Construction of Future Scene Spatial Model of Community Neighborhood Center Based on KANO-AHP

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Abstract. This paper introduces six future scenes from the concept of future community into the spatial construction of community neighborhood center, summarizes the relevant definition and correlation between neighborhood center and future scene, and builds the spatial model of community neighborhood center future scene. Starting from the use needs of community residents, this paper first conducts a case study to obtain the initial needs of users, and qualitatively divides the attributes of each demand through kano questionnaire survey. Then the AHP is used to calculate the weight of demand at each level, and the weight is sorted to obtain the importance of spatial demand quantitatively. Finally, the optimal neighborhood center future scene space model is constructed.

Keywords: Kano-AHP; Neighbourhood centres; Future scene; Future community

1 Introduction

The concept of "neighbourhood centres" originated in Singapore. It refers to the provision of social living facilities for residents under the leadership of the government, and the formation of a community complex integrating business, convenient service facilities, public institutions and resident management. It has three characteristics: functional integration, residential centralization and architectural integration[1]. The construction of community center combines the basic public services around the community with the commercial complex, which can not only improve the utilization rate of space facilities, but also improve the utilization rate of building land[2]. Suzhou is the first city in China to carry out the practice of neighborhood center construction. The successful construction of neighborhood center not only solves the various living needs of residents, but also strengthens the emotional connection between residents, and plays a great role in promoting the communication atmosphere of the community [3].

In 2019, China's Zhejiang Province took the lead in putting forward the concept of "future community", which focuses on people, builds nine future application scenarios around the dimensions of humanization, ecology and digitalization, and creates a beau-

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tiful and livable composite living space for people. As a core element of future community construction, "Future scenario" comprehensively covers all key areas from daily life to community governance. Through digital transformation and innovative practices, improve the quality of life of residents and enhance the sustainable development momentum of communities.

Through in-depth analysis of the conceptual characteristics of "neighborhood center" and "future scene", it can be found that they have significant similarities and the same goal: both are committed to bringing rich and beautiful life experience to residents in the region through diversified ways and scene construction[4]. It can be seen that the concept of "future scene" has far-reaching guiding significance for the planning and construction of "neighborhood center". However, due to the lack of attention to the needs of residents and spatial equity, from the perspective of the current spatial planning of the neighborhood center, its layout and service status can not effectively improve social benefits, and there are problems such as unclear positioning, weakening of interactive function, simple spatial function, single spatial form, and not prominent level. Nor does it pay attention to the small-scale, multi-level collaborative layout of facilities with spatial equity. Therefore, the purpose of this paper is to construct the inner space of the neighborhood center. This paper focuses on integrating six future soft scenes into the interior space design of the neighborhood center, identifying the future scene needs of the neighborhood center that can effectively meet the needs of users, so as to build a warm, convenient and harmonious modern neighborhood center space environment.

2 Method Principle and Process Construction

Kano is a typical method for dividing user demand attributes and can also be used to study the correlation between product demand and user satisfaction, as shown in Figure 1[5]. This method model divides user demand into five categories: charismatic demand (A), expected demand (O), essential demand (M), undifferentiated demand (I), and reverse demand (R). In design, it is important to avoid reverse requirements and focus on meeting essential, attractive, and expected requirements[6].

However, due to the fact that the Kano model can only be used for qualitative research on user needs, it has a strong subjective color and lacks accuracy and systematicity[7]. Therefore, the Analytic Hierarchy Process (AHP) is still needed to quantitatively obtain the hierarchy and weights of user needs[8]. The AHP, a multi-objective decision-making method that combines qualitative and quantitative analysis, has the advantages of objectivity, systematicity, simplicity, and practicality. By using AHP to determine the user demand weights in Kano, it can compensate for the shortcomings of traditional weight calculation and improve the differentiation of user demand types and the accuracy of weights; Therefore, the use of the Kano AHP model is highly feasible and scientific. The process of obtaining user demand hierarchy in this study is shown in Figure 1.

