Evaluation of the Human Settlements Environment of Public Housing Community: A Case Study of Guangzhou

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Abstract: With the improvement of social housing policies and an increase in the quantity of public housing stock, issues such as poor property management service, poor housing quality, and insufficient public services remain to be resolved. This study focuses on the human settlement environments of public housing communities in Guangzhou and establishes an evaluation system containing built environments and housing environments satisfaction criteria. In our analysis, the evaluation system was modified using data collected from surveys through factor analysis, which reduced dimensions to the indoor environment, the community environment, and social relations. Moreover, multivariable regression analysis was performed to identify the differences of needs among residents with different living environments and family backgrounds. The result shows that housing area, transportation resources, and public services have met the basic needs of residents who were generally satisfied with the community environment of their public housing. However, acoustic insulation and community amenities in the city were found to be relatively poor and still have space for improvement. Further, requirements on indoor housing environments and social relations of residents living alone need more attention. Specific recommendations based on this study can be used as a reference for future public housing construction and improvements.

Keywords: public housing community; human settlements environment; residential satisfaction; built environment evaluation

1. Introduction

With the rapid speed of urbanization globally, both housing demand and pressure in expanding urban areas of economic activities are increasing. Shortage of housing, especially social housing in urbanized areas, is getting more and more acute since more people are being drawn to urban areas for better job opportunities. Governments around the world, including China, have established various social housing policies that involve the construction of public housing to meet the needs of low-income people living within cities who are essential for the urban economy. Public housing policy in China was first proposed in the Circular of the State Council on Further Deepening the Urban Housing System Reform in 1994. Since 2006, China has accelerated the construction of public housing in urban cities. During the 12th Five-Year Plan period (2011–2015), the government set a target of building 36 million
public housing units, roughly double the number planned in the previous decade. At the same time, the government has improved the housing provision system, including the renovation of rundown areas and provision of more public rental housing etc.

However, if insufficient consideration was given to the design stage to public housing development, a lot of problems could arise later on in the operational stage. For instance, existing research on public housing in New York City pointed out that public housing is usually built in areas with poor economic conditions, which increases the residents’ sense of isolation [1]. Some researchers pointed out common problems in public housing such as insufficient communal areas and living space for low-income families when comparing with private housing in Hong Kong [2]. In addition, other problems such as poor indoor air quality, poor thermal comfort, negative impact on residents’ health from environmental problems, lack of privacy, home–work separation, poor housing quality were found to be common in cities around the world [3–5]. Therefore, in order to improve the residents’ quality of life (QoL) in public housing, public housing policy with respect to design elements must be improved upon.

As one of the first cities where public housing was built in China, Guangzhou has a relatively long history of social housing policy development. Compared with other cities in China, Guangzhou has a lower coverage rate of public housing. Urban villages with poor living conditions are still a favorable choice for middle and low-income people due to the low and hence affordable rental level [6].

The contradiction between the supply and demand in the housing markets is even more obvious in this first-tier city. In the current period of urban development in China, the developmental goal has changed from the original scale expansion policy to the improvement on housing quality, urban culture, residents’ QoL and scientific decision-making in urban governance [7]. Similarly, in addition to ensuring the quantities of public housing communities to be developed, other factors such as the quality of construction, residential environment in public housing, systematic management of public housing projects, scientific decision-making, financing efficiency, and post-occupancy evaluation should be given equal amount of attention. Research and evaluation of the public housing community situations help to understand the main problems of the current residential environment, which is needed for improving the construction quality and providing theoretical support for public housing policy improvement. Hence, this paper aims at providing suggestions for a more complete set of design parameters for public housing communities to satisfy residents’ demand.

In summary, this paper raises a major research question pertaining to the development of welfare housing, namely, the correlation between QoL and the housing environment for welfare tenants. This is an important aspect as residents living in welfare housing community by definition did not really make a location choice to live there. This is different from tenants or owners living in the private sector housing community where they select the best living environment that they can afford, with an objective of enhancing their QoL. From a public policy point of view, just because the welfare housing rental or price level is low does not and should not mean that the environmental quality should also be low. An empirical and scientific examination of how the residents in these welfare housing communities evaluate their living environment with respect to the optimal human settlement policy therefore will contribute to the general literature on housing policy debate. This paper takes Guangzhou as a case study and applies an empirical analytical framework to examine how residents in welfare housing communities evaluate the human settlement environment around them that would contribute to their QoL in living there.

Following the primary aim of this research, objectives of this study include understanding of the residential satisfaction and requirements of the residents in welfare housing; exploring the influencing factors of the residential environment in public housing communities; putting forward suggestions for the improvement of the living environment so as to provide a basis for enhancing residents’ QoL in the public housing community. To be specific, this study focuses on the following sub-questions:

- What are the criteria for evaluating residential satisfaction of public housing community from the Human Settlement perspective?
• What is the current situation in Guangzhou with respect to the application of an evaluation system for residents’ satisfaction?
• How is the residential satisfaction affected by various factors in the public housing communities in Guangzhou?
• How can human settlement environment be improved in the public housing community in general?

