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Exploring the Path of Shantytown Renewal Based on the Theory of Environment-behavior Studies: A Case Study of the Northwest Area of Saihantala in Baotou City

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Abstract The application of environment-behavior studies plays an important role in studying the renewal of shantytowns. One of the most humane ways of renewal is designing and constructing the necessary urban spatial environment from the perspective of human daily behavior. Most of the shantytown renovation projects currently carried out in China are mainly focused on demolition and reconstruction, which not only incurs high costs but also damages the original social structure and economic model. During the process of shantytown renewal, it should improve the urban landscape, living environment, and life quality of residents, and ensure the daily life of shantytown residents without increasing their economic burden, and preserve the traces of urban development. In order to achieve this goal, it should explore the renewal strategies of shantytowns from the perspective of environment-behavior studies through behavior maps, on-site research, and literature review. Updating and design from a human perspective often achieve faster and better development; the renewal of shantytowns should be a bottom-up approach and start from a grassroots perspective, completing the renovation design through the composition of the population and behavioral patterns.

Keywords Environment-behavior studies, Shantytown renewal, Economic type, Bottom view, Bottom-up

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"Shantytown" is a community concept that lies between urban and rural areas, and is a major product of urbanization. Most of them are forgotten areas of urban development in China, urban corners, and an important gathering place for residents in cultivated areas. Due to the poor living environment and quality of life in shantytowns, they are the main residence for the vast majority of families facing difficulties and low-income groups. By analyzing the current situation of shantytowns in Baotou City, environmental behavior theory is used to explore new models of shantytown renewal[1], to stimulate the vitality of shantytowns and improve the quality of living environment for residents. In this paper, the northwest area of Saihantala in Baotou City is taken as an example to explore the renewal strategy of shantytowns.

1 Concept and intervention of environment-behavior studies

1.1 Definition of relevant concepts

Basic concept of environment-behavior studies: the research field of environment-behavior studies originated in Europe and America in the 1960s, and is a science that studies the relationship between environmental design and human behavior. It applies some basic methods and theories of psychology to study human behavior and activities in cities and buildings, as well as human reactions to the spatial environment, and feeds back to the planning and design of cities and buildings to improve the living environment of humans[2].

The research goal of environment-behavior studies is to find and establish an ideal design theory system. The research of environment-behavior studies can be divided into four parts: ① perception of the relationship between humans and the environment; ② human behavior; ③ human preferences and perceptions; ④ space[3]. Environment-behavior studies is the main research field of human centered design, focusing on the relationship and interaction between human behavior and the environment. It applies basic psychological methods and theories to study human activities in the environment and their reactions to these environment. Feedback based information can be used to guide the renewal and transformation of the area. The active role of humans in the environment includes both material and functional roles, as well as the role of value endowing and reinterpreting[4]. In his book *Life between Buildings*, Jan Gehl mentioned that human behavior can be mainly divided into three categories: necessary activities, spontaneous activities, and social activities[5]. Necessary activities occur under various conditions; spontaneous activities only occur under suitable outdoor conditions; as long as the conditions for necessary and spontaneous activities in public spaces are improved, it will indirectly promote social activities.

1.2 Intervention of environment-behavior studies

The perspective of selecting environment-behavior studies to intervene in shantytowns mainly focuses on the current situation of shantytowns. After summarizing the common problems in shantytowns, three points are selected, and they are spatial issues, functional imperfection, and social issues. Space problems refer to the lack of activity and public spaces around shantytowns; the problem of incomplete function refers to the outdated functions that cannot meet the existing needs of residents, resulting in the loss of vitality of the original functions; social issues refer to the composition of the population in shantytowns, where the majority of the population is low-income. Low rent and convenient transportation in the surrounding areas are the main factors for them to live here. By observing human behavior and addressing questions from these three perspectives in a targeted manner, it can ensure the smooth and high-quality completion of shantytown renewal[6].

1.2.1 Space intervention. Due to the compact space of shantytowns, there is not enough green space, social space, public space, etc., and the only places where residents can communicate are on both sides of the road or the steps at the entrance. Therefore, behavior map and ant colony optimization (Fig.1) are used to determine the spaces where people often gather or pass

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through, and to set public activity areas and greening, in order to meet the needs of social activities and improve regional vitality.

