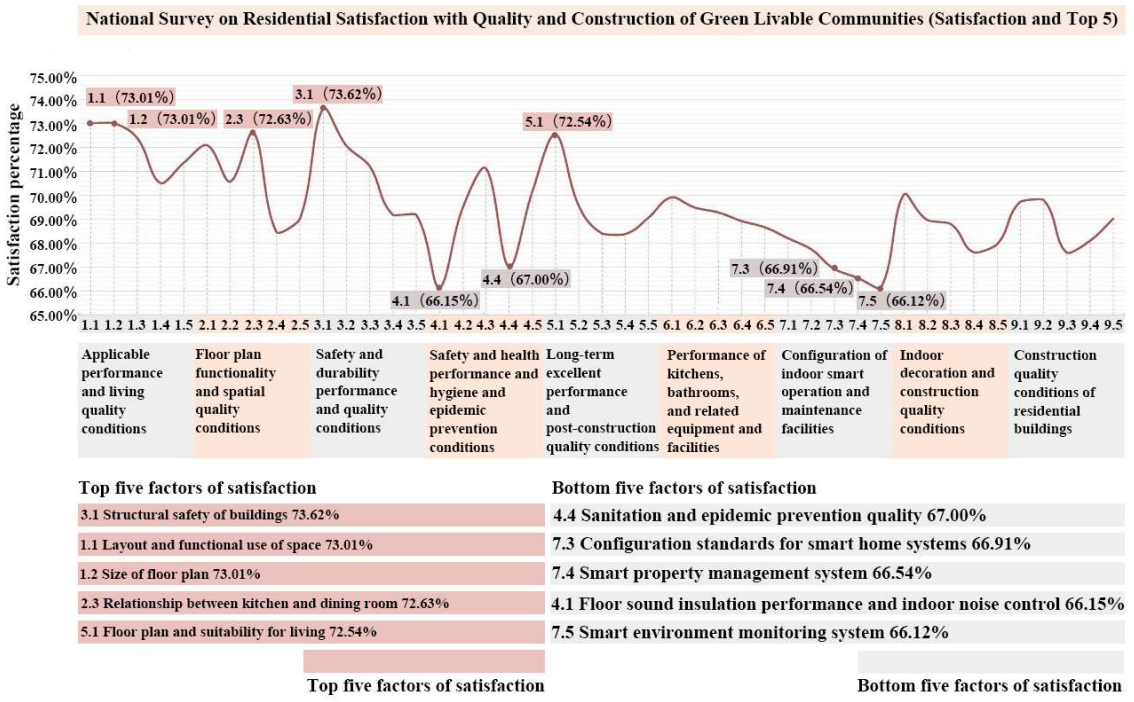


Figure 9. Satisfaction at the housing level. National Survey on Residential Satisfaction with Quality and Construction of Green Livable Communities (Satisfaction with Residential Buildings and Top 5).

While the overall residential satisfaction rate is high, survey data indicates that respondents also have high expectations for future improvements in their living conditions. Of the 30 aspects of community quality, 27 received a rating of over 40%, with seven receiving a rating of over 60%. This indicates that as societies and economies evolve, individuals' aspirations for an enhanced quality of life and demand for adequate housing are on the rise. The provision of healthy communities, amicable interpersonal relationships, efficient transportation systems, and effective governance has emerged as paramount demands (Figure 10).

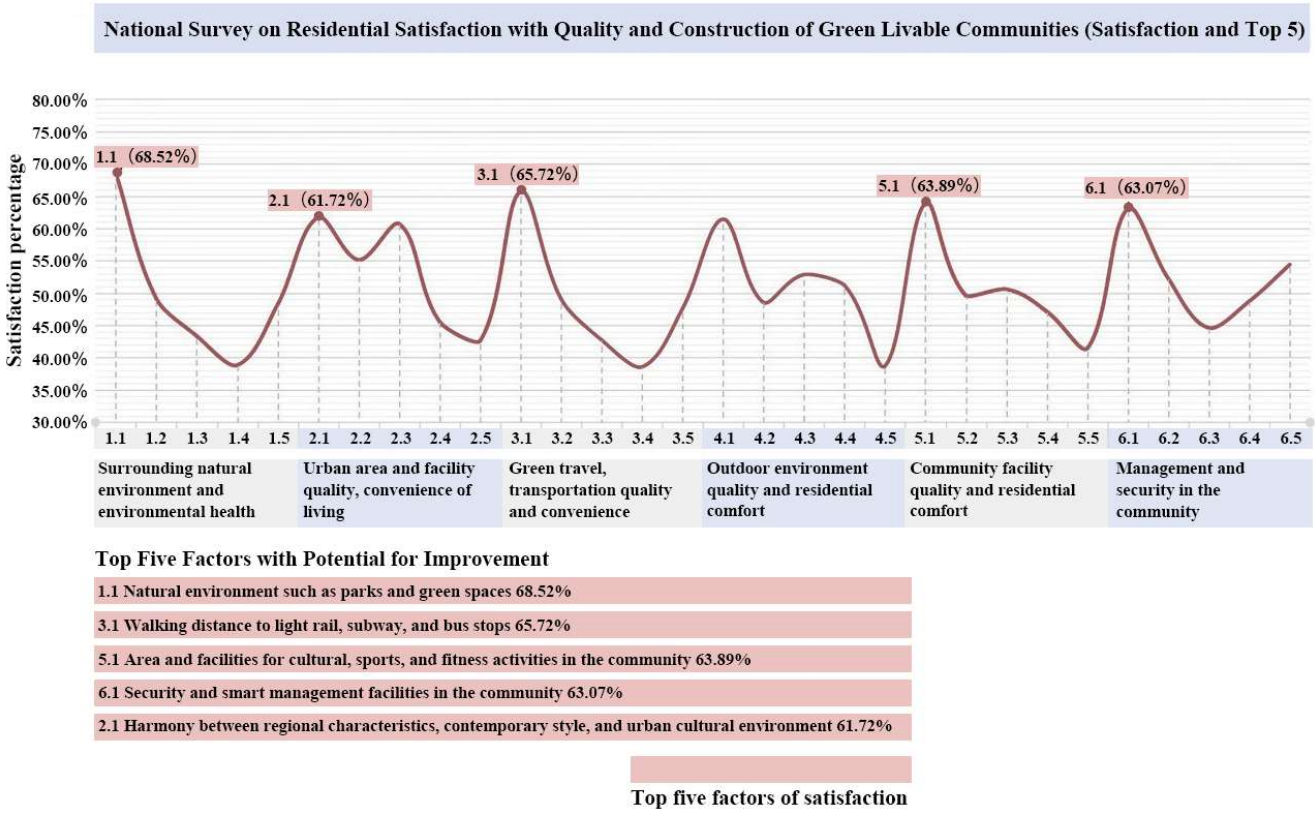


Figure 10. National Survey on Residential Satisfaction with Quality and Construction of Green Livable Communities (Satisfaction with Communities and Top 5 that can be improved).

A notable finding was the presence of substantial variations in satisfaction levels among the cities surveyed. Beijing demonstrated the highest level of satisfaction, with approximately 90% of respondents expressing satisfaction with key indicators such as community quality and building quality. Chongqing exhibited the lowest level of satisfaction, with the majority of indicators falling below 50%. In contrast, Tianjin demonstrated a marginally higher level of satisfaction. The satisfaction rate for the majority of indicators in Xi'an, Harbin, and Nanjing was approximately 60%. A clear distinction emerges in the levels of residential satisfaction among different cities. Beijing exhibits the highest satisfaction rate, which is nearly 40 percentage points higher than that of Chongqing, which has the lowest rate (Figure 11).

In order to better understand the changing needs of residents, the author focused on analyzing housing needs from the perspective of residents. Initially, a satisfaction survey was administered in older communities built before 2000. The survey questionnaire was then subjected to descriptive statistical analysis at the community and housing levels. The satisfaction feedback from residents was then subjected to a ranking process, the results of which are summarized in Table 7. This table presents the ten items that received the highest percentages, thereby offering a concise overview of the most salient issues. The author

then conducted a subsequent survey to ascertain the improvement needs of residents in communities built after 2000. Utilizing a statistical analysis of the survey questionnaire, the author evaluated and ranked the improvement needs reported by residents. As illustrated in Table 8, the top 10 improvement needs have been identified.

