“Technical Resilience” and “Institutional Resilience”: Enlightenment from the Response of Urban Public Space to Public Health Emergencies

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Abstract

Urban public space is an important guarantee for the emergency under the public health emergencies, and its resilience is related to the health of citizens and the basic operation of the city. Based on the concept of “resilient city”, the paper constructs an idea of resilient urban public space, and explains its connotation and characteristics. Combined with the staged anti-epidemic measures adopted by mainland cities in China in the COVID-2019, it analyzes the process and enlightenment of urban public space in response to public health emergencies, and summarizes a system of the “technical resilience- institutional resilience”. It further proposes: (1) the technical resilience depend on health-oriented planning, including integrating the health impact assessment into the whole process of planning, improving the planning of the emergency unit and capacity, establishing a resilient public space system made up of “hub-node-flow”, and designing the emergency space for “combination of peace and epidemic”; (2) urban public space institutional resilience depend on sound and smart social governance, including establishing the emergency response system, matching the emergency responsibilities, rights, capacities of communities, improving laws and regulations and other policy tools, and applying intelligent platforms for precise prevention and control. Technological resilience, integrated with institutional resilience, establishes a new paradigm for urban public space to respond to public health emergencies.

Keywords

Urban public space; Public health events; Resilient city; Planning interventions; Social governance

Since the end of 2019, the novel coronavirus (2019-nCov) has broken out and swept the world rapidly, and by November 2022, the cumulative number of confirmed cases worldwide exceeded 630 million, with 6.6 million deaths①. It has wreaked havoc on the lives and health of the global community. As one type of public emergency, public health emergencies are characterized by high uncertainty, high randomness, and high destructiveness (Xu, J. & Shao, Y, 2015). They pose a considerable impact and challenge to the urban medical service system and social emergency management capacity. Possessing the resilience to complete the "disruption-reorganization" process in the event of a public health emergency is pivotal to the sustainability of the urban system. Unlike other public emergencies, public health events generally do not directly damage the built environment, but their prevention, control, and treatment processes profoundly depend on how the urban public space can support emergency responses. During recent epidemic prevention and control efforts, cities in mainland China have deployed abundant resources for disease control, medical treatment, and emergency response, and urban public spaces have played a critical role. However, the lack of resilience was also exposed, such as the disorderly emergency space and low level of grassroots governance in the early stage. Therefore, based on the research consensus on "resilient cities," this paper analyzes the role of resilient urban public space in response to public health emergencies and discusses strategies to strengthen the technical and institutional resilience of urban public space from two levels: planning intervention and social governance.

1 Resilient Cities and Resilient Urban Public Space

1.1 Connotation and Characteristics of "Resilient Cities"

The word "resilience" is derived from the Latin word "resilio," which means "to return to the original state" (Alexander, 2013). Then, the concept of "resilience" was introduced into different disciplines and evolved from the initial engineering resilience to ecological resilience in the 1970s (Holling, 1973) and then to dynamic interactive socioecological resilience after 2000 (Walker et al., 2004), and its concept changed from "balance" to "adaptation." Since the 21st century, the concept of "resilience" has been introduced from the perspective of urban disaster prevention and gradually integrated into the study of urban systems. Since the 21st century, the concept of "resilience" has been introduced from the perspective of urban disaster prevention and gradually integrated into the study of urban systems, and "resilient cities" have become a consensus for research on coping with sudden impacts such as urban disasters and extreme weather and chronic pressures such as urban well-being and social harmony. In 2003,

① Data source: Johns Hopkins University Global COVID-19 Outbreak Statistics, USA, 12th NOV 2022, https://coronavirus.jhu.edu/map.htm

Bruneau et al. proposed the "TOSE" framework based on the study of resilient communities, namely, technological, organizational, social, and economic resilience (Bruneau et al., 2003). Godschalk proposed that a resilient city, from the perspective of urban disaster mitigation, is the integration of a sustainable physical system and human communities (Godschalk, 2003). Jha et al. further discussed the four components of urban resilience in terms of infrastructural, institutional, economic, and social resilience (Jha, 2013). The characteristics and elements of resilient cities have also been analyzed by Wildavsky and other scholars and organizations (Wildavsky, 1988; Ahern, 2011; Allan & Bryant, 2011). In general, reliability, redundancy, resourcefulness, and rapidity, or the "4Rs" dimensions, are the fundamental and distinctive features. Furthermore, the dimensions of adaptability, recoverability, ability to learn, and transformability are more advanced characteristics that distinguish resilient cities from other "resistant-only" cities (Li, 2017; Eraydin & Tasan-Kok, 2013).

Due to the connotative features of resistance, absorption, and recovery and a greater focus on social dimensions and nonphysical conditions, resilient cities have gradually become an adaptive strategy for urban development to confront uncertainties. Moreover, in recent years, resilient cities have been widely applied in urban public emergency research.