1.2.2 Functional intervention. The original shantytown has a cluttered interior, without dedicated space for garbage collection and parking. At the same time, the interior of each individual building is that a single room serves all the functions of the living room, bedroom, and kitchen. The courtyard is both a place for communication and dining. With the improvement of modern lifestyle, new functional requirements have emerged. It could observe surrounding infrastructure frequently visited by people in shantytowns through behavior maps, mark the paths they pass through and the required functions, and then select the shortest path to dispose of this function.

1.2.3 Intervention in social issues. There are more tenants within the shantytowns, and most of the people living here have low income and limited economic source. Therefore, economic issues should be fully considered in the update. By conducting surveys and visits, it aims to understand the range of rent changes that tenants can accept and the internal structural needs of the house. From the perspective of tenants, shantytowns are updated based on a bottom-up perspective.

2 Concepts and policies related to shantytowns

Shantytown refers to an area with a large number of simple structured houses, high building density, long service life, poor housing quality, multiple safety hazards, incomplete functional use, and inadequate supporting facilities. Urban dilapidated houses and urban villages are included in the scope of urban shantytowns.

The scope of policy transformation related to shantytowns was gradually expanding. From the government's investment in shantytowns of forest areas and factories of mining areas in 2005 to the launch of the "Affordable Housing Project" by the Central Committee of the Communist Party of China in 2008, to the promotion of shantytown transformation as a key livelihood project nationwide in 2009, the scope of shantytown transformation policy was gradually expanding. In 2011, the renovation scope was extended to administrative towns. By 2013, the *State Council's Opinions on Accelerating the Transformation of Shantytowns* (Guofa [2013] 25) was issued, accelerating the transformation of various types of shantytowns. In 2015, the renovation of dilapidated urban houses was included in the scope of shantytown renovation policies.

3 Correlation between shantytown renewal and environment–behavior studies

Environment-behavior studies believe that behavior is the result of the combined action of the environment and human needs[4]. A certain environment is required to exhibit certain behavioral activities, such as social activities[7]. Firstly, it is found through research that in addition to young workers, there are also many elderly and children in the area who require social activities. Public spaces can be set up according to the spaces where the crowd often walks or stays. Secondly, some functional facilities could be set up. Through research and observation, it can understand the functional facilities they need, and use environment-behavior studies to construct the needs of the population from a grassroots perspective, in order to carry out humanized shantytown renewal. The renewal of shantytowns has an impact on the composition of the population. If shantytowns are viewed as a large system and people as a small system, environment-behavior studies can accurately capture the "bottom-up" characteristics exhibited by the two systems in their respective development processes[8].

3.1 Purpose of shantytown renewal

The purpose of shantytown renewal is to update the urban landscape, improve the living environment of residents, and enhance their quality of life. While ensuring the daily lives of residents in shantytowns, it also preserves the traces of urban development without increasing their economic burden. The urban landscape is improved by using methods that have the least impact on the residents of shantytowns. Currently, most of the shantytown renovation projects carried out in China are mainly focused on demolition and reconstruction, which is completely feasible for improving the urban landscape. However, there are still some shortcomings in terms of social benefits, historical preservation, and other aspects.

3.2 Significance of shantytown renewal

3.2.1 Theoretical significance. Against the backdrop of rapid urban development in China, in order to meet the needs of residents for a better life and improve the urban landscape, the renovation project of shantytowns has been carried out on a large scale. However, this kind of demolition and reconstruction model is too monotonous and rough, which is a pity for the demolition and reconstruction of shantytowns