Literature Review

The sciences of Human Settlements first originated from the Greek architect, C.A.Doxiadis, and his Ekistics theory. A settlement refers to a community for people to live in. The human settlement environment consists of five dimensions: nature, human, society, residence, and supporting networks. These are reflected in various aspects including economy, society, politics, science and technology, and culture [8]. The concept of “Sciences of Human Settlements” in China was first proposed in 1993 by Wu Liangyong. His research framework composed of five systems and five research hierarchies which are shown in Figure 1 below [9]. It indicates different perspectives and scopes of human settlement analysis.

Among the five systems, the natural system and the human system are the two basic systems that constitute the main body of human settlement environment, while the residential, social, and supportive systems are the basic conditions to meet the requirements of human settlement. A good residential environment does not only need to be oriented to ‘biological man’ to meet the requirements of ecological environment, it also needs to be oriented to ‘social man’ to meet the requirements of cultural environment. Similarly, when providing public housing, the government should not ignore the feelings of ‘social man’ because of the low rental income, nor should the government view the provision of public housing as shelter only. Both private and public housing should meet the basic human needs for residential environment, including housing needs, community needs and social needs. Therefore, in this study, residential satisfaction with their settlement environment also includes their satisfaction with the indoor housing environment, community environment and social relations.

There are different evaluation criteria for different levels of human settlements. The evaluation of human settlement environment at the regional level involves comparison among cities, which is of great significance in realizing comprehensive and coordinated development of the region. Scholars, for instance, have evaluated the sustainability of human settlement environments within the Zhejiang province from the perspective of the ecological environment, economic development and public service convenience aspects [10]. Their study combined the physical environment with the residents’ subjective experience and provided a new research perspective on human settlement environments. Other researchers on the other hand studied the living environment of 11 cities in the Jiangxi province, taking the harmony between human and nature, the living environment and the social-economic environment as evaluation dimensions [11]. They concluded that the level of harmony in the housing community was the most important aspect, which was followed by the social-economic conditions, and then the living conditions.
On the other hand, research on the community level provides a more precise and detailed analysis on the construction of our urban and regional living environments. Existing research literature on the residential environments on the community level mostly focuses on two aspects—objective living conditions and the residents’ subjective feelings and levels of satisfaction towards the environment. Taking a residential community in Dalian, Liaoning Province as an example, scholars concluded that a resident’s background was the most important aspect in influencing the assessment of satisfaction towards the community environment, which is then followed by services available in the community [12]. Interestingly, the natural environment was the least influential aspect. On the other hand, some researchers took the transient population in the community as the research object and evaluated that the human settlement environment satisfaction may differ in this segment of relatively low-income residents. Their study found that transportation network was the most important factor affecting the residents’ satisfaction, followed by the community environment, while the influence of neighborhood relationships and indoor environments were similar [13].

Measuring residents’ satisfaction in the housing community is important not just as a measure to assess the success of housing policy, but also significant in contributing to residents’ public health and happiness, which correspond to basic human needs [14]. This is even more important for residents with special needs such as psychological disabilities [15]. Residential satisfaction refers to the gap between the residents’ psychological expectations and actual perception of the living environment. It is an important factor in measuring the residents’ QoL. Residents’ satisfaction can stem from personal reaction towards the physical environment, but it can also be contributed by the sentiment among the residents that they could influence the outcome of urban transformation in their community with their participation in the process [16]. This sense of control contributes a lot to the social impact of a well-designed housing community, especially a welfare housing community. In this way, it was also noted that psychological perception of the optimal environment among residents was also important, especially the residents’ perception of what could have been done from design stage and what could be changed in the future. It has been shown that residents who can change a suboptimal housing situation show higher appreciation of their environment because they have a better situation to look forward to [17].

Research in Hong Kong found that the housing environment was the most important factor affecting the overall QoL of low-income groups. After comparing the residential environment and needs of different income groups, the study found that, compared with the middle-income groups, the low-income groups had greater demand for better housing location in order to minimize commuting costs [4]. Therefore, the low-income characteristics of the general public housing residents should be considered and such characteristics and needs of residents should be combined in the establishment of the evaluation model for the residential satisfaction of welfare housing living environment.

In measuring residents’ satisfaction, there are different approaches. Some studies created an evaluation index system based on housing quality variables such as temperature and humidity, and evaluated residents’ comfort and satisfaction [18]. Others focused on external public facilities and communal spaces of the public housing community, indoor housing environment, public facilities, and overall neighborhood environment [5,19–22]. In addition, factors such as property management service in the community [23,24] and neighborhood relationships have also been considered as important variables in the construction of these evaluation indices in measuring residential satisfaction in the public housing community [25,26]. Notably, it has also been found that such factors as accessibility to various function areas in the housing community, environmental features of the housing structure, satisfaction in various facilities in the inhabited environment, environmental security, neighbor relationships, and the external appearance of the housing environment all contributed to residents’ satisfaction significantly [14,27,28]. Apart from these tangible community services, some intangible variables pertaining to the design scheme are also important. For instance, Aigbavboa and Wellington researched the neighborhood environment of public housing and found that privacy was the most important factor affecting residents’ satisfaction with the neighborhood environment [29].
hand, sense of privacy and safety does not mean exclusiveness as a good mix of both private sector and welfare residents within the same community area can also produce a harmonious environment for the residents altogether, among other variables [30]. These are all important attributes to human settlement. Hence, both the physical state of the housing units, including interior condition, physical setting of the environment, as well as the social environment, including the sense of community, sense of trust among residents and residents’ autonomy within the community, have been empirically found to be significant [31,32]. Based on these studies, an ideal evaluation system should have a comprehensive consideration of these dimensions such as the indoor housing environment, the outdoor community environment, the residents’ psychology, public facilities, policies, family financial situations, operation management, site selection, etc.

