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Construction of Urban Spatial Intelligent Planning and Design System Under the Background of Big Data

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ABSTRACT

Based on the induction of potentially utilisable micro-spaces in typical old residential communities, this study selects the communities located at 19 and 22 Yuhe Street, Taiyuan City, Shanxi Province, as typical research objects. By employing space syntax analysis, the spatial properties of these micro-spaces are examined and matched with the activity needs of various age groups within the community. By leveraging the characteristics of activity periods for all age groups, the study also proposes a composite design for less disruptive activity spaces. Consequently, optimisation suggestions for the renovation of public spaces in these two communities are presented, aiming to specifically meet the activity needs of residents of all ages within the limited space of the community. This research provides an analytical framework and methodological approach for the renovation strategies of old residential communities.

KEYWORDS

Old Residential Communities, Inter-Generational Co-Living Friendly Space, The Space Syntax

CONSTRUCTION OF URBAN SPATIAL INTELLIGENT PLANNING AND DESIGN SYSTEM UNDER THE BACKGROUND OF BIG DATA

As China's urban development enters a crucial phase of urban renewal, transitioning from extensive construction to the enhancement of existing structures, the focus has shifted toward improving the quality of existing urban spaces. Among these quality improvements, the revitalization of old residential communities has become a significant concern. However, owing to the early construction periods of these communities, they often lack sufficient public activity spaces. This shortage, compounded by a lack of awareness of providing specialized services for different age groups, results in intergenerational conflicts in the already scarce public activity spaces. Therefore, in upgrading these communities, a new emphasis is placed on constructing inter-generational co-living friendly spaces based on the concept of a lifelong healthy community, addressing the needs of various age groups and promoting intergenerational interactions.

Research Subjects

Taiyuan, located in the central part of Shanxi Province, is a representative old industrial base in China. During the urbanization process, Taiyuan constructed numerous multi-story residential

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communities, mostly built in the 1980s and 1990s. These old residential communities commonly face challenges related to insufficient public activity spaces. Addressing this situation, I aim to explore how to unlock the limited spatial potential within these old residential communities and develop renewal strategies for these cross-generational co-living spaces.

RESEARCH AND ANALYSIS OF THE CURRENT OUTDOOR PUBLIC SPACE IN OLD RESIDENTIAL COMMUNITIES IN THE SIX DISTRICTS OF TAIYUAN CITY

The empirical investigation of the current state of outdoor public spaces in old residential communities across the six administrative districts of Taiyuan City revealed that these neighbourhoods face common challenges: a scarcity of internal space resources, a monolithic form of green spaces, and the ineffective utilization of numerous abandoned and idle corner spaces. The revitalized public activity spaces in these old residential communities also exhibit issues, including low utilization rates, diminished vibrancy, and a limited diversity of user demographics. In summary, the limited activity spaces within old residential communities are insufficient to meet the diverse and differentiated activity needs of all age groups. The potential micro-spaces within these communities are also often in a state of neglect and have not been fully utilized.

Inter-Generational Friendliness

"Inter-generational" refers to every resident throughout their life cycle, including birth, growth, education, work, marriage, childbirth and elderly care, covering all age groups. "Friendliness" denotes providing inclusive public services for all age groups, while also catering to the specific and diversified needs of different age groups.

METHODS

Research Subjects

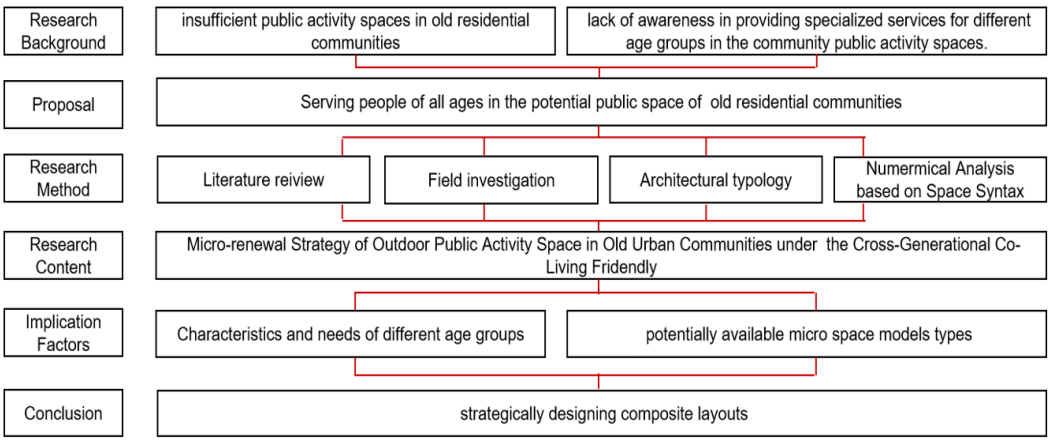
For this study I selected two representative old communities in Tianyuan City as the primary research subjects. The selection of these representative communities was based on the following criteria:

- The Taiyuan Urban Renewal Plan for Old Residential Communities 2020–2025 (Fang et al., 2021) issued by the Taiyuan Municipal Government focuses on the renovation of old residential communities built before 2000. These communities lack a complete infrastructure and whose residents express a strong desire for renovation.
- The communities targeted for renovation conform to two typical identified spatial structures.
- Potentially available micro-space models exist within the communities.

Research Process

The research process is shown in Figure 1. Through on-site inspections of old residential communities in Taiyuan, abstract methods were employed to summarize and extract the types and characteristics of potentially available micro-spaces. Using the mathematical logic principles of spatial syntax theory to quantify the spatial characteristics, I describe the spatial attributes of potentially available micro-spaces. Subsequently, by analyzing the physiological and psychological characteristics of different age groups, I further evaluated the degree of demand for the four major spatial attributes by different age groups. The corresponding population demands were matched with the spatial attribute data obtained from spatial syntax analysis, leading to the development of micro-space utilization strategies suitable for different age groups.

Figure 1. Research flowchart



SPACE TYPOLOGY INDUCTION

Two Typical Models of Old Residential Communities

In addressing the underutilization of potential spaces within old residential communities, I conducted on-site inspections of 48 randomly selected old residential communities across the six administrative districts of Taiyuan City. I compared and recorded the characteristics and locations of potential spaces, and then I identified two typical community models and nine potential micro-spaces. These spaces, to some extent, alleviate the land resource constraints in old residential communities and compensate for the sacrificed public spaces primarily used for addressing parking issues. They also serve as spatial samples for subsequent space renewal strategies in this study. The specific classifications are as follows:

The research revealed that the majority of old residential communities are enclosed, featuring two types of entrance locations: centrally positioned along the community's boundary and at the corners of the community's boundary. The architectural layout predominantly follows a row-style arrangement, with the community structured by a main road or multiple alleys leading to entrances and several paths leading to residential units. Green spaces between residences and outdoor parking areas are linearly arranged and integrated with residential units. A schematic representation is provided in Figures 2 and 3.

Models of Three Potential Micro-Spaces in Typical Old Residential Communities

In relation to the distinct spatial locations within the two typical old residential community models, the nine potentially usable micro-spaces (Hou & Guo, 2016) can be categorized. These categories are listed in Table 1.

SPATIAL SYNTAX ANALYSIS BASED ON MICRO-SPACES

I conducted a syntactic analysis based on micro-spaces using representative cases from the research. Both communities were constructed before 2000 and suffer from inadequate infrastructure, with residents expressing a strong desire for renovation. Within these communities, potentially utilizable micro-space models exist that have been identified through typological induction. These are, specifically, numbers 19 and 22 Yu He Street, corresponding to the central entrance and corner entrance types at the community boundary. Spatial syntax analysis is performed using depthmap

