Case Study Report

Research on the Renewal Design of the Neighborhood-scale Built Environment from the Perspective of Post Epidemic

——Take Dongba Street in Beijing as an example

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Abstract

China's urban living environment is dominated by residential blocks, and the built environment at the neighborhood scale has become the most important space for urban residents to carry out daily life. Especially during the period of COVID-19, high-density and high-clustering communities have become the focus of urban control.This paper takes Dongba Street in Beijing as the research sample, analyzes residents' behavior patterns and preferences by means of questionnaire survey, individual interview and big data collection, and divides them into three circles: residential units, neighborhood units and urban blocks. At the same time, combined with the configuration of spatial elements (such as buildings, green space, functions, facilities, etc.) of the built environment in different circles, the influence weight of spatial elements of the built environment in different circles was determined, and then the neighborhood scale built environment renewal design strategy from the perspective of post-epidemic was constructed.

Keywords

post-epidemic; Neighborhood scale; Built environment

1. Introduction

The outbreak of COVID-19 has made various industries reflect on how to effectively contain the spread of the epidemic. As of now, there are no specific drugs for COVID-19 and its mutant strains, so physical isolation is becoming very important. In the field of urban planning, the built environment and residents health related research, there are a lot of experts to explore can affect the health of residents in built environment elements, such as high population density, insufficient green area[1], poor street environmental quality, etc. However, previous studies focused more on how to prevent chronic diseases and promote physical health of residents [2,3], and there is still a lack of research on sudden large-scale infectious diseases. The World Health Organization (WHO) released the top 10 threats to global health in 2019, and infectious diseases accounted for six of them. Public health is becoming a new threat compared to the unhealthy behavior of individuals. In China with a high population density, the epidemic has further affected residents' travel patterns and choices. How to build a built environment that can meet residents' healthy travel has gradually become the focus of researchers' attention.

China's massive residential construction began in 2000, and its big cities are far more densely populated than many Western countries. China's Ministry of Housing and Urban-Rural Development released the

2019 "Statistical Guide to Urban Construction", in which the population density of major cities represented by Beijing, Shanghai and Shenzhen reached 1,132, 3,830 and 6,732 people per square kilometer. According to the results of the seventh census, Beijing has a population of 21,893,095. High-density areas provide rich urban life, but at the same time, urban public space is too compressed, which not only makes it difficult to ensure a pleasant living environment, but also makes it more difficult to control infectious diseases. Studies show that high population density increases the probability of infectious disease transmission[4].

The impact of the built environment on epidemic transmission has been well documented[5,6]. Bo Li et al. pointed out that convenient transportation provided good accessibility and promoted the vitality of commerce, but also accelerated the spread of the epidemic[7]; Tsz Leung Yip et al believe that clinics, restaurants, subways, public markets and other places are built environments that affect the spread of COVID-19[8]; Heyuan You et al. demonstrated that a high proportion of construction land increases the incidence of COVID-19[9]. In addition to the research on the built environment elements of blocks, other scholars have studied the impact of social distance and ventilation on the prevention of COVID-19 from a microscopic perspective, pointing out that the minimum safe distance for normal social activities is 1.6m-3m, and the maximum transmission distance of novel coronavirus may reach 8m[10]; At the same time, policy plays a positive role in the prevention of COVID-19. Through policy control, people can ensure good social distancing[11,12,13]. With the accumulation of experience in epidemic prevention and control, scholars have realized the dynamic role of residents in the spread of the epidemic, and shifted the research perspective to the impact of residents' space-time travel on the NOVEL coronavirus. With the accumulation of experience in epidemic prevention and control, scholars have realized the dynamic role of residents in the spread of the epidemic and shifted their research perspective to the impact of COVID-19 on residents' spatial-temporal travel. For example, Seok-Gyeong and others pointed out that after the end of the COVID-19 pandemic, independent travel with families and private cars as the main means of transportation will become the main mode of travel[14]. Chai yanwei and others pointed out that the epidemic has reduced the space for leisure activities and made people spend less time shopping[15]; Liu Jianrong et al. pointed out that in the post-epidemic stage, COVID-19 perception has no significant impact on short distance travel of the elderly, but has an impact on whether they choose to use public transportation for medium distance travel[16].

