Conservation and Renewal Strategies of Industrial Heritage Residential Areas from the Perspective of Heritage Protection: A Case Study of Residential Area of Wuchang Vehicle Factory

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Abstract The residential area of Wuchang Vehicle Factory is taken as a case to explore the protection and renewal strategies of industrial heritage residential areas. By analyzing the current situation of the residential area, issues such as functional decline, memory loss, and weakened community vitality are revealed. Three design concepts are proposed: building renovation, historical space renovation, and the introduction of cultural and creative industries, aiming to improve the living environment, showcase historical value, cultivate cultural and creative industries, promote economic transformation, and community vitality. This paper could provide reference for the protection and renewal of similar industrial heritage residential areas, and new ideas for the research and utilization of industrial heritage. By comprehensively considering heritage protection, cultural inheritance, and community development, systematic suggestions are proposed.

Key words Heritage protection; Industrial heritage residential areas; Conservation and renewal strategy

DOI 10.19547/j.issn2152 - 3940.2024.03.010

In 2003, the International Association for the Protection of Industrial Heritage passed the *Nizhny Tagil Charter* to promote international consensus. This charter expands the scope of protection for industrial heritage, including social activity venues related to industry, such as residential, religious, and educational facilities[1]. The charter emphasizes that the key to protecting industrial heritage lies in maintaining its functional integrity. On this basis, Weng Fangling first extended this concept to the knowledge field related to industrial heritage. She named it "industrial heritage community", mainly referring to worker villages, worker settlements, *etc*[2]. This concept expands the scope of industrial heritage protection, emphasizing not only architecture but also the integrity of social activity venues. Worker housing carries the spirit and memories of the times, and is an important component of industrial heritage, reflecting the transition from a single residence to a residential area, with profound historical significance. In this paper, the residential area of Wuchang Vehicle Factory is taken as an example to explore its protection and renewal strategies, aiming to maintain this precious historical heritage.

1 Protection and renewal background of industrial heritage residential areas

1.1 Industrial heritage residential areas with their unique conservation value Industrial heritage residential areas carry urban history and culture, record human activities and social changes, and reflect the daily life and emotions of residents. As part of existing residential areas, they have historical and cultural value while meeting residential needs. Therefore, protecting industrial heritage residential areas is not only related to historical culture and emotions, but also to the economic and social aspects.

Wuhan is a modern industrial center in central China, with numerous collectively owned industrial enterprises during the planned economy era. With the development of market economy, many industrial enterprises have relocated, leaving behind industrial heritage residential areas. The structure, architecture, environment, and lifestyle of residents in these areas reflect information from different periods and have important research value.

1.2 Urgent renewal of industrial heritage residential areas The Fifth Plenary Session of the 19th Central Committee of the Communist Party of China pointed out that urban renewal is a key strategy to promote high-quality development. China's urban planning is shifting towards stock management, and urbanization has entered a stage of quality improvement, shifting from incremental construction to stock enhancement, focusing on structural adjustment and optimization of existing resources, and improving urban quality and sustainability[3].

The cities where industrial heritage communities are located have advantages such as orderly land use, large scale, low building density, and low demolition costs, which are conducive to urban renewal. The industrial heritage community retains its original style and layout, and has important value as a historical heritage. The disintegration of the unit system and relocation of factories have led to the separation of residential areas and factories, imbalanced community development, aging environment, lagging infrastructure, and gradual decline of building facilities, making it dif-

Received: May 4, 2024 Accepted: June 11, 2024

Supported by Philosophy and Social Science Research Project of Hubei Provincial Department of Education (22Y066).

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ficult to meet the needs of residents. Therefore, it is particularly urgent to protect and update industrial heritage communities, balance historical heritage protection and sustainable community development[4].

2 Related theoretical research

2.1 Micro renewal theory The theory of micro renewal emphasizes small-scale and gradual urban renewal, centered on human needs, advocating for multifunctional and small-scale incremental renewal to avoid large-scale demolition. This theory emphasizes the organic collage of cities, advocates the restoration of traditional spatial forms, the creation of urban environments with historical characteristics, and the continuation of existing community spaces and ecosystems.