Figure 2. Type of entry at the center of the cell boundary

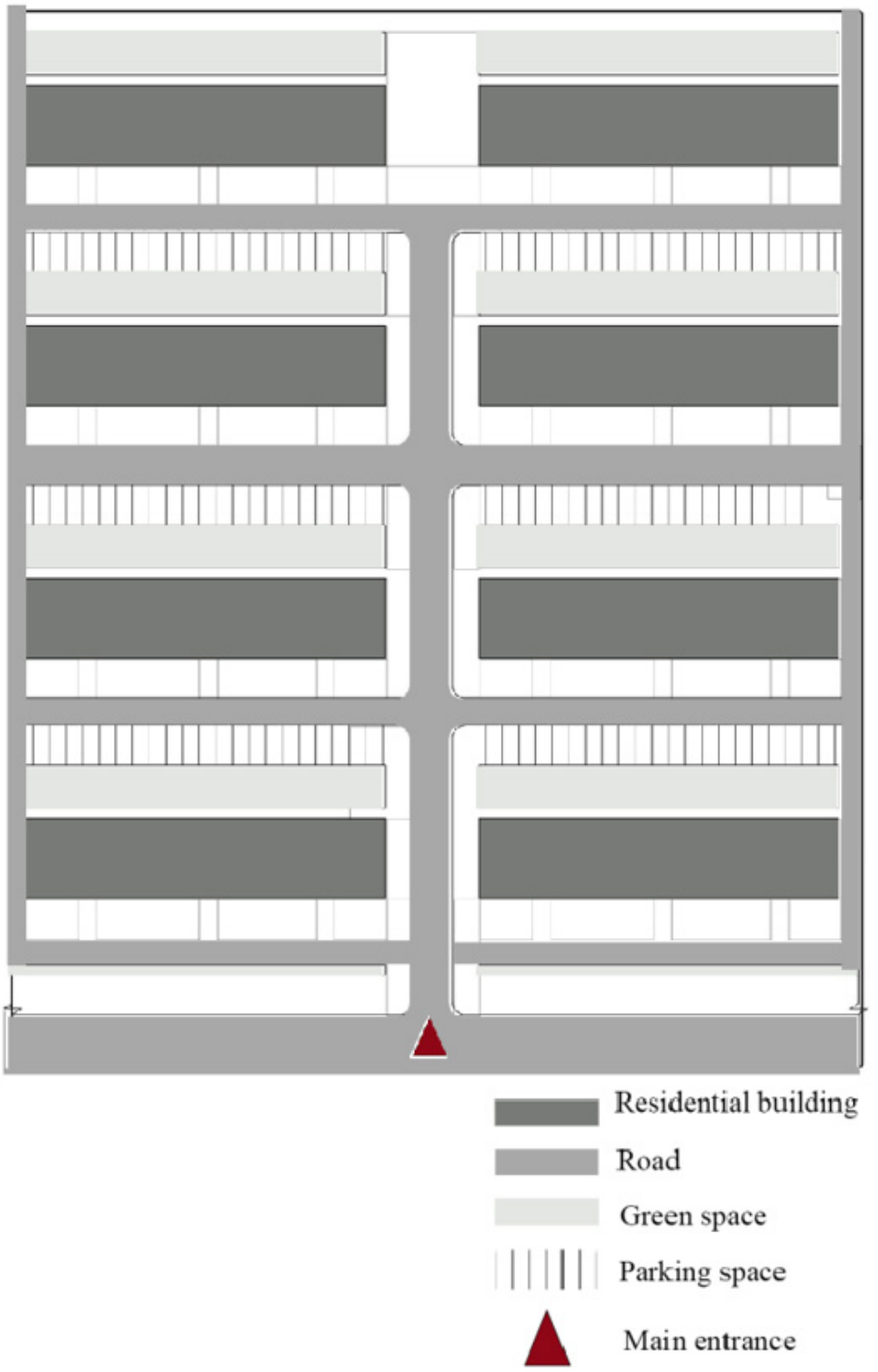


Figure 3. Type of entry at the center of the cell boundary

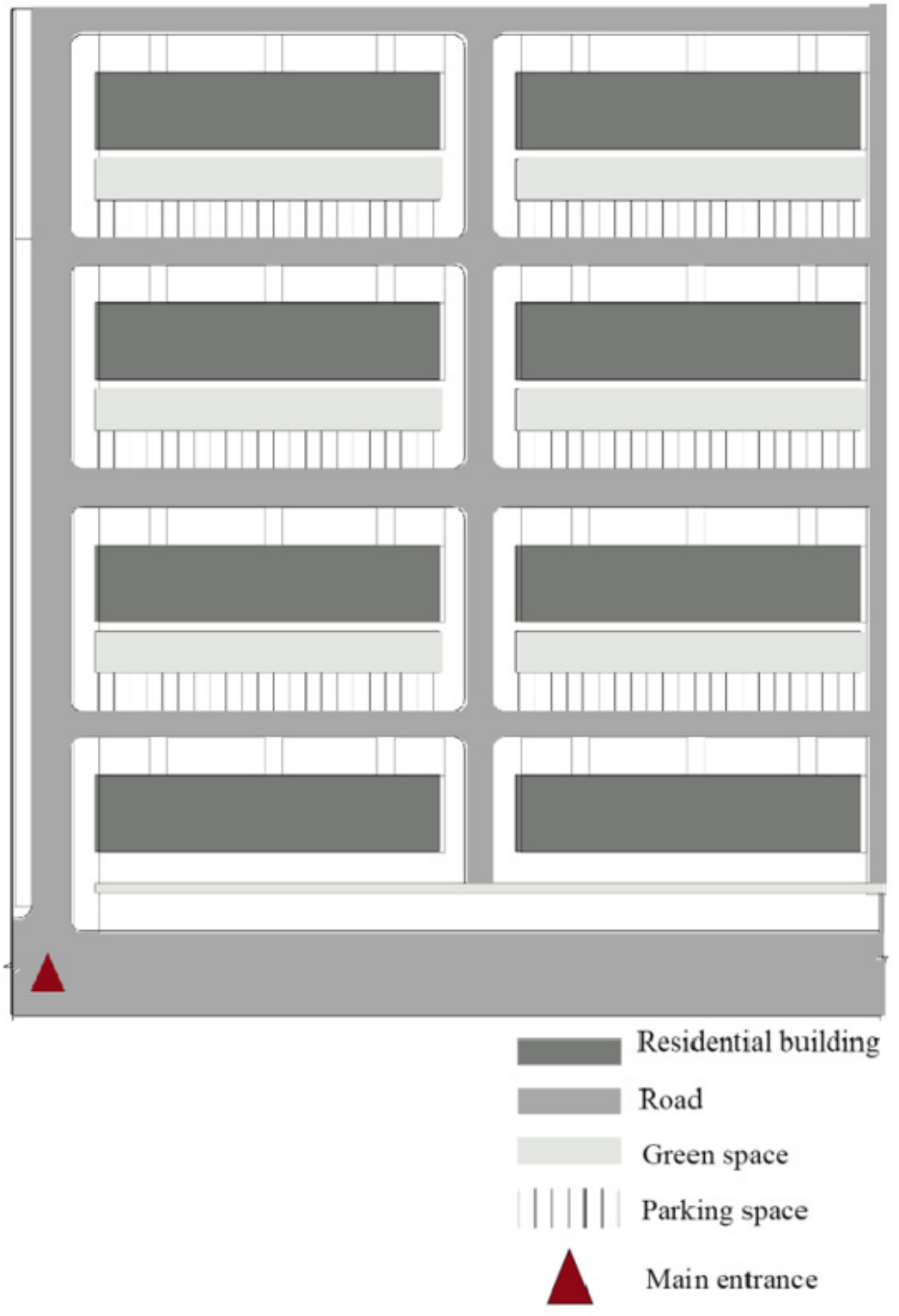


Table 1. Nine kinds of potentially available micro-space models for typical old residential areas

Site location	Model illustration		On-site representation
Spaces between residential building	1. End spaces adjacent to the walls between residential buildings		
	2. Wider green spaces between residential units		
	3. Spaces near group roads between residential units		

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Table 1. Continued

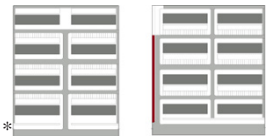
Site location	Model illustration		On-site representation
Spaces of the community boundaries	4. Wider sidewalks along the community boundaries		
	5. Spaces near group roads between residential units north-south elongated		
	6. Corner spaces at the turning points of the community boundaries		
	7. Narrow passages between community residential buildings and outer roads (east-west orientation)		

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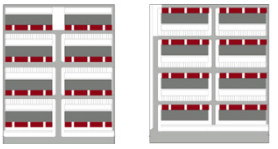
Table 1. Continued

Site location	Model illustration		On-site representation
Entry spaces	8. Entry spaces of the community		
	9. Entry spaces of residential units		

software to analyze their public spaces by axial line analysis and visibility graph analysis. This process aims to further assess the spatial attributes of various micro-spaces within these two typical old residential community models. Study area maps of 19 and 22 Yu He Street are shown in Figures 4 and 5, respectively.

Figure 4. Study area map of 19 Yu He Street

Figure 5. Study area map of 22 Yu He Street

Integration

The integration, starting from a particular element and reaching any other element in the spatial system, is calculated by summing the number of times the line of sight needs to turn from the starting point to the endpoint. This sum is considered as the global visual depth (total depth) from the starting point. On this basis, the visual global integration (int) is obtained. The normalized integration is represented in equation (1).

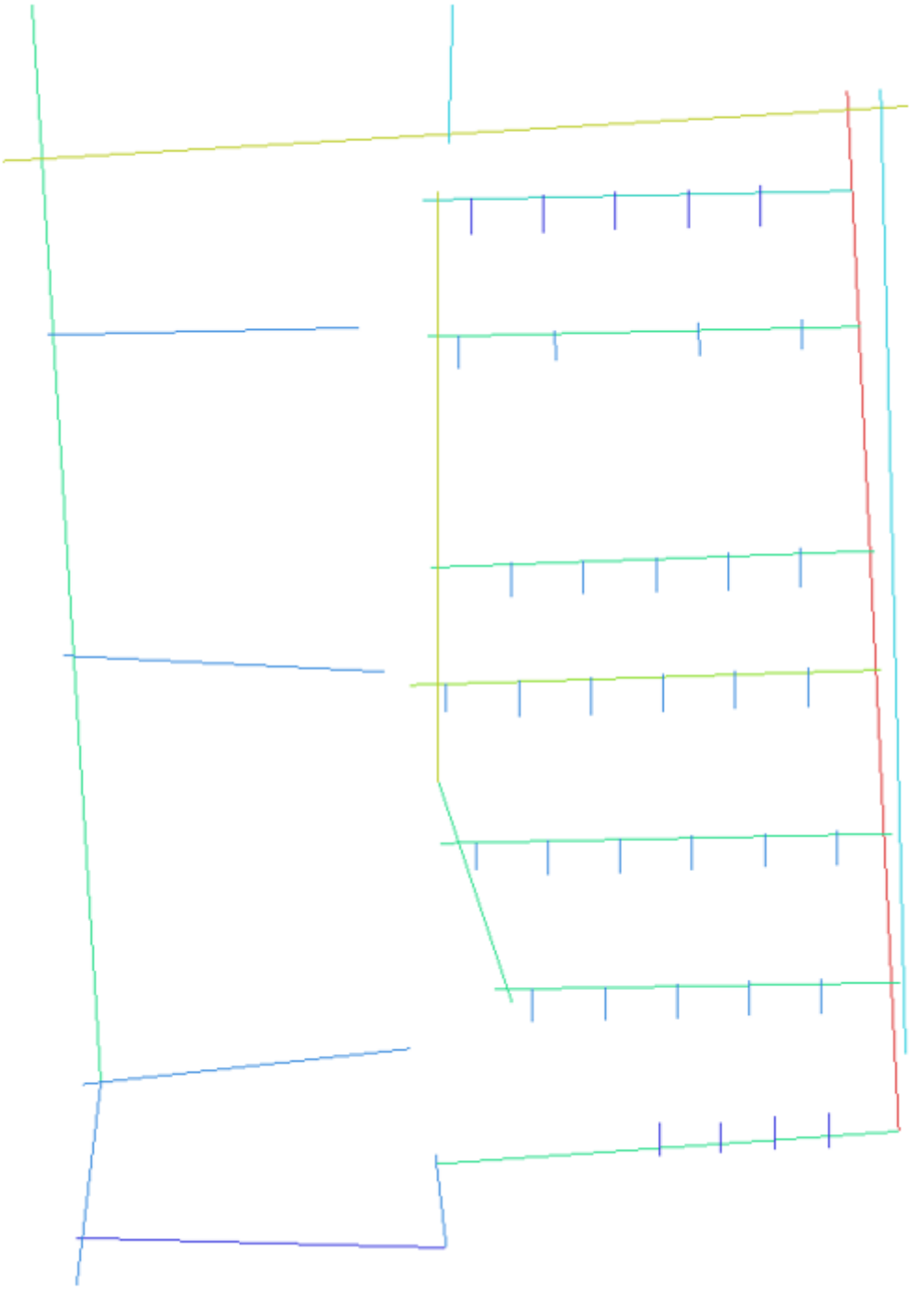
$$NAIN_i = n^{1.2} / \sum_{j=1}^{n-1} d(i-j), i \neq j \quad (1)$$

Integration signifies the closeness of the connections between an element and nearby elements within a few topological steps (Wang, 2012). A higher visual integration value indicates better accessibility from that element to others, facilitating the formation of pedestrian flow and triggering collective human behaviour (Jiang et al., 2021). Local integration refers to the computation of the degree of integration among three-step topological relationships, whereas global integration pertains to the computation of the degree of integration across all topological relationships (represented by Rn) (Fang et al., 2021). In most cases, the walking scale within an urban system can be represented by three syntactic steps. Table 2 presents the local integration value of the space syntax for 22 and 19 Yu He Street. Local integration analysis diagrams of 22 and 19 Yu He Street are shown in Figures 6 and 7, respectively.

