

The Renewal Strategy of the Old Community from the Perspective of Social Network

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Abstract:

As a crucial component of China's urban development transformation, the renewal of aging communities has become pivotal for achieving high-quality urbanization. With the shift from "incremental expansion" to "stock optimization" in urban renewal, communities built in the 20th century face challenges such as functional obsolescence, environmental degradation, and diminished vitality. Guided by national policies, aging community regeneration has been prioritized in urban renewal agendas. Public spaces within these communities are transitioning from single-function to multifunctional hubs, necessitating integration of health promotion, social interaction, and other demands. However, accelerated population aging and homogenized public spaces exacerbate resource allocation imbalances, weaken social cohesion, and deepen intergenerational spatial segregation, forming a vicious cycle of "behavioral fragmentation-spatial differentiation." This study focuses on the public spaces of Friendship Neighborhood No. 18, Baotou, an aging community, and establishes a theoretical framework and practical pathway for renewal based on social network theory. Key contributions include: (1) Elucidating the intrinsic linkages between public spaces and social networks in aging communities, proposing a spatial analysis framework under social network theory; (2) Decoding spatial morphology and resident activity patterns through on-site investigations, constructing dual network models (public space network and activity network) with social network analysis, and identifying spatial-behavioral mismatches via parameter extraction and comparative analysis; (3) Proposing systematic renewal strategies—node activation, connection enhancement, and structural optimization—tailored to four spatial typologies (nodal, functional, landscape, and traffic spaces) to foster social network integration; (4) Quantifying renewal outcomes through a social network re-evaluation mechanism, forming a closed-loop research process (theory-empiricism-strategy-verification) to support spatial revitalization and social trust restoration. The research reveals the co-evolutionary dynamics between public spaces and social networks in aging communities, highlighting how network fractures accelerate spatial decay and erode social trust. By prioritizing social network repair as a catalyst for spatial regeneration, this approach harmonizes physical-environmental and socio-relational rehabilitation, revitalizing community integrity and vitality. It offers innovative insights for sustainable renewal of aging neighborhoods under stock optimization paradigms.

Keywords:

Social Network, Old Community, Public Space, Renewal

1. The Types and Characteristics of the Research Object

1.1. Types and Characteristics of Public Spaces in Aging Communities

1.1.1. Types of Public Spaces

The public space of old communities usually refers to the physical space that is naturally formed during long-term residence and use, with diverse functions and distinct community characteristics. According to their uses and forms, they can be classified into four major categories: node space, functional space, traffic space and landscape space. [1]

Node space specifically refers to the core area with significant aggregation and identification in the community spatial structure. Such Spaces often form a strong place memory through long-term spontaneous use and undertake multiple functions such as residents' social interaction, information exchange, and cultural inheritance. Unlike the conventionally designed modern community squares, the node Spaces of old communities are more organic and local. Functional space is an area that centers on meeting the daily needs of residents and carries specific services or social functions. This type of space is usually designed based on the actual living scenarios of residents, such as for rest, fitness, and convenient services, while also featuring flexibility and complexity. Landscape space is an important carrier that carries the daily life of residents and maintains the community memory. Its spatial form needs to balance ecological restoration, functional integration and cultural continuation within the limited land use. Such Spaces are usually embedded in the community texture in a fragmented form, such as green Spaces in front of houses, corner gardens or abandoned corner plots, and functional activation is achieved by preserving the original vegetation and implanting modular facilities. The traffic space shows the complexity of functions in the limited land use. [2] The narrow streets are not only the main passageways but also extend multiple functions such as parking, temporary commercial stalls, and children's games due to the living needs of residents, forming a linear public area full of life atmosphere. Meanwhile, semi-enclosed areas such as stairwells and corridors have transcended their single function of passage and evolved into social nodes where neighbors can run into each other and chat.

1.1.2. Characteristics of public Spaces

The public Spaces in old communities have formed a unique characteristic system due to long-term evolution: Firstly, the functions are highly mixed. The same site often serves multiple purposes such as fitness, socializing, and parking. Residents give the space a dynamic definition through spontaneous practice. Secondly, the spatial distribution is fragmented and uneven. There are both concentrated activity nodes left over from history and a shortage of public resources in densely built-up areas, resulting in significant differences in community quality. The aging of facilities contrasts sharply with the self-organized micro-updates by residents, such as adding flower POTS and making tables and chairs by themselves. These actions not only make up for the functional deficiencies but also shape the community's personality. These Spaces serve as carriers of social relationships, maintaining a close network of

acquaintances. Scenes such as the elderly playing chess and parents taking care of children solidify a stable sense of community identity. However, accessibility barriers and ambiguous ownership issues are prominent. Phenomena such as vehicles occupying roads and unauthorized construction occur frequently. Disputes over the boundaries between public and private sectors have become a governance difficulty. Meanwhile, the space carries the symbols of The Times such as the unit system slogan wall and the collective activity venue. It is not only a container of cultural memory but also the focus of intergenerational demand conflicts - the expansion of motor vehicles squeezing the walking space, and the differences in intergenerational activities causing noise and safety contradictions. These characteristics jointly constitute the complexity of the renovation of public Spaces in old communities, and it is urgent to balance the multiple dimensions of historical memory, functional requirements and social governance in the renewal process.