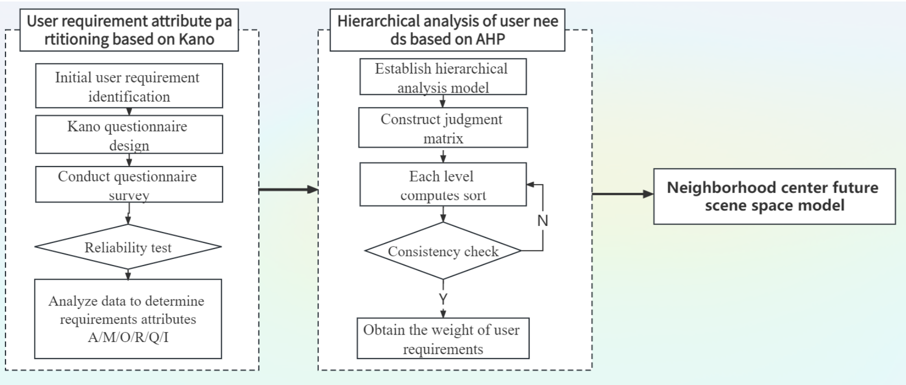

Fig. 1. User Requirement Hierarchy Acquisition Process Based on Kano AHP Model

3 Kano-AHP-Based User Requirement Hierarchy Study

3.1 Initial User Requirements Research

Neighborhood centers, as an emerging architectural form in China, have not yet formed a set of design specifications for such spaces, thus presenting a free exploratory trend in design. Through in-depth field research and rigorous case studies, the article selects typical examples of existing future communities and neighborhood centers, meticulously examines the diversity of their functional configurations, and systematically organizes and summarizes them.

This paper selected 16 Chinese and foreign samples, namely: Hongyan community in Shangyu City, Shaoxing City, China; Hangzhou Xiaoshan colorful community; Hangzhou Qiantang Yunfan community; Quzhou Kecheng Lixian community; Liangzhu Liangzhu Cultural Village Community; Suzhou New Town Community Center; Suzhou Guido Community Center; Suzhou Leader Community Center; Shanghai Vanke Qichen Community Center; Suzhou Chixun Community Center; Guangzhou Fanghe Garden Community Comprehensive Service Center; Guangzhou Fanghe Garden Community Comprehensive Service Center, Guangzhou, China; An enrichment town community center in Japan; Gleneagles Community Centre in Canada; And the Rehovot Community Center in Israel. It covers a full range of functional needs from administrative services, problem activities to life services. Through the scientific method, the user needs in the design activities are sorted out, and the fuzzy clustering method is used to preliminarily classify these needs. The summarized requirements are then coded, resulting in 42 basic requirements, as shown in the left column of Table 2.

3.2 Kano Based Segmentation of User Requirement Attributes

The users of this study include elderly people over 60 years old, middle-aged people between 40 and 60 years old, young people with children and young people without children, so as to strive for the rationality and applicability of the questionnaire results.

The preliminary requirements were sorted into Carnot questionnaires, and the research was carried out through network and field interviews. A total of 202 questionnaires were collected and 186 were valid. The effective recovery rate is over 90%. The questionnaire data were sorted out and all 42 attributes of requirements were classified and calculated one by one. According to the 42 functional space requirement elements identified above, as shown in Table 1, a "two-way" question is set for each requirement element, and the function of each requirement element is described in detail in the questionnaire, so that the questionnaire users can be more clear and intuitive.

Table 1. Kano questionnaire settings.

Demand item	satisfaction	Ought to be so	doesn't matter	acceptable	Unacceptable
Provide the demand	5	4	3	2	1
doesn't provide the demand	5	4	3	2	1

First of all, Kano questionnaire design and demand frequency calculation: summarize the results of each respondent to fill in the various demand quiz, get the frequency of five Kano attributes for each demand, and the item with the highest frequency is the attribute classification of this demand. However, this method of determining the percentage of demand ignores other demand attributes in the environmental elements.

Therefore, in order to overcome this defect, it is necessary to introduce the classification of demand attributes based on the good or bad coefficient for optimization: User satisfaction (SI), indicating that the availability of a function will increase user satisfaction. The closer the value is to 1, the greater the impact; The worse the coefficient is, the user dissatisfaction (DSI), that is, the lack of a certain function will reduce the user satisfaction. The closer the value is to -1, the greater the impact. The calculation formula is shown in equation (1) and (2). Demand attribute determination method is based on the size of SI and DSI values, when SI>0.5,|DSI|>0.5, the demand for the desired type of demand (O); when SI>0.5,|DSI|<0.5, for the charismatic type of demand (A); when SI<0.5,|DSI|>0.0, for the must-have type of demand (M); when SI<0.5,|DSI|<0.5, for the no-difference demand (I). differentiated needs (I).