The principle of micro renewal is to meet the living needs of local residents without changing the land use or building structure. It could improve small public spaces and facilities through renovation, repair, and improvement methods. Its goal is to organically and gradually improve the city, ensure sustainable community development, and protect and inherit the city's history and culture[5]. The old industrial residential areas have a long history and profound cultural heritage. Demolition and reconstruction have improved the economy and building quality, but have destroyed the original space and damaged neighborhood and social relationships.

2.2 Heritage protection theory In 1972, the convention *Protecting World Cultural and Natural Heritage Sites* included architectural heritage in the category of cultural heritage, laying the foundation for protection work. In 1976, UNESCO further elaborated on the importance of architectural heritage[6]. At present, the definition of architectural heritage is no longer limited to individual buildings, but includes those "historical buildings" with historical memory, specimen research value, and cultural symbolic significance.

Large-scale demolition has led to the gradual disappearance of the unique lifestyle and neighborhood relationships in old residential areas, resulting in a cultural rupture in the city. There is insufficient research on the renewal mechanism of old residential areas of non heritage buildings, especially on the cultural inheritance of old industrial residential areas. It needs to explore more flexible transformation models to address current urgent issues.

3 Current situation and problem analysis of residential areas in Wuchang Vehicle Factory

3.1 Current situation of residential areas in Wuchang Vehicle Factory The residential area of Wuchang Vehicle Factory is located within the Xujiapeng Street area of Wuchang District, Wuhan City, distributed on both sides of Heping Avenue, adjacent to the core area of Wuchang Binjiang. After the relocation of the vehicle factory, its residential areas have been relatively well preserved. After the relocation of the vehicle factory, the original site was transformed into the Binjiang Business District, and a Greenland Financial City was built. Numerous schools, enterprises, and businesses are surrounded the factory residential area (Fig. 1).

Fig. 1 Location of residential area of Wuchang Vehicle Factory

3.1.1 Historical evolution and construction process. The industrial heritage residential area of Wuchang Vehicle Factory showcases the construction process and resident life of industrial residential areas since the 1950s. In the past, residential areas were formed under the background of the "unit system", and factories provided comprehensive support for employees, promoting residents to work and learn together, and forming a unified identity.

During the planned economy period (1949 – 1978), industrial residential areas and production areas were constructed simultaneously, with adjacent site selection. In the early stage of state-owned enterprise reform (1979 – 1999), investment in Wuchang Vehicle Factory increased, promoting the construction of industrial residential areas. During the period of separation between generation and life (1999-present), with the deepening of state-owned enterprise reform, factories no longer bear the burden of living for residents in residential areas. Production areas were relocated, and the flow of residents in residential areas increased, and it was gradually open up.

3.1.2 Residential space and architectural style. The residential area of the vehicle factory mainly adopts a row layout, fully preserving the architectural characteristics since the 1950s. Although the layout of villages 1, 3, 6, 7, and 8 is similar, the building height and spacing are different. Village 4 has a curved layout, mainly consisting of plate type of multi story and point style of high-rise buildings. However, residential areas generally face problems such as insufficient private space and limited functionality, which contradict the growing demand of residents. Self built and renovated residential buildings are common, including expansion, additional structures, and exterior walls. Some have overhanging structures on external corridors or windowsills, while others directly occupy public spaces. These issues have led to a disorderly appearance and style of residential buildings.

3.1.3 Road traffic and landscape greening. The residential area of the vehicle factory includes buildings and spaces built in different periods, and the road system also reflects this characteristic. The road classification within the residential area is diverse, forming a multi-level structure. At the same time, residential areas are connected to the city, and internal roads directly connect multiple

urban branches. However, the greenery in residential areas is scattered. Except for a concentrated green space, most of which are distributed between houses and on both sides of roads, lacking leisure spaces for residents. Part of the greenery is abandoned and converted into vegetable fields by residents, lacking management planning (Fig. 2 – 3).

