Research on the Design of Community Creation Based on Analytic Hierarchy Process Under Social Innovation

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Abstract. A demand index system is established to explore the practice model of social innovation in community creation, and to build the corresponding design strategy. The affinity diagram is used to summarize user demand indicators, and each weight value is calculated with the help of hierarchical analysis and tested for consistency. According to the priority ranking of needs, two service design strategies are proposed to renew shared public space and construct a community service system to drive the community's revitalization.

Keywords: social innovation · community creation · service design · the hierarchical analysis

1 Introduction

With rapid urbanization, many communities in China are facing increasingly complex issues and challenges. Some cities try to break away from traditional thinking and creatively address community issues through social innovation [1]. Social innovation aims to connect multiple groups and integrate existing resources and capabilities [2] to produce various products, services or systems to empower society [3]. Community creation is a governance practice revitalizing the community through space updates and rebuilding social relationships. Still, most practices focus on physical spaces, lack non-material aspects such as neighbourhood communities and humanistic care, and are limited and fragmented. Based on social innovation, this paper applies the affinity diagram to establish the demand index system and clarifies the priority level of demand elements through the hierarchical analysis. And then proposes comprehensive evaluation design strategies to maximize the benefits of developing community creation scientifically and effectively.

2 Research Subjects - Machang Community

Machang community in Fuzhou, China, is a typical composite community facing problems such as fragmentation of old and new patterns, broken social network relationships, social differentiation, and complex management. The community has a mix of new centralized settlements, traditional compound housing units, and 13 scattered century-old
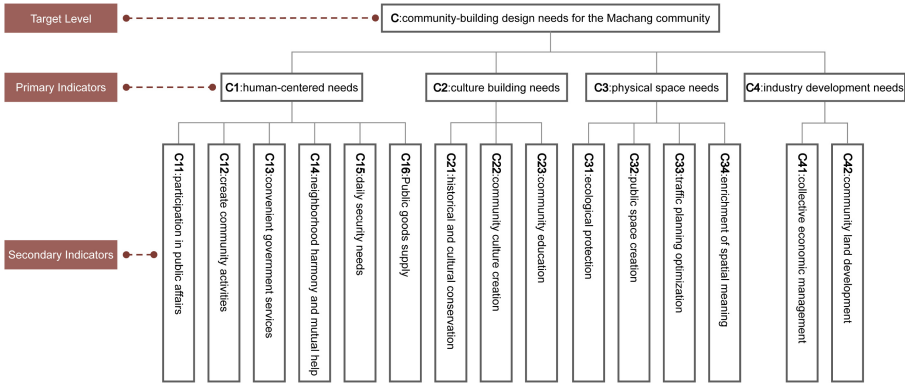
Fig. 1. Construction and geometrical dimensions of specimens

houses. The composite nature of the settlement pattern leads to a particular composite relationship in the composition of residents and social interaction. Historic areas and traditional compounds are primarily indigenous people with relatively stable and inward-looking social relationships. The new concentrated residential areas are foreign residents with less communication and certain extroversion.

3   Requirements Collation and Importance Analysis

3.1   Establishment of Demand Indicators Based on Affinity Diagram

The affinity diagram is a way to identify solutions by grouping and organizing elements in chaos through their interrelationships [4]. The selection of demand elements for composite communities is a collection involving multiple levels and factors. By reviewing the literature, collecting opinions from experts and designers, filtering and categorizing the contained elements with the help of the KJ method, and finally determining the hierarchy as one target layer, four primary and 15 secondary indicators (Fig. 1).

3.2   Hierarchical Analysis of the Weighting of Each Requirement Element

Analytic Hierarchy Process (AHP) is a method of systematizing complex problems, aiming to model complex decision problems in a hierarchical structure and evaluate them comprehensively in a quantitative manner to derive a ranking of the relative importance of decisions [5].

