Research on the Creation of Vibrant Public Space Suitable for People of all Ages in the Residential Block Based on Superposition Analysis of Behaviour Track——Examination of North Street of Sisheng Ancestral Temple in Chengdu City as an Example

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Abstract. As the dynamic carrier of different age groups, block public space is closely related to its space. This study takes the public space of the north street block of Sisheng ancestral temple as the research object. Through the field research of space observation, behaviour tracking and interviews of people of all ages, this paper studies the public space composition and characteristics of the north street block of Sisheng ancestral temple, analyzes the behaviour types and characteristics of different age groups, extracts the space elements, further analyzes the degree between space and behaviour correlation. On this basis, according to the space use needs of people of all ages, this paper puts forward strategies for creating vitality of public space for people of mixed ages in the residential blocks.

1. Introduction
Since the urbanization level of our country has reached 30% in 1998, it has increased rapidly at an average annual rate of 1.6%. By 2017, this data had reached 58.52%¹, according to the American geographer R. Northam S-shaped curve, after the urbanization level reaches 50% inflection point, the urbanization growth rate will gradually slow down, and the connotative growth development will gradually replace the extensional expansion development². Aiming at the transformation of the relationship between the increment of urban construction and the stock in China, the micro-renewal of the people-oriented urban environment has become dominant³. As an important part of urban public space, the public space at the residential block level is the most easily accessible and frequently used space for urban residents, so it has received great attention.

At present, the research on public space in residential blocks has accumulated rich research experience, especially in recent years, a large number of studies have focused on the relationship between people and the space environment from the perspective of users. Based on the theory of time geography, Guo Weiwei studied the daily outdoor activity habits, types of activities, activity trajectories, and the relationship between the environment and the environment of the elderly, and proposed a suitable aging design method for community outdoor activity spaces⁴. Li Qingtao divided the living space environment of the residential area into three categories: hard water area, green area, and waterfront area. He selected three periods of working day afternoon, evening and rest day afternoon to investigate and study the residents’ stay behavior in the residential area. Residential space
characteristics and residents' demand for activity space. Wang Zhiqiang and others took the streets of the Huimin community in the northwest corner of Tianjin as the research object, analyzed the relationship between behavior and spatial elements in various spaces from the aspects of crowd behavior and space type, using representative behavioral research data in the space, and then proposed micro-update of street space Principle. Most of these studies choose to study the crowd and space with a specific population, a specific time period, a specific type of space, etc., and use the behavioral characteristics of the crowd to guide the space design. However, under a certain regional cultural background, there are still few studies on the correlation between the behavior patterns of different groups of people and various types of public spaces, and there are still few studies on the mixed age and vitality spaces of blocks.

2. Research area and survey content

2.1. Research object and area
This article takes the public space of Sisheng ancestral temple North Street area in Chengdu as the research object, and intends to excavate the characteristics of the public space of Sisheng ancestral temple North Street area, the behaviour characteristics of different age groups and the behaviours of different people through trajectory research, behaviour observation and field investigation. Its relevance to the space, on the basis of this, it is expected that the public space use needs of different groups of people will be explored, and suggestions for the renewal design of the public space in the block will be proposed. The research area is located within the jurisdiction of Shuyuan Street, Jinjiang District, Chengdu City, Sichuan Province, China, with an area of 30.34ha. The public space in the survey plot is rich and diverse, carrying different functional needs, different people have different types of behaviours, and have a strong Chengdu well life.

2.2. Survey content
The survey in this paper mainly includes space survey and behaviour observation, which is scheduled to be sunny and windy and suitable for going out. The specific time was April 4, March 7, July 1, October 19, and December 28 in 2019. The spatial survey mainly focuses on the spatial form, facilities, ground pavement, landscape elements and so on. Representative space is selected for participatory behaviour observation, data acquisition is recorded by fixed-point photography and video recording, and the space is encoded and marked on the plane. Meanwhile, questionnaire survey and interview were conducted for different age groups in the research area to understand users' spatial feelings and needs.