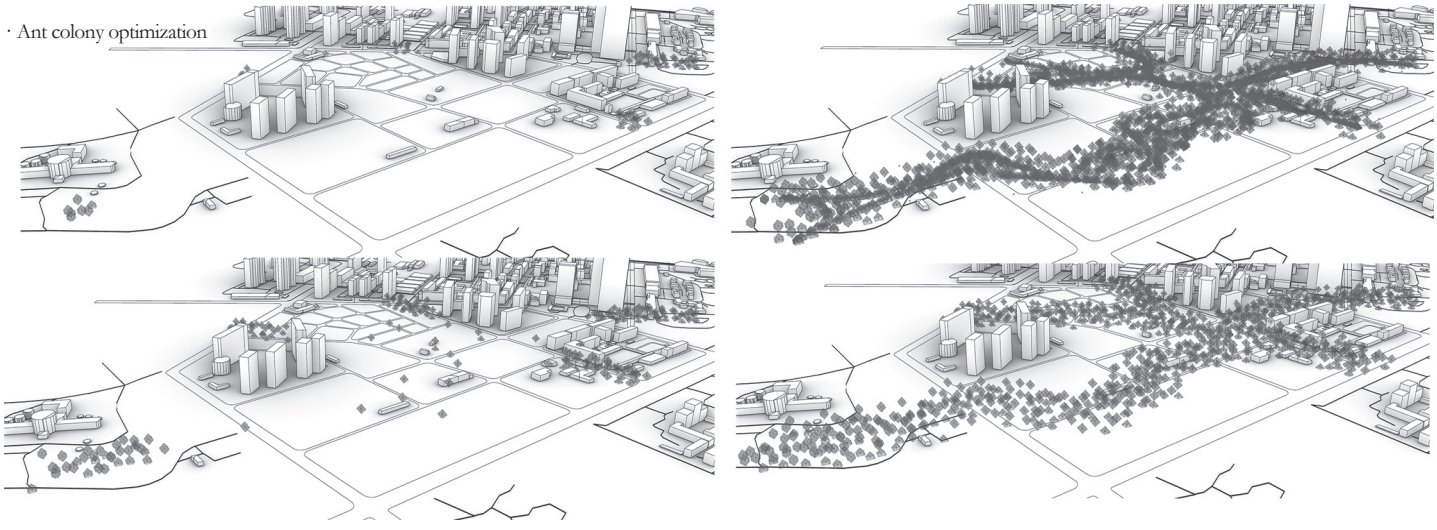


Fig.1 Simulation of human paths through algorithms (determination of public space location)

in some historical districts and those with certain cultural connotations or urban development traces[1].

3.2.2 Realistic meaning. It should pay attention to both economic and social aspects. From a purely architectural perspective, the vast majority of buildings in shantytowns lack artistic, technological, and material value, and they should be demolished and rebuilt as a whole. However, the buildings in shantytowns have social value from a practical perspective, and the majority of residents in shantytowns are migrant workers with limited economic capacity. The shantytown has a monthly rent of 200 yuan and is relatively close to the city center, making it their best choice overall. The rent for the demolished and rebuilt houses in shantytowns will undoubtedly exceed the affordability of tenants, forcing them to move out. This has changed the social structure and relationships of this shantytown. Through the use of environment-behavior studies to assist in design, both shantytown renewal and environment-behavior studies take people as the first perspective, and fully consider their needs. Starting from the perspective of residents at the bottom, bottom-up renewal is conducted, which is also the significance of renewal.

4 Taking the renovation of shantytowns in the northwest area of Saihantala in Baotou City as an example

4.1 Project background

The design project is located at the northwest corner of Saihantala Ecological Park in Baotou City, surrounded by Jianshe Road, Youyi Street, and Ziyou Road. The total land area is approximately 45 hm^2. This area is located at the northwest side of Saihantala and is an important urban business card area and stock space renewal area in Baotou City. Multiple urban spatial elements blend and mix to form a multifunctional weaving space. There are a large number of old residential areas and shantytowns around the plot, accounting for 1/4 of the total area.

4.2 Current situation of the shanty–town

Poor lighting and ventilation: due to overcrowding in shantytowns, inadequate lighting and ventilation, coupled with illegal construction, the lighting and ventilation conditions are even worse. The majority of heating methods used in shantytowns are coal burning, and insufficient ventilation can easily lead to carbon monoxide poisoning incidents. This type of safety incident often occurs in shantytowns.

Poor environmental hygiene: these essential public facilities for residents in their daily lives, such as garbage collection stations and trash cans on both sides of the street, are not yet densely distributed in residential land. The environment inside the shantytowns is very dirty, messy, and poor. It can see litter thrown away on the roads, which not only pollutes the environment but also affects the appearance of the streets.

Poor visual environment: there are many blind spots in the visual field, which are the most prone to darkness. At the same time, due to the lack of management in shantytowns, the crime rate in the area will increase.