1.2. Types and Characteristics of Social Network Theory

1.2.1. Characteristics of social network theory

In social network analysis, “nodes” are the key to the structure. The relationships and interactions among “nodes” are connected through “edges”, constituting the entire social network. Among them, “node” is the foundation of the network, representing individuals, groups or organizations in the system. A node can refer to any entity with social relations, such as people, companies, institutions, associations, etc. “Edge” in a social network represents the relationship or interaction behavior between nodes and is the key to connecting nodes. An edge can be directed or undirected, depending on the characteristics of the relationship. The attributes and intensities of edges reflect the interaction patterns among nodes and have a direct impact on information dissemination, resource allocation, and the diffusion of social behaviors. The core idea of today’s social network theory is to understand social interaction by analyzing the “edges” between “points, believing that an individual’s behavior and results are related to their position and relationship in the social network, rather than analyzing the functions that a single individual can perform. In conclusion, the fundamental principles of social networks are structuring and interactivity, that is, individuals influence each other, individuals and groups, or groups themselves, and the form of social networks is determined through various relationships. [3] (i.e., Figure 1)

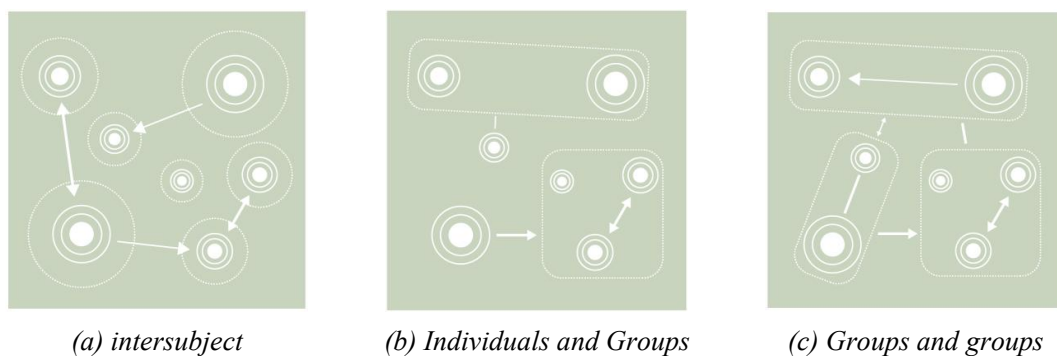


Figure 1. Basic principles of social networks.

1.2.2. Types of social network theory

Social networks can be classified and analyzed from multiple dimensions and are divided into three categories: First, based on the strength of relationships, they are classified into strong relationship and weak relationship networks [4]. The former is

characterized by high-frequency interaction and deep trust (such as kinship and friend relationships), emphasizing emotional support and precise information transmission; The latter is characterized by loose connections (such as ordinary social circles). Although it lacks emotional depth, it can link diverse resources and form a complementary cohesion and extensibility of social capital. Secondly, they are classified into closed and open networks based on the degree of structural closeness. Closed networks (such as traditional clan communities) strengthen group identity through high cohesion, but the flow of information is restricted. Open networks (such as modern urban communities) promote the circulation of resources across circles through blurred boundaries, but have relatively weak cohesion. The two jointly balance stability and expansion demands. [5] Thirdly, according to cultural logic differences, they can be divided into “group pattern” and “differential pattern” networks. [6] The former takes the institutionalized group identity as the core (such as Western social organizations) and relies on rules to maintain the structure. The latter is characterized by ethicalized differential order diffusion (such as traditional Chinese blood relations), allocating resources through the hierarchy of closeness and distance, and mapping the paths of social capital accumulation in different cultural contexts. The three classification criteria start from emotional intensity, structural form and cultural genes, providing a multi-dimensional analytical framework for social network research (i.e., Figure 2, Figure 3 or Figure 4).

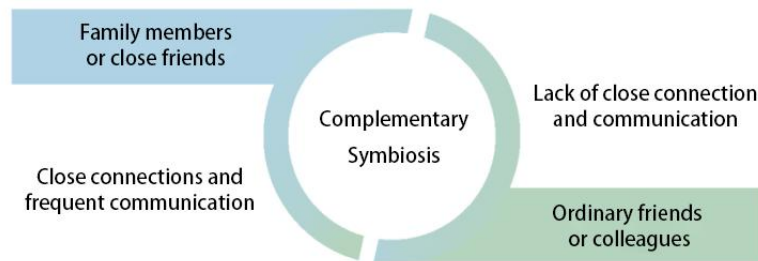


Figure 2. Strong Relation Network and Weak Relation Network.