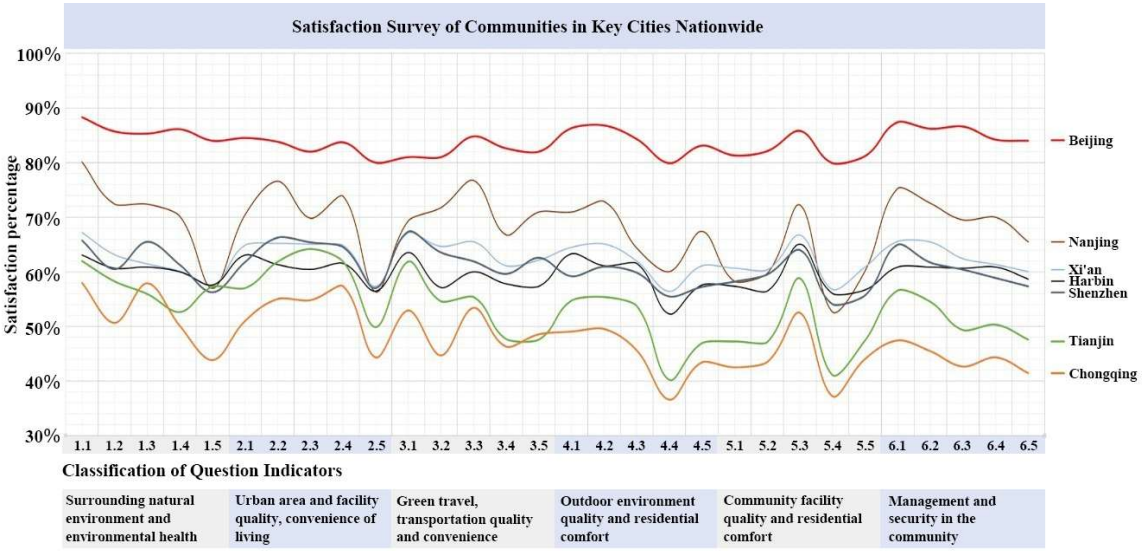


Figure 11. Satisfaction Survey of Communities in Key Cities Nationwide.

Table 7. Top 10 issues of dissatisfaction in old communities built before 2000.

No.	Community Level	Percentage	No.	Housing Level	Percentage
1	Parking spaces and charging stations for motor vehicles	18.66%	1	Configuration standards for smart security systems such as smart access control and fire alarms	16.62%
2	Noise from road traffic	15.75%	2	Configuration standards for smart environmental monitoring systems such as indoor health and hygiene monitoring	16.29%
3	Barrier-free access and continuity of traffic within communities	15.18%	3	Configuration standards for smart property management systems such as information networks and building energy consumption control and measurement	15.91%
4	Clubhouses and facilities for cultural and recreational activities	14.77%	4	Configuration standards for smart maintenance systems such as monitoring of indoor equipment and facilities	15.78%
5	Sewage discharge and water pollution, garbage and waste pollution	14.43%	5	Sound insulation performance between floor slabs and partition walls, and indoor noise control	15.63%
6	Maintenance and repair of elevators and public areas in residential buildings	14.38%	6	Configuration standards for smart lighting and smart home systems	14.95%

Table 7. *Cont.*

No.	Community Level	Percentage	No.	Housing Level	Percentage
7	Home care facilities and elderly care facilities in the community	14.27%	7	Separation of wet and dry areas in bathrooms	14.93%
8	Separate lanes for pedestrians and vehicles, safe and convenient, with priority given to pedestrians	14.15%	8	Aging-friendly living	14.21%
9	Emergency shelters for safety and disaster prevention in the surrounding area	14.00%	9	Health and epidemic prevention quality for preventing condensation and mold growth	13.65%
10	Outdoor sports and fitness facilities, venues for elderly and children's activities, courtyards, and small squares	13.64%	10	No water leakage in bathrooms, roofs, exterior walls, and exterior windows.	13.59%

As illustrated in Table 8, residents expressed a lower level of satisfaction with the configuration standards for smart security systems, including smart access control and fire alarms, at the housing building level. Additionally, residents indicated a lack of satisfaction with the configuration standards for smart environment monitoring systems, such as indoor health and hygiene monitoring. At the community level, satisfaction with parking and charging stations for motor vehicles and noise from road traffic is relatively low. The survey indicates that residents' dissatisfaction with housing at the housing level is among the most prevalent concerns, particularly with regard to smart features (e.g., smart access control, smart security systems, smart environment monitoring systems, smart property management), indoor equipment, and sound insulation (e.g., sound insulation between floor slabs and partition walls, and indoor noise). The following areas necessitate particular attention: entrance halls and entry spaces, leak-proof bathrooms, leak-proof roofs, exterior walls, and exterior windows; interior walls and flexibility; floor plan layout and functional use of space; overall quality and effect of interior decoration works; and configuration standards for kitchen space and equipment. This finding suggests that the factors most amenable to improvement by residents pertain predominantly to the quality of interior facilities. This phenomenon is exemplified by the following observations: Existing residential buildings are plagued by a combination of preexisting and emergent quality issues, with prevalent problems such as cracking, hollow walls, and water leakage persistently disrupting residents' daily lives. During the period of pandemic lockdown, issues such as sound insulation, thermal insulation, and aging-friendly design became even more prominent.

Since the turn of the 21st century, China's residential building quality has been marked by the coexistence of old and new issues. Persistent problems like cracking, hollow walls, and water leakage continue to affect satisfaction levels. Meanwhile, emerging concerns such as smart facilities, equipment performance, sound insulation, thermal insulation, and aging-friendly design are becoming increasingly prominent.

Recent community satisfaction surveys have identified key issues including parking, barrier-free roads, activity spaces and facilities, smart management, neighborly relations, and public participation in cultural environments. The main areas for improvement relate to the ecological environment, pedestrian accessibility, convenience, safety, and street aesthetics of communities. This indicates that community facility quality is crucial for motivating residents to enhance their communities. Presently, residents' needs extend beyond

basic living requirements such as functional spaces and well-developed infrastructure to include spiritual and cultural needs like a good ecological environment and community diversity. Demand for improvements in health and livability, transportation convenience, environmental comfort, and smart homes is particularly [38].

Table 8. Top 10 housing improvement needs in communities built after 2000.

No.	Community Level	Percentage	No.	Housing Level	Percentage
1	Natural environment such as parks and green spaces	68.19%	1	Configuration standards for smart security systems such as smart access control and fire alarms	66.23%
2	A suitable walking distance from light rail, subway, and bus stops	66.32%	2	Entrance hall and entry space	65.57%
3	Clubhouses and facilities for cultural and recreational activities	63.84%	3	Interior walls and flexibility	63.28%
4	Security, smart management facilities, and safety and security in the community	62.88%	4	No water leakage in bathrooms, roofs, exterior walls, and exterior windows	62.54%
5	The courtyards and street spaces facilitate neighborly interaction, creating a sense of belonging	61.36%	5	Floor plan layout and functional use of space	62.42%
6	Attractive street scenery with local characteristics and harmony with the human environment	61.27%	6	Seismic safety and evacuation	60.81%
7	Proximity to commercial, cultural, sports, and medical facilities for convenient living	61.22%	7	Overall quality and effect of interior decoration works	59.83%
8	Resident and public participation, and neighborhood activities	55.22%	8	Configuration standards for kitchen space and equipment	58.45%
9	Proximity to open public spaces, parks, and sports facilities in the city, with a lively atmosphere	52.42%	9	Configuration standards for smart lighting and smart home systems	57.80%
10	Outdoor sports and fitness facilities, facilities for the elderly and children, courtyards and small squares	50.49%	10	Sound insulation performance between floor slabs and partition walls, and indoor noise control	57.51%

Notably, both community and housing analyses reveal overlaps between residents' dissatisfaction and their demands for future improvements. This suggests that dissatisfaction and desires for improvement coexist, primarily in three areas: infrastructure needs like activity spaces for the elderly and children, barrier-free facilities, and parking and charging infrastructure; building performance needs such as waterproofing, leak prevention, sound insulation, and noise reduction; and intelligent needs like smart security and energy management systems. These overlaps highlight fundamental shortcomings in current community construction.

Further analysis shows a shift in residents' expectations for their future living environments, moving from a focus on basic functionality to an emphasis on quality enhancement. This shift is evident in four key dimensions. Firstly, health and safety concerns have grown,

especially regarding emergency shelters, air quality monitoring systems, and fresh air systems post-pandemic. Secondly, smart technology has become a standard requirement for new communities, with smart systems like access control and energy consumption management now expected. Thirdly, the humanistic care dimension sees residents seeking more public spaces and community activities to promote neighborly interaction. Finally, ecological sustainability is increasingly prioritized, with environmental facilities such as waste sorting and green transportation gaining importance [39].