There have only been a few studies that investigated the evaluation of the public housing communities based on the sciences of human settlements. Some researchers evaluated the human settlement environment and the willingness of the residents to live in public housing communities in Xi’an, China and established an evaluation system from four dimensions: public facilities, housing conditions, the ecological environment, and the social/humanistic environment [33]. Others evaluated the human settlement environment of low-income residential housing and communities in Guangzhou from the perspective of the built environment and the residents’ subjective satisfaction and proposed improvement strategies accordingly [34]. In this respect, there is still space for research on the public community environmental assessment, especially from the perspective of Human Settlement Science. To fill this gap, this paper builds an evaluation model based on the five systems that are included in the Sciences of Human Settlements theory, namely: nature, human, society, residence, and a supporting network, with respect to the environmental characteristics of Guangzhou.

2. Materials and Methods

In order to evaluate the housing environment of welfare housing in Guangzhou and explore the correlation between QoL and the housing environment for welfare tenants, the following hypotheses were made in this paper based on previous studies [31,35].

**Hypothesis 1.** There is a significant correlation between the community residential conditions and residential satisfaction with the residential environment.

**Hypothesis 2.** There is a significant correlation between the residents’ family background and residential satisfaction with the residential environment.

The data in this study were collected from a survey from four public housing communities in Guangzhou between November 2018 and May 2019. For privacy reasons, we will refer to these four communities as T Garden, P Garden, X Xuan, and H Xuan. These four communities were built in different periods, and they span from the eastern part of Guangzhou to the western end geographically, so as to have a better representation of data, as Figure 2 shows below. In general, they all have the following commonalities:

(i). All surveyed sites can be regarded as a community; that is, residents living in a certain area have personal connections and common characteristics that are suitable for conducting an investigation on the feelings among public housing residents.

(ii). They are all relatively mature public housing communities with a high occupancy rate, and hence residents are rather familiar with their environment as well as their needs.
At the same time, due to the different construction periods and geographical locations, there are some differences among these communities which can be used for comparison. Based on the above reasons and suggestions from the government’s housing department of Guangzhou, the four communities were selected, as they can reflect the general situation of public housing communities in Guangzhou to a certain extent, and can be used for comparing the residents’ satisfaction with the features of the community.

In all these four communities, there were 760 households in total, of which 587 households were approached for the questionnaire surveys, and 552 of them completed the questionnaire. Finally, 490 valid questionnaires were collected with a validity rate of 88.77%.

In these four public housing communities surveyed, nuclear families, which consists of one couple and their dependent child, accounted for the largest proportion (39.96%). The highest education level attained by a family member was mainly at the high school or vocational school level. The average monthly income for 63.03% of households was less than ¥1425, which, in 2018, was in line with the standard for a low-income family in Guangzhou. The statistics indicate that the overall level of education and family income of residents in public housing were both relatively low. The survey also shows that 23.47% of households had at least one family member in need of special care, among which the proportion of those with disabilities was the highest (43.48%), followed by mental illness (17.39%). According to various research on housing policy of low-income families, the proportion of residents suffering from serious illnesses and disabilities in low-income families is relatively high. Due to the poor financial conditions and high cost of daily medical care, such groups of residents should be given more focus in housing policies and social security systems [35].

2.1. Evaluation Index System

The evaluation system of public housing in this study is composed of two criterion layers: objective evaluation of built environments’ attributes and residential satisfaction. In the existing evaluation systems of human settlement environments, most scholars took cities or regions as the basic unit for examination, and collected data such as population density and average earnings to evaluate the human settlement environment from an objective perspective [36–38]. By contrast, this paper focuses on the community level, paying more attention to indices such as public facilities available in the community. The indices for residential satisfaction dimension in this study were obtained through a household survey using a 7-point Likert scale (1–7, with 1 being ‘very dissatisfied’ and 7 being
‘very satisfied’). The specific index selection references and evaluation system construction process are to be explained in the next subsection.

2.2. Objective Variable Descriptions

Based on existing research, the built environment dimension in this study was evaluated from four aspects: the housing environment, public transportation, public facilities and location. Under the housing environment aspect, the per capita housing area is set as an evaluation index as it is one of the important factors to measure residents’ QoL [38]. Under the public transportation aspect, the number and distance of metro stations and bus stops around the community were analysed. These two factors reflect the convenience of commuting and the travelling demand of residents in public housing [34,39]. The public facility conditions were measured by the number and distance of medical facilities, educational facilities, commercial facilities, as well as parks and recreational facilities in the respective community. This reflects the living conditions and the capacity that satisfies the residents’ basic daily needs in the public housing community. The diversification of public facilities will indicate the land-use pattern diversity. Multi-functional land use in a city is regarded as beneficial for solving the employment challenges to some extent and maintaining a work-life balance for the residents [40]. In addition, the distance from downtown Guangzhou is an important factor that reflects the location of the public housing community, as it has a significant impact on residential satisfaction as reflected in other similar studies [23,41].