Lack of public activity space: with the change of modern lifestyle, local residents spontaneously expand outward from their own land. This expansion not only encroaches on road space, but also damages the existing public space, making the places where social activities among residents can occur scattered and chaotic, which affects the normal life trajectory of local residents to some extent.Additionally, due to the lack of relevant management and regulatory personnel, there is a serious phenomenon of motor vehicles and non motor vehicles being parked randomly in the community, making the original road space even more congested.

Housing quality issues: because most people rent houses, even if the houses are in disrepair for a long time, tenants will not take the initiative to repair them. Over time, quality problems may occur in houses, especially in wooden structures. Due to lack of maintenance, the beam structure of most houses is corroded and loses its bearing capacity, which is not conducive to earthquake resistance or bearing large loads.

Traffic congestion and narrow roads: the housing in shantytowns is already quite crowded. Due to some disorderly expansion, the originally narrow road space is even narrower. There are also issues with disorderly parking of vehicles, and some normal large vehicles are difficult to pass through, such as fire trucks, emergency vehicles, etc. This has led to that rescue efforts cannot be rushed in time when some dangerous situations occur, and has also increased the safety hazards in shantytowns.

Partial retention and partial demolition: firstly, the quality and age of the building are evaluated, and old and dilapidated buildings and added dangerous buildings are demolished. Secondly, eddy3d (Fig.2) and Ladybug (Fig.3) in Gresshopper are used to simulate wind, light, and heat, and some houses with poor ventilation and lighting are demolished. Finally, according to the road texture of the city, the internal roads of shantytowns are regulated, and some buildings that do not conform to the road texture are demolished.

4.3 Adaptability of shantytown renewal

It could integrate the willingness of residents to update into the renewal of shantytowns, which could increase their sense of participation and responsibility during the renewal process, laying the foundation for later shared maintenance and use and emotional resonance[9]. This update can maintain existing social relationships and networks. At the same time, it also allows the residents of shantytowns to have no economic burden and makes the functional structure of shantytowns more complete.

4.4 Principle of shantytown renewal

The principle of shantytown renewal is to selectively add new elements from the bottom level perspective based on human behavior patterns, and inclusively accept and improve old elements. Meanwhile, the internal spatial structure is reconstructed (Fig.4). The originally disordered shantytown is update and organized, making it more orderly.