These changing demands impose new requirements on community construction. On the one hand, it is essential to address infrastructure shortcomings by resolving common quality issues like waterproofing and soundproofing. On the other hand, the trend towards smart communities must be embraced, and intelligent systems must be developed. Simultaneously, efforts should be made to foster a humanistic atmosphere and enhance the ecological environment within communities. A dual-track strategy of "basic security + quality improvement" is recommended. In the short term, priority should be given to resolving infrastructure problems that concern residents. In the medium and long term, there needs to be systematic planning for the construction of smart and healthy communities. Additionally, a continuous feedback mechanism for residents' needs should be established to ensure ongoing improvements in community quality.

5. Conclusions

This study set out to evaluate the factors influencing satisfaction with green and livable communities in China, employing big data mining and artificial neural network techniques. We analyzed a substantial dataset comprising 32,277 valid surveys. The results revealed that while overall satisfaction is relatively high, with over 65% of respondents satisfied across most indicators, there are significant disparities between cities. For instance, satisfaction levels in Beijing are markedly higher than those in Chongqing. Key issues such as infrastructure and building quality in older communities, and environmental sustainability, advanced facilities, and humanistic care in newer communities were identified. A weighted analysis highlighted health and safety, smart operation and maintenance, and neighborhood interaction as critical areas for improvement. Based on these findings, we proposed a "basic security + quality improvement" strategy to address immediate quality concerns and promote long-term smart and sustainable growth in green and livable communities.

Despite the comprehensive nature of this study, there are several limitations and areas for future research. One limitation is the potential for regional bias in the dataset, as the survey responses may not fully represent the diverse range of communities across China. Future studies could expand the dataset to include more regions and diverse community types to enhance the generalizability of the findings. Additionally, the dynamic nature of resident satisfaction over time was not captured in this study. Longitudinal research could provide valuable insights into how satisfaction evolves with community development and changing resident expectations. Furthermore, while the study identified key factors influencing satisfaction, the causal relationships between these factors and satisfaction outcomes warrant further exploration. Experimental or intervention studies could help establish causality and inform more targeted improvement strategies. Overall, this study provides a solid foundation for understanding resident satisfaction in green and livable communities, and future research building on these findings has the potential to further advance the development of sustainable and resident-centered communities.

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supervision, H.Z.; project administration, J.L.; funding acquisition, H.Z. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: This study is waived for ethical review since it does not involve any medical experiments, human intervention, clinical treatment, collection of biological samples, or the use of any non-public or sensitive personal information, in accordance with the Implementation Rules for Academic Conduct of Southeast University and relevant national regulations.

Informed Consent Statement: Informed consent for participation was obtained from all subjects involved in the study.

Data Availability Statement: Dataset is available on request from the authors.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Survey Questionnaire Design

The questionnaire comprises a total of 75 indicators. For the purpose of presenting the information in charts and graphs, the indicators of the questionnaire have been assigned numbers. The natural environment, including parks and green spaces, is represented by "Y201." Sewage discharge and water pollution, as well as garbage and waste pollution, are represented by "Y202." The remaining items are shown in the following table.

Table A1. Survey Questionnaire Design.

Overall Objective Layer	Major Indicators	Sub-Indicators	
Indicators of satisfaction with living conditions in the community	Y20 Natural ecology and environmental health	Natural environment such as parks and green spaces	Y201
		Sewage discharge and water pollution, garbage and waste pollution	Y202
		Air pollution and air quality	Y203
		Emergency shelters for safety and disaster prevention in the surrounding area	Y204
		Noise from road traffic	Y205
	Y21 Urban facilities and convenience	Attractive street scenery with local characteristics and harmony with the human environment	Y211
		Proximity to open public spaces, with a lively atmosphere	Y212
		Proximity to commercial, cultural, sports, and medical facilities	Y213
		Proximity to educational facilities, as well as facilities for youth activities	Y214
		Proximity to facilities for the elderly	Y215
	Y22 Green travel and traffic convenience	Communities within walking distance of public transportation	Y221
		Walkways, bike lanes, and commercial streets	Y222
		Walking paths around the community connected to elementary schools	Y223
		Accessible outdoor routes with complete signage	Y224
		Separate lanes for pedestrians and vehicles, safe and convenient, with priority given to pedestrians	Y225

Table A1. *Cont.*

Overall Objective Layer	Major Indicators	Sub-Indicators	
Indicators of satisfaction with living conditions in the community	Y23 Outdoor environment and livability	The courtyards and street spaces facilitate neighborly interaction, creating a sense of belonging.	Y231
		Natural vegetation, vivid landscapes, and attractive residential exteriors	Y232
		Courtyard square layout for outdoor fitness and activities for the elderly and children	Y233
		Parking spaces and charging stations for motor vehicles	Y234
		Barrier-free access to roads within the community and uninterrupted traffic flow	Y235
	Y24 Facilities in the community and comfort	Clubhouses and facilities for cultural and recreational activities	Y241
		Sanitary services and health management facilities in the community	Y242
		Amenities such as convenience stores, delivery services, etc.	Y243
		Home care facilities and elderly care facilities in the community	Y244
		Kindergartens and childcare facilities	Y245
	Y25 Community management and security	Security, smart management, and safety and security in the community	Y251
		Outdoor cleanliness and hygiene, operation of public facilities and equipment in the community	Y252
		Maintenance and repair of elevators and public areas in residential buildings	Y253
		Waste management measures and collection and treatment facilities	Y254
		Resident and public participation, and neighborhood activities	Y255
Satisfaction indicators for residential livability quality	Y30 Applicable performance and living quality	Floor plan layout and functional use of space	Y301
		Floor area size	Y302
		Thermal insulation and heat retention, sunlight exposure, and ventilation	Y303
		Indoor finishing standards and configuration level of kitchen and bathroom facilities	Y304
		Configuration standards for indoor water supply and drainage, heating and air conditioning, and gas	Y305
	Y31 Floor plan functionality and spatial quality	Entrance hall and entry space	Y311
		Separation of clean and dirty areas and auxiliary spaces for housework	Y312
		Relationship between kitchen and dining room	Y313
		Closet and storage space	Y314
		Separation of wet and dry areas in bathrooms	Y315
	Y32 Building safety and durability	Structural safety of buildings	Y321
		Seismic safety and evacuation	Y322
		Fire safety and escape, gas and electrical safety	Y323
		Durability of residential facades and exterior walls	Y324
		Durability of building materials and piping	Y325

Table A1. *Cont.*

Overall Objective Layer	Major Indicators	Sub-Indicators	
Satisfaction indicators for residential livability quality	Y33 Safety, health performance, and hygiene quality	Sound insulation performance between floor slabs and walls, and indoor noise control	Y331
		Indoor water supply and drinking water quality	Y332
		Indoor air quality, ventilation, and fresh air exchange	Y333
		Health and epidemic prevention quality for preventing condensation and mold growth	Y334
		Indoor temperature and humidity	Y335
	Y34 Long-term excellent performance and post-construction quality	Floor plan and living adaptability	Y341
		Interior walls and flexibility	Y342
		Secondary renovation and piping	Y343
		Equipment piping maintenance and renovation	Y344
		Aging-friendly living	Y345
	Y35 Kitchen and bathroom equipment and facilities	Configuration standards for kitchen space and equipment	Y351
		Ventilation and air exchange in kitchens	Y352
		Configuration standards for bathroom space and equipment	Y353
		Pipelines in bathrooms	Y354
		Bathroom equipment and facilities	Y355
	Y36 Indoor smart operations and management	Smart security systems such as smart access control and fire alarms	Y361
		Smart maintenance systems such as monitoring of indoor equipment and facilities	Y362
		Smart lighting and smart home systems	Y363
		Smart property management systems such as information networks and building energy consumption control and measurement	Y364
		Smart environmental monitoring systems such as indoor health and hygiene monitoring	Y365
	Y37 Quality of interior decoration works	Overall quality and effectiveness	Y371
		Construction quality	Y372
		Quality of building materials	Y373
		Quality of post-construction use	Y374
		Quality of concealed works such as water supply and drainage and electrical piping	Y375
	Y38 Overall quality of housing construction	No water leakage in bathrooms; no water seepage through roofs, walls, or windows	Y381
		Quality of building materials such as walls, doors, windows, insulation, and waterproofing	Y382
		No cracks in beams or slabs; no cracks or hollow areas in wall plaster	Y383
		Heat retention of exterior walls; heat insulation of exterior windows	Y384
		Pipe installation; smooth drainage; electrical connections	Y385

Appendix B. Likert Scale

The author conducted a preliminary data interpretation of the "satisfaction" evaluation at the "community" and "housing" levels based on the responses to the questionnaire. In the satisfaction evaluation, responses indicating "very satisfied" and "relatively satisfied" were combined into "satisfied." Similarly, responses indicating "dissatisfied" and "very dissatisfied" were combined into "dissatisfied.".