3. Research framework and theories

3.1. Research Framework
This article focuses on the composition of public spaces in residential blocks and the usage status of different groups of people. It is divided into three steps to complete the purpose of the research: 1) Studying the daily behaviour trajectories of different groups, obtain trajectory overlay space, and analyzing the types and characteristics of behaviour activities of different groups in the space; 2) Analyzing the compositional characteristics of various types of space from spatial form, accessibility, functional activities, landscape elements, pavement, facilities, etc.; 3) Selecting representative spaces to conduct spatial-behaviour correlation analysis on spatial characteristics and crowd behaviour, Mining the space usage needs of different groups of people, and then propose an update strategy.

3.2. Time geography theory
Time geography is a research method to study the spatiotemporal characteristics of human behaviour under various constraints. It uses the two levels of time and space as the framework to analyze the "time-space" behaviour of human activities. The time geography method system is an effective means
of biographical investigation of individual behaviours at the micro level and statistical research of individual behaviours to summarize results on a large scale. It is mainly applied to the study of daily behaviours of inhabitants[8].

3.3 Behavior Map
The behaviour map was proposed and developed by Ittleson et al. in 1970. The map is to draw the people activity space into a plan, record the gathering number and location of the people group, the type of behaviour, the location of the event, record the photos of the event scene, mark the walking route and the node of the activity concentration on the map with dots and lines, and form the crowd behaviour trajectory to study the relationship between people daily behaviour and space [9].

4. Results and analysis

4.1. Analysis of crowd behavior

4.1.1. Classification of samples for all ages.
Analyze the composition of the population in the research area and divide it into four categories according to age. They are age-appropriate children (0-17 years old. The age-appropriate children mentioned in this article are mainly for minors older than 6 years old. Individual activities, their behavioral activities are greatly restricted by parents, so they are not considered separately, but they are included in the population of school-age children for the convenience of classification), youth (18-44 years old), middle-aged (45-60 years old), Elderly (over 60 years old).

4.1.2. Types of behaviour.
According to the characteristics of the main behavior in the public space of the block, the outdoor activities that occur are classified into leisure behavior, entertainment behavior, fitness behavior and shopping behavior. Activities such as walking, chatting, resting, and other activities are leisure activities. The amount of activity is relatively small, and the number of participants is relatively small. One person can also perform; entertainment activities include children's games, chess, card games, mahjong, dancing, festivals, etc. The purpose of the activity is clear and requires multiple people to participate in it; shopping behaviors include grocery shopping, stalls, etc., which occur in a specific time period, such as morning and evening; fitness activities mainly include various forms of exercise activities such as cycling and Tai Chi.

4.2. Composition and characteristics of superimposed space.
The behavior track of different age group are superimposed to obtain superimposed space points. The details are shown in Figure 1. The superimposed space is a relatively high vitality space in the study area. According to the main types of activities taking place in the space, the public space for crowd activities in the study area is divided into leisure space, entertainment space, fitness space and shopping space. According to the survey results, the constituent elements and characteristics of each space are summarized in Table 1.

Leisure spaces mainly support activities such as rest, chatting, talking, drinking tea, etc., and exist in large numbers in the study area. There are few facilities in the space, mainly seats, lighting facilities, shelter facilities, etc. Vegetation greening is mostly distributed at the edges, the sense of space limitation is stronger, the plant species are more monotonous, and the landscape variability is less. The entertainment space mainly supports children's games, playing chess, playing cards, playing mahjong, and square dance. The facilities and positions in the space play a key role in the function of the space. Amusement facilities are mostly arranged in the center of the space, and the seating facilities are mostly arranged in a semi-circular or corner type (combined with vegetation and access). The size of the space varies, and overall the larger the amount of activity, the greater the space in which it occurs.
The fitness space mainly supports various forms of exercise activities, and is less distributed in the study area. In addition to fitness equipment, there are also simple sitting and resting facilities in the space, most of which are planted with tall trees and the space is shaded.

Shopping behavior often occurs in a linear street space, which is greatly affected by the placement of stalls (or storefronts). The transient nature of shopping behavior makes the size and shape of crowd activity spaces change more. The facilities in the space are mainly sheltered facilities, planting sidewalk trees and single vegetation.