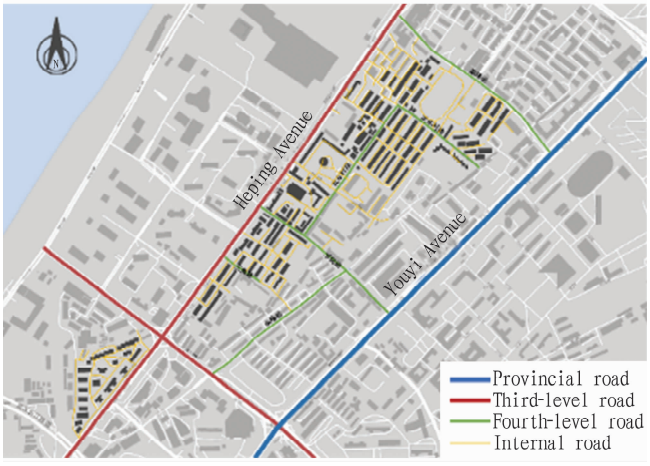

Fig. 2 Road traffic in residential area of vehicle factory

Fig. 3 Landscape and greening in residential area of vehicle factory

3.1.4 Public services and supporting facilities. The public service facilities in the residential area of the vehicle factory are very complete, providing rich supporting functions. The strong demand has given rise to diverse business models, with a wide variety and small scale[7]. Medical, educational, and entertainment facilities are concentrated in villages 1 and 3, forming a cluster of public facilities. Commercial activities are mainly distributed on urban roads and internal routes, with active opening of shops through broken walls and later addition of shops. However, cultural and creative industries in residential areas lack of vitality cannot reflect the historical and cultural value of industrial heritage, and the collective memory of residents is gradually losing (Fig. 4). However, residential areas lack dynamic cultural and creative industries, and the historical and cultural value of industrial heritage residential areas cannot be reflected, leading to the gradual loss of collective memory among residents.

Fig. 4 Public services and supporting facilities in residential area of vehicle factory

3.2 Value analysis of residential areas in Wuchang Vehicle Factory

3.2.1 Historical and cultural values. Industrial heritage residential areas are physical relics of historical construction activities, recording rich historical information[8]. It witnesses human activities at specific historical moments and reflects the life and social changes of different periods[9]. The vehicle factory residential area vividly displays the evolution history of the relationship between residential areas and cities in Chinese cities from the "unit system" to the disintegration, and is a dynamic record of the development of industrial residential areas.

3.2.2 Humanistic emotional value. Residents of industrial heritage residential areas engage in diverse daily activities in this area. The space of different eras, property rights, and living conditions within the residential area of the vehicle factory interweaves together[10], and long-term interaction has created a real and interesting living space. This interaction not only closely combines functions and needs, but also contains rich humanistic and emotional values.

3.2.3 Economic and social value. The use value of industrial heritage residential areas refers to their direct utilization value that meets the actual living needs of residents, including building quality, service facilities, transportation, and environment[11]. The residential areas of the vehicle factory and the engine factory retain public and commercial facilities, attracting foreign tenants because there are many enterprises and schools in the surrounding area, and the rental competition advantage is significant[7].

3.3 Problems of residential area in Wuchang Vehicle Factory

3.3.1 Unknown venue identification. First, inconsistent architectural style: the architectural appearance of the residential area in the vehicle factory is arbitrarily painted and renovated, resulting in a disorderly appearance and a lack of overall planning. Second, less open space: the residential area lacks outdoor activity areas, street green spaces, and parking lots, with only one green space adjacent to a garbage dump, resulting in poor experience. Internal passages are unclear, making it difficult to form a public space. Third, lack of landscape signage: due to multiple "informal" renovations, the residential area lacks street furniture

and landscape ornaments, and many recreational areas have been converted into drying areas and vegetable gardens by residents because they are not suitable.