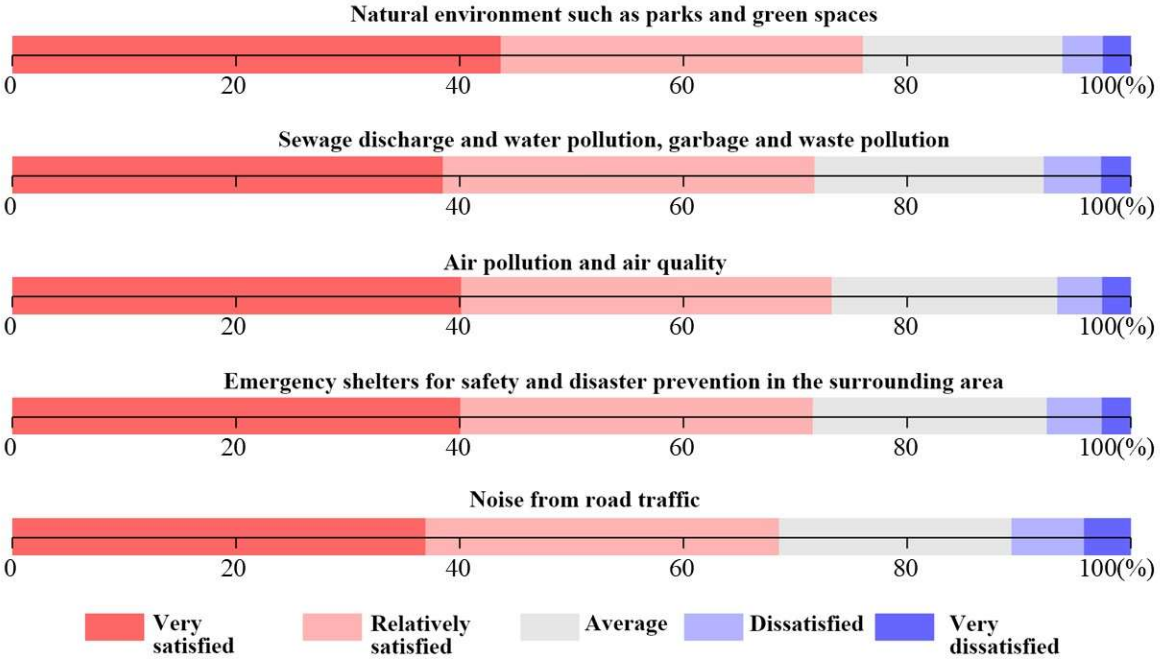


Figure A1. Satisfaction with natural ecology and environmental health.

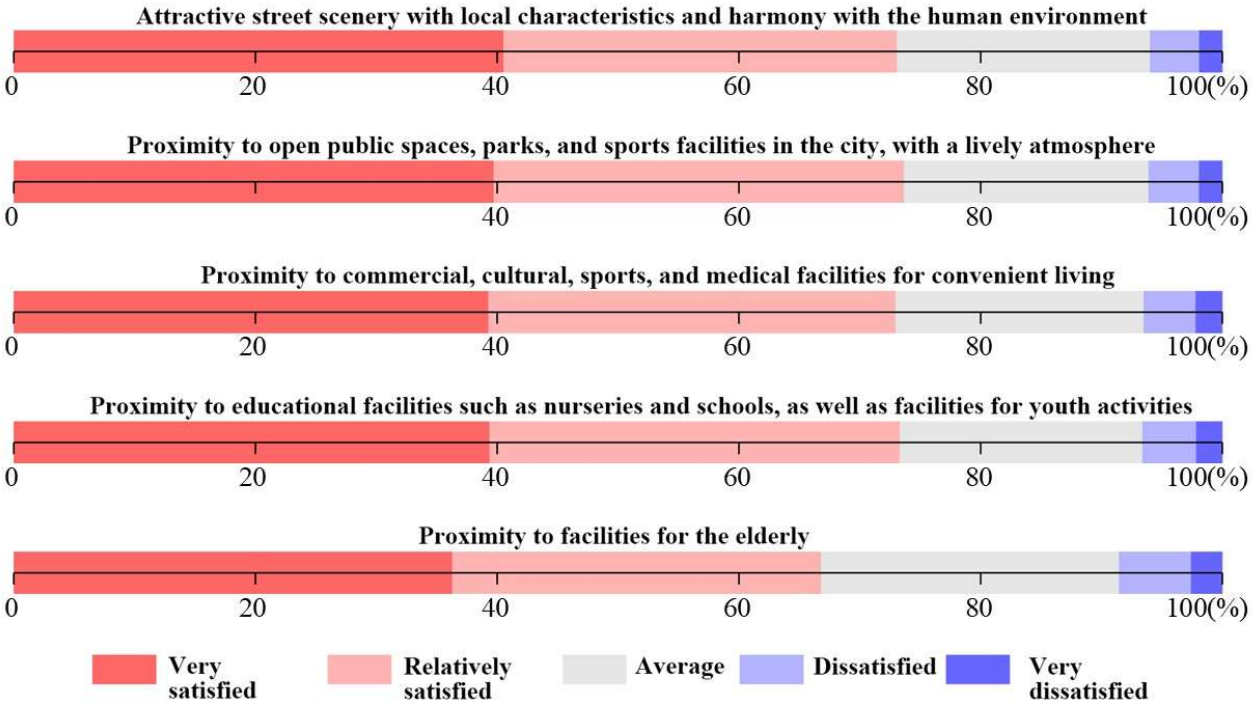


Figure A2. Satisfaction with urban facilities and convenience of daily life.

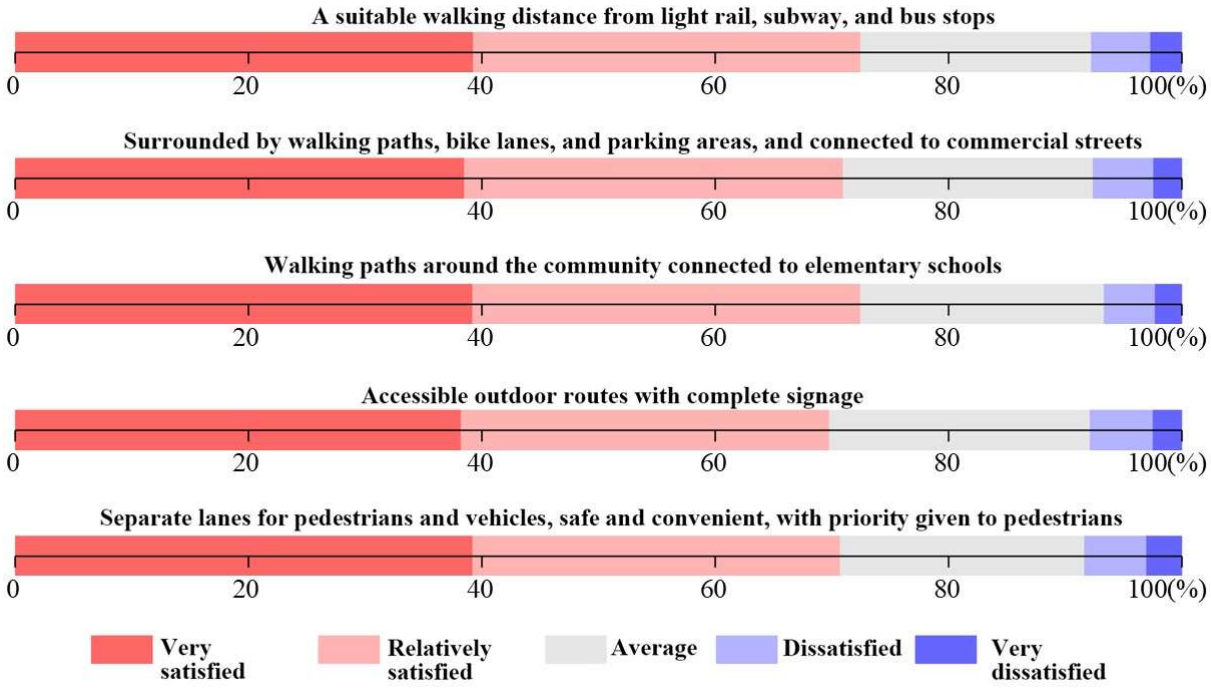


Figure A3. Satisfaction with green travel and transport convenience.