1.2 Connotation and Characteristics of Resilient Urban Public Space

1.2.1 Urban Public Space Should Have Resilient Service Capacity

Urban public space is an essential resource for cities. The textbook "Principles of Urban Planning" defines the concept of urban public space in a narrow and broad sense: in a narrow sense, it refers to the outdoor space for the daily life and public use of urban residents, including streets, squares, parks, and sports grounds; in a broad sense, the concept can be based on the spatial dimension, extending to the space of public facilities, such as the city center, commercial areas and urban green space (Wu & Li, 2010). From the perspective of resilient use, the definition of urban public space should consider the temporal dimension, i.e., there are two states: daily and emergency. In the daily state, urban public space carries citizens' activities, maintains the quality of urban space, and points to the public domain instead of the private domain. In the emergency state, urban public space can ensure the collection, storage, flow, and recovery of various emergency resources, as well as the placement, quarantine, and treatment of people (Figure 1). Urban public space is the container for urban activities and possesses both "physical" and "social" properties due to human intervention and participation.

Furthermore, it is also the result of spatial intervention and social governance. Under the impact of public emergencies, urban public space, as an essential guarantee for urban emer-

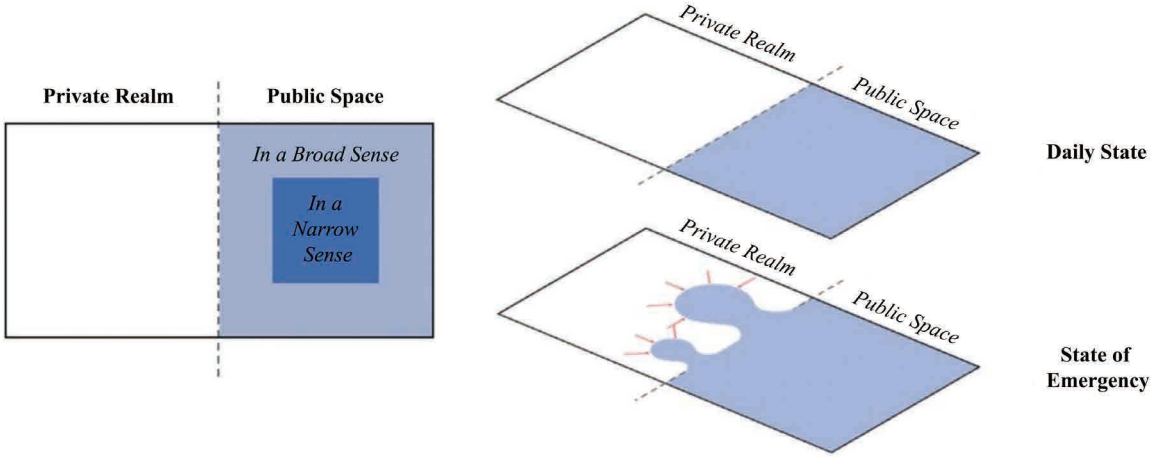


Figure 1 The concept of "urban public space" in the spatial and temporal sense. Source: Drawn by the author.

gency response, should have sufficient capacity for service resilience. On the one hand, it can safeguard urban emergency facilities and lifelines through specific functions at the material level. On the other hand, social emergency activities such as organization, management, and action should be performed through social-level interventions. The resilience service capacity of urban public space enables cities to complete the process of "disturbance-reorganization" and preserve sustainable urban development.

1.2.2 Characteristics and Forms of Resilient Urban Public Space

Drawing on the characteristics of "resilient cities," to effectively counter the entire process of disturbance, a resilient urban public space should have basic characteristics such as robustness, resourcefulness, rapidity, and redundancy, as well as advanced characteristics such as recoverability, adaptability, ability to learn and transformability. Prior to the onset of a disturbance, urban public space can evaluate uncertainty and vulnerability, plan and prepare in advance (identifying priorities and deployable resources), reserve flexible and convertible space, and provide multiple risk-taking plans. During a disturbance, urban public space can rapidly respond, resist and cope with external impacts and mitigate the degree of impact to ensure that the effectiveness is stable. After the subsiding of a disturbance, the reversibility and recoverability of urban public space help the urban system return to its original structure or state and adjust its form and function according to the changes in surroundings to adapt to various emergency scenarios. Then, experiences and lessons should be drawn from disasters and converted into bedrocks of innovation so that sustainable urban development can be further promoted (Figure 2).