2.3. Subjective Variable Descriptions

This study established an evaluation system by summarising factors selected by recent literature. There is no universal standard that evaluates the human settlement environment of public housing communities at present, and the determination of what dimensions and factors should be used varies widely. Therefore, based on the theory of the Sciences of Human Settlements, this paper summarises an index from the perspectives of the housing conditions, the public supporting facilities, the ecological environment, the social relations, and the psychological experience that takes into consideration the residential, supportive, natural, social, and human systems [4–6,23,31,33,39,41,42]. Moreover, the residential satisfaction criterion layer includes three field layers: indoor environment, community environment, and social relations. Indoor environment includes space design, housing area, housing quality, lighting and ventilation, acoustic insulation, and maintenance. The community environment includes landscape, sanitation, public facilities, community amenities, security and estate management service. The social relations layer includes relations with the neighbourhood, friends and family.

2.4. System Validation

After selecting the index, the residential satisfaction layer was further modified and verified using the questionnaire data collected from the household survey. Exploratory factor analysis was used to reduce the dimensions of the index. The commonality of public facilities index was lower than 0.400 after principal component extraction, indicating that the extracted principal component could not explain precisely what this variable’s variance was. Therefore, the public facilities index was removed from factor analysis. The Kaiser-Meyer-Olkin (KMO) value of the remaining 14 indices was 0.809, which was greater than 0.800, and the chi-square value of Bartlett’s test reached 1828.274 with 91 degrees of freedom. Further, the significance level was 0.000, less than 0.050, which indicates that the data are suitable for factor analysis. According to the results of factor analysis, three common factors with eigenvalues greater than one were extracted for subsequent analysis. After Varimax rotation, the explanatory variables for the three common factors were 20.907%, 18.200%, and 13.865%, respectively, indicating 52.972% of the total variance could be explained. Accordingly, these three common factors are: community environment, indoor environment, and social relations. The final residential satisfaction criterion layer was composed of 14 indices in three field layers.
SPSS25.0 and AMOS24.0 were used to evaluate the model’s reliability, validity and model fit. Cronbach’s alpha ranged from 0.666–0.766, which indicates good reliability of the evaluation model. The overall Cronbach’s alpha was 0.847, and the composite reliability (CR) values of each field layer were all greater than 0.6. Among the model fitting indices, the values of goodness of fit index (GFI), adjusted goodness of fit index (AGFI), comparative fit index (CFI), and Tucker–Lewis index (TLI) were all greater than 0.9, while the normed fit index (NFI) value was slightly lower than 0.9. In summary, the model fitting indices were basically in range of the ideal values, which proves that the model for residential satisfaction evaluation is rational and reliable. Therefore, based on the results of model validation, the final index system was established and shown in Table 1 below, which contains 2 criterion layers, 7 field layers, and 22 indices in total.

| Target Layer A | Criterion Layer B | Field Layer C | Index Layer D       |
|----------------|-------------------|---------------|---------------------|
| B1 Built environment | C1 Housing environment | D1 Per capita housing area |
|                   | C2 Public transportation | D2 Metro station       |
|                   |                   | D3 Bus stop         |
|                   | C3 Public facilities   | D4 Medical facilities |
|                   |                   | D5 Educational facilities |
|                   |                   | D6 Commercial facilities |
|                   |                   | D7 Parks and recreational facilities |
| C4 Location       |                   | D8 Distance from the city center |
| Human settlement environment evaluation of the public housing community in Guangzhou | C5 Indoor environment | D9 Space design |
|                   |                   | D10 Housing area |
|                   | C6 Community environment | D11 Housing quality |
|                   |                   | D12 Ventilation and lighting |
|                   |                   | D13 Acoustic insulation |
|                   |                   | D14 Maintenance |
|                   |                   | D15 Landscape |
|                   |                   | D16 Sanitation |
|                   |                   | D17 Community amenities |
|                   |                   | D18 Security |
|                   |                   | D19 Estate management service |
| C7 Social relations |                   | D20 Relations with neighborhood |
|                   |                   | D21 Relations with friend |
|                   |                   | D22 Relations with family |

3. Results

3.1. The Objective Situation of the Built Environment

The objective built environment layer contains eight indices which are categorized into four field layers. Public facility indices are further subdivided by their constituent and different types. Based on the information from the Guangzhou government’s housing department, field research and various statistics, the corresponding information of each index is summarized in Table 2 below.