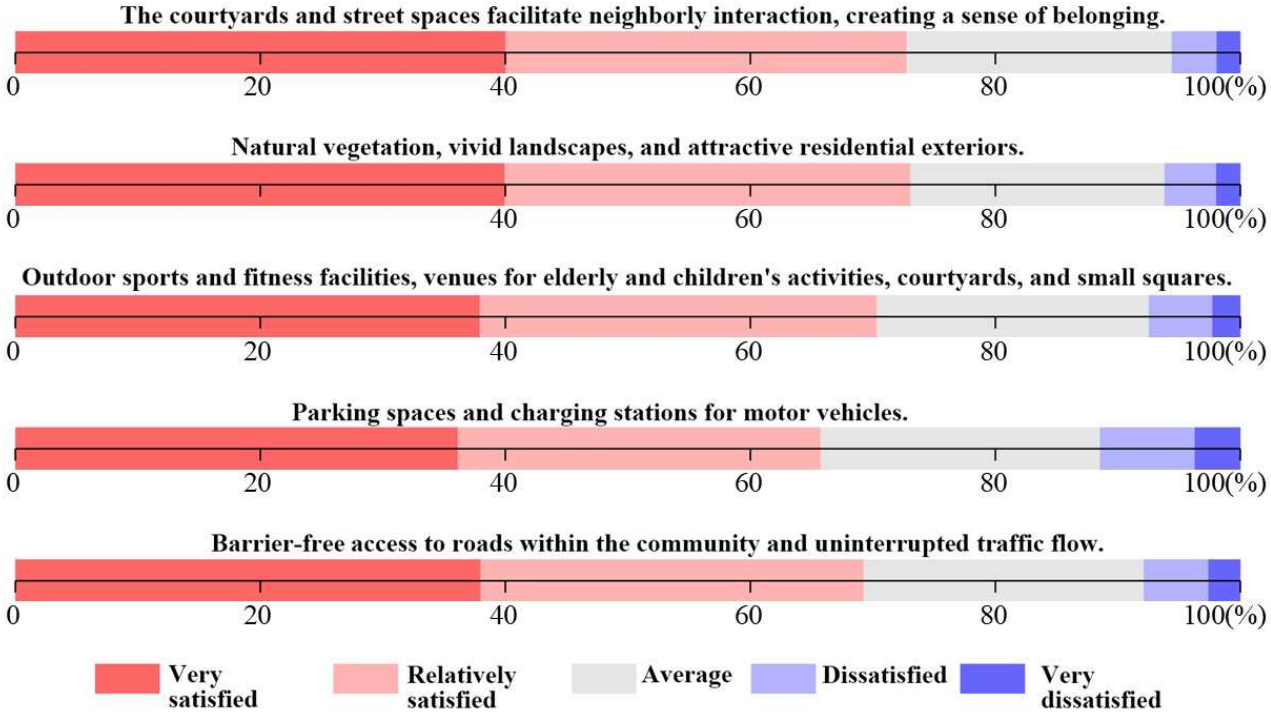


Figure A4. Satisfaction with outdoor environment and livability.

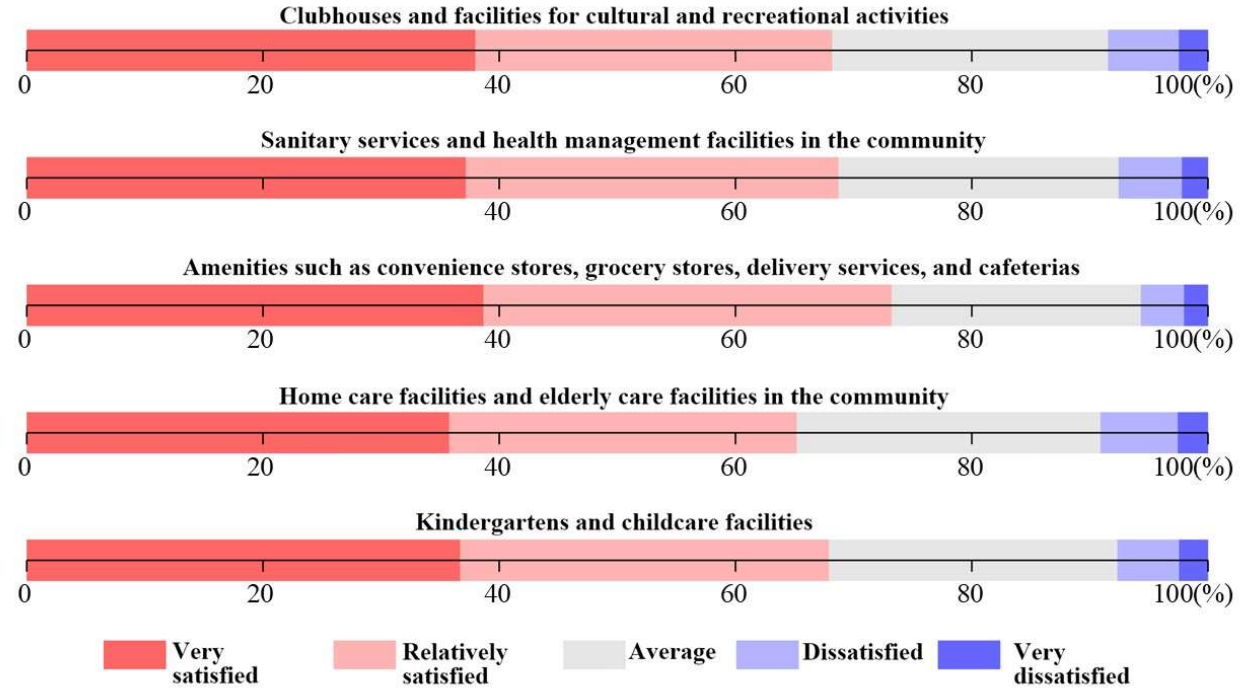


Figure A5. Satisfaction with community facilities and comfort.

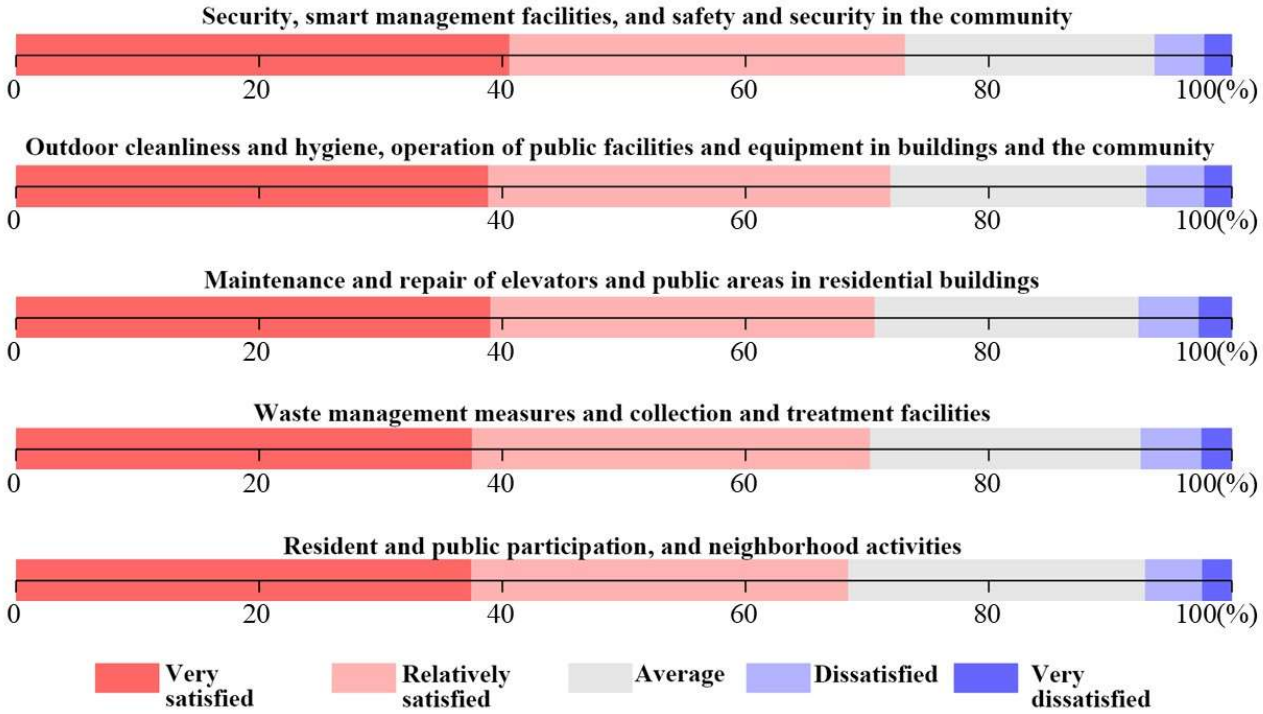


Figure A6. Satisfaction with community management and safety.