Intelligibility

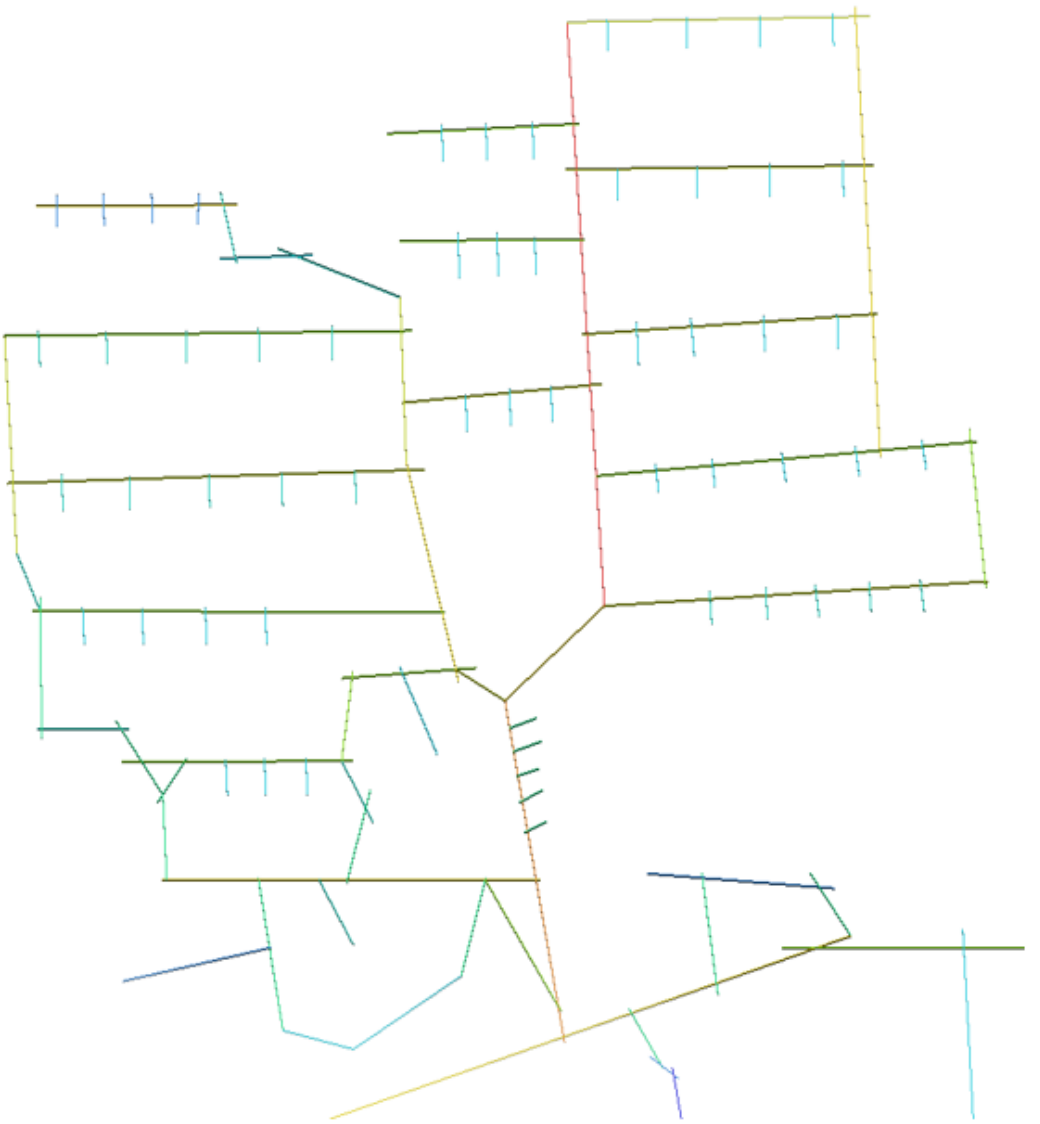
The comprehensibility of a space is reflected in the linear analysis and fitting relationship values (R3) between connectivity and local integration. A higher R3 indicates a stronger correlation between connectivity and local integration, suggesting that residents can better predict the overall spatial conditions from local spaces, guiding their own travel activities (Shaoyao, at al., 2018). When R3 is less than 0.5, it indicates poor spatial comprehensibility, thus implying a lower level of recognition

Figure 6. Local integration analysis diagram of 22 Yu He Street



for the space. Figures 8 and 9 show intelligibility analysis of the 19 and 22 Yu He Street Courtyards, respectively. Table 3 lists R3 values for various types of micro-spaces for 19 and 22 Yu He Street.

Figure 7. Local integration analysis diagram of 19 Yu He Street



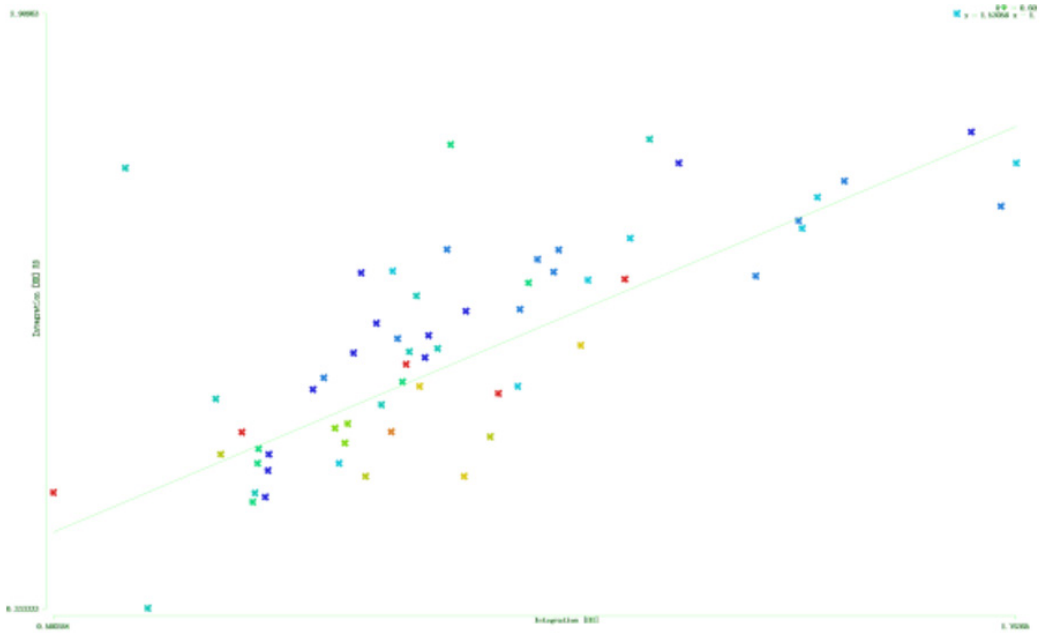
Choice

Choice refers to the ratio of the number of times the shortest path $\sigma_{s,t}$ crosses a specific axis i to the total number of shortest paths, aiming to describe the extent to which a street segment is part of the shortest path and measure the spatial potential of crossing that street. This calculation is shown in equation (2).

$$Ch_i = \sigma_{s,t}(i)\sigma_{s,t}, i \neq s \neq t \quad (2)$$

In segment analysis, a higher number of segments makes the choice more influenced by the scale of the urban system. The normalized choice is determined by the ratio of choice to the generalized

Figure 8. Intelligibility analysis of 19 Yu He Street Courtyard

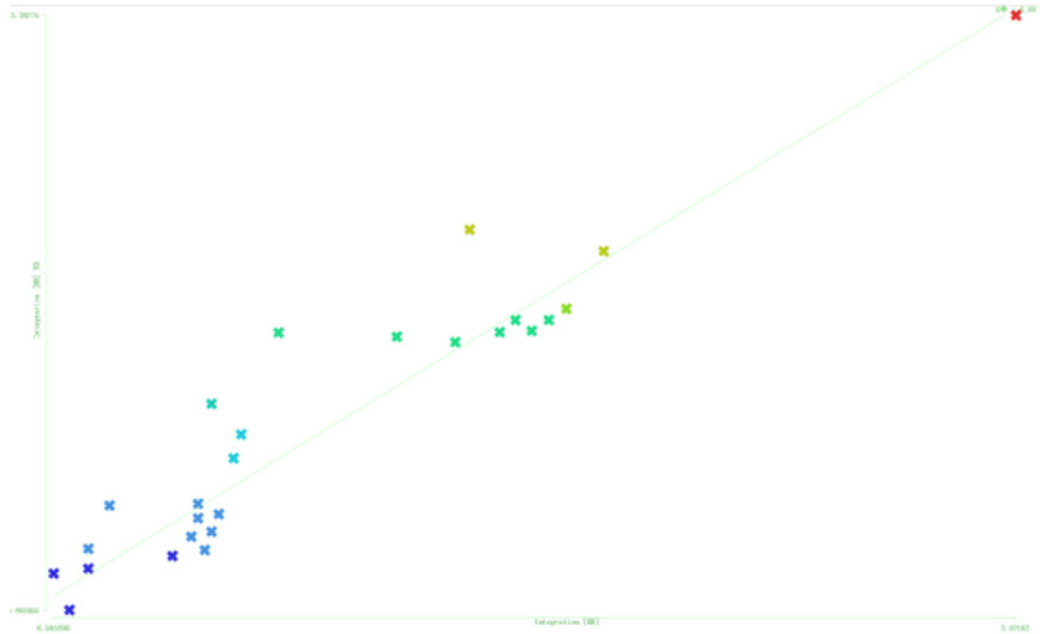


distance (total depth). This ratio signifies that individuals located on a specific street segment are likely to encounter others traveling along the shortest path to that segment without reaching other

Table 2. Spatial integration of micro-space

Old residential community type	Space name	Local integration value
The type of entry at the center of the cell boundary(19 Yu He Street)	End spaces adjacent to the walls between residential buildings	2.99
	Entry spaces of the community	2.46
	Narrow passages between community residential buildings and outer roads (east-west orientation)	2.40
	Spaces near group roads between residential units	2.32
	Wider green spaces between residential units	1.89
	Entry spaces of residential units	1.06
Type of entry at the corner of the cell boundary(22 Yu He Street)	Entry spaces of the community	3.40
	Narrow passages between community residential buildings and outer roads (east-west orientation)	2.48
	Corner spaces at the turning points of the community boundaries	2.11
	Spaces near group roads between residential units	2.10
	Spaces near group roads between residential units	2.00
	Wider sidewalks along the community boundaries	1.51
	Entry spaces of residential units	1.27

Figure 9. Intelligibility analysis of 22 Yu He Street Courtyard



street segments. This type of ratio is considered as potential spatial benefits. The higher the choice of a spatial node area within a community, the more likely it is to attract residents. Consequently, the potential for residents to appear, linger, and rest in that spatial node increases, enhancing its vitality. This calculation is shown in equation (3).

$$NACH_i = \log\left(\sigma_{s,t}(i)/\sigma_{s,t} + 1\right)/\log\left(\sum_{j=1}^{n} d(i,j) + 3\right), i \neq j, i \neq s \neq t \quad (3)$$

Figures 10 and 11 show selection analysis results for 19 and 22 Yu He Street Courtyards, respectively. Table 4 lists choices of micro-spaces for 19 and 22 Yu He Street Courtyards.

