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Exploring Resilient Housing Design in the Post-Epidemic Era

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Abstract: *The outbreak of the novel coronavirus (COVID-19) in early 2020 has dramatically changed how people live and work. With most people experiencing months of living and working from home under the sudden risk, the home has become a vital fortress against the outbreak. Taking the post-pandemic era as a backdrop, the author thinks about how better to play the role of housing shelter in the future and puts forward the form of residential architecture in Beijing in the future -- resilient housing. Starting from the connotation of resilient housing and its relationship with the resilient city, we analyze the reasons for the emergence of resilient housing. Then, the specific operation mode of resilient housing is discussed, and a student's concept competition scheme is taken as an example to analyze the specific risk-coping mode of resilient housing. It aims to put forward operational strategies for the development of residential buildings in Beijing in 2050 so that people can live better.*

Keywords: *Future urban spaces; Resilient housing; Resilient cities; Post-epidemic era; Risk resistance*

1. Introduction

The paper proposes flexible housing as the form of future residential buildings in Beijing post-epidemic. Based on the connotation of flexible housing and its relationship with flexible cities, the paper analyzes the reasons for flexible housing. A student concept competition scheme is used to illustrate the specific risk response mode of flexible housing. In the future, and then hope that there will be a sound housing system and a safe housing system to establish a "flexible housing" model, all parties must cooperate and work together.

2. Analysis of Future Urban Spaces in the Post-epidemic Era

The year 2020 was an unusual one. The sudden arrival of the new coronavirus (COVID-19) outbreak put both the city and the buildings to the test. At the beginning of the outbreak, the lack of medical resources made it difficult for facilities to meet the demands of medical use, making the situation very chaotic at the time. But buildings such as Thunder God Mountain hospital and Thunder God Mountain hospital, which reflect China's speed, and the city's excellent facilities and operational efficiency, show the unyielding resilience of our cities and buildings. For most people, working from home and meeting online has been the norm over the past year. In the face of the risks posed by the epidemic, residential buildings have become shelters for people's safety.

As the first battleground in the fight against the epidemic, residential buildings are no longer simply the primary space for people to live, work, study, and play but also the first barrier to protecting their health. Although China has achieved some strategic victories in the battle against the epidemic, the impact of the epidemic on people's lives cannot be ignored. People's way of living has changed to a certain extent, and this will last for the next 30 years or more. The author's vision of Beijing in 2050 will therefore take the post-epidemic era as the backdrop for thinking about the changes that will take place in residential architecture in the future.

Advances in internet technology have led to an exponential increase in the speed of information dissemination. While the epidemic has prevented people from communicating face-to-face in real life, it has brought them closer together in the virtual online world. The epidemic has also triggered a reflection on real life, with various sectors, including planning and architecture, thinking about how to respond to the uncertainty it has created. There is urgent pressure from academics to address these practical issues, and strategies are being proposed to move from healthy cities to healthy communities and healthy

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buildings and from resilient cities to resilient communities [1]. In the face of the epidemic, our residential buildings have given us a relatively adequate sense of security. However, residential buildings in urban spaces should not simply stop at preventing the recurrence of epidemics but should be prepared for danger in times of peace, reflect more systematically on the potential risks that our residential buildings may face, prevent all kinds of hazards that may arise in the future, and improve the resilience of residential buildings in a comprehensive manner. In addition to simply satisfying the basic need to live, residential buildings in the urban space of the future will also need to have a certain degree of RESILIENCE.

3. The Creation of Resilient Housing

In the face of growing urban problems, natural disasters, wars in parts of the world, and epidemics on a global scale, scholars at home and abroad have begun to focus on the study of urban resilience. As the theory of resilient cities continues to develop, the perspective of resilience has been narrowed to a more microscopic scale. In this paper, based on the consideration of resilience, the author proposes a vision of the future of residential architecture in urban space - "resilient housing" - in the context of the post-epidemic era. In the following section, the reasons for the emergence of resilient housing and the inevitability of its development will be elaborated.