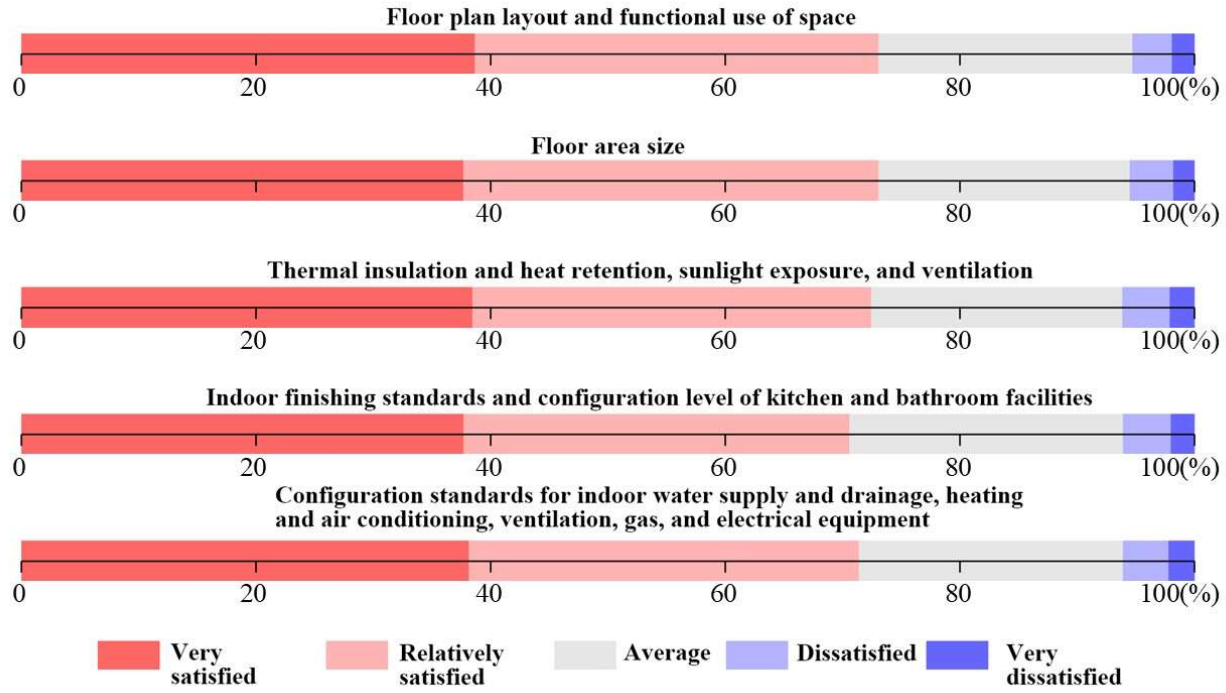


Figure A7. Satisfaction with applicable performance and residential quality.

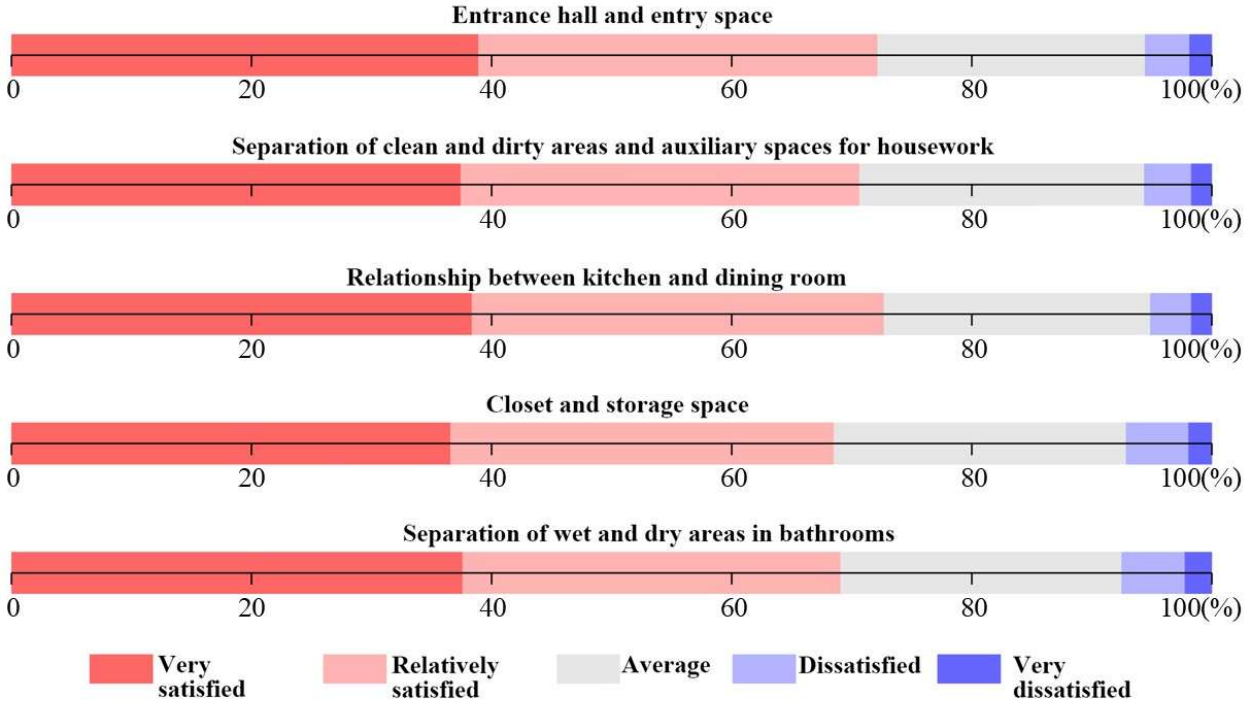


Figure A8. Satisfaction with floor plan functionality and spatial quality.

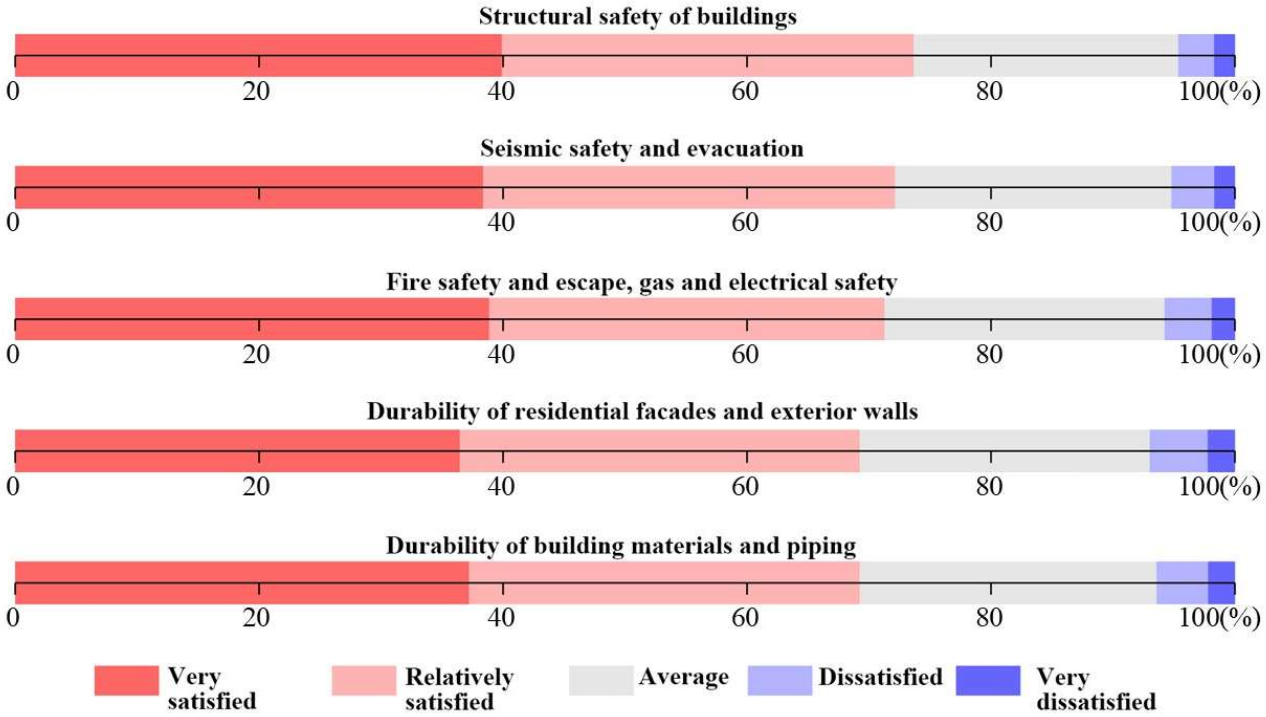


Figure A9. Satisfaction with building safety and durability performance.