![Figure 1. Locations of the Superimposed space](image)

| Number | Form | Accessibility | Activity/Function | Landscape Elements | Floor Covering | Facility | Crowd Behaviour |
|-------|------|---------------|-------------------|--------------------|---------------|----------|-----------------|
|       |      |               |                   |                    |               |          |                 |
| 1     | P    | High          | Pass / Dining     | Street Tree /      | □              | Merchants own table and chairs | ▲ |
|       |      |               |                   | Landscape Sculpture |         |          |                 |
| 2     | P    | high          | Talk / wait / pass| Street tree /      | □              | —        | ▲ ▲ △           |
|       |      |               |                   | flower             |         |          |                 |
| 3     | P    | high          | Chess / Talking / Basking | Shop / Street Tree | □              | Teahouse | ▲ ▲ △           |
|       |      |               |                   |                    |         |          |                 |
| 4     | P    | high          | Chess / Talking / Basking | Cultural Wall / Street Tree | □ | Tree pool seating facilities | ▲ ▲ |
|       |      |               |                   |                    |         |          |                 |
| 5     | P    | Average       | Games / walking / conversation | Landscape tree | ○ | Rides / seats | ▲ ▲ |
|       |      |               |                   |                    |         |          |                 |
| 6     | L    | high          | Access / Shopping | Street tree       | □              | Hospital / Bus platform | ▲ |
|       |      |               |                   |                    |         |          |                 |
| 7     | L    | high          | Shopping / sale / catering | Shop / Street Tree | □              | —        | ▲               |
|       |      |               |                   |                    |         |          |                 |
| 8     | L    | Average       | Shopping / selling | Historic Building / Street Tree | □ | Community Service Center | ▲ |
|       |      |               |                   |                    |         |          |                 |
| 9     | P    | Average       | Pass / wait / talk | Church / Street Tree | □              | —        | ▲               |
|       |      |               |                   |                    |         |          |                 |
| 10    | P    | high          | Sell / Talking / Pass | Historic Building / Street Tree | □ | —        | ▲               |
|       |      |               |                   |                    |         |          |                 |
| 11    | P    | Average       | Pass / Chess / Talking | Street tree | □ | Residents own seats | ▲ ▲ |
|       |      |               |                   |                    |         |          |                 |
| 12    | P    | high          | Fitness / Talking / Viewing | Street tree | □ | fitness facilities | ▲ ▲ |
|       |      |               |                   |                    |         |          |                 |
| 13    | P    | Low           | Drying / Waterfront Leisure | River / Landscape Plants | ◇ | Seat | ▲ ▲ |
|       |      |               |                   |                    |         |          |                 |
| 14    | P    | high          | Sunbathing / River / Chengdu | River / Leisure | ◇ | Seat | ▲ ▲ |

Table 1. Statistics of various spatial components
|   |   |   | 339 |
|---|---|---|-----|
| 15 | L | high | Shopping / Sightseeing |
| 16 | L | high | Historic Building / Ancient Ginkgo |
| 17 | P | Average | exercise / Walking / Viewing |
| 18 | P | Low | Pass / Talking |
| 19 | P | Low | Pass / dry / Talking |
| 20 | P | Low | Conversation / exercise / viewing |

Note: □ stands for concrete floor tiles, ○ stands for asphalt floors, ◇ stands for cement floors, △ stands for blue brick tiles
P = point-like superimposed space, L = linear superimposed space, ▲ = dominant behavior, △ = secondary behavior.

4.3. Space-behavior correlation analysis

4.3.1. Selection of representative space. In the selection of representative space, considering the amount of data required for the analysis of behavioral activities, the representative space should select a space with abundant material constituent elements, more frequent leading activities, and sufficient representativeness. Based on this, select space 20 (leisure space), 4 (entertainment space), 12 (fitness space), and 21 (shopping space) as representative spaces for detailed analysis. Figure 2 reflects the current status of these four representative spaces.