The idea of a "healthy city" was first proposed in 1984. Today, In 2016, China put forward the "Healthy China 2030" plan outline, which proposes to prevent and treat major diseases; In September 2020, the Evaluation Standard for Healthy Communities was put forward again, and six evaluation forms for healthy communities were constructed. The issuance of a series of documents shows that China attaches increasing importance to the construction of healthy cities. In terms of block scale, many cities have formulated their own guidelines for street design. Although there is no unified standard document, the study of block and street scale has become a focus that cannot be ignored.

Table.1 Street design guidelines total

Number	City/Region	Guideline	Time
1	Shanghai	Shanghai Street Design Guidelines	2016
2	Nanjing	Nanjing Street Design Guidelines (Trial)	2017
3	Guangzhou	Guangzhou Complete Streer Design Manual	2017
4	Luohu District, Shenzhen	Shenzhen Luohu Complete Street Design Manual	2017
5	Yunnan	Guidelines for urban Block Planning and Design in Yunnan Province	2017
6	Xiamen	Xiamen City Block Facade Renovation and Upgrading Design Guidelines (Trial Version 2)	2018
7	Foshan	Foshan Street Design Guidelines	2018
8	Beijing	Bejing Street Design Guidelines	2018
9	Xicheng District, Beijing	Beijing Xicheng District Urban Design Guidelines	2018
10	Zhengzhou	Zhengzhou Street Design Guidelines	2018
11	Chaoyang District, Beijing	Beijing Chaoyang District Urban Design Guidelines	2019
12	Zhuzhou	Zhuzhou Street Design Guidelines	2019
13	Wuhan	Wuhan Complete Streer Design Manual	2019
14	Qingdao	Qingdao Street Design Guidelines (Trial)	2019
15	Haikou	Haikou Street Design Guidelines	2019
16	Maoming	Maoming Complete Streer Design Manual	2019
17	Chengdu	Chengdu Park Urban Street Integration Design Guidelines	2020
18	Ganzhou	Ganzhou Street Design Guidelines	2020
19	Zhongshan	Technical guidelines for urban design of Zhongshan City	2020
20	Futian District, Shenzhen	Bejing Street Design Guidelines Street Design Guidelines	2021

Based on previous studies, this paper mainly discusses several questions: Will residents' travel behavior change in the post-epidemic era? Is there any change in residents' demand for the built environment? If yes, what is the impact of different built environment elements on residents' travel behavior? In order to solve these problems, we select dongba Town, Chaoyang District, Beijing block scale built environment research.

2. Meterials and Methods

2.1. Study Area

This study takes Dongba Township, Chaoyang District, Beijing as the research object. This area is close to Beijing's east fifth Ring Road, and is the "threshold" of Beijing's eastern suburbs. The township covers an area of 24.6 square kilometers, which is a new area of urban expansion. Large-scale construction leads to the lack of refined built environment, low density of road network, insufficient supporting facilities and other problems. According to several Opinions on Further Strengthening Urban Planning, Construction and Management in 2016, "by 2020, the average road network density of urban built-up area will increase to 8 km/square km", while the road network density of Dongba is only 4.429 km/square km, which has a lot of room for improvement.

The scope of this study mainly selects the urban construction area south of Bahe in Dongba Township. According to previous studies and block definition[17], dongba is divided into 18 blocks according to natural roads (Figure 1).

Figure 1. Block division of Dongba Township. Source: Owner-draw

2.2. Determination of built environment indicators

Due to the current lack of evaluation indexes on the scale of blocks, based on the existing research results[18,19,20], this paper will update influence factors are divided into blocks built environment health layout, health environment, health services and health traffic, choose the residents health travel behavior related environmental indicators, finally get 8 indicators, 12 specific indicators.