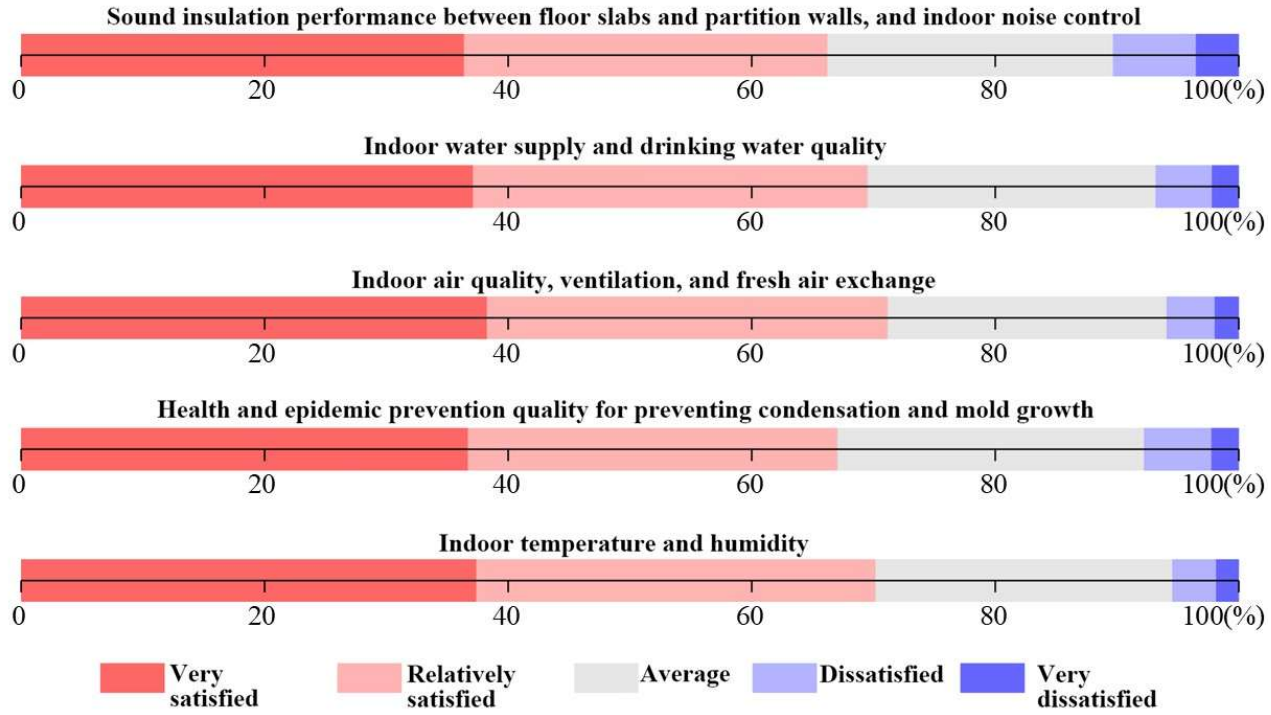


Figure A10. Satisfaction with safety, health performance, and hygiene quality.

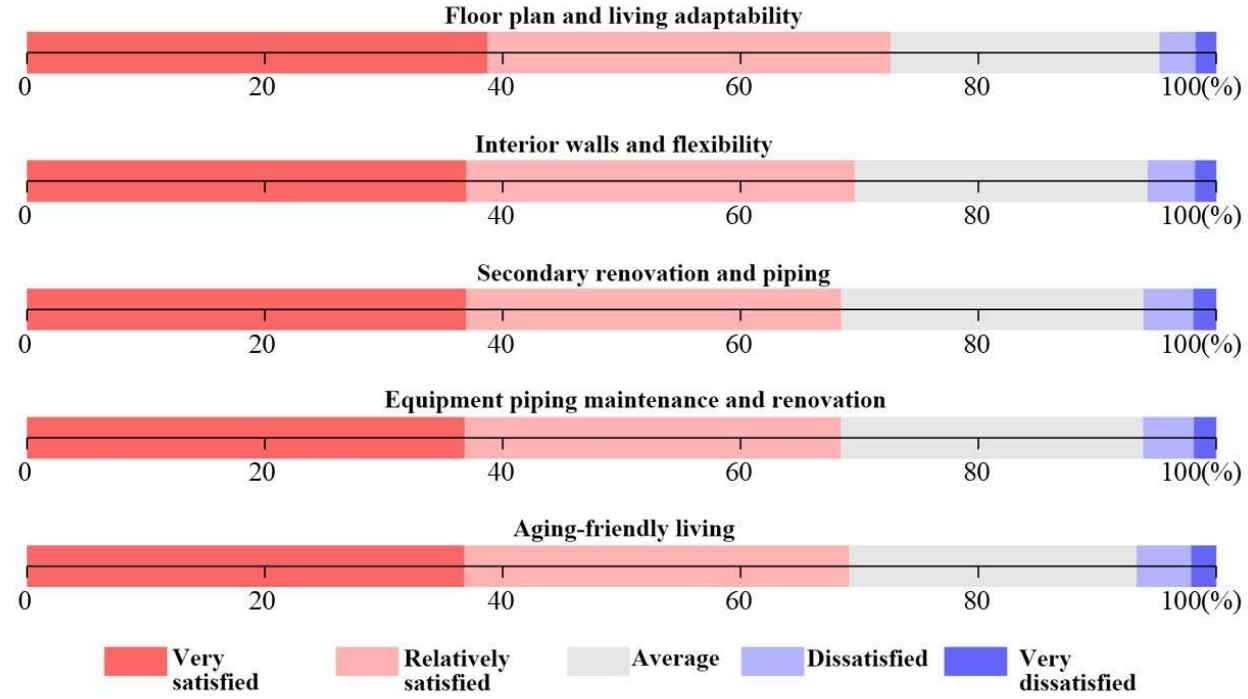


Figure A11. Satisfaction with long-term performance and post-construction quality.

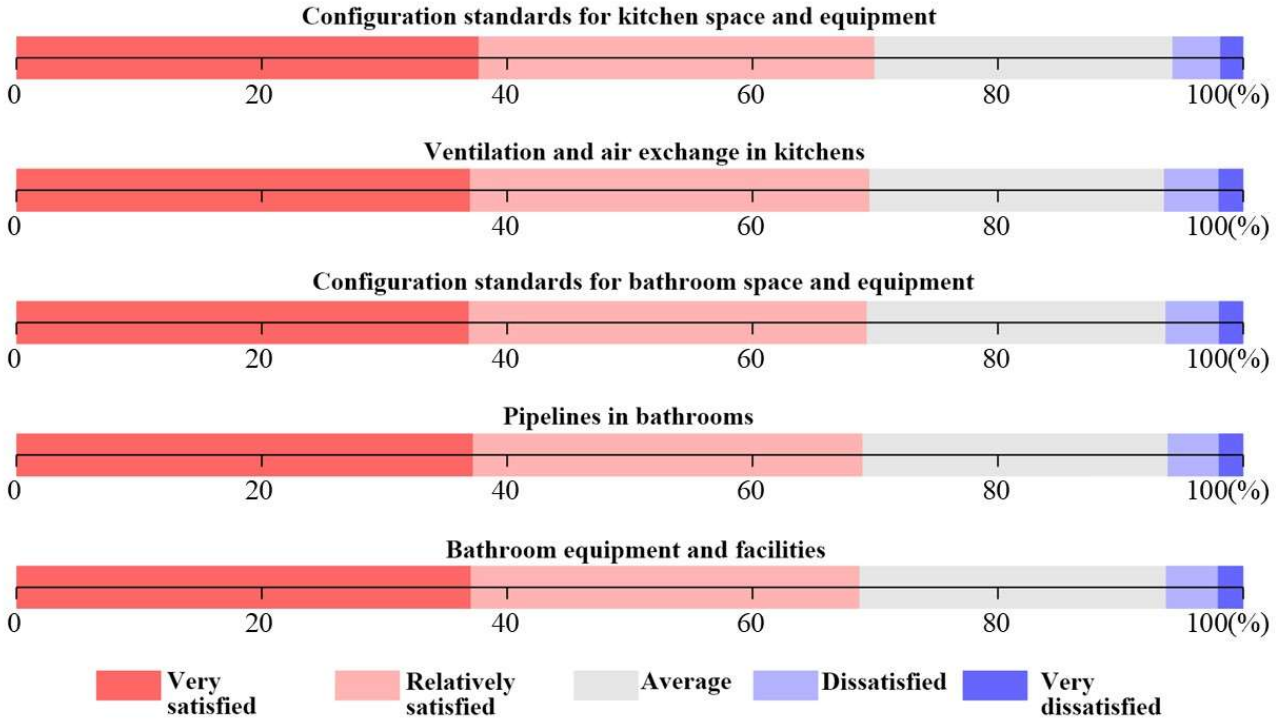


Figure A12. Satisfaction with kitchen and bathroom facilities and equipment.