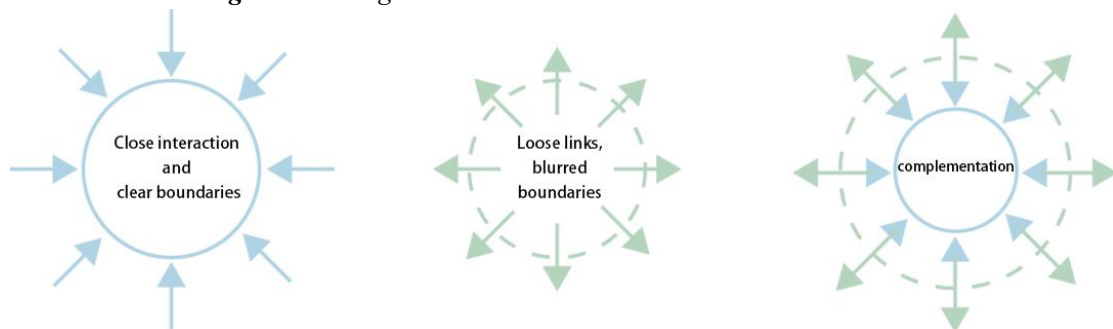


Figure 3. Schematic diagram of closed Network and Open network.

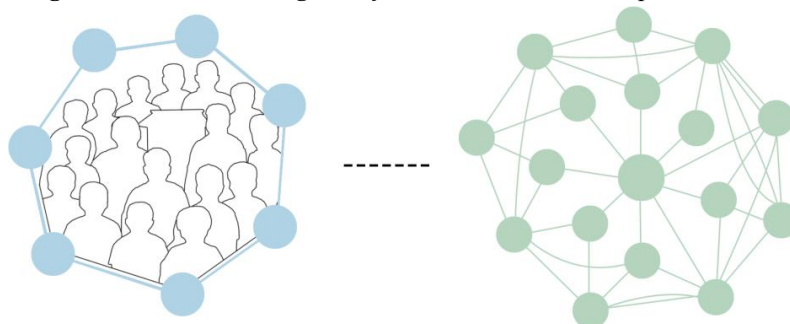


Figure 4. Schematic diagram of the “group pattern” network and the “differential pattern” network.

2. The Renewal Logic of Public Space in Old Communities Under the Theory of Social Networks

2.1. The collaborative construction of public Spaces and social networks

A social network is a specific structure formed by individuals or groups relying on a specific place space and conducting continuous social interaction through mutual relationships. As the main carrier of social interaction, public space has important functions of promoting interaction, transmitting information and building relationships. The two form two-way interaction through public activities as the medium: On the one hand, the public space shapes the structure and form of the social network through the "spatial production" mechanism; On the other hand, social networks react on the functions and layouts of public Spaces by influencing the types and intensifies of public activities[7]. This interactive relationship indicates that public Spaces are not only the material basis of social networks but also the core venues for enhancing social cohesion and repairing relationship networks, as shown in the Figure 5.

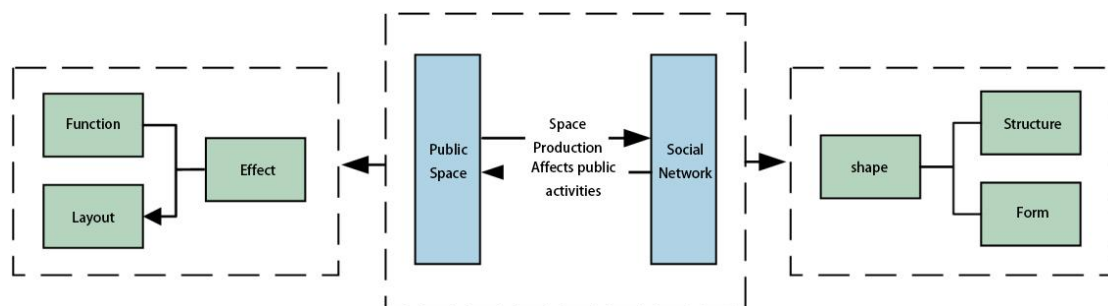


Figure 5. Schematic diagram of the Collaborative Construction of Public Space and Social Network.