4.5 Mode of shantytown renewal

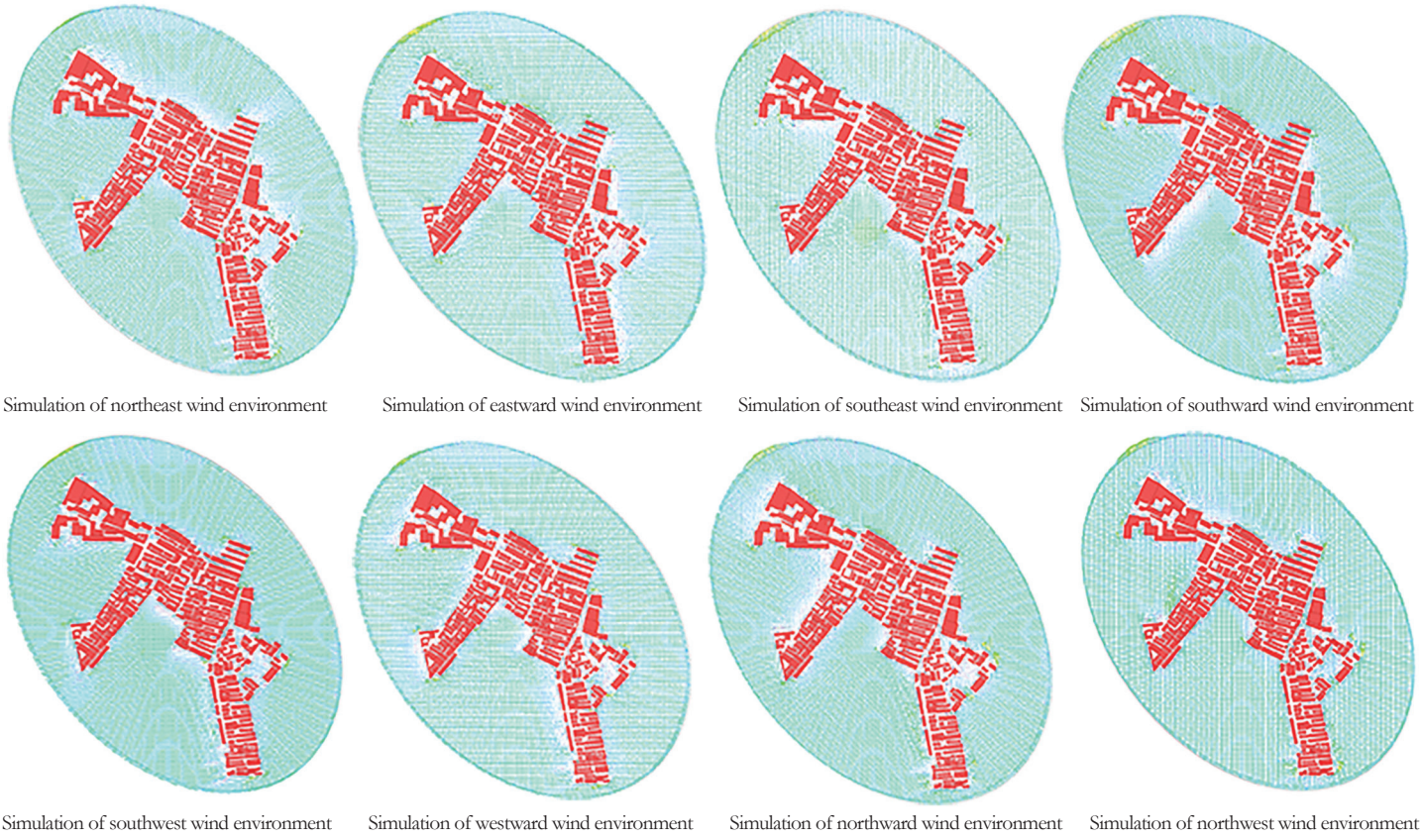
There are two main modes for updating buildings: single building and overall space. The update object of the first mode is a single building (adding new catalyst points to activate the surrounding space), which includes three strategies: external space (mode 1 in Fig.5), internal space (mode 2 in Fig.5), and push-pull space (mode 3 in Fig.5). The main idea is to insert a box shaped space, inserting new spaces inside old buildings. It retains the original wooden structure while giving the interior a completely new look.

The second mode is the handling of the overall space. There are subtraction strategies: cutting buildings, gray space processing, placing sunlight room, area replacement, cutting road, subtraction processing (modes 1 and 2 in Fig.6). Because the roads in the region have certain texture relationship, some buildings that disrupt the texture relationship are reduced to give way to the roads. There are additive processing strategies: aerial corridor, three-dimensional walkway, active solar house, passive solar house, etc. (mode 3 in Fig.6). Most of the buildings in this shantytown are not fully functional and can be added with new features such as kitchen and bathroom.

5 Conclusions

The renewal of shantytowns needs to be

· Simulation of wind environment in shantytowns



Simulation of northeast wind environment | Simulation of eastward wind environment | Simulation of southeast wind environment | Simulation of southward wind environment

Simulation of southwest wind environment | Simulation of westward wind environment | Simulation of northward wind environment | Simulation of northwest wind environment