Visual Connectivity

The algorithm principle for visual connectivity involves establishing a grid within the spatial region under study, with each grid representing an element. In this context, a grid cell is set to be 1,000 × 1,000 mm, with the assumption that one person occupies a width of 500–550 mm in a pedestrian flow. Each element's visual connectivity value is determined by counting how many other elements are visible when looking outward from that element. Lower numerical values correspond to cooler colors, while higher values result in warmer colors. The color spectrum, with red representing the highest numerical range, visually indicates the intensity of visual connectivity. A higher visual connectivity value for a specific element implies a tighter connection with the surrounding space, making it more easily noticeable. From the perspective of community visibility, higher visual connectivity leads to smaller visual blind spots, enhancing safety.

Integration [HH] (global integration) is used to describe the accessibility and connectivity of a space within the entire spatial system. It measures the centrality or integration level of a space in the overall system, specifically indicating the average number of steps (or distance) required to reach all other spaces in the system from that particular space. A higher integration [HH] value means that the

Table 3. Intelligibility of micro-space

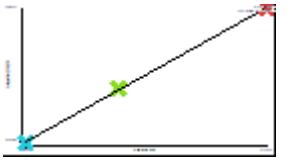
Old residential community type	Space name	R3	Scatter plot
The type of entry at the center of the cell boundary(19 Yu He Street)	End spaces adjacent to the walls between residential buildings	0.999	
	Entry spaces of the community	0.875	
	Narrow passages between community residential buildings and outer roads (east-west orientation)	0.197	
	Spaces near group roads between residential units	0.628	
	Wider green spaces between residential units	0.65	
	Entry spaces of residential units	0.414	

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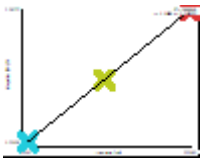
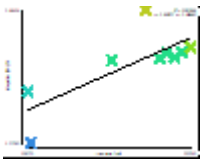
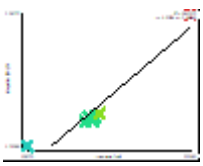
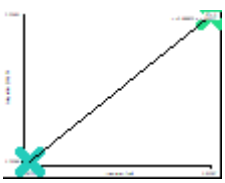
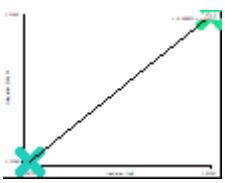
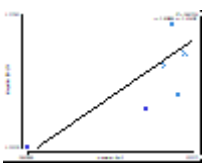
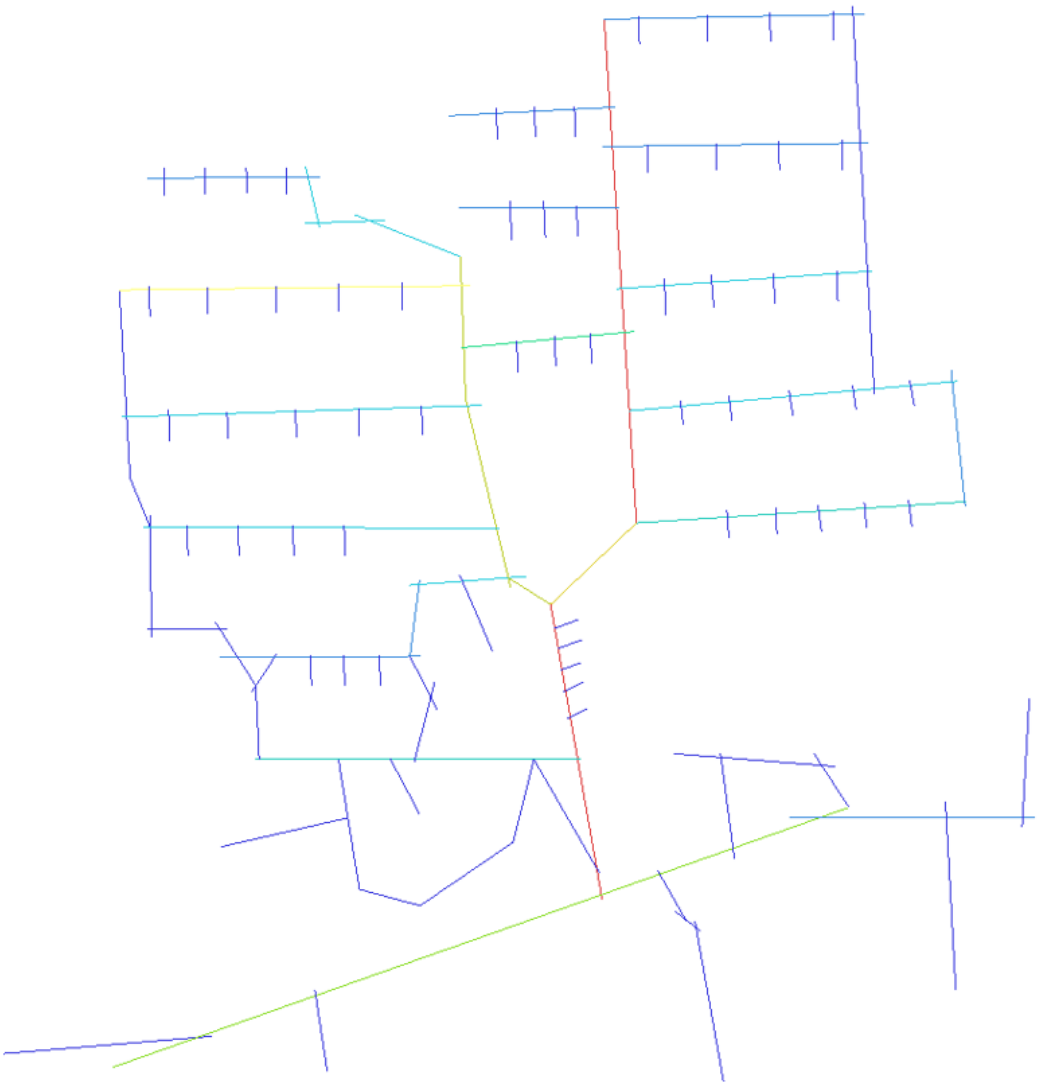
Table 3. Continued

Old residential community type	Space name	R3	Scatter plot
Type of entry at the corner of the cell boundary(22 Yu He Street)	Entry spaces of the community	0.999	
	Narrow passages between community residential buildings and outer roads (east-west orientation)	0.588	
	Corner spaces at the turning points of the community boundaries	0.881	
	Spaces near group roads between residential units	0.917	
	Spaces near group roads between residential units north-south elongated	1	
	Wider sidewalks along the community boundaries	1	
	Entry spaces of residential units	0.667	

space is more easily accessible from other locations within the system, implying greater centrality and connectivity within the entire system.

Figures 12 and 13 show visual connectivity analysis of the 19 and 22 Yu He Street Communities, respectively. Figures 14 and 15 show integration [HH] for the 19 and 22 Yu He Street Communities, respectively. Table 5 lists visual connectivity of various micro-spaces.

Figure 10. Selection analysis of 19 Yu He Street Courtyard



ANALYSIS OF ACTIVITY PREFERENCES AND DEMANDS FOR RESIDENTS OF ALL AGES

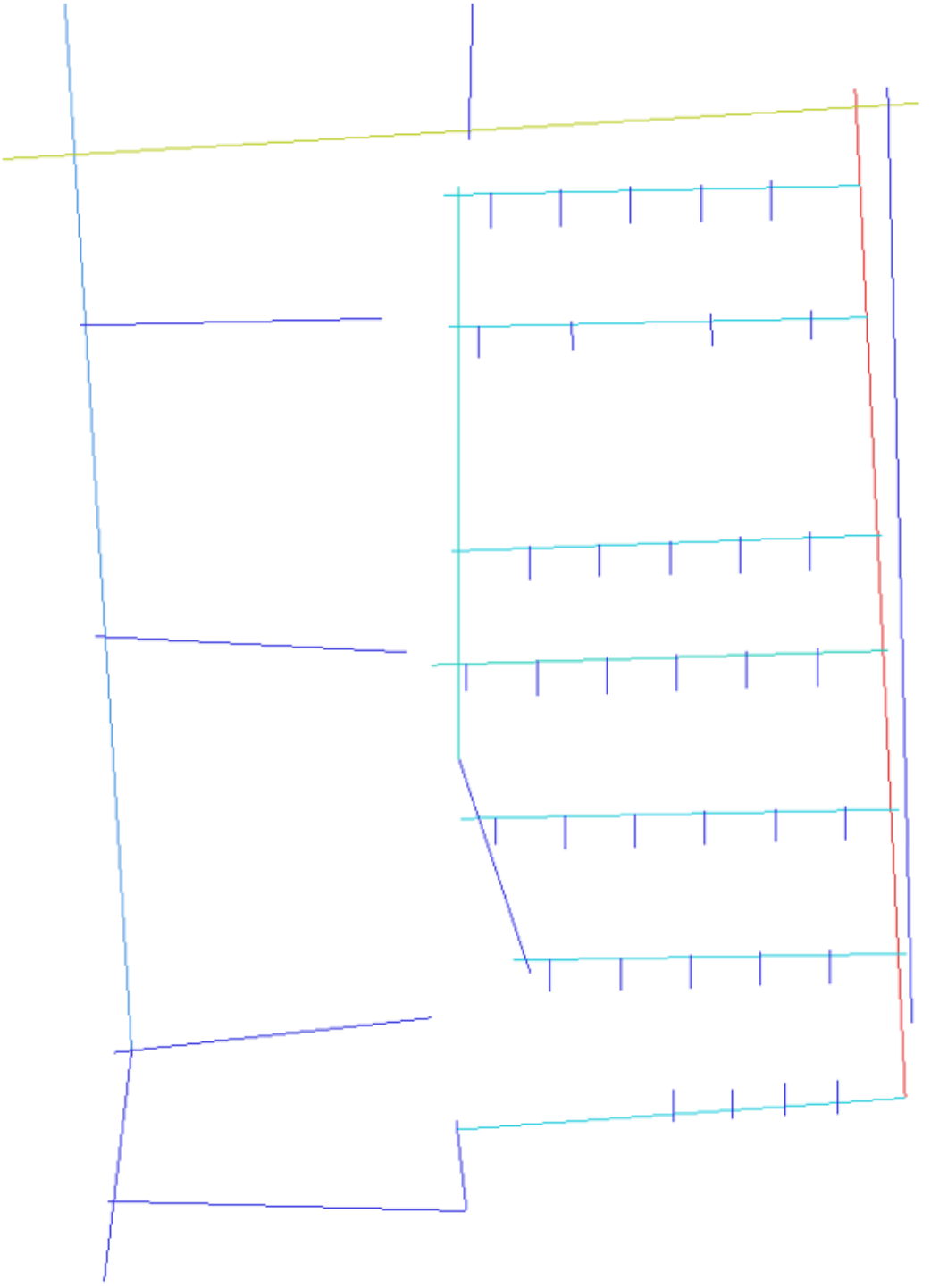
By examining the psychological and physiological characteristics of different age groups, surveying their preferences for spatial privacy, openness, socializing and solitude, and considering their preferred activity periods, I intend to further evaluate the proportional demands of residents of all ages for micro-spaces in terms of accessibility, safety, recognizability, and vitality index.