3.2.1   Construct Judgment Matrix and Perform Index Weighting

Based on the above needs' collation, the contents of the hierarchical model were output. Five aborigines and five foreign residents of Machang community were invited to assess the needs comprehensively, using the 1–9 proportional scale method to compare each indicator. The square root method calculates the human-oriented demand, cultural construction demand, physical space demand, industrial development demand, and the

secondary indicators' weight under their respective hierarchies. The calculation steps are as follows:

(1) Calculate the product of each row of the judgment matrix to obtain m_i.

$$m_i = \prod_{j=1}^{n} a_{ij}, \text{i} = 1, 2, ..., \text{n} \tag{1}$$

(2) Calculate the nth root of m_i.

$$\overline{w_i} = \sqrt[n]{m_i}, \text{i} = 1, 2, ..., \text{n} \tag{2}$$

(3) The vector results are normalized to obtain the weight vector w_i.

$$w_i = \overline{w_i} \bigg/ \sum_{k=1}^{n} \overline{w_k}, \text{i} = 1, 2, ..., \text{n} \tag{3}$$

The ranking of the importance of requirements can provide data support for design. According to the weight values of the primary indicators, the important ranking is human-centred needs, physical space needs, cultural construction needs, and industrial development needs. (Table 1).

3.2.2 Perform Consistency Checks

A consistency test is required to ensure the rationality of the judgment matrix and avoid the influence of subjective factors. The calculation steps are as follows:

(4) Calculate the maximum characteristic root of the judgment matrix $\lambda_{\max}$.

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(Aw)_i}{w_i} \tag{4}$$

(5) Perform the calculation of consistency index CI.

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{5}$$

(6) Calculate the consistency ratio CR.

$$CR = \frac{CI}{RI} \tag{6}$$

After calculation, it can be seen that the test coefficient CR = 0.0337 < 0.1 for design requirement C. Therefore, the current judgment matrix is consistent. Similarly, the CR values of the remaining judgment matrices were less than 0.1, indicating that all judgment matrices passed the consistency test.

Table 1. Design demand indicator composite weights

Target Level	Primary Indicators	W_i	Secondary Indicators	W_i
C: community-building design needs for Machang community	C1: human-centred needs	0.4586	C11: participation in public affairs	0.0779
			C12: create community activities	0.0487
			C13: convenient government services	0.0986
			C14: neighborhood harmony and mutual help	0.0407
			C15: daily security needs	0.1411
			C16: Public goods supply	0.0515
	C2: culture building needs	0.1432	C21: historical and cultural conservation	0.0445
			C22: community culture creation	0.0707
			C23: community education	0.0280
	C3: physical space needs	0.3048	C31: ecological protection	0.0429
			C32: public space creation	0.1388
			C33: traffic planning optimization	0.0801
			C34: enrichment of spatial meaning	0.0429
	C4: industry development needs	0.0934	C41: collective economic management	0.0223
			C42: community land development	0.0128

4　Design for Community Creation Based on Social Innovation

Based on the results of the weighting analysis of the indicators, the needs with higher weighting are given priority in the design. The priority is to build a social support network so that residents can be shaped into a community with a sense of community and participate in community building. The second is to renew the physical space, which

satisfies the multiple needs of residents for social life and is a field where social relations are interwoven.

4.1 Physical Space - Renewal of Shared Public Spaces

In the case of the leisure function node of Ke Yuan, it is possible to remove part of the courtyard wall and open up the cut-off road, introduce a slow-moving system to link the node and other areas, and lead to the formation of a closed loop of paths. The internal space of the original node can be externalized into street space. We add functional connections other than passing traffic so residents' behaviour can be changed from passive to active, enhancing the node's outward orientation and attractiveness while enriching the path's interactivity and fun and creating a community communication station.