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

$$DSI = \frac{O + M}{A + O + M + I} \times (-1) \tag{2}$$

Table 2. Kano data analysis table.

	Coding	Demand Content	A	O	M	I	SI	DSI	property
Future Neighborhood	A1	Community Council Hall	58	49	45	34	0.55	-0.51	0
	A2	Shared Garden	49	54	41	42	0.55	0.51	O
	A3	Roof garden	76	24	22	64	0.54	-0.25	A
	A4	Pet sharing area	84	41	18	43	0.67	-0.31	A
	A5	Shared cinema	59	41	38	48	0.53	-0.42	A

	A6	Chess tea room	40	51	47	45	0.49	-0.53	M
	A7	Shared workshop	81	52	22	32	0.71	-0.39	A
	A8	Sitting space	56	25	31	74	0.43	-0.30	I
	A9	Square	43	48	59	36	0.48	-0.57	M
Future Education	B1	Senior class	50	39	58	39	0.47	-0.52	M
	B2	Shared reading room	44	47	61	34	0.48	-0.58	M
	B3	Painting room	91	39	46	10	0.69	-0.45	A
	B4	Music and dance studio	71	46	49	20	0.63	-0.51	O
	B5	Children's play area	39	42	51	54	0.43	-0.50	M
	B6	Child care room	61	51	43	31	0.60	-0.51	O
	B7	Shared study room	49	53	47	37	0.54	-0.53	O
Future Health	C1	Day care area	37	49	48	52	0.46	-0.52	M
	C2	One-minute consulting room	53	69	32	32	0.66	-0.51	O
	C3	Integrated motion space	39	59	47	41	0.52	-0.56	O
	C4	Fitness area	58	35	37	56	0.51	-0.38	A
	C5	TCM physiotherapy room	88	28	39	31	0.62	-0.36	A
	C6	Senior fitness area	43	39	37	67	0.49	-0.40	I
Future Entrepreneurship	D1	Co-working area	71	22	19	74	0.50	-0.22	A
	D2	Meeting and talking area	52	26	29	79	0.41	-0.29	I
	D3	Shared coffee bar	69	46	21	50	0.61	-0.36	A
	D4	Road show area	57	23	19	87	0.43	-0.26	I
	D5	Entrepreneurship service hall	49	18	16	91	0.36	-0.18	I
	D6	Shared kitchen	41	25	22	98	0.35	-0.25	I
	D7	Shared studio	39	28	24	95	0.36	-0.28	I
Future Governance	E1	Community office	32	54	61	39	0.46	-0.61	M
	E2	Psychological counseling	86	31	16	53	0.62	-0.25	A
	E3	Conflict resolution room	54	55	39	38	0.58	-0.50	O
	E4	The community council room	46	49	51	40	0.51	-0.53	O
Future Service	F1	Community canteen	64	51	48	23	0.61	-0.53	O
	F2	Community vegetable market	69	28	18	71	0.52	-0.24	A
	F3	enience supermarkets	50	56	37	43	0.57	-0.50	O
	F4	Laundry	61	52	42	31	0.61	-0.51	O
	F5	Medicamentarius	58	42	57	29	0.54	-0.23	O
	F6	Bakery	63	31	24	68	0.51	-0.32	A
	F7	Repair shop	42	26	19	99	0.37	-0.24	I
	F8	Apparel shop	46	25	31	84	0.38	0.30	I
	F9	Self-service express locker	49	19	21	97	0.36	-0.22	I

From the perspective of essential demand content (M), it includes: parent-child play space, chess and card teahouse interaction space, activity square, elderly classroom, shared library, day care center and community government service hall. Such needs should be primarily satisfied in space design. From the perspective of expected demand content (O), it includes: community auditorium, shared vegetable garden, shared study room, shared study room, music and dance classroom, child care room, one-minute consulting room, comprehensive sports field, conflict resolution room, community hall, community canteen, wash shop, convenience supermarket and drugstore. Such requirements are the environmental requirements that are met first on the basis of must-have requirements. From the perspective of charm demand content (A), it includes: roof garden, pet interaction space, shared cinema, shared workshop, book and painting room, traditional Chinese medicine therapy room, shared gym, shared office area and shared coffee bar; Psychological counseling room, community vegetable market and bakery. From the perspective of undifferentiated demand content (I), it includes: shared sitting space, exclusive fitness space for the elderly, meeting and talking space, road show space, entrepreneurial service hall, shared kitchen and shared broadcast room, self-service express cabinets, repair shops and clothing stores.