Table 2 Index system of healthy blocks

System	Indicators	Specific Indicators	Interpretation
Health layout	Land use	The complexity of street life	Number of POI types per square kilometer (category/square kilometer)
Health environment	Ecological	Accessibility of public green space	Number of green space within 15 minutes walking distance of residence (number)
		Green rate	The green proportion of the human field of vision(%)
	Living environment	Population density	Population/land use(people/km2)
		Length of residence	Proportion of housing in total housing before 2000(%)
Health service	Business	Accessibility of commercial facilities	Number of commercial facilities covered within 15 minutes walking distance
	Treatment	Accessibility of medical facilities	Number of medical facilities covered within a 15-minute walk
	School	Accessibility of school facilities	Number of schools covered within a 15-minute walk
Health traffic	Transportation	Road density	Road length/block area(km/km2)
		Density of bus stops	The number of bus stops covered by a 15-minute walk
		Intersection density	The number of intersections within the block
	Street interface	The degree of street openness	The proportion of the sky area visible to the human eye(%)

The healthy layout is mainly reflected in the mix degree of land use in the block, which is calculated by the number of POI types contained in the block. The block with a high mix degree has a high vitality

degree and is more likely to promote residents to go out for activities. Healthy environment reflects the greening and residential conditions in the block, and the accessibility of public green space is calculated by the number of public green space covered by residents walking for 15 minutes; Obtain Baidu Street View pictures every 50m from the road in the block and identify the green proportion of human visual field; Data on population density and housing age are obtained from second-hand housing websites and the government. The health service selects commercial, medical and school resources related to residents' life and travel, and is calculated by the number of facilities covered by a 15-minute walk from the entrance of the residential area in the block. Healthy traffic includes traffic travel and street interface. The road network density is calculated by GIS to calculate the road length in each block. The number of bus stops is obtained through Baidu POI, and the number of stops covered by a 15-minute walk is calculated from the entrance of residential area. The intersection density calculates the number of intersections of roads in blocks other than roads in residential areas within a block; The degree of street openness was calculated from the proportion of sky identified in street view images. The final block index is calculated by entropy method to get the score of each block.

2.3.Resident travel behavior

In order to explore residents' travel behavior, this study distributed 50 questionnaires in Dongba area through online questionnaire survey, which was divided into three parts: residents' basic information, changes in residents' travel patterns under the background of epidemic, and their opinions on the built environment of Dongba. At the same time, the real-time thermal maps of 8:30, 10:30, 14:30 and 18:30 on working days and rest days were intercepted by baidu thermal map to explore the distribution of residents in Dongba area.

3. Results

According to the result of entropy method, the health degree of Dongba block is divided into four grades from high to low: very healthy (0.1007-0.0883), healthy (0.0742-0.0579), relatively unhealthy (0.0558-0.0441) and unhealthy (0.436-0.0167). There are three very healthy blocks, namely Block 1, Block 2 and Block 14; four healthy blocks, namely, block 3, Block 5, block 6 and block 11;five unhealthy blocks, which were block 7, Block 8, block 9, block 13 and block 16.;five unhealthy blocks: Block 4, Block 10, Block 12, block 15, block 17 and block 18.

3.1. The overall level of the block showed a trend of high in the east and low in the west, and the difference of health indicators among some blocks was obvious.

According to the calculation results of entropy value method, it can be seen that the overall healthy block level in Dongba Township is high in the east and low in the west, and the blocks with medium score occupy the majority, which are generally distributed in the middle of Dongba township(Fig2). Further analysis showed that very healthy neighborhoods were characterized by high intersection density and public green space accessibility. The block with the highest health level is Block 1, including Hengda Jiangwan, Baxin Jiayuan, Liwan Jiayuan and other communities. Its intersection density score is 0.0296, and the accessibility score of public green space is 0.0241. Although it has a large block area, it is divided by multiple residential areas, and the roads are smooth. Block 1 also has Hengda Square, a commercial center, which avoids the problem of single land nature caused by large-scale development by a single developer. In the north, There is Bahe Park, which is convenient for residents to have a rest and entertainment. Block 15 has the lowest health score, only 167, nearly 6 times higher than the highest score. This block is located at the edge of the city and consists of a single residential area with low level of

block complexity. Although it is close to the largest country park in Dongba, it is far away from the entrance and exit, so it is difficult to provide services for residents.