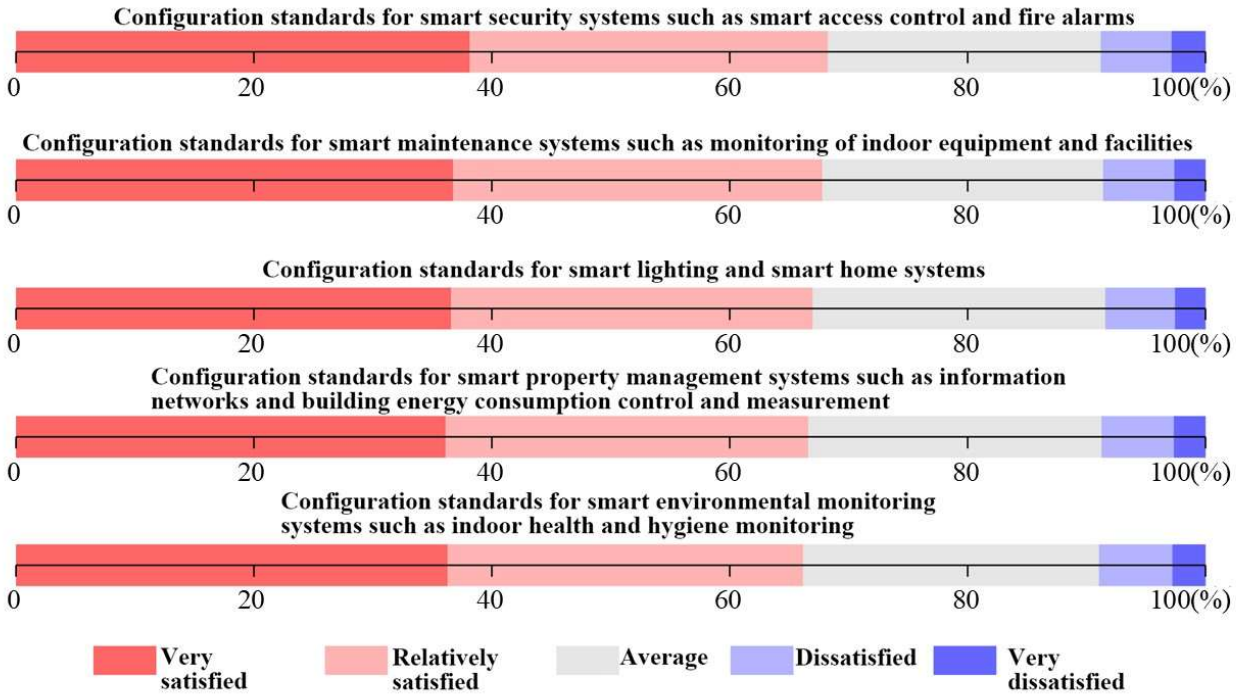


Figure A13. Satisfaction with smart indoor operation and maintenance.

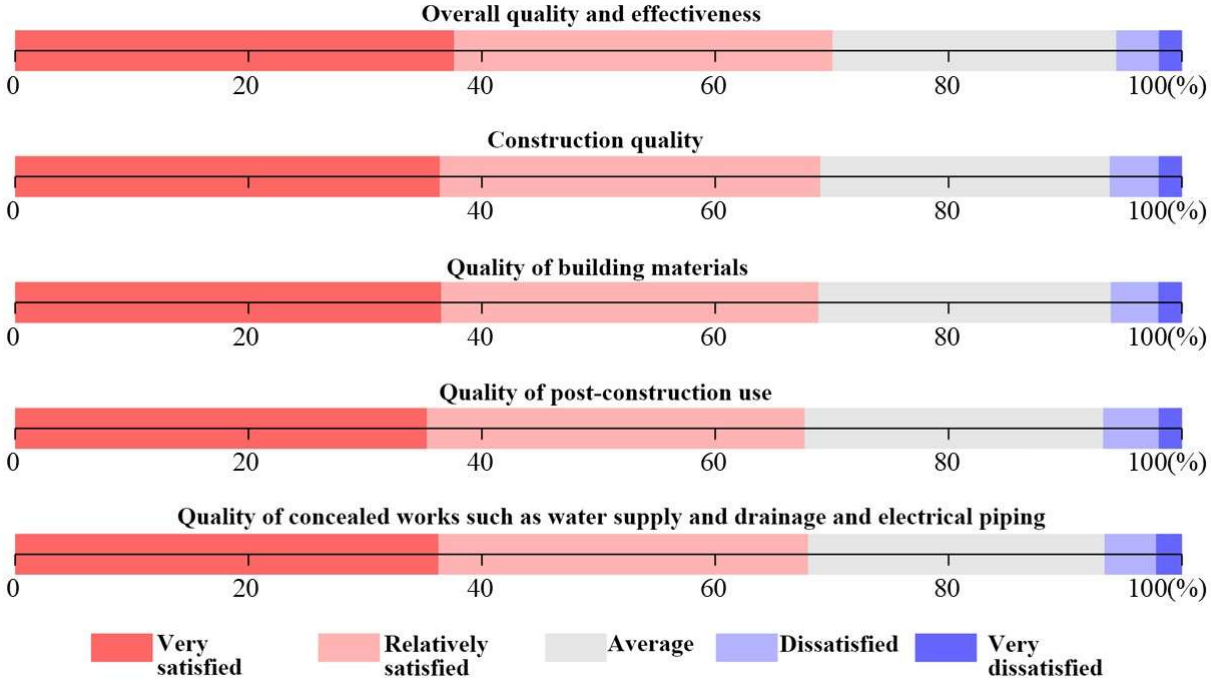


Figure A14. Satisfaction with quality of interior decoration works.

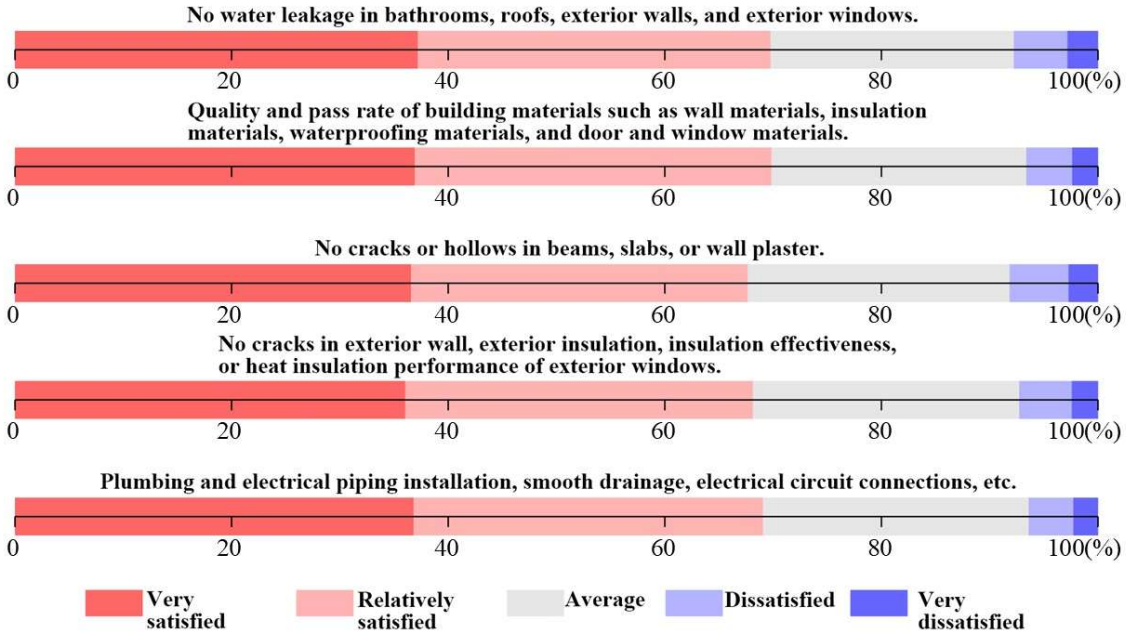


Figure A15. Satisfaction with overall quality of residential construction.

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