The public space of the old community is a shared place located within the residential community and open to all residents for daily activities, social interaction and cultural inheritance. Its core features lie in the local nature of the service recipients, the complexity of functional design and the diversity of spatial forms [8]. Compared with city-level public Spaces, the service scope of public Spaces in old communities is more focused on specific residential groups, with clear coverage boundaries and user subjects. In terms of functional design, public Spaces in old communities pay more attention to complexity and inclusiveness. By integrating multiple functions such as leisure, fitness, social interaction, and culture, they meet the needs of all age groups, from children to the elderly [9]. In contrast, city-level public Spaces tend to undertake more single functions. The form of community public Spaces is closer to the scale of residents' daily lives, including small-scale and networked layouts such as pocket parks, neighborhood squares, and walkways. With the help of a series of public activities, a social network of "space - activity - relationship" is formed. [10]

2.2. Interaction Mechanism of Spatial-Social Attributes

The interaction between public Spaces and social networks presents the mutual construction logic of the dual attributes of "spatial-society": On the one hand, space, as the material carrier of social relations, reflects and strengthens the intensity and pattern of social interaction through functional layout and environmental design; On the other hand, social networks have a counter-effect on the function and layout of

space by influencing the types and intensity of public activities [11]. This two-way interconstruction relationship reveals that public space is not only the material basis of social networks, but also the core place for the accumulation of social capital and the reconstruction of cultural identity. Lefebvre's "Theory of Space Production" provides theoretical support for this logic, emphasizing that space is both the product of social relations and the medium of their reproduction [12], as shown in the Figure 6.

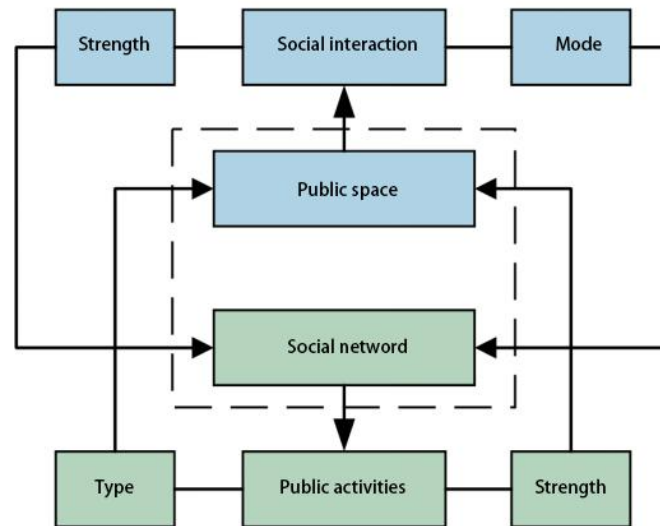


Figure 6. Schematic diagram of the interaction mechanism between spatial and social attributes.

2.3. Practical Paths for Public Spaces to Promote Social Integration

Public Spaces promote the integration of social networks through functional mixing and scene design. The key lies in breaking down barriers between groups, increasing interaction frequency, and restoring social capital. Through the layout of open interfaces and pedestrian networks, the space provides a material basis for communication among different groups [13]. Meanwhile, with the implantation of cultural symbols and the configuration of flexible facilities, it meets the needs of residents of different ages, occupations and cultural backgrounds. This integration path not only strengthens the trust foundation within the community, but also provides the connection of external resources and the introduction conditions of innovative elements, forming a complementary capital accumulation mechanism of "strong relationship - weak relationship", and ultimately achieving the dynamic balance and sustainable development of the social network, as shown in the Figure 7 [14].

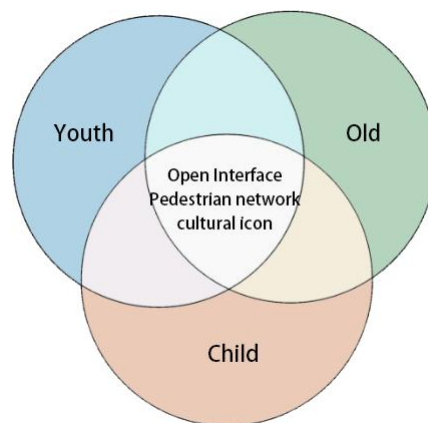


Figure 7. A schematic diagram of the practical path for promoting social integration in public Spaces

2.4. Spatial Feedback Mechanism of Social Network Changes

The dynamic changes of social networks have put forward new requirements for public Spaces, mainly reflected in the intensification of mobility and the differentiation of intergenerational demands. With the intensification of population mobility, the traditional strong relationship network based on geography is gradually weakening. The youth group is more willing to build social capital relying on online communities and professional networks. This prompts the functions of community public Spaces to shift towards diversification to meet the efficient interaction needs of the youth group. Moreover, intergenerational demands have become differentiated. For instance, the elderly group's reliance on static rest Spaces and the young group's preference for dynamic activity scenarios have driven the transformation of spatial design towards flexibility and modularization. For example, detachable stages and multi-functional squares are adopted to meet the diverse needs of different groups. Furthermore, the openness of social networks requires that the public Spaces in old communities should have greater inclusiveness and compatibility. They should not only be able to host diverse activities such as cultural markets and exhibitions, but also lower the participation threshold through open interfaces to avoid spatial exclusion, as shown in the figure. This driving mechanism indicates that in the process of social network changes, public Spaces should not only passively adapt to new demands but also actively innovate and design [15]. Its design needs to balance the requirements of functional adaptation and cultural resilience to cope with the complex challenges brought about by changes in social structure.(i.e., Figure 8)