3.1. Increasing Demand for Health and Safety

The severe consequences of the COVID-19 outbreak exceeded people's predictions, and life became very fragile in the face of the disease. In the next 2050, people will not only focus on nutrition and exercise to stay healthy but also pay more attention to the health and safety features of housing, gradually pursuing a healthier lifestyle and a safer living environment.

3.2. Increasing Demand for Diversity in Family Life

After a long period of home isolation during the outbreak, one wonders if there is more flexibility and variability in residential architecture to meet different needs. Will smart homes and the internet under artificial intelligence change the face of home life? The author believes that in the future, the spaces in residential interiors will become more versatile and complex to meet the new demands of home and family life, home offices, and online meetings.

3.3. People Are More Inclined to Avoid Unknown Risks

The spread of the global epidemic not only threatens people's lives but also has a significant impact on their financial situation. Many of these people have also experienced personal or business financial crises during the epidemic. People are gradually becoming more aware and attentive to possible future risks and are preparing for them in real-time. Life is changing every day, and it is difficult to accurately identify unknown risks. In the case of housing, increasing the resilience of residential buildings will enable us to react quickly to change.

4. Operational Model of the Resilient Homes System

For future urban spaces, in addition to epidemics, there may be natural risks such as typhoons and earthquakes; human risks such as fires and house collapses; and chronic risks such as pollution, infectious diseases, and haze, and the author enumerates these possible risks (Table 1) [2]. The impact of these risks on us will be devastating if there is no systematic coping analysis strategy for them. Therefore, the author proposes Resilient Housing as a form of residential architecture in the future urban space and envisages a specific mode of operation that includes four stages: vulnerability analysis, risk prevention, response to risks, and post-risk recovery and enhancement.

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Table 1: Analysis of potential risks to the future

Risk Type	Concrete Risk
A Natural risks	A1 Earthquakes, volcanoes, mudslides and other geological disasters
	A2 Typhoon, rainstorm, blizzard, hail and other weather
	A3 Termites, cockroaches and other biological invasions
B Human risks	B1 Theft, break-in and other human incidents
	B2 Residential risks such as injury to occupants due to improper design
	B3 Chemical disasters such as home fires
	B4 Risk of house collapse, falling objects, etc.
C Chronic risk	C1 Environmental pollution such as smog, water pollution, waste pollution, etc.
	C2 Infectious diseases, sudden diseases and other diseases spread

4.1. Vulnerability Analysis

The analysis of the vulnerability of the "resilient housing" model includes both internal and external vulnerabilities of the system.

The first step is to analyze the internal vulnerability of the residential building, and the relationship between the objective physical system and human use, in order to prevent incompatible contradictions. Resilience is the part of the building that deals with the unknown and is not visualized, but the vulnerability of residential buildings is often relatively visualized. The vulnerability of residential buildings is often relatively visual, as evidenced by direct manifestations such as cracks in floors and vibrations in windows and doors. The government analyzes physical vulnerabilities, developers, designers, and construction teams at the outset of the project design process to avoid these vulnerabilities as much as possible during the planning, design, and construction process. The exposures of non-residential building entities, on the other hand, are more insidious. Examples include design errors due to an architect's neglect of an issue during design or substandard quality of work due to speculation on the part of the builder. This requires an analysis of the causes of vulnerability by the individual subjects. Moreover, the vulnerability of the system is not static. The dynamic processes of aging of the building structure, wear and tear of the facilities, and changes in the external environment make it necessary for the individual subjects to maintain a dynamic analysis of vulnerability as well.

The second step is to analyze the vulnerability of the exterior of the residential building. One system can be integrated into another. For example, the smallest resilient housing system may be a house, beyond which there are larger resilient systems such as residential buildings, clusters of settlements, communities, etc., which are both interconnected and relatively independent. Therefore, the vulnerability of the exterior of residential buildings also requires attention. The remaining risks that cannot be temporarily identified as having relevance are kept somewhat open and current and are added to in a timely manner.