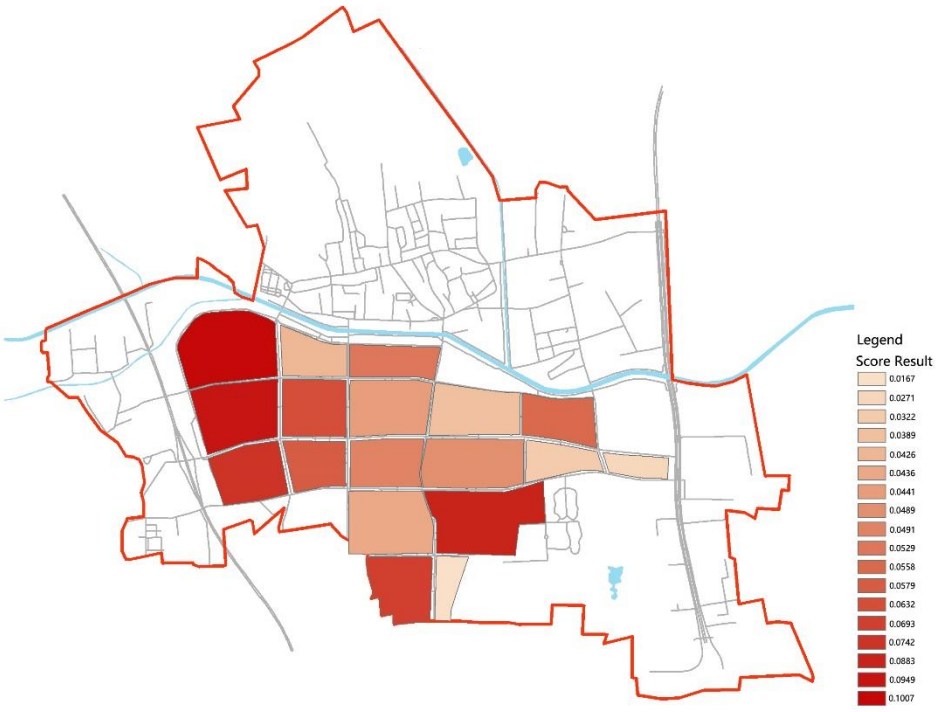

Figure 2. Score of Healthy blocks in Dongba. Source: Owner-draw

3.2. Residents have different built environment needs in different blocks

According to the questionnaire survey, 25.49% of people have changed their way of traveling to work after the epidemic, from public transportation to non-motor vehicle or self-driven private transportation, and the frequency and distance of traveling for leisure and entertainment have been significantly reduced. According to the thermal map and interviews with residents, due to the lack of outdoor leisure venues, community public green space has become the main place for outdoor activities of Dongba residents, which has not changed significantly before and after the COVID-19.

Table 3 Residents' travel and demand in each block of Dongba after the COVID-19

Block	Travel distance	Blocks demand	Block	Travel distance	Blocks demand
1	Within 500m	Public rest space; Children's entertainment	10	Within 500m	Public rest space; Children's entertainment facilities
2	500m-1km	Public rest space; Greening diversity; Children's recreational facilities; Quality of street paving	11	500m-1km	Street connectivity; Pedestrian environment
3	500m-1km	Lighting facilities; Street greening; Walking environment; Health conditions	12	500m-1km	Street greening; Commercial facilities; Children's recreational facilities; Public open space
4	500m-1km	Public rest space; Commercial facilities; Walking environment; Children's entertainment facilities	13	Within 500m	Street greening; Public rest space; The street environment
5	500m-1km	Street greening; Greening diversity; Street connectivity; Public open space	14	Within 500m	Public rest space; Fitness facilities; Street connectivity; Quality of street paving
6	Within 500m	Public rest space; Street greening; Street connectivity	15	500m-1km	Children's recreational facilities; Greening diversity
7	500m-1km	Catering and entertainment facilities; Public open space	16	Within 500m	Street connectivity, street environment
8	1km-2km	Catering and entertainment facilities; Health conditions	17	500m-1km	Street environment; Greening diversity; Public open space, children's entertainment facilities
9	500-1km	Catering and entertainment facilities; Public rest space; Street greening	18	500m-1km	Street environment; Greening diversity; Public open space, children's entertainment facilities