The per capita housing area of the surveyed communities can be seen to be lower than the urban residents per capita for a living area of 35 square meters in Guangzhou, but it is still higher than the minimum requirement of 15 square meters. It indicates that this index has met the basic requirements. According to the standard for urban residential area planning and design in Guangzhou (GB50180–2018), a 15 min (or 1 km) community life circle should be equipped with at least one bus stop. The surveyed communities all meet the design standards. However, X Xuan is relatively further away from the metro station, so the traffic convenience of this community is relatively weak compared to the
other public housing communities. Furthermore, on the requirements of travelling needs, the design standard necessitates that a 15 min community life circle must be equipped with middle schools, a large multi-purpose sports venue, community hospitals, clinics, and shopping malls. These communities are all equipped with adequate medical facilities, which consist of different levels of hospitals and clinics within a 1 km distance. The basic requirements of residents are adequately fulfilled. In terms of educational facilities, the communities of X Xuan and H Xuan, which are located near downtown Guangzhou, can be seen to have a more abundant supply of educational resources compared to T Garden and P Garden. As for the commercial facilities, residents in H Xuan have many more choices, while the other three communities fail to meet the official design standard of “shopping malls being equipped in the 10-min community life circle” (GB50180-2018). The number of parks and sports facilities around T Garden is the largest, while by comparison, the recreational facilities around H Xuan are scarce. Moreover, the distance between the closest community cultural center and the community is greater than 300 m in T Garden and H Xuan, which do not meet the requirements of the standard. In view of the distance between the surveyed communities and the city center, H Xuan and X Xuan have the best geographical location, followed by P Garden, while T Garden is relatively remote.

| Table 2. Statistics of Built Environment Indices. |
|-------------------------------------------------|
| **Built Environment Layer** | **Built Environment Index Layer** | **T Garden** | **P Garden** | **X Xuan** | **H Xuan** |
|-----------------------------------------------|---------------------------------|-------------|-------------|-------------|-------------|
| Housing environment | Per capita housing area (m²) | 20.96 | 23.15 | 16.9 | 24.91 |
| Public transportation | Number of metro stations within 1 km | 1 | 1 | 0 | 2 |
| | Number of bus stops within 1 km | 18 | 15 | 16 | 20 |
| Public facilities | Number of medical facilities within 1 km | 3A hospital | 1 | 1 | 2 | 2 |
| | Community hospital | 2 | 1 | 4 | 2 |
| | Kindergarten | 9 | 12 | 13 | 21 |
| | Primary school | 5 | 6 | 8 | 10 |
| | Middle school | 2 | 4 | 5 | 5 |
| | Number of educational facilities within 1 km | 5 | 1 | 1 | 0 |
| | Parks | 3 | 2 | 2 | 0 |
| | Sports facility | 3 | 1 | 1 | 0 |
| | Number of recreational facilities within 1 km | 3 | 1 | 1 | 6 |
| Location | Distance from the city center | 14.1 | 10.9 | 4.2 | 2.9 |

Generally speaking, the surveyed communities meet the basic requirements in terms of the per capita housing area, and they all enjoy convenient public transport and abundant public supporting facilities. However, due to the unbalanced development among the communities, there are deficiencies in different aspects. The results of the objective built environment evaluation and the deficiencies of each community are summarized in Table 3.

| Table 3. Comparison of Built Environment among the Subject Public Housing Communities. |
|-------------------------------------------------|
| **Housing Environment** | **Public Transportation** | **Public Facilities** | **Location** |
| T Garden | At the medium level among surveyed communities | Close to many bus stops and metro stations | Equipped with sufficient medical and educational resources, but are far away from the community cultural center and commercial facilities | Located in the fringes of cities |
| P Garden | At the upper level among surveyed communities | Close to many bus stops and metro stations | Equipped with sufficient medical and educational resources, but are far away from commercial facilities | Close to the old city center |
| X Xuan | Relatively poor but satisfy the minimum standard | Meet the basic requirement of bus stop arrangements. However, the metro station is far from the community. | Enjoy rich medical and educational resources, but are far away from commercial facilities | Close to the new city center |
| H Xuan | At the medium level among surveyed communities | Close to abundant bus stops and metro stations | Enjoy rich medical and educational resources, but suffer from lack of public recreational facilities | Close to the new city center |
3.2. Subjective Evaluation of Residential Satisfaction

The average subjective evaluation score was 4.92, which means that residents were relatively satisfied with the public housing community. In terms of different field layers of residential satisfaction, the score ranges from being the lowest in community environment (4.63), to the highest in social relations (5.85), as indicated in Table 4.

| Field Layer            | Average Score of Each Layer | T Garden | P Garden | X Xuan | H Xuan |
|------------------------|-----------------------------|----------|----------|-------|-------|
| Indoor environment     | 4.69                        | 4.61     | 4.59     | 4.36  | 5.11  |
|                        | Standard Deviation          | 1.15     | 1.23     | 1.26  | 1.01  |
| Community environment  | 4.63                        | 3.54     | 4.80     | 4.66  | 4.66  |
|                        | Standard Deviation          | 1.39     | 1.20     | 1.15  | 1.16  |
| Social relations       | 5.85                        | 5.90     | 5.70     | 5.95  | 5.95  |
|                        | Standard Deviation          | 1.00     | 1.11     | 0.92  | 0.82  |

The average score of the indoor environment in X Xuan was relatively low, especially for space design, housing area, housing quality and acoustic insulation. T Garden’s performance in housing quality and facility maintenance was poor. According to respondents, they could not get timely responses from their maintenance service requests. P Garden can be seen to have poor performance in lighting and ventilation, as well as acoustic insulation. Some windows in this community are facing towards the public corridor, which results in poor lighting and ventilation conditions.