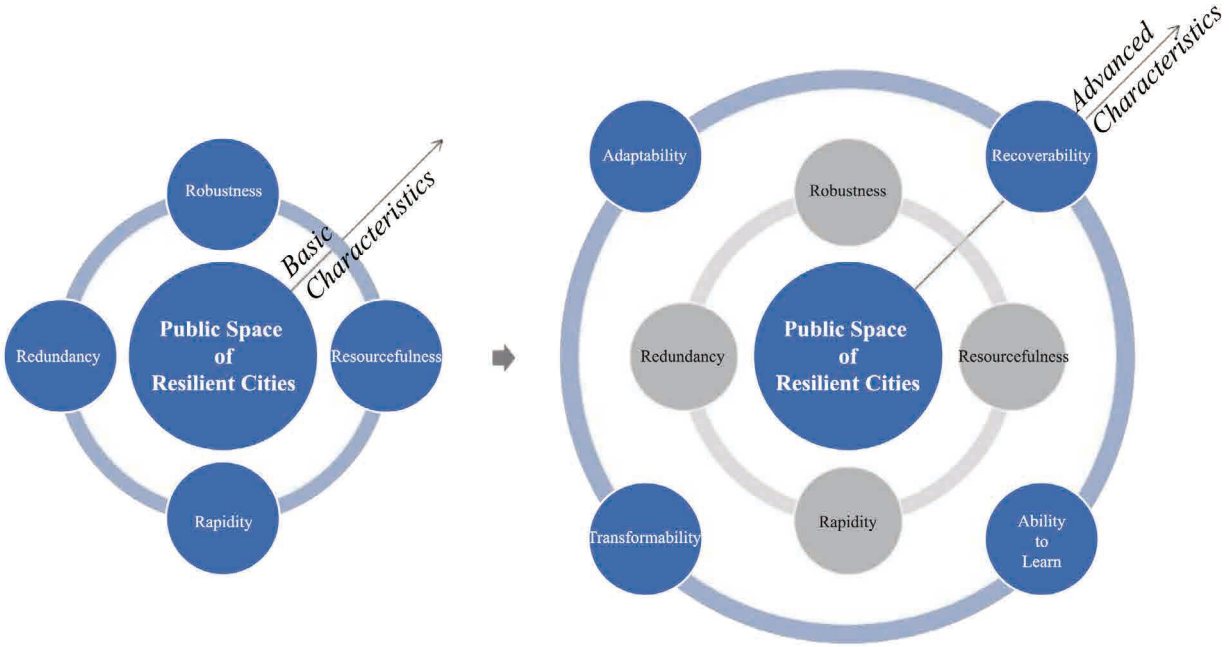


Figure 2 Basic and advanced characteristics of public space of resilient cities. Source: Drawn by the author.

According to different types of space and methods of use, several forms of resilient urban public space respond to emergencies, such as mandatory closure, expanded use, public expropriation, and shared use. Among them, mandatory closure involves urban roads, transportation stations, and public facilities and refers to the closing, disabling, or conversion of urban public space to prevent crisis contagion. Expanded use refers to the direct emergency construction, conversion, or expansion of public facilities, involving systematic preparation of land reserves, urban planning, and construction capacity. Public expropriation refers to expropriating various public facilities and some private facilities when necessary. Shared use refers to the society or individual providing facilities or space to be incorporated into the city's emergency response system in a self-initiated fashion to ensure public service effectiveness. It also includes different forms of voluntary or provision in targeted conditions.

2 Public Health Emergencies and Urban Public Space Response

2.1 Emergency Process of Medical Services under Public Health Emergencies

Public health emergencies refer to major infectious disease outbreaks, unexplained mass diseases, major food and occupational poison-

ing, and other events that cause or may cause severe damage to public health (China Government Legal Information Network, 2011). Under public health emergencies, prevention and treatment are the primary emergency processes in urban medical systems. Taking major epidemic prevention as an example, the methods include vaccine development in the field of scientific research, as well as basic aspects such as controlling the source of infection, cutting off transmission routes, and protecting susceptible populations. Epidemic treatments include procedures such as detection, diagnosis, quarantine, and treatment, and all these emergency efforts require adequate, safe, and standardized social and medical spaces. Ever since the 21st century, major infectious disease outbreaks such as severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), Ebola virus (EBoV), avian influenza (AI), novel coronavirus (2019-nCoV), and monkeypox virus (MPV) have emerged globally. Human society seems to have entered an "active" period of infectious diseases, and the occurrence of public health emergencies is becoming increasingly uncertain. To effectively respond to public health emergencies and support emergency medical services such as prevention and treatment, urban planning and construction should further collaborate with public health departments to coordinate spatial demands.

2.2 National Prevention Response to the COVID-19 Outbreaks in Different Phases

2.2.1 Phase 1: Static Prevention and Control

In 2019, the COVID-19 outbreak occurred, with the city of Wuhan in China bearing the brunt of being the ground zero. Given that "human-to-human" transmission has appeared, Wuhan declared a "citywide lockdown" on January 23, 2020, to effectively stem the spread of the epidemic: "Buses, subways, ferries, and long-distance passenger transportation are suspended citywide. Citizens should not leave Wuhan without special reasons, and the airport and train station was temporarily closed to the public." As a result, the city was shut down (Fig-

Figure 3 The closure of Wuhan Highways. Source: Sina Weibo.