4.2. Risk Prevention

Vulnerability analysis is the basis of risk prevention, and risk prevention embodies an important feature of resilient housing. That is, if a risk occurs, part of the system is damaged. It will not affect the operation of the whole system because of its replacement. Similarly, in terms of preventive methods, it is also necessary to put forward preventive measures from the objective material and human aspects to the vulnerability obtained from the analysis. For example, to deal with the risk of an earthquake, not only should the earthquake level of the building itself be strengthened, but also residents need to understand the knowledge of earthquake escape and carry out earthquake safety drills. In addition, resilient housing does not necessarily become a self-organizing system due to limited resources. In rural areas, villagers with farmland can achieve self-sufficiency, but not in urban homes. In the future of resilient housing, a large number of smart devices will be used, such as drones for delivery. In the information age, the housing system has a great dependence on external materials. Therefore, the risk prevention of a resilient

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housing system should consider the system itself and the relationship and linkage with other systems.

There is also a need to focus on the equity of risk prevention. The ability to resist risk varies greatly between homes, and the type and level of risk varies depending on the home's environment. The economic and cultural levels of households are more diverse, and vulnerable groups are generally at higher risk. This also requires a combination of resilient housing, resilient communities, and resilient cities.

4.3. Risk Response

Risk response refers to the way in which systems respond when the risk occurs, a combination of the reactive nature of physical systems and the proactive nature of human organizations. When disaster strikes, resilient homes need to play a key role in responding to unanticipated risks through emergency response measures. For example, the COVID-19 epidemic struck in 2020, more than ten years after the last SARS outbreak, and although there was an awareness of infectious diseases in the aftermath of SARS, people inevitably relaxed after too long and were still caught off guard when dealing with new risks again. "No one can predict when the next outbreak will occur; all we can do is make ourselves strong" [3].

The high speed of data and information dissemination in the information age has played an important role in preventing and controlling epidemics, providing a good early warning system. In the construction of future urban spaces, early warning of risks in the age of intelligence is likely to be even faster and more efficient. The full spread of intelligence will play a very important role in enhancing the ability to respond to risks in residential buildings.

4.4. Recovery and Ascension

The recovery and enhancement phase refers to the need to repair and build on the damage suffered after the system has responded to the risk. This phase focuses on the resilience of housing. If a risk inevitably causes a disaster or loss, then it is not necessary to keep the system intact. A degree of loss is an important way to continuously improve the resilience of the system. The recovery of a resilient housing system is to compensate for the material and energy lost within the system and often requires energy support from outside the system. For example, in the case of collapsed buildings, damaged equipment, and even health threats to occupants caused by an earthquake, if these losses are unavoidable despite the system's own response to the risks, it is necessary to absorb energy from outside, such as social assistance, housing reconstruction and psychological and medical support for the affected population, in active collaboration with other systems [4].

The recovery of the system is not only a return to the state before the risk but also an enhancement of the previous state. In the case of natural or man-made risks, restoration is usually timely. However, in the case of long-term and insignificant risks such as environmental pollution or infectious diseases, prevention, response, repair, and enhancement may all occur simultaneously. For example, in the post-epidemic era, one has to analyze the principles of epidemic transmission, analyze the risks and at the same time take countermeasures such as regular indoor disinfection and wearing of masks as well as restoring and improving the damage that has already occurred [5]. The four components of a resilient housing system can therefore form a closed loop and, at the same time, influence each other.

5. Conclusion and Prospect

The coronavirus pandemic has changed the way we live and work, and the earlier containment of the epidemic in our country has a lot to do with the self-restraint of each individual. While the city was closed and the community closed, the cooperation of every household was needed. As a result, the smaller units in the city have become more resilient, and the construction of resilient housing systems has begun to show its importance to the city, the community, and the individual household. Looking to the future of urban space, I hope that the future will have a sound housing system and a safe shelter and that the establishment of a 'resilient housing' model will require the collaboration and joint efforts of all actors involved. Resilient cities, resilient communities, and resilient housing are multi-disciplinary, multi-disciplinary, and multi-disciplinary, and it is worthwhile to continue to study how to achieve more active and efficient multi-disciplinary cooperation.

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