In terms of the community environment, T Garden has more potential to improve compared to the other public housing communities. T Garden was also built simultaneously with the commodity residential housing (which is the private sector housing project in the housing market in China) on the same site. Residents living in public housing and commodity housing sections share the communal garden, which provides a place to relax and socialize. Hence, the community landscape and amenity facilities were better constructed compared to other communities. This echoes other studies showing harmonious social environment when public and private housing projects co-exist within the same community district [30].

As for the social relations aspect, the overall evaluation of indicators is high. Discrimination or exclusion due to living in the public housing community is rare. Among surveyed communities, residents in P Garden had the lowest satisfaction of social relations, which may be related to the relatively low degree of social integration due to the high proportion of disabled and seriously ill people in this community.

3.3. Residents’ Demand Analysis

Based on the result of the residential satisfaction in each community and the resident background differences, it is possible to further understand the relationship between factors such as the construction period, per capita housing area, space design, family background, and the satisfaction evaluation of residents. Within the category of household characteristics, the independent variables were divided into two groups: family background and community residential conditions. This study adopted a multiple regression method to analyze the relationship between independent variables and three field layers. The analysis framework is shown in Figure 3 below.

This paper carried out a multiple regression analysis based on the three dimensions obtained by factor analysis. It explored the variables that may affect the residential satisfaction of the human settlement environment, as well as the demand characteristics of different households. The value and meaning of the independent variables are shown in Table 5 below.
Table 5. Value and Meaning of Independent Variables.

| Independent Variable                              | Type of Variable | Value of Variable                                                                 |
|--------------------------------------------------|------------------|-----------------------------------------------------------------------------------|
| Per capita housing area                           | Continuous variable | Actual per capita housing area                                                    |
| Flat design                                       | Dummy variable   | One-bedroom flat = 1, others = 0                                                  |
| (reference group: single room)                    |                  | Two-bedroom flat = 1, others = 0                                                  |
|                                                   |                  | Three-bedroom flat = 1, others = 0                                                 |
| Geographical location                             | Dummy variable   | Close to the new city center = 0                                                   |
|                                                   |                  | Close to the old city center = 1                                                   |
|                                                   |                  | Fringes of the city = 2                                                            |
| Construction period                               | Dummy variable   | Built later than 2000 = 1                                                          |
| (reference group: built before 2000)              |                  | Built before 2000 = 0                                                              |
| Highest educational attainment of household member| Dummy variable   | Elementary school or below = 0                                                     |
|                                                   |                  | Middle school = 1                                                                  |
|                                                   |                  | High school or vocational school = 2                                               |
|                                                   |                  | Associate degree = 3                                                               |
|                                                   |                  | Bachelor’s degree or above = 4                                                     |
| Family structure                                  | Dummy variable   | Live alone = 1, others = 0                                                          |
| (reference group: nuclear families)               |                  | Single parent family = 1, others = 0                                              |
|                                                   |                  | Couples without children = 1, others = 0                                           |
|                                                   |                  | Three generations family = 1, others = 0                                           |
| Household monthly income per person               | Continuous variable | Actual household monthly income per person                                         |
| Health conditions of householder member           | Dummy variable   | Have at least one ill or disabled member = 1                                       |
| (reference group: Have no ill or disabled member) |                  | Have no ill or disabled member = 0                                                 |
| Length of residence                               | Continuous variable | Actual period of residence                                                        |

The results of the multiple regression analysis are shown in Table 6. Model 1 tests the differences of the residents’ evaluation of the housing environment, the community environment, and the social relations under different community objective housing conditions without considering family background. Model 2 examines the residential satisfaction differences among different housing conditions, as well as family background.

Through the analysis of Model 2, it was found that the adjusted R-squared value was higher after adding family background factors. Thus, Model 2 has a stronger explanatory power for residential evaluation at all field layers compared to Model 1.
Table 6. Multiple Regression Analysis of Residential Satisfaction.