Figure 4 The suspension of citywide public transport. Source: Sina Weibo.

ure 3, 4). During this period, to tackle the shortage and crowding of medical space and chaotic medical support, the city urgently selected sites and built Huoshenshan and Leishenshan makeshift hospitals, converted 16 large facilities such as convention, exhibition, and sports facilities into "mobile cabin" hospitals to treat mild cases, and requisitioned university dormitories as centralized quarantine and observation facilities for suspected cases (Figures 5, 6). To avoid the further spread of the epidemic within the city, the lockdown was implemented community-by-community, and citizens were ordered to quarantine at home and not go out unless absolutely necessary. Wuhan's "citywide lockdown," a key measure for early response to an uncertain outbreak, is a typical static control method that stringently limits human flow, prevents mass cross-infection, and prioritizes people's lives and health. However, the cost of static prevention and control is immense. For cities, incalculable economic damage and social burdens were made because all activities were halted except epidemic prevention and lifeline support; for citizens, the lockdown restricted daily travel and activities, and the prolonged closure put them under great physiological and psychological stress. In the long run, large-scale static control of the city is unsustainable.

2.2.2 Phase 2: Dynamic Zero-COVID

With the continuous mutation of 2019-nCov, domestic outbreaks are becoming more scattered, more frequent, and covering more provinces, and mainland cities have adjusted epidemic prevention and control measures in a timely manner. In December 2021, the National Health Commission proposed a "Dynamic Zero-COVID" approach to epidemic prevention and control: through early detection, rapid containment, and stemming transmission, the optimal result can be achieved with a minimal social cost. To address the pandemic, cities have been exploring and optimizing prevention and control measures.

Regarding epidemic treatment, a multilevel medical space system consisting of "designated hospitals – mobile cabin hospitals - quarantine observation points" has been established, and

Figure 5 The construction of Huoshenshan hospital in Wuhan. Source: Xinhuanet.

Figure 6 Wuhan converted stadiums into mobile cabin hospitals. Source: Xinhuanet.

large-scale nucleic acid testing of citizens has been conducted by fully utilizing community squares, sports facilities, community parks, and other urban public spaces.

Regarding epidemic prevention, to control the source of infection and stem transmission and protect vulnerable populations, areas where outbreaks occur are carefully divided into high-risk, medium-risk, and low-risk zones according to the risk of epidemic transmission, and each zone is assigned exclusive measures of

Figure 7 The delineation of risk zones and a real-world example. Source: Left, drawn by the author; Right, Guangzhou Bendibao.

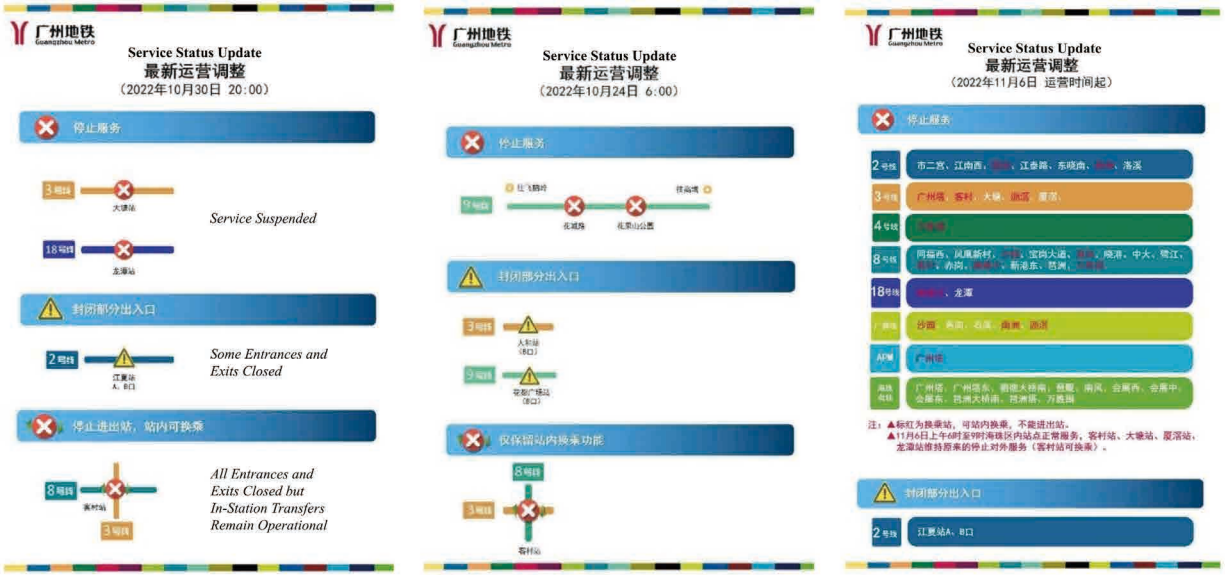


Figure 8 Dynamic service status update of the Guangzhou Metro. Source: Guangzhou Metro.

management (Figure 7). Urban public transportation also takes dynamic measures to ensure essential operation. For example, the Guangzhou Metro takes measures such as "stopping service, closing some entrances and exits, and reserving only in-station transfers" when passing through stations in areas with outbreaks, while other stations operate normally to ensure the city's "life flow" is largely unaffected (Figure 8). Dynamic Zero-COVID is the primary preventive measure adopted by mainland cities, which effectively balances epidemic prevention and control with economic and social development and enables preventive and control measures to be more scientific, accurate, and targeted.