Analysis of Characteristics for Residents of All Age Groups

Children (Under 17 Years Old)

Children are in the early stages of growth and development, with incomplete physical functions, leading to a strong demand for safety and accessibility in community public activity spaces. Because

Figure 11. Selection analysis of 22 Yu He Street Courtyard



of their limited cognitive abilities, requirements for the recognizability of spaces are higher. Given

Table 4. Choice of micro-space

Old residential community type	Space name	Choice
The type of entry at the center of the cell boundary(19 Yu He Street)	Entry spaces of the community	5,424
	End spaces adjacent to the walls between residential buildings	5,265
	Spaces near group roads between residential units	4,082
	Wider green spaces between residential units	1,102
	Narrow passages between community residential buildings and outer roads (east-west orientation)	949
	Entry spaces of residential units	0
Type of entry at the corner of the cell boundary(22 Yu He Street)	Entry spaces of the community	2,590
	Spaces near group roads between residential units	1,594
	Narrow passages between community residential buildings and outer roads (east-west orientation)	817
	Corner spaces at the turning points of the community boundaries	704
	Spaces near group roads between residential units	590
	Wider sidewalks along the community boundaries	0
	Entry spaces of residential units	0

that their activities are often accompanied by adults, considering the needs of parents for external spaces during supervision is crucial. Therefore, integrating public activity spaces for adults with those designed for children is advisable.

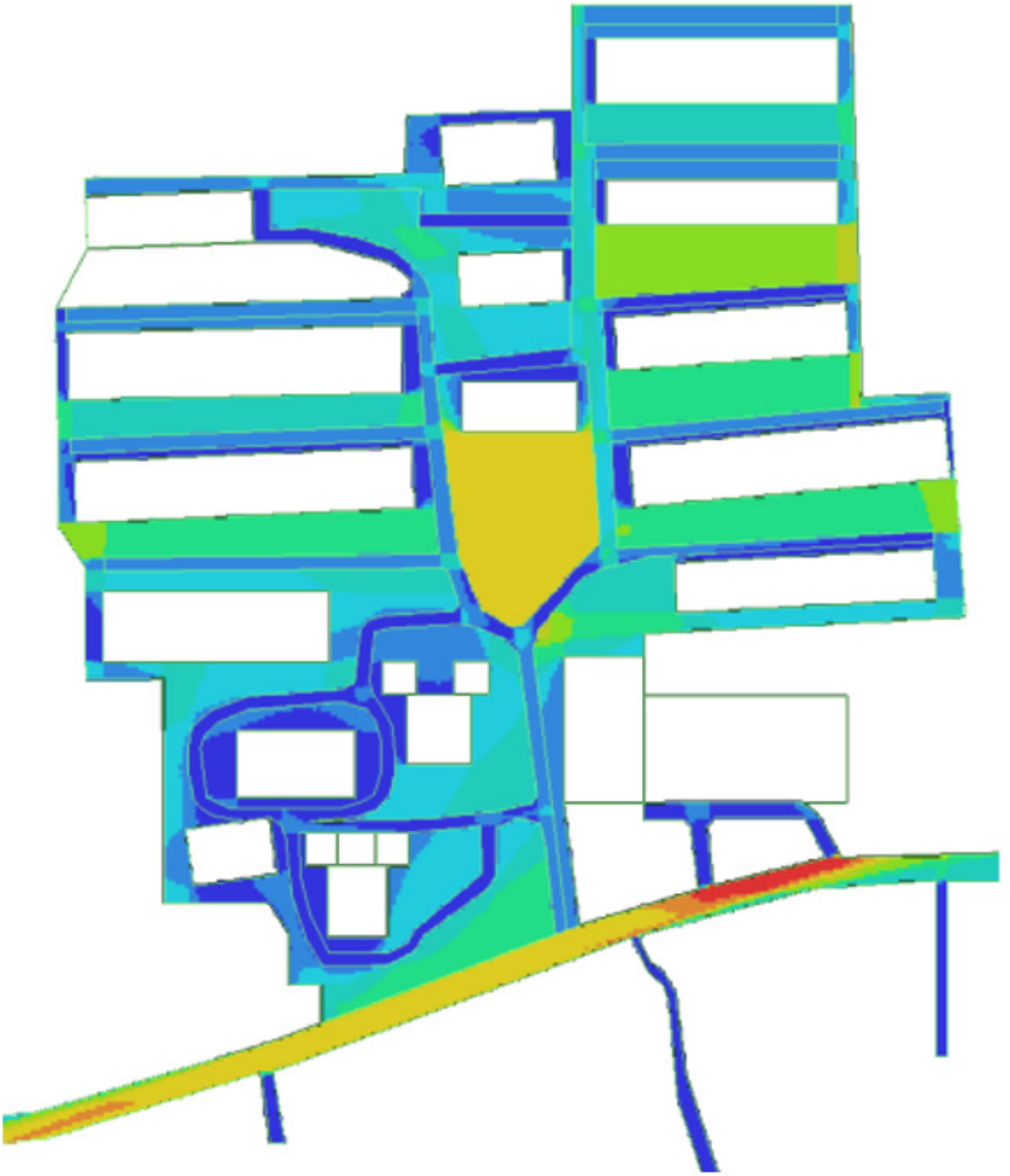
Youth (Ages 8–18)

The adolescent group is still in a stage of physical and mental growth, and community public spaces become an important means for them to interact with society. Their daily activities mostly occur within the community without being limited by distance. Any space within the community can serve as a venue for their activities, with relatively lower requirements for space accessibility. Compared with the children's group, adolescents have lower safety requirements for their activities, although it remains an important consideration.

Adults (Ages 19–40)

The young adult group is in a stage of physical and mental maturity, with superior perceptual abilities, cognitive functions, and muscle coordination. Their demand for external spaces to fulfil exercise and socialization needs is at its peak (Jin, 2019). Consequently, their requirements for space safety and recognizability are relatively low. Given that most young adults are actively engaged in learning and working, with busy schedules occupying the majority of their time, the frequency of using external spaces within the residential area is relatively low. However, they have higher expectations for accessibility and convenience in these external spaces. Another characteristic of the young adult group is frequent outdoor activities. Compared with community activities, they tend to engage in activities within the city, meeting only their essential activity needs within the community. The most concentrated activities in the community for this group include fitness exercises, walking, jogging, and similar pursuits.

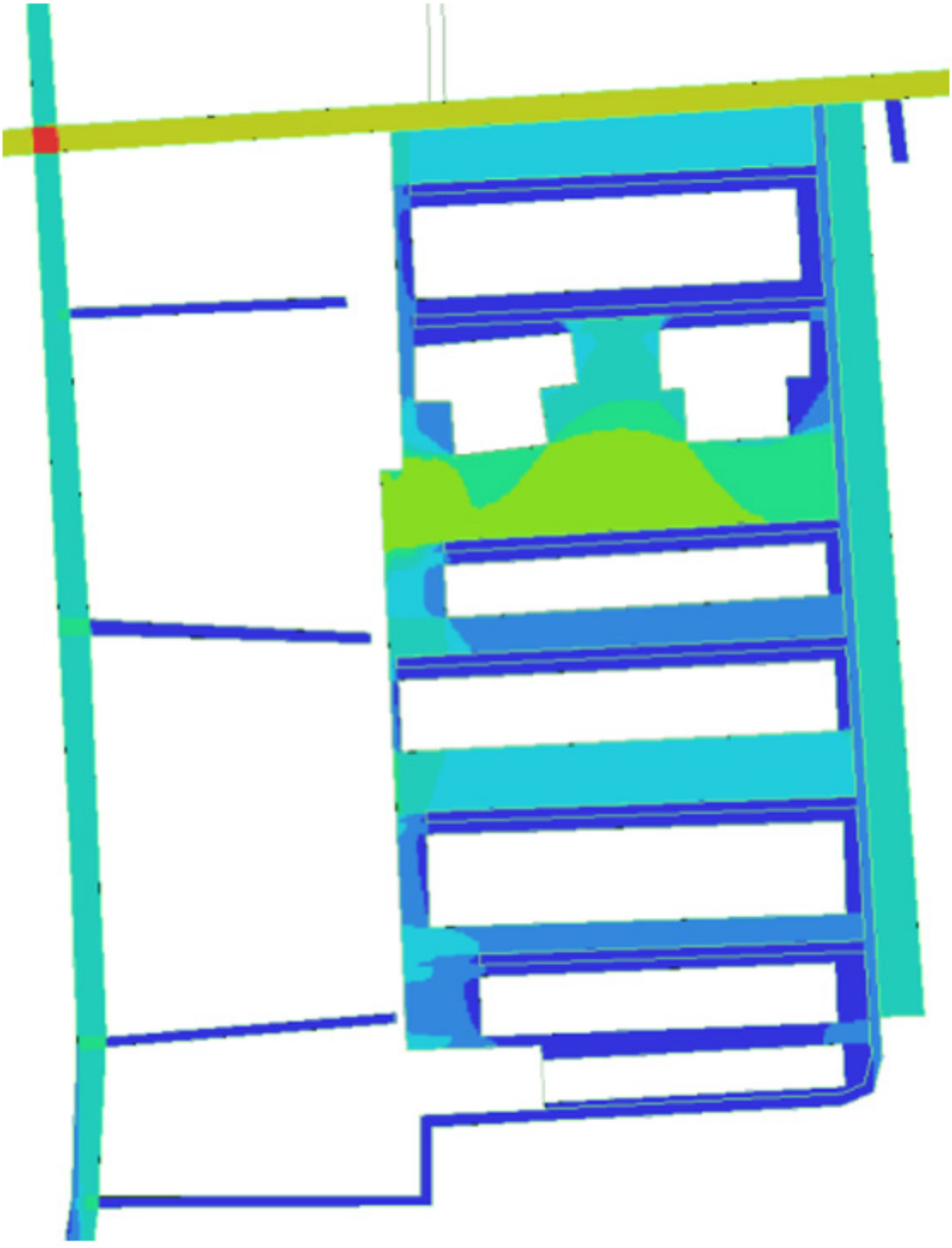
Figure 12. Visual connectivity analysis of 19 Yu He Street Community



Middle-Aged (Ages 41–65)

The typical feature of the middle-aged stage is a gradual decline in physical functions from vitality to decline (Li, 2018). Consequently, increased attention to safety is essential. With some economic stability and work pressures, they prefer engaging in leisure and social activities during their leisure time. They have higher demands for accessibility and convenience in external spaces within the residential area, requiring spaces for physical activity. Additionally, the middle-aged group plays a pivotal role in the family, taking on responsibilities such as caring for children and accompanying the elderly. They have relatively high inter-generational interactions with both the elderly and children.