Figure 2. Current status of representative space

4.3.2. "Time-space" characteristics of crowd behaviour. Figure 3 reflects the quantity change and spatial location of various behaviors of people at different times in a representative space, from which we can summarize the following "time-space" characteristics of behaviors:

Most of the spaces have obvious peak periods of people flow, and the occurrence time of different types of behaviors varies greatly. The activity time in the entertainment space is concentrated in the afternoon, the type of activity and the number of people are large, and the flow of people changes significantly. The peak of the flow of people appears between 3:00 and 4:00 in the afternoon; the number of people who use the space in the shopping space reaches the maximum around 10:00 in the morning; there is a small peak from 5:00-6:00; the number of people in the fitness space is small, and the crowd is more active around 19:00; the change in the number of people in the leisure space is not obvious, and the peak appears at 11:00 and 16:00 in the morning. Around the morning, the rest is mostly rest behavior, and the afternoon is more accompanied by conversation behavior.

In terms of spatial distribution, the crowd mostly moves under the tree, around the seat equipment, and at the corners of the space. In the hidden space provided by the lush trees, there are many activities such as playing chess, talking, waiting, stopping and watching; the seat equipment etc. provide support for activities such as rest and fitness exercises, and the crowd behavior activities surround it; the edge area will not hinder other The passage of people can also provide a better perspective of space observation for the stopper, bring a sense of psychological security to himself, and also provide convenience for leaving at any time. Therefore, the crowd stops to watch, stands and talks, observes and other behaviors mostly occur in this part.
4.3.3. Space-behaviour correlation. The entertainment space (Figure 1, number 4) is a recessed space facing the street. The space is equipped with stone tables and benches and a tree pool that can sit on the outside of the street. The main activities in the space are playing cards, playing chess, stopping and watching, talking, etc. It can be seen from the analysis of space characteristics and crowd behavior that seating facilities provide basic conditions for the crowd to carry out activities; the concave space has a certain degree of enclosing, which brings a sense of security to the crowd of activities; the lush branches and leaves of the sidewalk provide shaded under tree space for crowd activities.

The fitness space (Figure 1, number 12) is a small open space next to the entrance and exit of the residential group. It has built-in fitness equipment and is located at the edge of the space. The main activities in the space are exercise stretching, conversation, and waiting. Fitness equipment attracts the crowd to perform simple sports exercises here, which is the basis for the crowd to carry out fitness activities; surrounding walls, buildings, etc. make the space enclosed highly, and the sense of security of the space is extremely strong.

The leisure space (Figure 1, number 20) is close to the river. The space is planted with landscape trees, flowers and plants, with seats, a tree pool for sitting, etc. It mainly carries activities such as sitting, talking, Tai Chi, viewing, and sunbathing. There are more people gathered under special-shaped seats and landscape trees. The fixed seats and lush trees create the possibility for the crowd to participate in this activity; vegetation planting forms a semi-enclosed space, giving people a sense of security, and at the same time the vegetation The changes in the landscape can make people feel the changes of the seasons and the passage of time; the unique paving texture of the ground makes a certain division and path guidance to the space, which alleviates the spatial conflicts during the activities.

The shopping space (Figure 1, number 21) is located on the side of the street, and there are a large number of active people, mainly engaged in shopping, stopping and talking. The canopy built in the space forms the top interface, and the stalls divide the space to a certain extent; the trees are located at the edge of the space, creating a certain sheltered space. When the crowd encounters, they will stay and talk to ease the indifferent interpersonal relationship in the modern city.

| Number | Spatial Feature | Behaviour and factor relevance |
|--------|----------------|-------------------------------|
|        | Accessibility | Elements | Position | Age group | Time | Behaviour activity | Leisure | Entertainment | Fitness | Shopping |
| 2      | High          | Street tree / flower | center | Youth / middle-aged / elderly | Almost all day | Stop to chat / wait / shop | Strong | weak | medium | medium |
| 3      | Average       | Street trees / Flowerbeds | All around | Children / middle-aged / elderly | morning | Chat / stop | Strong | Strong | weak | medium |
| 4      | High          | Stone table / culture wall | Both sides | Middle-aged / elderly | morning | Playing cards / playing chess | Strong | Strong | weak | weak |
4.3.4. User space requirements based on space-behaviour correlation. The reason why people will conduct various behavioral activities stems from their different levels of physical and psychological needs. [10]. Based on Maslow's hierarchy of needs theory combined with space-behavior correlation analysis and the characteristics of different groups of people, mapping the needs of various levels of people into the public space of the study area is reflected as follows:

- **Children of school age.** Children of school age are mainly dominated by dynamic games and sports and fitness activities. The demand for space for these groups of people is as follows: ① an event venue that can meet different types of activities; ② the game space environment is flexible and changeable to ensure the fun of the game venue; ③ the event area should be as complete as possible to improve the construction of safety measures, such as games the place should be properly laid with anti-fall floor mats to improve the quality of night lighting facilities.

- **Youth.** The youth stage is a group of people of all ages with the least free time, usually under the double pressure of family and career, and its main activity area is family and work unit. By observing the behavior types of young people in the base, it mainly takes the behavior of bringing children, and at the same time will conduct simple communication activities with other residents with children. The space requirements of this group of people are as follows: ① have sports and fitness facilities or a venue that meets the sports conditions, and should not be too far from the residence; ② have a suitable amount of children's play facilities; ③ rest facilities for chatting and sitting.

- **Middle age.** With the increase of age, the physical functions of middle-aged people began to gradually decline, focusing more on health and exercise; on the other hand, with the change of retirement roles, the middle-aged people gradually shifted their focus from career to family, and leisure time began to increase the phenomenon of bringing grandchildren has become common. The demand for space for these people is as follows: ① hard-paved areas suitable for sports, outdoor fitness equipment areas, etc.; ② well-closed communication places, seating-type rest facilities and so on; ③ places available for chess and card activities; ④ Green space available for activities and small children's play facilities, easy to bring children.

- **Elders.** Due to the aging of various functions of the elderly, coupled with the need to adapt to changes in roles such as retirement and widowing, they often feel lonely and lonely in their hearts and need to interact with others and obtain spiritual comfort. The demand for space for these people is as follows: ① open squares and outdoor fitness equipment areas with relatively large areas suitable for sports for the elderly; ② exchange places with good sense of surroundings, seating and leisure facilities and so on; Places for chess and card activities; ④ Open hard square area can be set up with some viewing areas; ⑤ Green space available for activities and small children’s play facilities to facilitate the elderly to take care of children or to walk dogs.
5. Conclusions and spatial strategies of mixed age vitality
Based on the above analysis of crowd behavior, spatial characteristics, and space-behavior correlation in the north street area of the Sisheng ancestral temple, as well as the space use needs of people of different ages on the block's public space, the following space construction strategies are proposed:

5.1. Space design pays attention to the environmental comfort and the compound of functions
From the comparison of space-behaviour correlation analysis, it is recommended to start with ground pavement, planting, sheltering facilities, etc. to ensure the basic comfort of the site environment. According to the usage characteristics and needs of different groups of people, the concept of mixed age vitality space is proposed, that is, the venue can meet the needs of different groups of people and meet the individual needs of a certain group of people at a specific time of day. For this type of space, consideration can be given to the combination of functions through the addition of space facilities or the planning of festivals and activities.

5.2. Fully consider the space use demand of local recreational behavior
The citizens of Chengdu are more enthusiastic about activities such as drinking tea, playing chess, playing cards, and playing mahjong, and such activities often take place in outdoor public spaces, such as spaces 3 and 13. Figure 1. For such activities, it is possible to appropriately design a relatively natural and ecological space, and configure the design in terms of enclosure, plant configuration, ground pavement, landscape sketches, facilities and equipment and so on, to create an ecological and authentic public well-being space.

5.3. Strengthen the barrier-free design of spaces and facilities
Because the proportion of the elderly and middle-aged people in the use group is large, and the staying time is long. At the same time, the middle-aged people and the elderly are more common in taking children and accompanying children, so the design should pay attention to the needs of young children and the elderly and strengthen Accessible Design, such as laying soft ground, ensuring adequate night lighting, using environmentally friendly facilities and equipment, and setting up handrails in key parts to ensure safety and comfort.

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