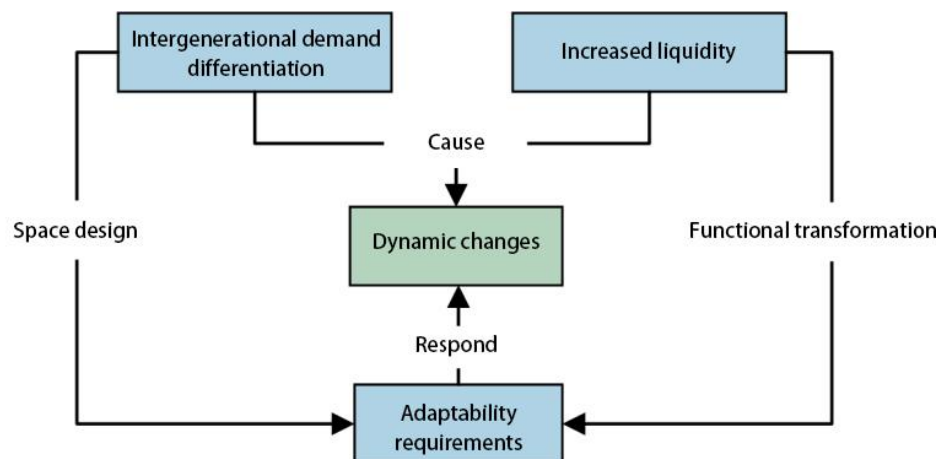


Figure 8. The spatial feedback mechanism of social network changes.

3. Case Study

3.1. Project Background

The renovation project focuses on the 18th block of Friendship in Baotou, an industrial city in northern China. It uses the social network analysis method to analyze the structural contradictions of its public space and propose renewal strategies. As a typical remnant of the workers' community during the planned economy period, the Soviet-style red brick building complex in the neighborhood carries a unique industrial memory. However, with the iteration of urban functions, the original public space has gradually exposed problems such as outdated facilities, fragmented functions and declining vitality. The high-density residential areas around the area are relatively concentrated, but there is a lack of shared activity venues that meet

contemporary needs. It is urgent to activate the community cohesion through spatial reconstruction. The existing industrial-style architectural space in Friendship 18th Block (i.e., Figure 9 or Figure 10).



Figure 9. Depthmap visual integration degree filters the results of public Spaces.



Figure 10. The public space further selects the numbered schematic diagram.

3.3. The construction of the public space

Network model is based on the “Urban Residential Area Planning and Design Standard GB50180-2018”. Residential areas are divided into four levels according to the service radius. This study focuses on the “residential neighborhood” level. Combining the feature that the proportion of the elderly population in the community is high, the accessibility threshold of the public space is set at a walking distance of 300 meters (about 5 minutes). Taking the shortest path of the current road as the benchmark, if the distance between the public Spaces is ≤ 300 meters, it is marked as “1” (with connection), and vice versa, it is marked as “0” (without connection). Based on this, a symmetrical adjacency matrix is constructed to provide a data basis for the quantitative analysis of the connection efficiency of the public space network (i.e., Figure 11)

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0	1	1	0	0	0	0	0	0	0	0	0	0
2	1	0	1	1	1	0	0	0	0	0	0	0	0
3	1	1	0	1	1	1	1	1	0	0	0	0	0
4	0	1	1	0	1	1	1	1	0	1	0	0	0
5	0	1	1	1	0	1	1	0	0	1	0	0	0
6	0	0	1	1	1	0	1	1	1	1	0	0	0
7	0	0	1	1	1	1	0	1	1	1	1	0	0
8	0	0	1	0	0	1	1	0	1	1	1	1	0
9	0	0	0	0	0	1	1	1	0	1	1	1	1
10	0	0	0	1	1	1	1	1	1	0	1	0	1
11	0	0	0	0	0	0	1	1	1	1	0	1	0
12	0	0	0	0	0	0	0	1	1	0	1	0	1
13	0	0	0	0	0	0	0	1	1	0	1	0	0

Figure 11. Adjacency matrix of public space network model.

The public space network model of Friendship 18th Block was constructed based on UCINET software, and the 13 nodes were color-coded according to four types of functions: leisure, sports, street corner and residential land. The network structure presents core-edge characteristics: It is composed of 64 connection lines forming a clustered layout. The central location nodes form a dense interactive network, while the edge nodes (especially in the community corners) show weak connections or isolated states (i.e., Figure 12)



Figure 12. Netdraw and neighborhood plane overlay model.