| Variable                          | Indoor Environment | Community Environment | Social Relations |
|-----------------------------------|--------------------|-----------------------|-----------------|
|                                   | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
|                                   | B       | SE     | B       | SE     | B       | SE     | B       | SE     |
| Community residential conditions  |         |        |         |        |         |        |         |        |
| Per capita housing area           | 0.012***| 0.005  | 0.034***| 0.008  | −0.009**| 0.005  | −0.020**| 0.009  | 0.001  | 0.004  | 0.009  | 0.006  |
| Flat design (reference group: single room) |       |        |         |        |         |        |         |        |
| One-bedroom flat                  | 0.151   | 0.367  | 0.216   | 0.367  | 0.178   | 0.371  | 0.218   | 0.374  | −0.066 | 0.287  | −0.019 | 0.284  |
| Two-bedroom flat                  | 0.015   | 0.353  | −0.009  | 0.352  | −0.072  | 0.357  | 0.021   | 0.359  | 0.127  | 0.276  | 0.081  | 0.273  |
| Three-bedroom flat                | −0.256  | 0.372  | −0.251  | 0.372  | −0.033  | 0.376  | 0.085   | 0.380  | 0.078  | 0.291  | 0.042  | 0.289  |
| Geographical location             | −0.097  | 0.080  | −0.088  | 0.080  | −0.668***| 0.081  | −0.665***| 0.082  | 0.032  | 0.063  | 0.050  | 0.062  |
| Construction period (reference group: built before 2000) |       |        |         |        |         |        |         |        |
| Built later than 2000             | 0.027   | 0.171  | 0.696*  | 0.358  | −0.620***| 0.173  | −0.193  | 0.365  | 0.168  | 0.134  | 1.169***| 0.278  |
| Family background (control variables) |       |        |         |        |         |        |         |        |
| Highest educational attainment of household member | −0.056  | 0.053  | −0.044  | 0.054  | −0.044  | 0.041  |         |        |        |        |        |        |
| Family structure (reference group: nuclear families) |       |        |         |        |         |        |         |        |
| Live alone                        | −0.963***| 0.344  | 0.401   | 0.351  | −0.695***| 0.267  |         |        |        |        |        |        |
| Single parent family              | −0.113  | 0.164  | 0.078   | 0.167  | 0.032   | 0.127  |         |        |        |        |        |        |
| Couples without children          | −0.314  | 0.217  | 0.145   | 0.222  | −0.081  | 0.169  |         |        |        |        |        |        |
| Three generations family          | −0.122  | 0.178  | −0.431**| 0.182  | −0.098  | 0.138  |         |        |        |        |        |        |
| Household monthly income per person | −0.000**| 0.000  | 0.000   | 0.000  | 0.000   | 0.000  |         |        |        |        |        |        |
| Health conditions of householder member (reference group: Have no ill or disabled member) |       |        |         |        |         |        |         |        |
| Have at least one ill or disabled member | −0.049  | 0.132  | −0.043  | 0.135  | 0.131   | 0.103  |         |        |        |        |        |        |
| Period of residence               | 0.064*  | 0.033  | 0.050   | 0.034  | 0.099***| 0.026  |         |        |        |        |        |        |
| Constant                          | 4.445   | 0.392  | 3.460   | 0.631  | 5.653   | 0.396  | 5.280   | 0.644  | 5.595  | 0.306  | 4.070  | 0.490  |
| Adjusted R-squared               | 0.015   | 0.041  | 0.125   | 0.131  | −0.001  | 0.042  |         |        |        |        |        |        |
| F-value                           | 2.251** | 2.478***| 12.633***| 6.244***| 0.935   | 2.513***|         |        |        |        |        |        |

N = 490; * p < 0.1; **: p < 0.05; ***: p < 0.01.
From the result of the multiple regression analysis, the differences in all the variables, beginning from the evaluation of indoor environments, the community environments, and finally the social relations among public housing residents were all correlated with the physical community conditions and family backgrounds. What seems to be interesting to note is that different flat designs, education background, and the health conditions of family members did not impact the satisfaction evaluation of the residents. However, other independent variables such as per capita housing area, location, and construction period in the category of community residential conditions, and the family structure, household monthly income per person, and the length of residence in that community in the category of family background factors have different degrees of significant correlation with residents’ satisfaction. The results of the different analyses can therefore provide a certain degree of reference when it comes to public housing community renovation.

After considering the family background, the results of the indoor environment show that the variable of per capita housing area still had a positive influence on the residential satisfaction, but that changes in construction period had no obvious positive correlation with this layer. In terms of family structure, the satisfaction of residents living alone is significantly lower as compared to the nuclear family, which indicates that there is a significant difference between the demand of residents living alone and those in nuclear families. With the improvement of family economic conditions, the residents’ demand for housing conditions has therefore increased. Research has shown that income is an important factor affecting the housing demand of residents [31]. More importantly, lower-income groups will focus more on their basic daily needs, but their expectations will be increased to a higher level with the increase in their family income.

As for the analysis of the community environmental layer, the variable of per capita housing area remains associated with a negative correlation with the satisfaction evaluation. Regarding geographical location—the better the location, the higher the residents’ satisfaction of the community environment. In Model 2, there is no correlation between the construction period and the assessment of the community environment. As for the family structure, compared to the nuclear family, the family of three generations living together had a significantly lower evaluation on the community environment. It can be seen that the family of three generations had higher requirements for the community environment, in order to meet the diversified needs of family members with different ages.

The independent variables relating to the family background had a great influence on the level of social relations. Among them, the most significant one is the length of residence. Residents who have lived a longer period had a higher satisfaction on social relations, which to some extent indicates that residential stability can promote communication among residents. In terms of family structure, the evaluation of social relations among residents living alone was significantly lower than that of nuclear families, indicating that the social and psychological needs of residents living alone should be given more attention.

4. Discussion

Based on the analysis of the physical environment of the four public housing communities in this study, the residential environment of the surveyed public housing communities meets the basic requirements. To be specific, the per capita living area reaches the minimum standard. Transportation resources and basic public facilities are abundant. However, there is still a lack of community activity centers and shopping malls around the public housing communities, and there is still room to improve living standards for residents within the public housing communities.