3.3.2 Functional weakness. First: pursuit of urban spatial quality: it has led to the marginalization of old industrial residential areas such as vehicle factory and their buildings, resulting in a decrease in attention. Second, the reduction of residential quality: some building structures are no longer suitable for modern living needs, and the phenomenon of spontaneous renovation by residents is prominent, resulting in an overall "unhabitable" state in the residential area. Third, a decrease in social identity: policies and other factors lead to a lower sense of identity among residents towards old industrial residential areas, and the public generally does not understand or are unwilling to adopt conservation based renovations. Fourth, cognitive limitations: the understanding of the regeneration or reuse mode of old industrial residential areas is limited, and urban construction tends to be demolition and reconstruction, rather than supporting single functional replacement or quality repair.

3.3.3 Collective memory loss. One of the main reasons for the continuous "marginalization" of old industrial residential areas is the lack of collective memory. The majority of the elderly population in the residential area of the vehicle factory expect to obtain a new living environment through demolition and old renovation. The degree of appreciation for the historical and collective memory of the old industrial residential area is significantly lower than the expectation of livability in residential areas.

4 Design concept for protection and renewal of Wuchang Vehicle Factory

4.1 Renovation of residential buildings to ensure the normal life of residents It should classify buildings within residential areas and develop repair plans. Moreover, the original structure and materials should be respected. For example, some red brick houses in the residential area of vehicle factory have a strong historical and contemporary flavor, and it should conform to the original characteristics to avoid excessive renovation and damage. It could moderately renovate the interior, improve lighting, ventilation, sound insulation and other functions, enhance livability and energy efficiency. It should standardize the installation of components, remove unreasonable or unsafe components, and maintain overall coordination. Regular inspection and maintenance should be conducted, to solve safety hazards, and ensure the normal life of residents.

4.2 Renovation of historical space to continue traditional community culture The historical space of residential areas should be sorted out, to protect representative landmarks and characteristic spaces, such as factory gates, squares, *etc.*, and improve their quality. It should conduct cultural exhibitions, set up introduction and identification signs, tell historical stories, and enhance the cultural atmosphere. Creative utilization of space should be conducted, and community services and leisure facilities could be introduced, to enrich functionality and vitality. It should encourage residents to participate in space protection and management, cultivate a sense of community responsibility, and promote harmonious development.

4.3 Incorporating cultural and creative industries to revitalize neighborhood communication vitality It should optimize residential space, transform vacant factories, warehouses, *etc.* into carriers of cultural and creative industries; innovatively explore industrial, community, and folk culture, and develop cultural products, such as exploring the historical evolution of residential area of vehicle factory, and sorting out the cultural stories behind residential area of vehicle factory based on historical context; cultivate cultural and creative industries such as design and animation, and provide policy support; establish cultural and creative brands, hold cultural events, and increase visibility.

5 Conclusion

Through the study of protection and renewal strategies for the residential area of Wuchang Vehicle Factory, this paper proposes a series of substantive design concepts, including building renovation, historical space renovation, and the integration of cultural and creative industries. It should emphasize the consideration of history and culture, humanistic emotions, and economic and social factors. It is suggested classifying and repairing buildings, unifying their appearance, and improving the interior to enhance the quality of life for residents. By transforming historical spaces, it aims to protect representative historical spaces and continue traditional community culture. By introducing cultural and creative industries, space is optimized, to promote neighborhood exchanges and economic development. These strategies not only focus on architectural restoration, but also emphasize the integration of traditional culture and emerging industries, providing comprehensive solutions for the protection of industrial heritage residential areas. We look forward to the revitalization of the residential area of Wuchang Vehicle Factory, becoming a model of harmonious coexistence between history and modernity, and contributing to urban development and cultural inheritance.

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velopment of numerical models, the accuracy of rainfall forecasting will also increase, and its application to flood forecasting will become better and better. This is also a trend of coupling hydrology and meteorology. On the other hand, due to the limited number of collected flood cases, there is still room for improvement in the effectiveness of model forecasting. In the later stage, with the collection and use of more flood data for process inversion, it will help improve the model parameter structure and further enhance the forecasting accuracy.

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