3.4. Construction of the Public Activity Space Network Model

Through on-site research, collect the activity preference data of the residents in the 18th block of Friendship: Firstly, mark 13 public space nodes in combination with the community map, and conduct interviews to record the high-frequency activity paths of residents in scenarios such as leisure, fitness, and consumption; Secondly, the individual activity trajectory is abstracted as a “node-path” relationship diagram. If there is an actual walking correlation between two nodes, it is marked as “1”, and if there is no correlation, it is marked as “0” [16]. Finally, the full sample paths are superimposed to form a weighted adjacency matrix. After this matrix is imported into

UCinet software, it can quantitatively analyze the shaping effect of residents' behavioral preferences on the spatial network, reveal the mismatch between implicit activity patterns and spatial demands, and provide empirical basis for the precise optimization of the functional configuration of public Spaces (i.e., Figure 13)

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0	1	0	0	0	0	0	0	0	0	0	0	0
2	1	0	3	1	0	0	0	3	1	0	0	0	1
3	0	3	0	1	0	0	0	7	0	0	1	0	2
4	0	1	1	0	4	0	0	0	1	2	1	0	1
5	0	0	0	3	0	1	0	0	0	1	1	0	1
6	0	0	0	0	1	0	1	0	2	2	0	2	0
7	0	0	0	0	0	2	0	1	2	5	4	1	1
8	0	3	7	0	1	0	1	0	4	8	6	2	4
9	0	1	0	1	0	2	2	4	0	0	2	5	1
10	0	0	0	2	1	2	5	8	0	0	0	1	0
11	0	0	1	1	1	0	1	6	2	0	0	2	0
12	0	0	0	0	0	2	1	2	5	1	2	0	0
13	0	1	2	1	1	0	1	4	1	0	0	0	0

Figure 13. Public activity network adjacency matrix.

The public activity space network model of Friendship 18th Block was constructed based on UCINET software, and the 13 nodes were color-coded according to functional types (leisure, sports, street corner, residential land). The model shows that the network is composed of 79 connection lines forming a closely clustered structure. The nodes in the central area interact densely, while the edge nodes (such as street corner Spaces) present weak connection characteristics (i.e., Figure 14)



Figure 14. Netdraw and neighborhood plane overlay model

3.5. Analysis of the Current Spatial Network Model and Transformation Strategies

(1) The difference in network density of spatial efficiency imbalance (0.5191 for public space - 0.5064 for activity space) indicates that residents' activities are concentrated in a few nodes (such as fitness squares, community activity squares), while some edge nodes (such as vacant Spaces between houses) are idle due to single functions or poor accessibility, forming a “cored-edge” differentiation. Although the core nodes (such as the Southwest Gate entrance square and the leisure square)

undertake the majority of the activity traffic, excessive reliance leads to significant network vulnerability - if the core nodes fail, the overall connectivity will drop sharply.

(2) Significant structural faults. The public space network of Friendship 18th Block shows significant structural contradictions: Firstly, the hierarchical fragmentation leads to insufficient spatial continuity. The mean centrality of the core node (18.7) differs greatly from that of the edge nodes (2.3), and the absence of intermediate transitional levels creates a fault effect. Secondly, the imbalance of location intensifies spatial differentiation. The vast majority of highly active nodes are concentrated on the main thoroughfares on the south side, while on the north side, due to historical planning flaws, residents have no willingness to go to this area, resulting in a relatively high rate of broken cross-district walking connections. Thirdly, functional misalignment highlights the disconnection between planning and demand. A typical example is that Node 4 (the entrance square) has the highest centrality in the public space (23.7), but drops to the 4th place (9.1) in the activity network. Node 2 (the fitness square) is completely isolated in the public space due to accessibility barriers, but rises to the top (22.8) in the activity network. The superposition of the three reflects that the spatial supply system is difficult to bear the dynamically evolving behavioral demands.

(3) Insufficient behavior-space adaptability: The carrying capacity of the public space in the 18th block of Friendship presents a dual contradiction: Firstly, although the actual activity paths of residents (79 connection lines) are denser than the spatial supply network (64 lines), the clustering coefficient of the activity network (0.31) is significantly lower than that of the public space network (0.42), reflecting that informal social behaviors (such as gathering on open Spaces between houses) are adapted to spatial functions.