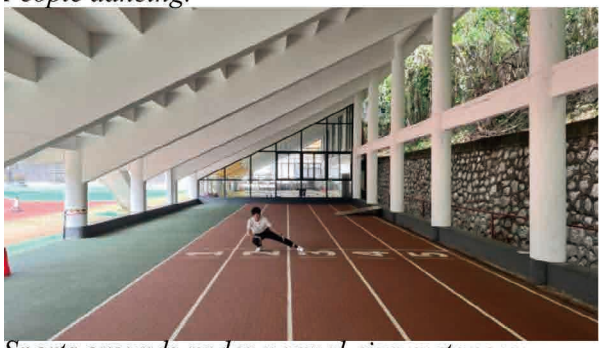
2.3 Process of Resilient Responses in Urban Public Space and the Resilience System

2.3.1 Resilient Response in Urban Public Space: "Functional Participation" and "Activity Intervention"

As prevention and control measures evolve from static to dynamic, urban public space provides an essential guarantee for medical and social emergencies, and its response process

Community square under normal circumstances: People dancing.

Community square during emergencies: Distributing essential supplies.



Sports grounds under normal circumstances: People exercising.

Sports grounds during emergencies: Mass Nucleic Acid Testing

Figure 9 Real-world examples of resilient cities' public space responding to the COVID-19 pandemic. Source: Shot by the author.

can be summarized into two aspects: functional participation and activity intervention. The functional participation of urban public space is mainly reflected in the emergency expansion of medical space, including new medical facilities, conversion and expansion of urban public facilities for quarantine and treatment, and sharing of community squares and urban green spaces for nucleic acid testing and distribution of essential supplies (Figure 9). Activity interventions in urban public spaces are reflected in emergency response and safeguarding basic livelihoods, including the implementation of citywide lockdowns, classification and management of risk areas, promotion of "social distance" in public places, and organization, management, and restraint of activities within urban public spaces during emergencies. In addition, grassroots facilities serve as the base unit of epidemic prevention, and they are not only responsible for epidemic prevention spot checks such as screening and quarantine but also for safeguarding the basic livelihood of residents.

2.3.2 Resilience System of Urban Public Space: "Technical Resilience" and "Institutional Resilience

Evaluated in terms of robustness, redundancy, resourcefulness, and rapidity, the resilience of urban public space in mainland cities during epidemic prevention has been improving. On the one hand, expanding medical space through functional participation can buy more time from spatial interventions to secure more leeway for epidemic prevention resource deployment. This process is supported not only by healthy and smart urban planning interventions but also by the "technical resilience" of urban public space, where functional participation is based on site reservation, prioritization, and timing of emergency construction. On the other hand, the "institutional resilience" of urban public space supports this process through activity interventions to respond to emergencies and ensure basic livelihoods, regulate activities by rules, and sustain urban vitality by activities. The COVID-19 pandemic has embroiled the city from normalcy into a state of emergency, and spatial activity interventions are founded upon rules and procedures, using management and constraints as means, and aims at perfecting and promoting smart urban and social governance.

3 Strengthen the Technical Resilience of Public Spaces via Healthy and Smart Planning Interventions

3.1 Integrate Health Impact Assessment Throughout the Planning Process to Reduce Vulnerability

Urban planning emerged from urban public health and is centered on ensuring the spatial support of urban public services and healthy economic and social development; health impact assessment (HIA) evaluates the potential impact of policies, programs, or projects on the health of specific populations.

Incorporating HIA into planning interventions in urban public spaces benefits public health by promoting health-oriented decisions, reducing cities' vulnerability to emergencies, and

helping society and government establish unified health values. In the preparation process of urban public space planning, planning departments should conduct joint monographic studies with public health departments. They should compare and evaluate different options according to HIA norms and procedures, ensure that urban land use, spatial layout, and construction meet the standards of a healthy city, and establish a clear link between health objectives and means of spatial management. Drawing on Singapore's "white site" policy, urban planning should reserve sufficient space for the health index and flexible development to strengthen the robustness of urban public space. In public health emergencies, redundant spaces can be converted into temporary treatment sites. Then, related equipment and services can be arranged in those sites per evolving epidemic situations and technological development to reduce the city's vulnerability to risks.