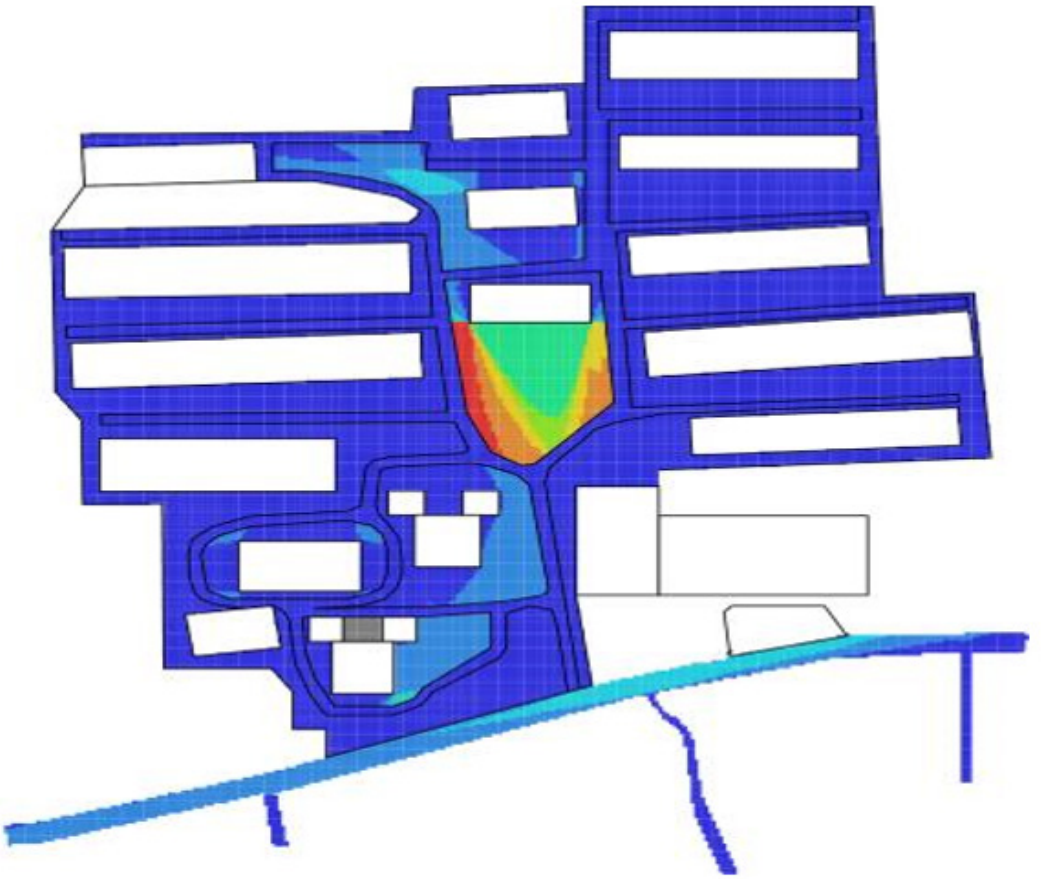
Figure 13. Visual connectivity analysis of 22 Yu He Street Community



The Elderly (Ages 66 and Older)

The elderly experience physiological degradation, with a slower and weaker response to changes in their surroundings and a diminished focus on various aspects of self. They place a higher priority on

Figure 14. Integration [HH] of 19 Yu He Street Community



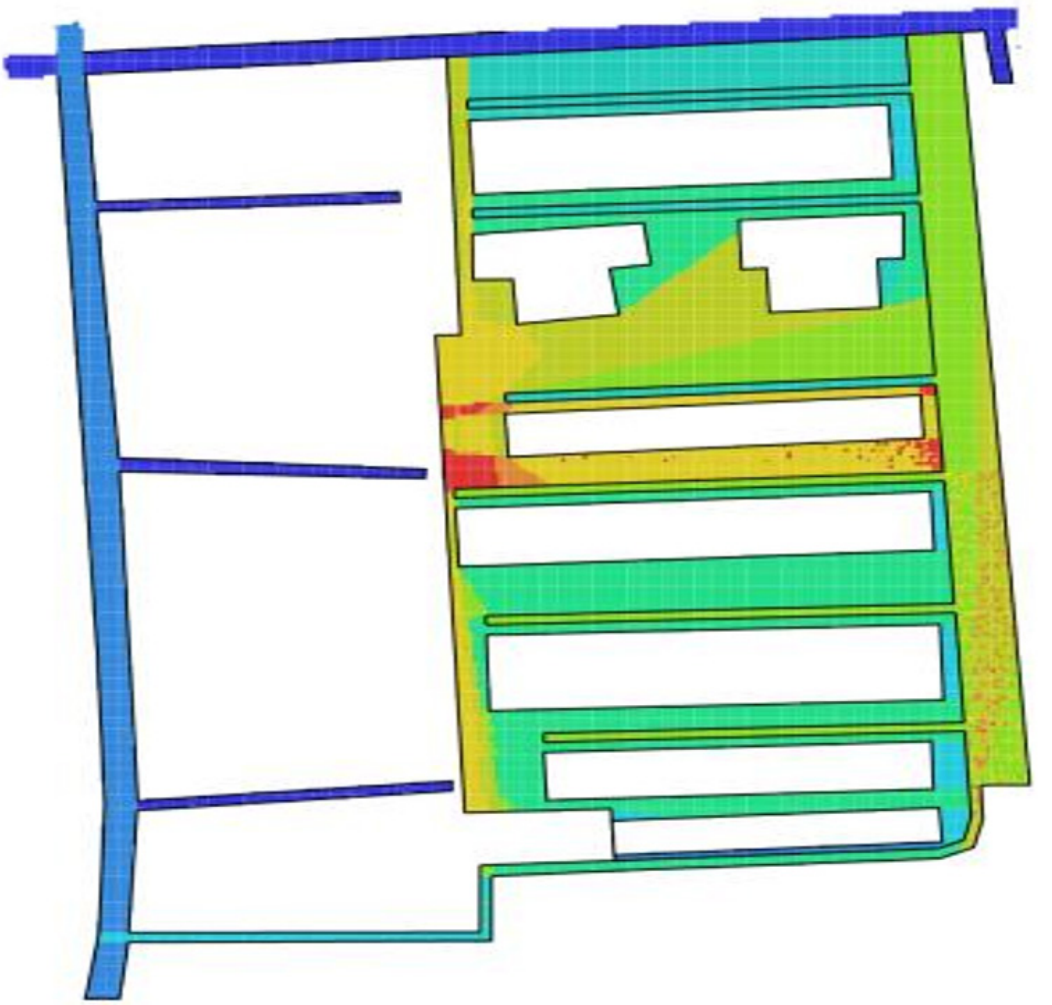
environmental safety and spend more time in community public spaces, leading to increased demands for these spaces. Their accessibility requirements are not high, and they tend to have a heightened need for psychological well-being, including a sense of belonging and social interaction. Because of age-related cognitive decline in areas such as thinking and perception, they exhibit varying degrees of deterioration in sensory abilities, including visual, auditory, and tactile senses. There is a strong need for recognizability and a sense of belonging.

Analysis of Vitality Demands Among Residents of All Ages

The demand for spatial vitality is difficult to ascertain directly through analysis. For this study, I employed a 10-level scale questionnaire survey to investigate the preferences of residents of all ages in 19 and 22 Yu He Street Courtyard for the privacy versus openness and gathering versus solitude aspects of space. The aim was to assess the average demand differences for spatial vitality among different age groups. The specific analysis is shown in Figures 16 and 17.

Based on the analysis of preferences for the openness and sociability of spaces across all age groups, the ranking of vitality requirements is as follows: children, adolescents, adults, the elderly, middle-aged.