Fig.2 Wind simulation

· Climate analysis

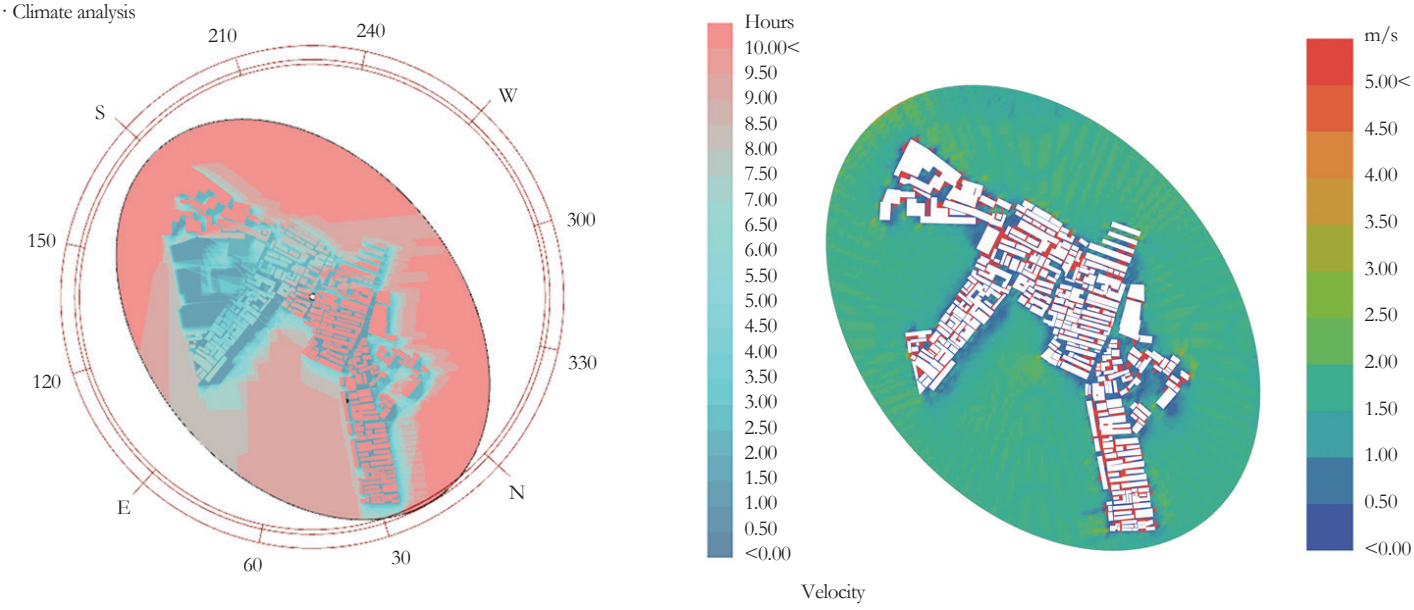


Fig.3 Simulation of sunshine and wind speed

approached from the perspective of architectural environment-behavior studies, fully considering human behavior, psychological, and physiological needs. Starting from a humanized spatial scale, humanized spatial levels and sequences are rationally divided. Only in this way can a closely connected and vibrant urban spatial environment be created[10].

In this paper, three strategies for the renewal of shantytowns are summarized through research and literature review: ① for the internal space of shantytowns, prefabricated PU sandwich panels are used for additive treatment through demand analysis, which is economical and labor-saving while ensuring that the housing structure is not damaged. ② For the external space of shantytowns, the positions of public and green spaces, as well as the areas for walking,