For other spaces with similar functions, different themes can be placed according to the primary service targets, respecting the site texture and the relationship between people and places and focusing on tapping community characteristics for adaptive design. For example, recreational facilities for the elderly, healing gardens for parent-child activities, etc., can improve nodes' utilization rate and radiation capacity, and increase social and emotional behavioural ties. In response to the weaknesses of the composite needs of the community, we guide the formation of hybrid nodes for joint construction, sharing and governance. For example, in response to the ageing problem, we add shared kitchens, shared living rooms, community medical care, and volunteer service stations to make up for the lack of original functions in physical space. Through activity organization, platform building, and publicity management, we guide residents to form the thinking and behaviour of co-build, share, and rule together, triggering more spontaneous social activities and enhancing community cohesion (Fig. 2).
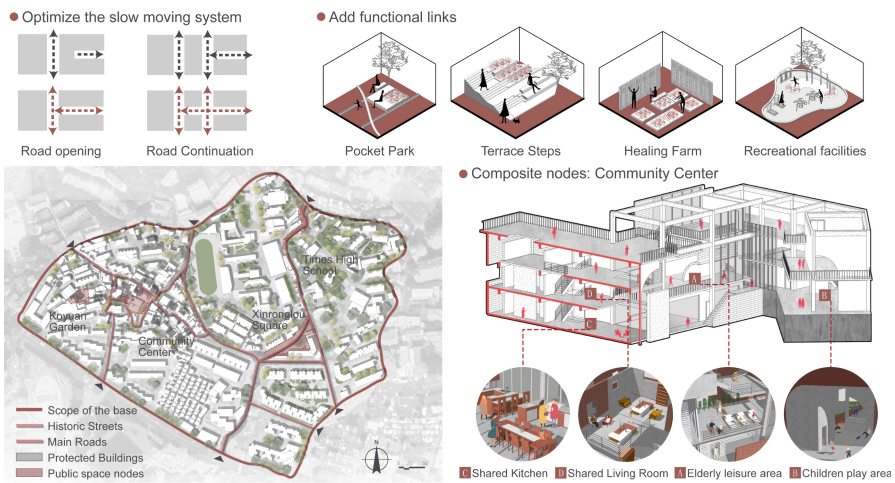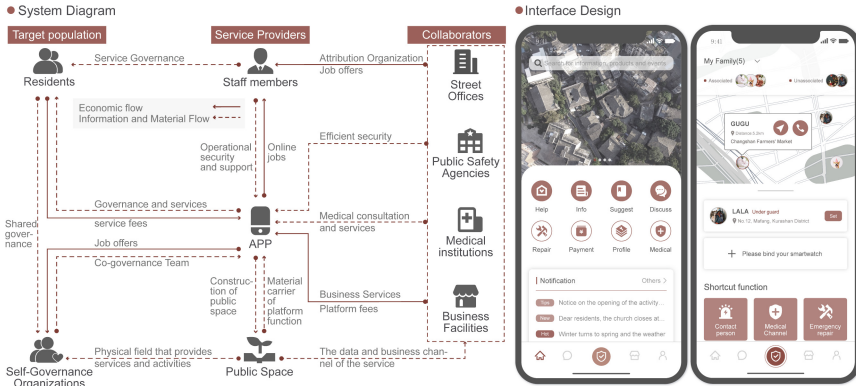

Fig. 2. Optimized design of public space in Machang Community

Fig. 3. System diagram and interface display of the online platform of Machang Community

4.2 Social Space - Community Service System Building

With the rapid development of the Internet, the traditional sense of "community" has been reconstructed. This app aims to start from the problems, such as indifferent neighbours and lagging services, and build a shared community, culture and three-dimensional collaborative communication network by relying on the design of shared public space [6]. The online circle of friends and the consultation and autonomy circle can effectively break social barriers and inspire them to promote community creation in a collaborative way, which in turn has a positive catalytic effect on the design of public space and then drives the community.

The functional structure includes the home page, personal account, neighbourhood, business circle and guardian. "Home" comprises quick service entrance, service bulletin board, life, business circle and activity recommendation, etc. The card-type layout brings users an immersive experience and guides them to locate quickly. "Neighborhood" relies on the public space material carrier to create a shared living room, a healing farm, a shared kitchen and other open platforms. It also provides community activities, lectures on epidemic prevention, and volunteer services. The "business circle" drives the commercial facilities inside and outside the horse factory, effectively improves the efficiency of material support under the normalization of an epidemic, improves the closed loop of community products through multi-linkage, and creates mutual help market to realize the exchange and resale of goods. "Guardian" generates guardian groups based on family members' information, associates family members for location sharing, can bind intelligent wearable devices for real-time health monitoring, and provides security guards and epidemic prevention services (Fig. 3).

5 Conclusion

Social innovation brings a new perspective to problem-solving for community creation. Based on the affinity diagram and hierarchical analysis, this study prioritizes numerous perceptual needs, avoiding the subjectivity and uncertainty of previous designs. The conclusions are obtained as below:

(1) In the evaluation of the primary indicators, residents put human-centred needs ($w_i = 0.4586$) and physical space needs ($w_i = 0.3048$) in the first place, followed by considering cultural building needs ($w_i = 0.1432$) and industrial development needs ($w_i = 0.0934$).

(2) Residents rated the secondary indicators higher for daily safety needs ($w_i = 0.1411$), public space creation ($w_i = 0.1388$), convenient government services ($w_i = 0.0986$), and transportation planning optimization ($w_i = 0.0801$).

(3) Based on demand indicator findings, design strategies for the renewal of public spaces and the construction of service systems are proposed in collaboration with the material and non-material dimensions to provide a reference for community creation in the perspective of social innovation.

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