Figure 15. Integration [HH] of 22 Yu He Street Community



Comparison of Demand for the Four Major Spatial Attributes Among Different Age Groups

In this section, I compare the requirements for the four major spatial attributes by age group:

- Degree of safety requirements: Children, adolescents, the elderly, middle-aged, adults
- Degree of accessibility requirements: Children, adults, middle-aged, the elderly, adolescents
- Degree of recognizability requirements: The elderly, children, adults, the elderly, middle-aged
- Degree of vitality requirements: Children, adolescents, middle-aged, the elderly, adults

Table 5. Visual connectivity of micro-space

Old residential community type	Space name	The value of connectivity	The value of visual integration
The type of entry at the center of the cell boundary(19 Yu He Street)	Spaces near group roads between residential units	907	3.78
	Entry spaces of the community	974	9.41
	End spaces adjacent to the walls between residential buildings	643	3.58
	Wider green spaces between residential units	1,194	4.11
	Entry spaces of residential units	351	2.81
	Narrow passages between community residential buildings and outer roads (east-west orientation)	799	4.71
Type of entry at the corner of the cell boundary(22 Yu He Street)	Wider sidewalks along the community boundaries	2,990	3.75
	Entry spaces of the community	1,413	3.00
	Corner spaces at the turning points of the community boundaries	3,303.42	4.14
	Spaces near group roads between residential units	1,687.98	3.08
	Narrow passages between community residential buildings and outer roads (east-west orientation)	1,506.43	3.94
	Spaces near group roads between residential units	467.75	3.03
	Entry spaces of residential units	336.782	3.15

ANALYSIS

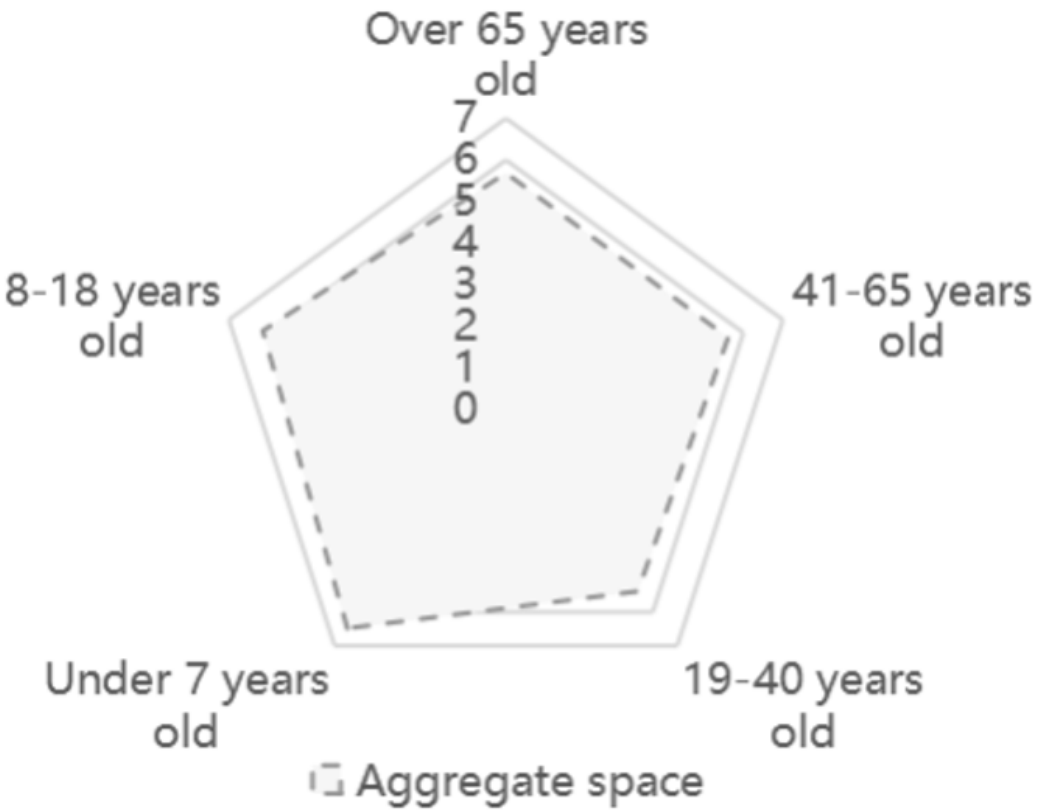
Compound Utilization in Spatial Dimensions

I adopted a "targeted acupuncture" approach to address the utilization of potentially available micro-spaces within old residential communities. The four spatial attributes of potentially utilizable micro-spaces identified through space syntax analysis were ranked, generating a spatial attribute radar chart for each micro-space. These rankings were then matched against the radar charts of the prioritized spatial demands for public activity spaces across all age groups. This method enables precise alignment of spatial attributes with the needs of the population, optimizing the utilization efficiency of micro-spaces and enhancing the overall quality of public spaces in old residential communities. Table 6 lists spatial needs by age group. Tables 7 and 8 list the attributes of micro-spaces in 19 and 22 Yu He Street, respectively.

The corresponding target populations for the potential micro-spaces within the communities of 19 Yu He Street can be identified, as shown in Table 9. Figure 18 shows a distribution map of micro-spaces in 19 Yu He Street.

In the 19 Yu He Street community, the end spaces adjacent to the walls between residential buildings are relatively enclosed and quiet, with minimal traffic. However, they are connected to the main road of the community. This connection offers a wide view that allows for the monitoring of children's activities, thereby preventing insufficient supervision owing to overly secluded spaces.

Figure 16. Selection difference map of spatial attributes among all age groups (aggregate space)



These spaces are suitable for children and adolescents to play, while also allowing adults to easily supervise. Small children's play facilities can be designed in this area.

The entry spaces of the community are daily commuting routes for residents. Middle-aged individuals, who are often too busy with work to visit specific leisure areas, would benefit from spaces and facilities designed for social interaction and brief relaxation here. The elderly, who enjoy lively environments, can use this space to observe the activities of others, enriching their spiritual lives.

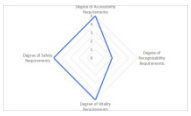
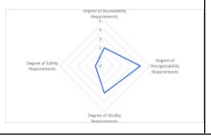
The narrow passages between community residential buildings and outer roads (east–west orientation) have a high degree of intelligibility, making them easy for elderly residents to navigate. Installing a silicone track in these elongated east–west passageways provides a space for adolescents, adults, and the elderly to walk and jog daily, while also improving the utilization of underused corner spaces within the community.

Spaces near group roads between residential units, located at the junction of the main roads and interior pathways, can be furnished with simple seating to facilitate interaction among adults.

Wider green spaces between residential units are often overgrown and not easily accessible to residents, resulting in poor interaction. Integrating green spaces with public activity areas can further activate and utilize these green spaces. Creating office leisure spaces in these areas for middle-aged individuals, the elderly, and adults to have afternoon tea or hold business meetings will not disturb nearby residents and can enhance their living experience.

The entry spaces of residential units can also be furnished with seating for waiting and resting. These areas are suitable for the elderly to sit and children to play.

Table 6. Spatial needs of different age groups

Children	Adolescents	Adults	Middle-aged	The elderly
				

Target populations for the potential micro-spaces within the communities of 22 Yu He Street are listed in Table 10. A distribution map of micro-spaces in 22 Yu He Street is shown in Figure 19.

In the 22 Yu He Street community, the same spaces are utilized with identical strategies and serve the same demographic groups as in 19 Yu He Street.

Corner spaces at the turning points of the community boundaries can provide leisure areas for playing chess and recreational activities. These spaces, located at the community's edges, minimally impact residents' daily lives and can be designed with playful installations. The corner spaces at these turning points are long and narrow, positioned adjacent to boundary walls, and offer a quiet environment. During the survey, many elderly residents come to these spaces to sunbathe, garden, and grow vegetables. Therefore, more planting areas and leisure seating can be designed here for elderly, adolescent, and middle-aged individuals.

Figure 17. Selection difference map of spatial attributes among all age groups (open space)

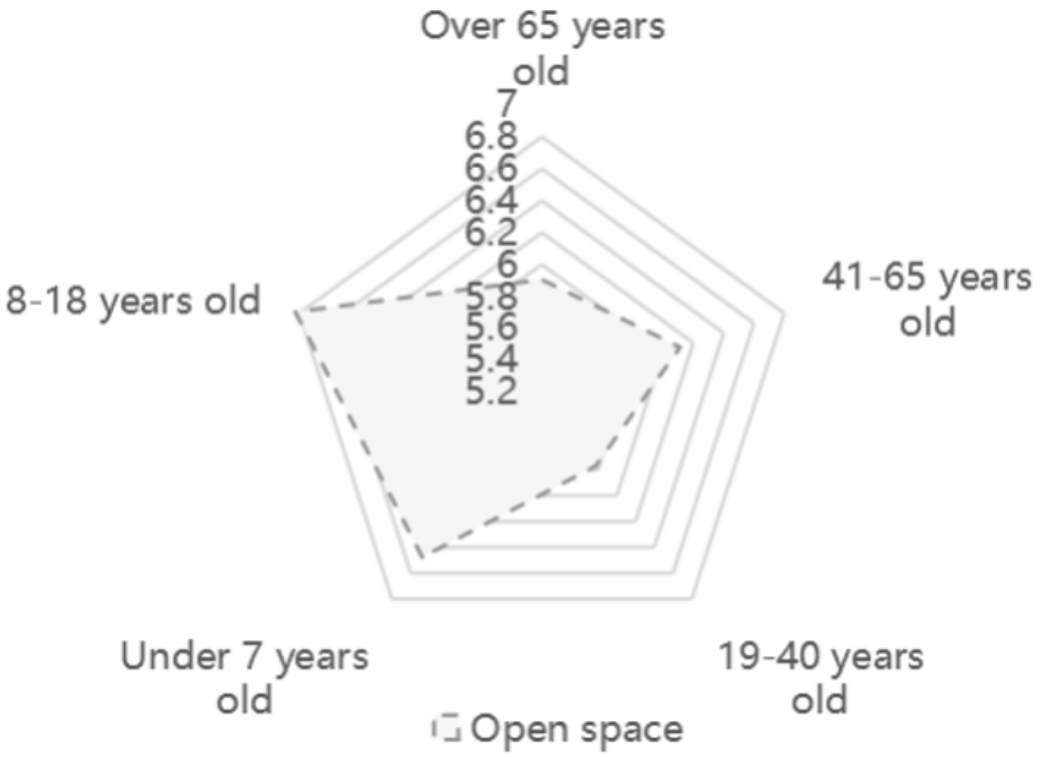
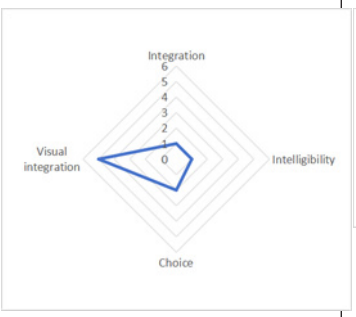
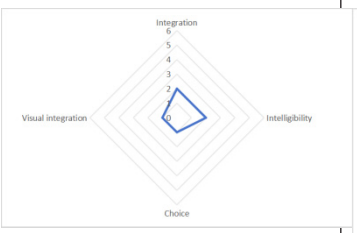
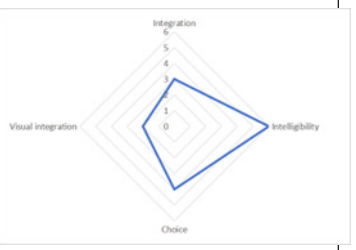
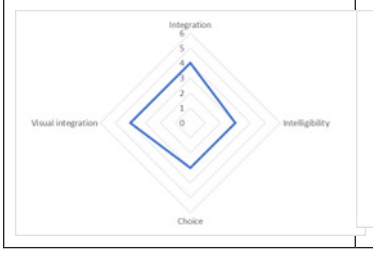
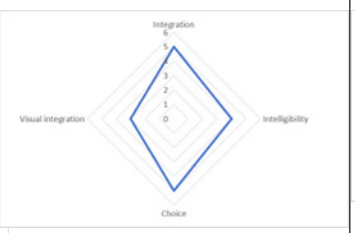
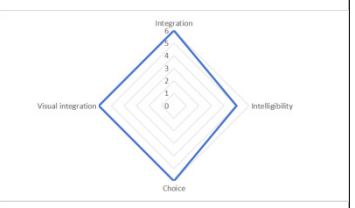