3.2 Improve the Planning of Urban Emergency Spatial Unit and its Capacity to Cope with Uncertainty

The planning of comprehensive urban disaster prevention is a special work in the current urban planning system. It is also systematically mature and takes various engineering and preventive or emergency measures to counter disasters such as earthquakes, floods, typhoons, and wars. It also includes technical provisions for conventional hospitals, infectious disease hospitals, and disease control and prevention centers. However, as the current system primarily focuses on the standards of facility configuration, it is not enough to cope with the uncertainties of public health emergencies. Based on diversifying the urban public space and creating more redundancy, comprehensive urban disaster prevention planning should shift from static facility configuration to preparing a dynamic emergency response, integrating engineering and technical measures and emergency governance measures. It may include

1. Building disaster prevention and mitigation facilities that meet the standards, improving emergency coordination, and the capacity for emergency conversion and expansion;

2. Ensuring the size of emergency shelter facilities at all levels, improving emergency resource support and healing capacity;

3. Constructing reliable supporting infrastructure and setting up credible public warning channels and emergency regulations.

In order to prepare for a rainy day, urban emergency units and healthy communities should undergo a grid-by-grid restructuring. In order to promote the normalization of nucleic acid testing, cities such as Beijing, Shenzhen, Hangzhou, and Ningbo have established 15-minute nucleic acid "testing circles," where people in different risk areas go to nucleic acid testing sites and hospital testing sites that are most adjacent to their location (Figure 10). The making of a healthy community should center on general and specialized hospitals, supplemented by private medical institutions and emergency supplies storage facilities to safeguard public health security. Additionally, a healthy commu-

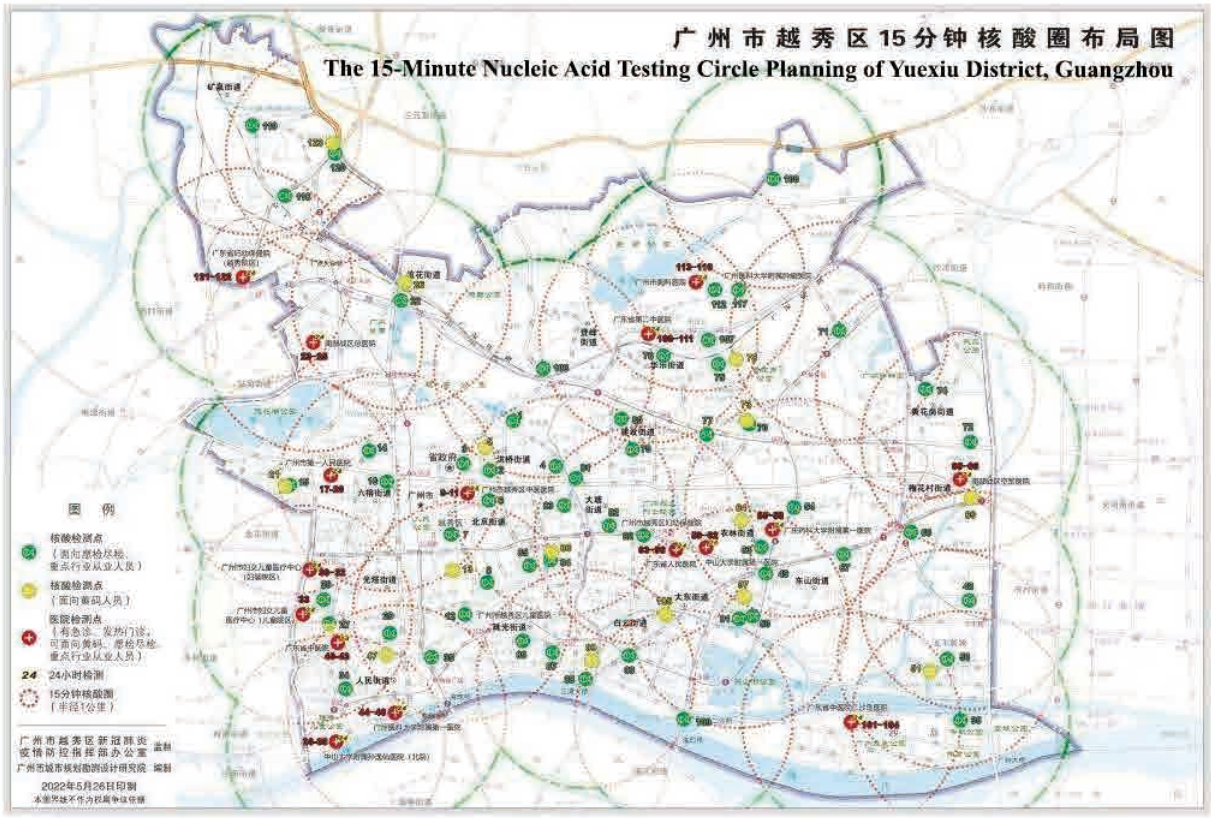


Figure 10 The 15-minute nucleic acid testing circle planning of Yuexiu District, Guangzhou. Source: Command center of the COVID-19 prevention and control of Yuexiu District, Guangzhou

nity should combine with the 5-minute neighborhood and a neighborhood-level healthcare system, including community health centers, pharmacies, and emergency testing points, to institute a complete public support system for a healthy community countering an epidemic.