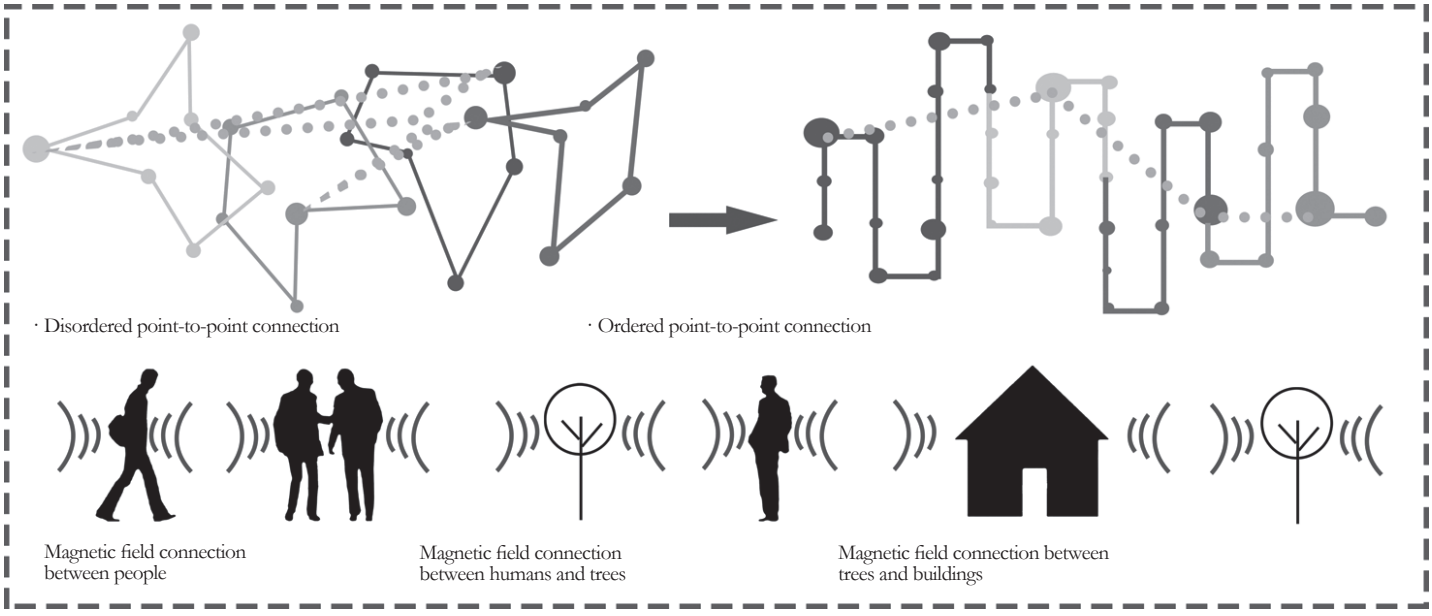


Fig.4 Reconstructed space

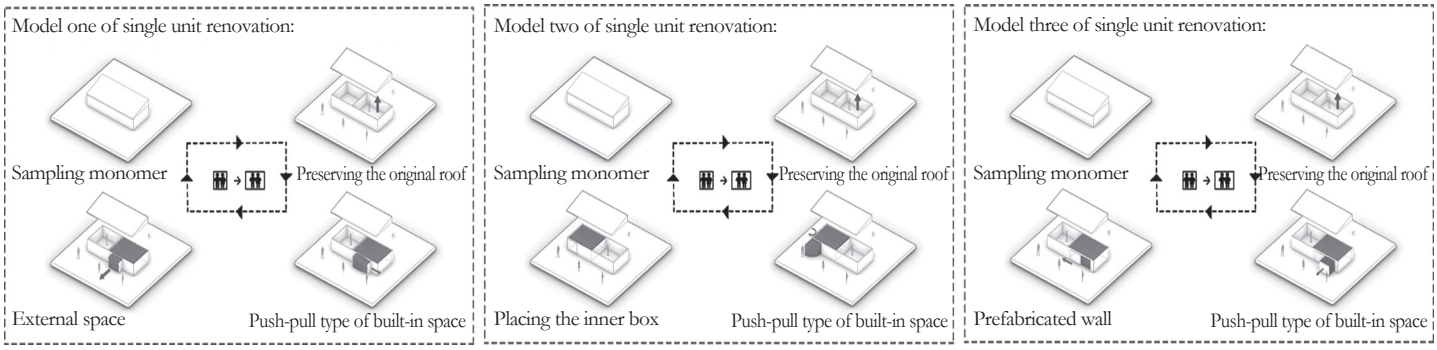


Fig.5 Update strategy

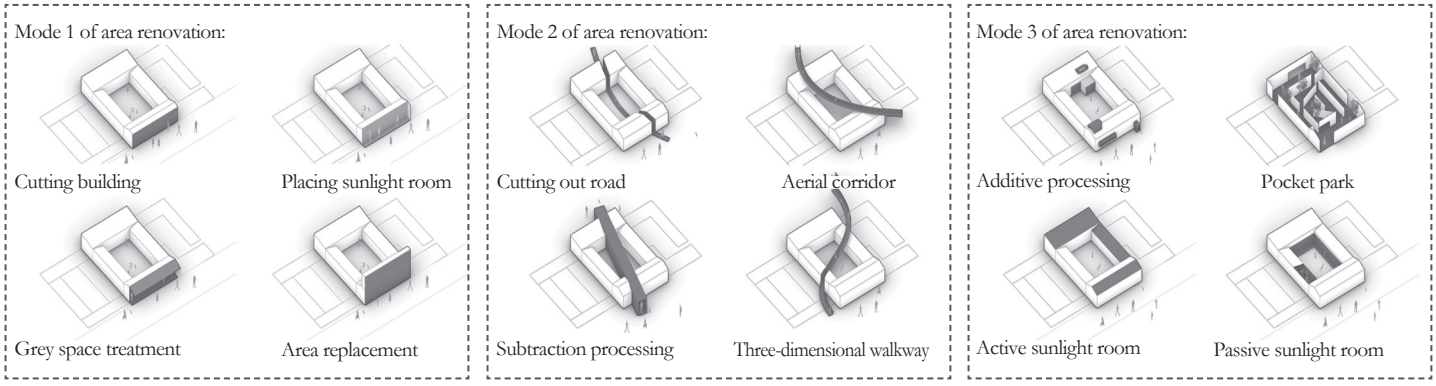


Fig.6 External space processing

are determined based on the daily behavior patterns of the crowd, and pocket park and trail designs are carried out. ③ For the layout of basic functional facilities, the behavior map method is used to mark the surrounding facility points that are most commonly visited by people in shantytowns, to understand specific functional facility requirements, and place functional areas based on the length of the path and accessibility.

Through these strategies, it can also be seen that the renewal of shantytowns should be a bottom-up approach.

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communication and cooperation between different landscape architects and enterprises, so as to promote technology exchange and sharing, and to jointly promote the wider application and development of AI technology in the landscape industry.

3.4 Lack of subjective creativity and artistic sense

In landscape design, AI technology can aid designers in planning and design, but it still cannot completely replace the subjective creativity and artistic sense of human designers. This is because landscape design needs to consider many factors, such as culture, history, environment, function, etc, which require human designers to make decisions and judgments based on their professional knowledge and aesthetic concepts. Firstly, landscape design is an artistic creation that requires designers to express their thoughts and creativity through their subjective creativity and aesthetic concepts. Although AI can aid designers in planning and design, it still cannot completely replace the creativity and imagination of human designers, nor can it express emotions like human designers. Secondly, landscape design needs to consider local cultural, historical, and environmental factors, which require human designers to judge and analyze based on their own knowledge and experience. Although AI can process a large amount of data and information, it still cannot have a deep understanding and sensitivity to cultural, historical, and environmental factors like human designers. Finally, there are many complex design decisions to be made in landscape design, including spatial layout, landscape planning, plant configuration, etc. These decisions require human designers to make and judge based on their professional knowledge and experience. Although AI can aid designers in planning and design, it still cannot completely replace the important role of human designers in complex design decisions. Therefore, in landscape design, it is necessary to give full play to the subjective creativity and artistic sense of human designers, while combining the aided role of AI technology to jointly promote innovation and development in landscape design.