3.3 User Demand Weight Analysis Based on AHP

Based on the Kano model for the analysis of user demand attributes of the future scenario of the neighborhood center, a hierarchical analysis model is constructed by combining the AHP method, in which the spatial scheme of the future scenario of the neighborhood center is the target layer, the necessary attribute M, the desired attribute O, and the charming attribute A are set as the criterion layer, and the functional space under each type of demand attribute is set as the indicator layer and coded, as shown in Figure 2.

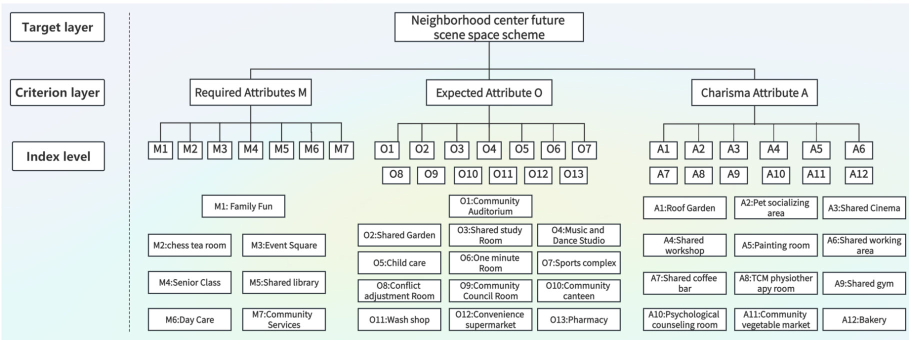

Fig. 2. Hierarchical analysis model of future scenarios for neighborhood centers

For the elements of the same level space, a judgment matrix is constructed. For example, each required element in the necessary attributes is numbered according to Mn to form a single-level judgment matrix of the necessary attribute. A pairwise comparison was made on their importance. The importance was measured by the 1-9 scale method proposed by Saaty, where 1 meant that the two elements were equally important to the target, 9 meant that one element was absolutely important than the other, 3 was slightly important, 5 was obviously important, and 7 was strongly important. The importance of 2, 4, 6, and 8 is between the odd numbers before and after, and if an element is equal to or less important than its comparison element, the score ranges from 1 to 1/9.

In order to ensure the diversity and rigor of the weights, a total of 12 relevant professionals were selected to evaluate the importance of the AHP questionnaire, including 2 community workers, 5 architectural design industry practitioners, 3 industrial design master students and 2 doctoral students. The importance of each spatial element is scored according to the principles of use frequency and function priority.

In the previous section, Kano qualitatively divided the requirements attributes and got the weight ranking of the three requirements attributes. Therefore, the weight calculation of this AHP only calculates and sorts the spatial elements under each criterion layer. The spatial element weight ordering under each attribute is obtained. There are six steps for single-criterion sorting:

(1) Average the scores of 12 experts to obtain the final judgment matrix.

(2) The judgment matrix is processed by "column normalization", and then each horizontal row is added to obtain the eigenvector value ω;

(3) The feature vectors are processed by "column normalization" again to obtain the weight value of each feature vector.

(4) Add the product of each matrix item and its weight to obtain the matrix value Aω.

(5) Calculate the maximum feature root according to equation (3):

(6) For consistency test, the consistency index is represented by CI, the smaller the CI, the greater the consistency; Considering the subjectivity and randomness of the questionnaire score, the random consistency index RI was introduced, as shown in equation (4). RI refers to the average random consistency index, and each order has corresponding values. CR refers to the consistency ratio, when $CR \leq 0.1$, indicating that the consistency test is passed; If $CR > 0.1$, it indicates that the consistency test has not passed, and the judgment matrix needs to be checked, corrected, and analyzed again.

$$\lambda_{\max} = \frac{1}{n} \sum_{n}^{i=1} \frac{(AW)_i}{W_i} \tag{3}$$

$$CI = \frac{\lambda_{\max} - n}{n-1}, \quad CR = \frac{CI}{RI} \tag{4}$$

The hierarchical importance ranking of 42 demand factors under the three index layers is obtained based on the hierarchical ranking Aω.