3.3 Establish a "Hub-Node-Emergency Flow" Public Space System to Ensure Rapidity

A "hub-node-emergency flow" system should be devised for resilient urban public spaces to coordinate with the rapidity effectively demanded under medical and social emergencies. The "hub" of urban public space is divided into city and street levels. The city level includes large parks, green space, squares, and other public facilities with the potential for emergency resilience, within both city and district levels. The

street-level "hub" is a series of emergency public services supported by major public facilities and surrounding public spaces. Public medical resources and emergency supplies are reserved beforehand at this level. The "nodes" of urban public space systems are established at the community level, with neighborhood entrances and exits, vegetable markets, and parking lots. Management nodes and external public spaces of offices and commercial facilities or temporarily requisitioned areas were used as health buffer nodes. Each area will be assigned different emergency supplies and functions (Figure 11). Then, the "emergency flow" of urban public space ensures the flow of emergency transportation, energy, communication, and material supplies. Additionally, essential logistics of food, daily necessities, and domestic wastes, as well as the reverse flow under certain conditions, are secured. In the public space system of resilient cities, "hubs" assume the pivotal public functions of emergency support, "nodes" can quickly cover all urban residents, and "emergency flows" operate efficiently between clear destinations, forming a multilevel and multiform spatial strategy for rapid response to urban

Neighborhood Entrance

Pedestrian Sidewalk

Community square

Office Building Entrance

Figure 11 Community nodes as temporary testing sites. Source: Shot by the author.

public health emergencies.

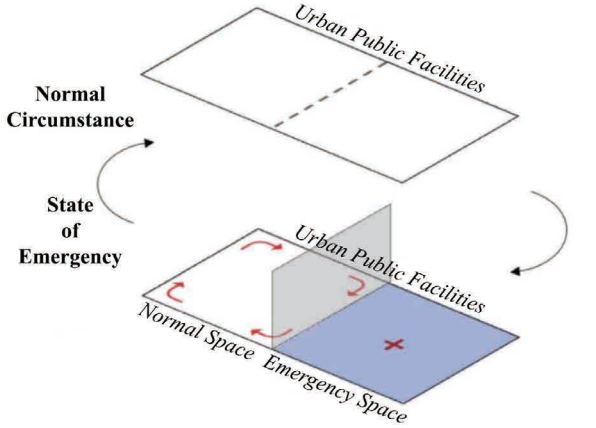
3.4 Enhance the Transformability and Adaptability of Urban Public Space to Adapt to Both Normal Circumstance and State of Emergency

All urban public facilities, such as airports, stations, terminals, gymnasiums, libraries, and educational and medical facilities, such as schools and hospitals, should consider a system, process, and operation that enable the transition between normalcy and state of emergency. Hence, the resilience and redundancy of urban public space can be enhanced, and the urban public space can adapt to both circumstances (Figure 12).

On the one hand, the space of large public facilities, daily commercial facilities, and educational and medical facilities in the city should be made more versatile so that they can assume public services during normalcy and be converted into emergency resources in a state of emergency. For example, convention and sports architectures can be converted into "mobile cabin hospitals," and daily commercial facilities can be transformed into epidemic resource distribution centers and material storage sites, and closed sports. Cultural facilities can be converted into temporary epidemic prevention sites, such as nucleic acid testing points, epidemic control centers, and fever clinics.

On the other hand, the city needs to increase the redundancy and external support of urban public space. The expansion and transformation of medical facilities and the rapid conversion of other public facilities require not only the operation reliability of public facilities and sufficient medical resource reserve but also external energy and transportation support.

The urban public space's ability to adapt to both normalcy and a state of emergency can effectively expand emergency spatial resources and minimize the epidemic's impact on residents' daily life.



Nucleic acid testing on the left, and people playing basketball on the right.

Figure 12 Urban public space adapting to both normal circumstance and state of emergency. Source: Drawn by the author (top) and shot by the author (bottom).

4 Improving Smart Social Governance and Enhancing the "Institutional Resilience" of Urban Public Space

4.1 Establishing a Comprehensive Emergency Response System and Enhancing Emergency Decision-making Capability

After the occurrence of a major epidemic, the emergency decision-making capability related to urban public space is crucial for epidemic prevention, and cities should rapidly follow contingency plans and enter the process of urban public space intervention according to related laws. In response to the need for functional participation, urban public space should be converted into space prioritized for epidemic prevention, and the indoor and outdoor spaces of various facilities should be allocated as emergency spatial resources to ensure that emergency flows and other essential flows are undisrupted. For the demand for activity interventions, activities should be restricted in high-risk areas that are prone to superspreading events, including major social gatherings, crowded areas, and human flow hotspots such as airports, train stations, and gateways (Figure 13). The core of a sound urban emergency management system is a strong institutional authority to intervene in the functions and activities of urban public space. In the early stage of COVID-19 prevention, countries such as Singapore and South Korea responded so rapidly because their public health systems responded at the national level. The disease outbreak response system condition (DORSCON) of Singapore grades public alert levels into several levels based on the severity