3.5 High dependence on technology and equipment

Due to the large amount of data, algorithms, and computing resources involved in the application, AI relies on advanced technology and equipment, but the rapid technological updates and high equipment costs have brought certain difficulties and challenges to the application of the landscape architecture industry. Firstly, technological updates costs high. With the continuous development of AI, new technologies and algorithms continue to emerge, and these new technologies require new hardware and software support, requiring users to constantly update their technology and equipment, which will also increase the use costs and technical thresholds. Secondly, the application of AI needs the support of high-performance computers and servers, which have high costs and may be difficult for some small businesses and institutions to afford. In addition, equipment maintenance and upgrading also require certain costs and manpower investment. Finally, due to the complex technology and algorithms involved in the application of AI technology, technical personnel is required for the installation, configuration, and maintenance. The limitations in technical proficiency and experience may make it difficult for some technical personnel to provide comprehensive technical support and services. In summary, the high dependence on technology and equipment is a key issue in the application of AI technology in the landscape industry. To solve this problem, it is necessary to strengthen technical research and development, reduce the cost of technology and equipment, while improving the level of technical personnel and providing comprehensive technical support services.

4 Conclusion

AI technology plays an important role in the landscape architecture industry. It can optimize workflow, and improve efficiency and quality, making significant contributions to the innovation and development of the industry. With the continuous updating and development of technology, the application of AI in the landscape industry will become more and more extensive and in-depth, providing stronger support and guarantee for the sustainable development and innovation of the industry. Therefore, it is necessary to actively explore and research the application of AI technology in the landscape architecture industry, so as to promote the modernization development of the industry.

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