To analyze the difference of residents' demand for built environment in different blocks based on health grade of blocks. In the blocks rated as very healthy, the common travel distance of residents is within 500m. The complex degree of the blocks meets the residents' demand for public service facilities. The high road network density provides convenience for residents to travel, but residents also reflect the lack of public recreation space and concerns about the safety of pedestrian trails. Within the score for healthy neighborhoods, residents generally travel distance in 500 m - 1 km, analyzes its built found that represented by Chang qing teng, Olympic garden blocks 5, 6, 11, is due to its large residential areas, on the street connectivity and street public space, there are some drawbacks in places in the community more public green space, Large communities also allow residents to travel longer distances on foot, so there is greater demand for street connectivity and a walking environment. Within the score for more unhealthy blocks, residents travel distance is different, the type blocks most of old residential area and construction land, residential fixed number of year is bigger, block was in school, segmentation, such as institute of road network density is low, lead to residents need to walk a long time to reach places of entertainment, commercial facilities, poor accessibility, Therefore, residents show more demand for public service facilities, such as catering and entertainment facilities. In the districts rated as unhealthy, the general travel distance of residents is 500-1km, and the demand for walking environment and life service facilities is more obvious.

4. Discussion

Through the study of Dongba, this paper mainly draws the following conclusions :(1) in the post-epidemic era, the scope of residents' trips is generally shortened and the frequency of trips is reduced. (2) In the post-epidemic era, residents prefer leisure and entertainment places that maintain good social distancing; (3) Public recreation space and street safety are the built environment factors that affect residents' travel in the neighborhood with high land use mix degree. In the single block, street connectivity and public service facilities are the focus of residents' travel. The occurrence and spread of the epidemic are

intrinsically related to the behavior status and spatial attributes of residents. Therefore, in the post-epidemic era of healthy block renewal design, how to improve the block's ability to deal with major impact is worth thinking about.

4.1. Macro level: Connect each block with slow traffic system and pocket park

The epidemic caused some residents to shift from public transportation to non-motor vehicles or self-drive, which increased the residents' demand for street space, and also reflected the neglect of the slow street system in China's large-scale construction. The management of closed communities in China has stopped the spread of the epidemic in time, but the large scale of the community also reduces the degree of cooperation of residents[21]. The city is composed of different blocks, and blocks composed of a single large-scale community turn urban branch roads into intra-community roads, impeding the connectivity of the urban road network, and the lack of internal service facilities makes it more difficult to obtain the cooperation of residents in the context of public health emergencies. Therefore, in the macro scale design of built environment renewal, we should promote healthy and low-carbon space use, pay attention to the construction of street road network system, and connect all streets with slow traffic system. A pocket park is set at the node to provide residents with a good street walking environment with a fine slow walking system. In this way, the risk of epidemic disease caused by the use of public transport is reduced and the environmental pollution caused by the excessive use of private cars is avoided.

4.2. Middle level: demarcation of epidemic prevention and safety units

The epidemic has reduced the travel range and travel time of residents. Compared with the long-distance travel and entertainment in the past, residents prefer to walk and exercise within the walking distance, and 500m-1km has become the most common travel distance for leisure and entertainment. In this context, safety units for epidemic prevention can be designated according to a certain population size and service facilities. Public service facilities for shopping, medical treatment, dining and other activities convenient for residents shall be set up in the epidemic prevention and safety units to disperse a large number of community population. At the same time, in the delineation of epidemic prevention and safety units, it is necessary to find out the needs and activity rules of residents in different units for facilities, configure public service facilities that meet the needs of residents in safety units, and improve the use efficiency of public service facilities. For example, public service facilities such as vegetable market and fitness should be provided mainly in the security units of old residential areas.

4.3. Micro level: Ensure the integrity of the internal functions of the community

Community is the smallest unit of residents' life and the space that residents must go through in daily travel. In the process of epidemic prevention and control, community has also become the only place for residents' activities, and the degree of refinement and perfection of its space Settings is directly related to residents' activities and trips. In the design of community level in the post-pandemic era, more attention should be paid to the flexible use of small idle space in the community to develop more available space for community residents and enhance its accessibility; In terms of the configuration of public service facilities, the community should improve the configuration of convenience stores, supermarkets and other small public service facilities to ensure that the internal life of each residential unit can meet certain living needs of residents. In terms of refined design, information delivery cabinets can be set up at the entrance of residential areas to reduce the entry of outsiders and the phenomenon of community residents gathering to get express delivery. Optimize the internal environment of the community according to the population characteristics of the community residents.

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