As shown in Table 3, the weight values of basic needs from high to low are: activity square, community government service hall, parent-child game space, day care center, chess and card tea room, shared library, senior class. It basically covers the six soft scenes of the future community, covers the whole age group, and is the guarantee of the basic life of community residents.

Table 3. Calculation of factor weights of necessary attributes.

M	M1	M2	M3	M4	M5	M6	M7	ω_i	Weight%	$A\omega_i$	Sort
M1	1	3	1/3	6	4	3	1/3	1.102	15.74	1.236	3
M2	1/3	1	1/5	4	3	1/3	1/5	0.495	7.08	0.515	5
M3	3	5	1	7	6	4	2	2.320	33.14	2.572	1
M4	1/6	1/4	1/7	1	1/3	1/5	1/7	0.185	2.65	0.192	7
M5	1/4	1/3	1/6	3	1	1/4	1/6	0.307	4.39	0.192	6
M6	1/3	3	1/4	5	4	1	1/3	0.788	11.26	0.853	4
M7	3	5	1/2	7	6	3	1	1.802	25.74	2.036	2
Consistency check		CI=0.0245 RI=1.36 CR=0.018 pass an inspection									

As shown in Table 4, the expected demand weight values in descending order are: comprehensive sports ground, community canteen, convenience supermarket, pharmacy, one-minute consultation room, music and dance room, community auditorium, childcare room, shared study room, shared vegetable garden, conflict mediation room, community council room, laundry.

Table 4. Expected attribute factor weight calculation.

O	O1	O2	O3	O4	O5	O6	O7	O8	O9	O10	O11	O12	O13	ω_i	Weight%	$A\omega_i$	Sort
O1	1	3	3	1	2	1/3	1/4	4	4	1/4	5	1/2	1/2	0.85	6.56	0.915	6
O2	1/3	1	1/2	1/5	1/3	1/5	1/5	3	3	1/6	3	1/4	1/4	0.40	3.15	0.418	9
O3	1/3	2	1	1/3	1/2	1/4	1/5	3	3	1/5	5	1/3	1/3	0.48	3.72	0.541	8
O4	1	5	3	1	2	1/3	1/4	4	4	1/4	5	1/2	1/2	0.90	6.95	0.978	5
O5	1/2	3	2	1/2	1	1/4	1/4	3	3	1/5	4	1/3	1/3	0.61	4.74	0.653	7
O6	3	5	4	3	4	1	1/3	4	4	1/2	5	1/2	1/2	1.34	10.3	1.508	4
O7	4	5	5	4	4	3	1	6	6	2	7	3	3	2.68	20.6	2.926	1
O8	1/4	1/3	1/3	1/4	1/3	1/4	1/6	1	1	1/6	3	1/5	1/5	0.28	2.17	0.289	10
O9	1/4	1/3	1/3	1/4	1/3	1/4	1/6	1	1	1/6	3	1/5	1/5	0.28	2.16	0.289	11
O10	4	6	5	4	5	2	1/2	6	6	1	7	2	2	2.17	16.7	2.417	2
O11	1/5	1/3	1/5	1/5	1/4	1/5	1/7	1/3	1/3	1/7	1	1/6	1/6	0.18	1.43	0.195	12
O12	2	4	3	2	3	2	1/3	5	5	1/2	6	1	1	1.38	10.6	1.525	3
O13	2	4	3	2	3	2	1/3	5	5	1/2	6	1	1	1.38	10.6	1.525	3
Consistency check				CI=0.089 RI=1.57 CR=0.057 pass an inspection													

As shown in Table 5, the weight values of charm demand in descending order are: community wet market, shared gym, roof garden, pet interactive space, shared cinema, shared office area, shared coffee bar, book and painting room, traditional Chinese medicine treatment room, bakery, psychological consultation room and shared workshop.

Table 5. Charm attribute factor weight calculation.