In terms of satisfaction evaluation, residents are generally satisfied (with an average score of 4.92) with their community. Among the three field layers, residents have the highest rate of satisfaction with social relations (with an average score of 5.85), followed by housing environment (with an average score of 4.69), and community environment (with an average score of 4.63). Public housing residents generally enjoy a good relationship with relatives, their neighbors, as well as old friends without the presence of discrimination. In addition, long-term residential stability is beneficial to increasing
the satisfaction of social relations. However, residents living alone have relatively low satisfaction regarding social relations and this may require attention in future policy refinement. In the layer of the indoor environment, residents generally have a low level of satisfaction with the acoustic insulation, which echoes findings in similar studies [18]. Flat design and housing areas are important factors that affect the satisfaction of the indoor environment as well.

Based on the multiple regression analysis of the community environment and the residents’ family background, it is seen that the evaluation of the indoor environment is significantly and positively correlated with per capita housing area and length of residence but negatively correlated with the family’s financial conditions. Moreover, the evaluation of residents living alone is relatively low. In the dimension of the community environment, residents are not satisfied with the community amenities. Results of the regression analysis show that residents living in a good location have higher levels of satisfaction with the community environment. However, it must be addressed that families of three generations together have different requirements for their community environment, which may be the reason for their lower satisfaction of this layer. According to the existing literature, it is necessary to focus on aspects such as the social interaction of residents, project designs, construction stages, a mix of housing types, etc., of public housing communities [34,43,44].

The conclusion of existing research and the analysis results of this study are considered together to propose universal suggestions for improving the human settlement environment of the public housing communities as follows:

1. Pay more attention to public facilities and neighborhood environments in the public housing community. Accessibility to various function areas contributes to residents’ satisfaction significantly [14,28]. The number of community centers for social/cultural activities, shopping malls, and other functional facilities needs to be increased according to the design standards of different countries and regions. It is a socially feasible method to improve the living quality of residents in public housing communities by sharing function areas with private sector housing, which also helps to prevent the NIMBY (Not In My Backyard) Syndrome and produce a harmonious atmosphere for the residents altogether [30].

2. In renovating existing public housing communities, it is suggested to give priority to acoustic insulation and community amenities. In addition, fitness facilities can be created to promote the communication of residents and vitality of the community. At the same time, estate management services, security, landscape settings, and the maintenance of the community should be ensured.

3. Improve the supervision and regulation of the public housing community’s lifecycle. The focus on the construction of public housing should be shifted from “quantity” to “quality and quantity.” It is necessary to strengthen the government’s supervision on design, construction, and operational stages, formulating and improving the existing standards about public housing construction. This is to ensure the quality of the indoor housing environment as well as the external environment.

4. Pay attention to the needs of households with different family structures. Families of three generations have higher requirements from the community environment, while residents living alone have apparent demands for better indoor housing environment and social activities. Corresponding measures should be taken according to these differences. For instance, community workers should offer more care to residents living alone, tending to their living and psychological needs. Flexible design situations can also be reserved to meet residents’ needs in different life periods, so as to realize the life-long design concept and gain higher satisfaction by raising residents’ expectations [17].

5. Establish and improve laws and regulations relating to public housing in order to promote enforcement of public housing policies, including entry and exit mechanisms. The implementation and supervision mechanisms should be built well to ensure the effectiveness of the entry and exit mechanisms. Residents who are not eligible for public housing should be identified in time to ensure social fairness. On the premise of fulfilling basic eligibility criteria, residential stability should be improved as much as possible.
5. Conclusions

Based on the theories, including the Science of Human Settlements, QoL, and residential satisfaction, this study evaluated the current situation of public housing communities in Guangzhou. This paper summarized evaluation factors from the existing research literature and built an evaluation system adapted to the target communities in Guangzhou. The evaluation system consisted of the objectively built environment performance and the subjective evaluation made by residents. In total, the system includes seven criterion layers: housing environment, public transportation, public facilities, location under the objective layer, the indoor environment, community environment, and social relations under the subjective layer. Twenty-two factors were included in the evaluation system. From the outcomes, it seems to be necessary to pay more attention to the acoustic insulation and the community amenities of public housing. Through the multiple regression analysis, the relationship between the built environment, the residents’ family background, and the evaluation result of the public housing community was analyzed, and specific suggestions were put forward as references to the design, construction, and maintenance of public housing communities, which all contribute to increasing the residents’ satisfaction.

Based on this research, relevant future research vectors include increasing the diversity of survey samples and applying the evaluation system to more public housing communities in order to further verify our results here. In addition to the residents of public housing, other stakeholders, such as government housing departments and developers can also be involved in the survey so as to understand the views and needs of all parties fully. Besides the residents’ evaluation of each factor, the importance of each factor remains to be further researched. The Science of Human Settlements not only includes aspects like transportation, public facilities, and location, but also others such as layout planning, economic, and environmental indicators. In the process of investigation, some residents pointed out problems like home–work separation. Therefore, other factors such as job opportunities in the community, commuting time, and ecological environmental quality can be added to further study of public housing communities.

In conclusion, more research is needed on exploring the factors affecting the residential satisfaction within public housing communities so as to have a more effective and comprehensive understanding of the relationships between the residential environment and the residents’ subjective feelings of the environment in public housing communities.

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