4. Results and Discussion

4.1. Renovation Strategies

The public space renewal of Friendship 18th Block needs to establish a three-level collaborative strategy: Node activation focuses on three key Spaces - high-frequency used strong relationship nodes (squares, fitness areas), weak relationship nodes that promote cross-class interaction (express delivery stations, shared gardens), and cultural anchor points that carry collective memory (industrial heritage renovation), strengthening the material basis of social capital through functional iteration. Connection strengthening involves connecting scattered nodes through a slow-moving system, implanting guiding facilities such as art walls and circular walkways, shaping continuous behavioral trajectories, and enhancing the penetration rate of the spatial network [17]. Structural optimization addresses the issue of hierarchical fragmentation by filling structural holes (adding mixed-function nodes), implementing a multi-center layout (distributing service facilities to 3-5 secondary nodes), and activating edge Spaces (transforming carports into convenience stations). This reconstructs the “core-transient-edge” gradient hierarchy, achieving a simultaneous improvement in spatial efficiency and community resilience.

4.2. Construction of the Transformed Spatial Network model

The public space update of Friendship 18th Block reconstructs the social network through the four-dimensional strategy of “node value-added - node strengthening -

node replacement - node development”: Node proliferation precisely fills the network gaps. Based on topological analysis, inefficient nodes such as 3, 6, and 7 are extracted. Ten composite functional nodes (such as shared gardens and landscape corridors) are implanted in the idle areas to activate the spatial blind spots through functional complementarity and line of sight connection. Node strengthening focuses on core hubs (nodes 10 and 17), enhancing the spatial magnetic force of strongly related nodes such as the entrance square and community activity center through the implantation of art installations and the upgrade of smart lighting, thereby driving the efficiency improvement of surrounding nodes. Node replacement is aimed at contradictory Spaces with high topological value but low activity (such as node 11), transforming them into community farms and neighborhood deliberation halls to achieve a functional leap from “passage channels” to “communication carriers”. Node development explores hidden demand scenarios. For instance, the low-topology node 5 beside the primary school is transformed into a waiting area for parents. By embedding interactive water features and rest facilities, the average daily usage time is increased. The four types of strategies form a closed-loop logic of “filling - improving quality - transforming - activating”, enhancing network density and reducing the vulnerability of core nodes (i.e., Figure 15)



Figure 15. Update of public space nodes.

4.3. Comparison and Analysis of Spatial Network Models Before and after Renovation

The updated public spatial network model of Friendship 18th Block follows the dual principles of “residential level adaptation” and “5-minute walking accessibility”: taking 300 meters (the adult walking threshold) as the connection determination benchmark, the node spacing is calculated based on the shortest path of the existing roads, and a binary adjacency matrix is generated. The specific process is as follows: Starting from the geometric center of each node, if the distance between two nodes is ≤ 300 meters, it is marked as “1” (connection exists); if it is > 300 meters, it is marked as “0” (no connection). Eventually, a symmetric matrix is formed. This model quantitatively represents the topological correlation strength of the updated spatial network, providing a data basis for verifying the optimization efficiency of nodes and the improvement of network resilience (i.e., Figure 16 or Figure 17).

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0	1	1	0	0	0	0	0	0	0	0	0	0
2	1	0	1	1	1	0	0	0	0	0	0	0	0
3	1	1	0	1	1	1	1	1	0	0	0	0	0
4	0	1	1	0	1	1	1	1	0	1	0	0	0
5	0	1	1	1	0	1	1	0	0	1	0	0	0
6	0	0	1	1	1	0	1	1	1	1	0	0	0
7	0	0	1	1	1	1	0	1	1	1	1	0	0
8	0	0	1	0	0	1	1	0	1	1	1	1	0
9	0	0	0	0	0	1	1	1	0	1	1	1	1
10	0	0	0	1	1	1	1	1	1	0	1	0	1
11	0	0	0	0	0	0	1	1	1	1	0	1	0
12	0	0	0	0	0	0	0	1	1	0	1	0	1
13	0	0	0	0	0	0	0	1	1	0	1	0	0

Figure 16. Update the pre-matrix model.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	0	1	1	1	1	1	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0
2	1	0	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0
3	1	1	0	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
4	1	1	1	0	1	1	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0
5	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0
6	1	1	1	1	1	0	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0
7	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0
8	0	0	0	0	1	1	1	0	1	1	1	1	1	1	0	0	1	1	0	0	0	0	1
9	0	0	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	1
10	0	0	0	1	1	1	1	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	1
11	0	0	0	0	0	0	1	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	1
12	0	0	0	0	0	0	1	1	1	1	1	0	0	1	0	0	1	1	0	0	0	0	1
13	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0
14	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	1
15	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	1	1	1	0
16	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	1	1	1	0	0
17	0	1	0	0	0	0	1	1	1	0	0	1	1	1	1	1	0	1	1	1	1	0	0
18	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1
19	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	0	1	1	1	1
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	1	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	0
23	0	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	1	1	1	0	0	0	0

Figure 17. Updated matrix model.