Table 7. Attributes of micro-spaces in 19 Yu He Street

End spaces adjacent to the walls between residential buildings	Entry spaces of the community	Narrow passages between community residential buildings and outer roads (east-west orientation)
		
Spaces near group roads between residential units	**Wider green spaces between residential units**	**Entry spaces of residential units**
		

Temporal Dimension Composite Utilization

To investigate the activity periods of different age groups within the old 19 and 22 communities on Yu He Street, the following data were obtained. Figure 20 shows that children and adolescents are most active in playing and engaging in activities between 4:00 p.m. and 6:00 p.m. This corresponds to their

Table 8. Attributes of micro-spaces in 22 Yu He Street

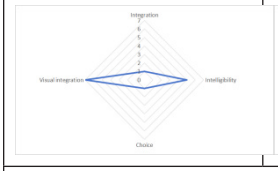
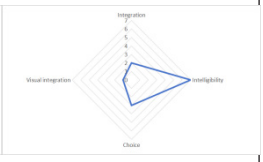
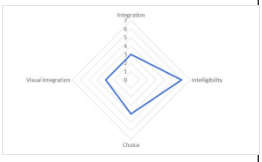
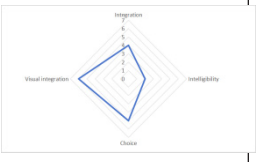
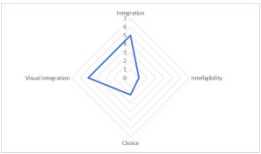
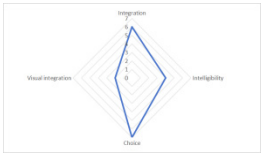
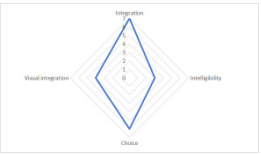
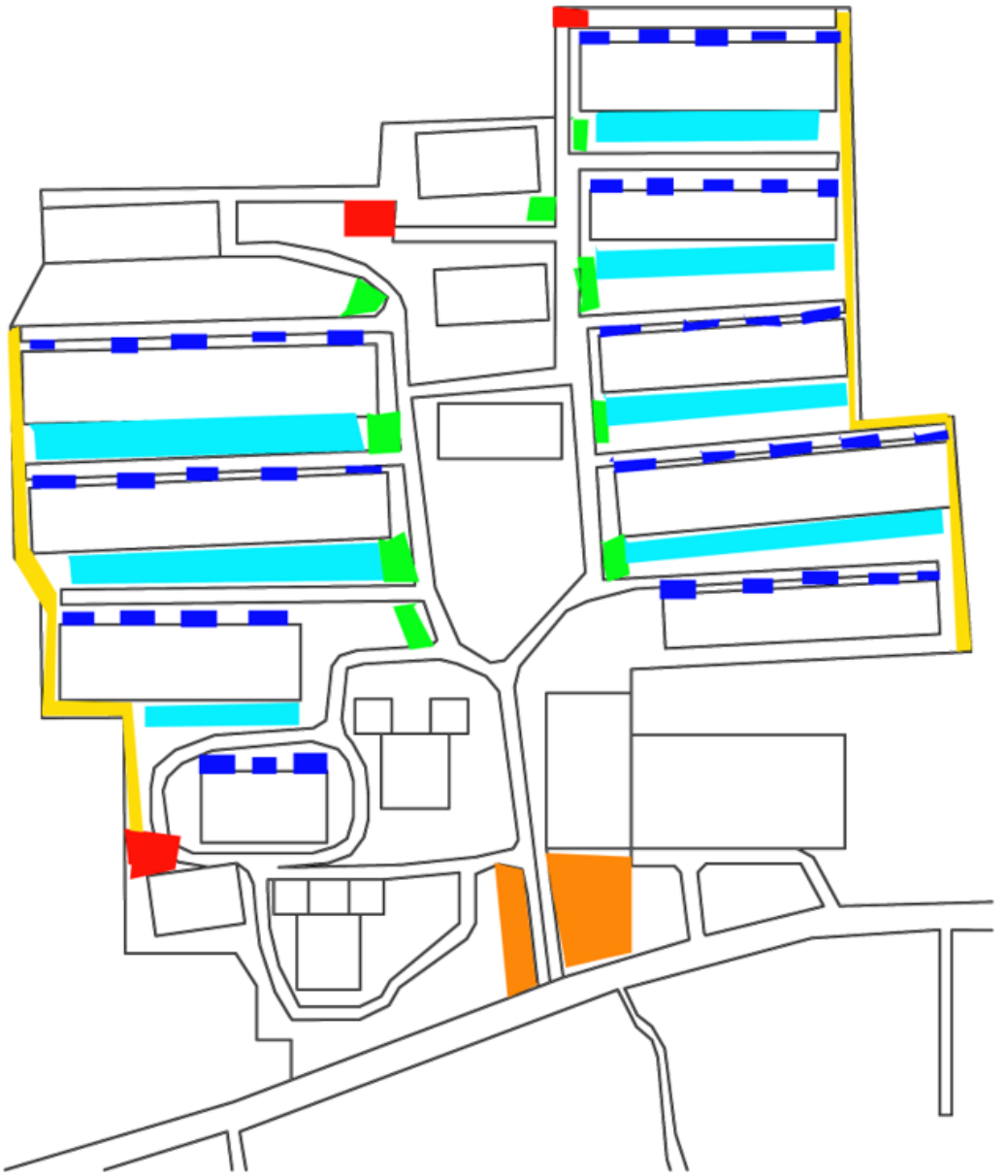
Entry spaces of the community	Narrow passages between community residential buildings and outer roads (east-west orientation)	Corner spaces at the turning points of the community boundaries	Spaces near group roads between residential units north-south elongated
			
Spaces near group roads between residential units	**Wider sidewalks along the community boundaries**	**Entry spaces of residential units**	
			

Figure 18. Distribution map of micro-spaces in 19 Yu He Street



regular study periods, and their daily external space activities are directly related to these restrictions. Young adults are primarily active in the morning from 5:00 to 10:00 and in the afternoon from 2:00 to 4:00, with a small portion engaging in activities in the evening from 6:00 to 8:00. Middle-aged individuals, possibly influenced by work schedules, are more active in the early morning from 5:00 to 8:00 and in the evening around 6:00 to 8:00. The elderly concentrate their activities around 8:00 a.m. to noon and from 2:00 p.m. to 4:00 p.m., during periods when sunlight is available.

Because of the differences in activity times across age groups, combinations of multifunctional facilities can be implemented to ensure that people of different ages can utilize the space efficiently

Table 9. Type of entry at the center of cell boundary (19 Yu He Street)

Chart	Space name	Target audience
	End spaces adjacent to the walls between residential buildings	Children, adolescents, adults
	Entry spaces of the community	Children, middle-aged, the elderly
	Narrow passages between community residential buildings and outer roads (east-west orientation)	The elderly, adults, middle-aged
	Spaces near group roads between residential units	Adolescents, children, adults
	Wider green spaces between residential units	Middle-aged, the elderly, adults
	Entry spaces of residential units	Children, the elderly, adolescents

during their respective periods, achieving efficient utilization in the temporal domain. Additionally, during the time slots of 8:00 a.m. to 10:00 a.m. and 2:00 p.m. to 4:00 p.m., young and elderly individuals are active in public spaces. From 4:00 p.m. to 8:00 p.m., children and adolescents are also active simultaneously. For different age groups appearing during the same time slot, I attempted to enhance the possibility of intergenerational communication by placing their required activity spaces and facilities adjacent to each other.

CONCLUSION AND RECOMMENDATIONS

This study used the communities of 19 and 22 Yu He Street as case studies to explore methods for transforming outdoor public activity spaces in old residential communities in the context of urban renewal. This research consisted of four main components.

First, the study focused on defining and classifying the potential micro-spaces within old residential communities using a typological approach. Second, each type of space was evaluated for its four spatial attributes through space syntax analysis. The research also analyzed five age groups, assessing each group's spatial needs and corresponding priorities. Lastly, the attributes of each micro-space were matched with the spatial needs of different age groups, resulting in the identification of suitable service populations for each space.

Overall, this study provides valuable insights into the utilization of potential micro-spaces in the two communities, determining the appropriate service groups for each space and revitalizing previously neglected micro-spaces more efficiently and purposefully. This planning approach can also be applied to big data analysis, combining the natural attributes analyzed by space syntax with the social attributes derived from more precise big data analysis to better support urban renewal.

CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest regarding the publication of this article.

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Figure 19. Distribution map of micro-spaces in 22 Yu He Street

PROCESS DATES

07, 2024

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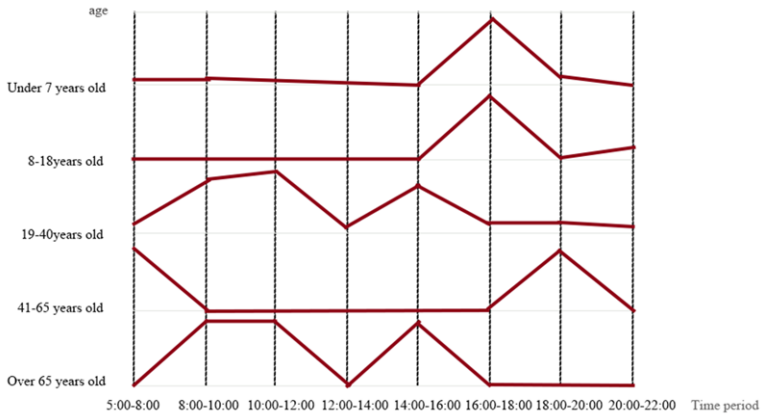
Table 10. Type of entry at the center of cell boundary (22 Yu He Street)

	Space name	Target audience
	Entry spaces of the community	Middle-aged, the elderly, adults
	Narrow passages between community residential buildings and outer roads (east-west orientation)	Adolescents, adults, the elderly
	Corner spaces at the turning points of the community boundaries	The elderly, adults, adolescents
	Spaces near group roads between residential units	Children, middle-aged, adults
	Spaces near group roads between residential units North-south elongated	The elderly, adolescents, middle-aged
	Wider sidewalks along the community boundaries	The elderly, middle-aged, children
	Entry spaces of residential units	Adolescents, middle-aged, children

Figure 20. Activity time curve of all age groups



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