A	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	ω_i	Weight%	$A\omega_i$	Sort
A1	1	2	2	7	5	4	4	5	1/3	6	1/3	6	1.611	13.43	1.837	3
A2	1/2	1	2	7	4	2	3	5	1/3	6	1/4	5	1.259	10.49	1.403	4

A3	1/2	1/2	1	6	4	3	3	4	1/3	5	1/4	5	1.128	9.40	1.257	5
A4	1/7	1/7	1/6	1	1/4	1/5	1/5	1/3	1/7	1/2	1/7	1/2	0.179	1.50	0.189	12
A5	1/5	1/4	1/4	4	1	1/3	1/2	2	1/5	4	1/6	3	0.489	4.07	0.503	8
A6	1/4	1/2	1/3	5	3	1	2	3	1/4	5	1/5	4	0.785	6.54	0.845	6
A7	1/4	1/3	1/3	5	2	1/2	1	2	1/5	4	1/5	3	0.580	4.83	0.605	7
A8	1/5	1/5	1/4	3	1/2	1/3	1/2	1	1/6	3	1/6	2	0.374	3.11	0.384	9
A9	3	3	3	7	5	4	5	6	1	7	1/3	6	2.174	18.12	2.523	2
A10	1/6	1/6	1/5	2	1/4	1/5	1/4	1/3	1/7	1	1/7	1/2	0.216	1.80	0.225	11
A11	3	4	4	7	6	5	5	6	3	7	1	6	2.929	24.41	3.354	1
A12	1/6	1/5	1/5	2	1/3	1/4	1/3	1/2	1/6	2	1/6	1	0.275	2.29	0.283	10
Consistency check	CI=0.082 RI=1.56 CR=0.053 pass an inspection															

4 Construction of Future Scene Spatial Model of Neighborhood Center Based on Kano-AHP

The necessary demand, expectation demand and charm demand are divided from 42 kinds of demands in the future scene design of the neighborhood center, and the weight of each factor under each attribute demand is calculated to get its factor ordering. Construct a spatial model index for the future scene construction of the community center, as shown in Figure 3.

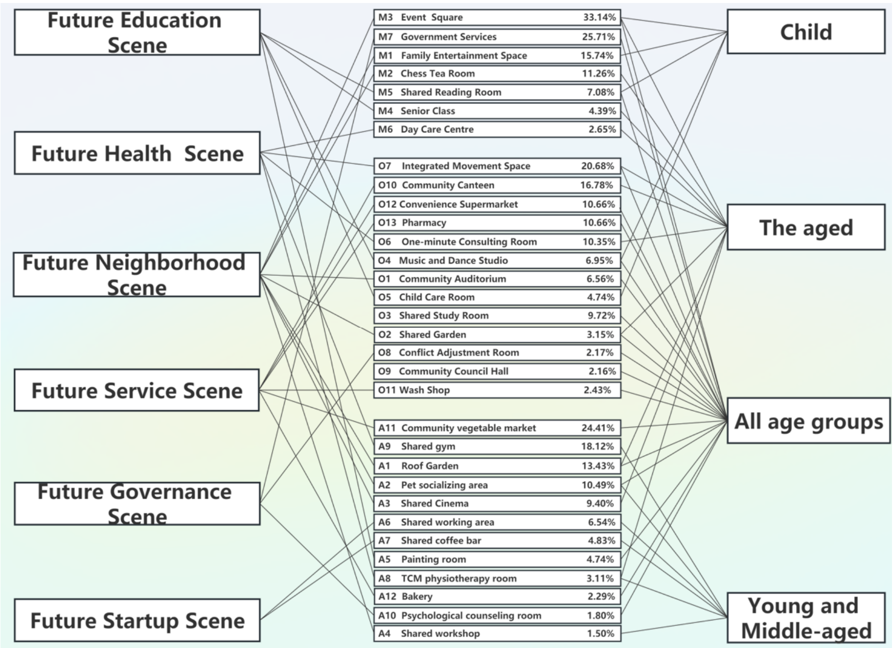

Fig. 3. The spatial model index is constructed for the future scene construction of neighborhood center

5 Conclusion

Integrating the concept of future scene into the construction of neighborhood center is an innovative breakthrough in the concept of neighborhood center construction, and also an innovative design means to realize the modernization of community service and social governance. It will create six future soft scenes for community residents, give more functional space to the neighborhood center, cover all age groups, improve the utilization rate of community space and public facilities, improve the quality of community public space environment, so as to improve urban living environment and promote urban modernization. The spatial model index of the future scene of the neighborhood center constructed in this paper also has important guiding significance for the construction of the neighborhood center, which can guide the functional configuration and composition of the neighborhood center, ensure the reasonable planning and layout of the neighborhood center, meet the use needs of residents and improve the spatial efficiency, so as to optimize the service function of the neighborhood center and promote the long-term operation and sustainable development of the neighborhood center.

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