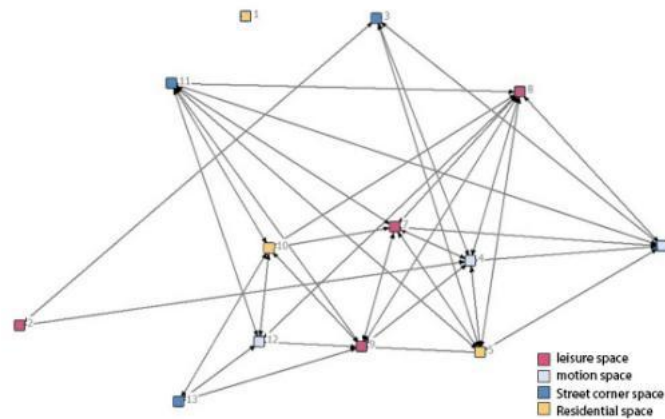


Figure 18. Update the Netdraw model of the public space network before.

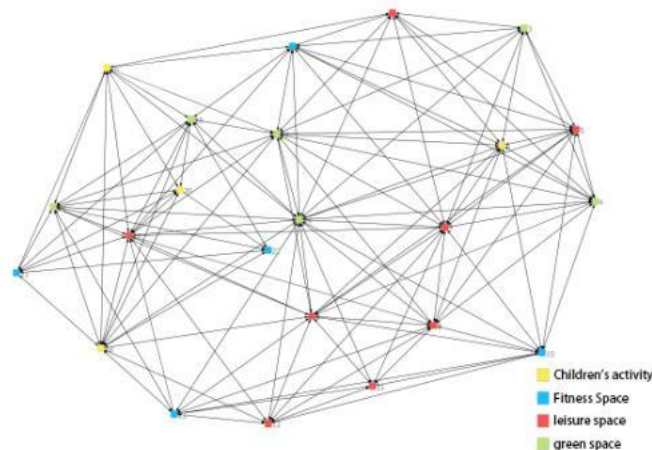


Figure 19. Updated Netdraw model of the public space network.

The updated public space network model of Friendship 18th Block was constructed through UCInet software and color-coded with four types of functions (nodes, functions, landscapes, and traffic Spaces). Compared with the network before the update, it is found that the addition of new nodes significantly increases the network density, isolated nodes are completely eliminated, and the average number of

connections per node increases to 6-7, forming a cluster structure with all-domain penetration (i.e., Figure 18 or Figure 19)

The public space update of Friendship 18th Block has achieved a multi-dimensional performance leap: the network density has jumped from 0.519 to 0.852, the feature path length has shortened by 37.5%, and the average node degree has increased from 5.385 to 10.696, confirming that the spatial connection strength and synergy have been significantly enhanced. By reconstructing the gradient hierarchy of “core - secondary - edge”, the control power of the core node decreased, and the small-world value increased to 2.46. This not only retained the characteristics of moderate clustering but also achieved full-domain penetration - the number of nodes within a 300-meter walking range of residents increased by 2-3, and the frequency of intergenerational interaction was enhanced. The optimization of the transportation system enhances the clarity of the spatial hierarchy, and the clustering coefficient reaches 0.57, confirming the improvement of functional complementarity. Data show that the “space-society” collaborative mechanism has successfully solved the problem of intergenerational isolation: the simultaneous renewal of the material environment repairs the disruption of the social network, integrates fragmented Spaces into resilient networks carrying complex activities, increases the average daily occurrence rate of non-essential activities, and thereby achieves the two-way appreciation of spatial efficiency and social capital.

5. Conclusions

This study proposes an old community renewal paradigm centered on the restoration of social networks, and its effectiveness is empirically verified through the 18th block of Friendship in Baotou City. Research reveals that industrial heritage communities lead to the loss of social capital due to spatial hierarchy fragmentation, functional dislocation and insufficient accessibility. Based on the analysis of social networks, a three-level strategy of “node activation - connection strengthening - structure optimization” was constructed. After implanting 10 composite functional nodes, the network density was increased, the length of feature paths was shortened, and the small-world value was increased, thereby achieving bidirectional empowerment of “space - society”. This model, through the methods of gradient repair, dynamic adaptation and cultural anchoring, not only continues the emotional identity of the community, but also reconstructs the resilient network, providing a replicable path to break the binary dilemma of “demolition and reconstruction - static protection”. The research aims to provide scientific methods for the renewal of urban public Spaces and promote the sound development of Spaces during the renewal process.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Author Contributions

Methodology: Han xu; Formal analysis: Han Xu; Investigation: Hanxu.Tie Wenyan.; Resources: Hanxu.Tie Wenyan.; Data Curation: Tie Wenyan; Writing – original draft preparation: Han Xu; Writing – review and editing: Hanxu.Tie Wenyan.;

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