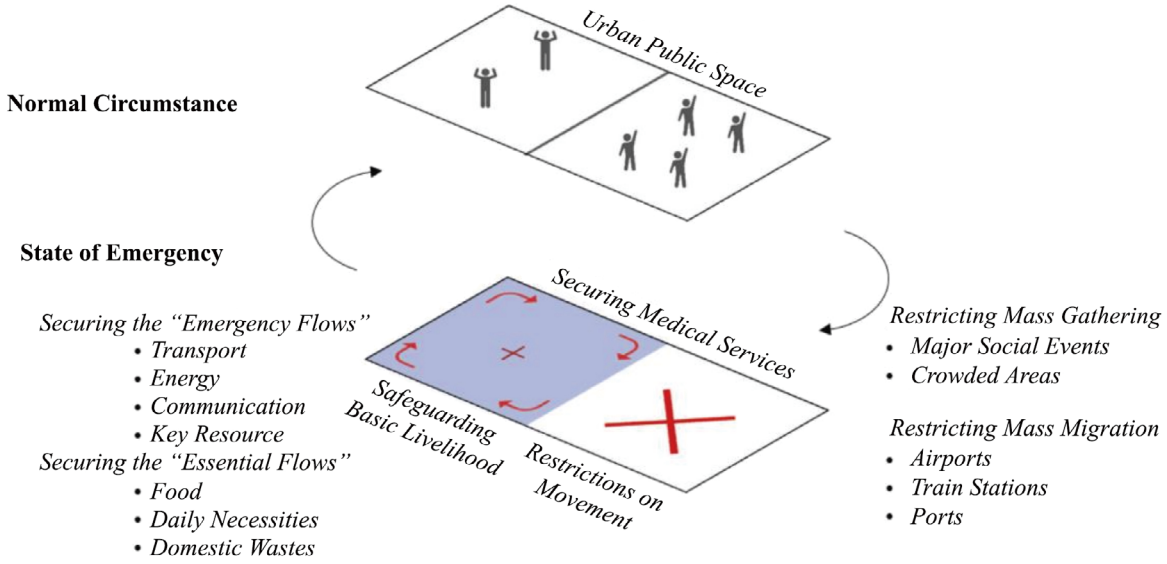


Figure 13 Contingency plans for urban public space responding to emergencies. Source: Drawn by the author.

and situation of local transmission. Moreover, each level of alert is assigned targeted advice for the public and notice on how people's daily lives could be affected as a result (Government of Singapore, 2021). Once their health department adjusts the alert level, government departments, education and other departments, will immediately respond.

4.2 Coordinating Responsibilities, Powers, and Capacities in Emergency Responses to Strengthen Community Governance

The community is the front line of urban grassroots governance and epidemic prevention and control. It is indispensable for alleviating epidemics and returning to normalcy. Thus, the community life circle is the disaster and epidemic prevention circle (Wang & Li, 2020). In 2020, the state issued the "Municipal Territorial Spatial Master Plan Guidelines", which specifies the "community life circle" as the base unit for the urban "health and safety unit". To strengthen the capability of community governance, the priority is to ensure that all emergency resources, such as epidemic prevention personnel and related materials, can permeate into all communities in need so that the extraordinary pressure of community governance can be alleviated. At present, Guangzhou, Shanghai and Shenzhen are equipped with "a squad of 3", consisting of a village cadre, grassroots police and a healthcare professional. Their task is to undertake screening of residents' health conditions, take care of specific groups of people and provide daily services, thus effectively supporting community epidemic prevention and control at the grassroots level. Second, a community epidemic prevention and vulnerability assessment mechanism should be established. It identifies the spatial distribution of vulnerable populations based on the actual situation of community residents, the built environment and medical facilities and supports decision-making by public health and epidemic prevention departments. In addition, members of the communist party of China, professional social organizations, temporary relief organizations, and volunteers with professional skills should all be mobilized in the community and set up community prevention and control offices①. The working mechanism and division of responsibilities should be clarified, thus consolidating "epidemic prevention circles" in the community and strengthening community resilience (Figure 14).

4.3 Improve Laws, Regulations, and Policy Tools to Ensure the Operation and Maintenance of Urban Systems

In terms of expanding medical resources, urban planning departments should work with public health departments to establish special rules for the use of urban public space under medical emergency situations during epidemics. For

① The State Council's task force on the collective response for control and treatment of the COVID-19 pandemic issued the "The COVID-19 Prevention and Control Plan (9th Edition)", requiring communities in medium- and high-risk areas to establish community prevention and control offices.

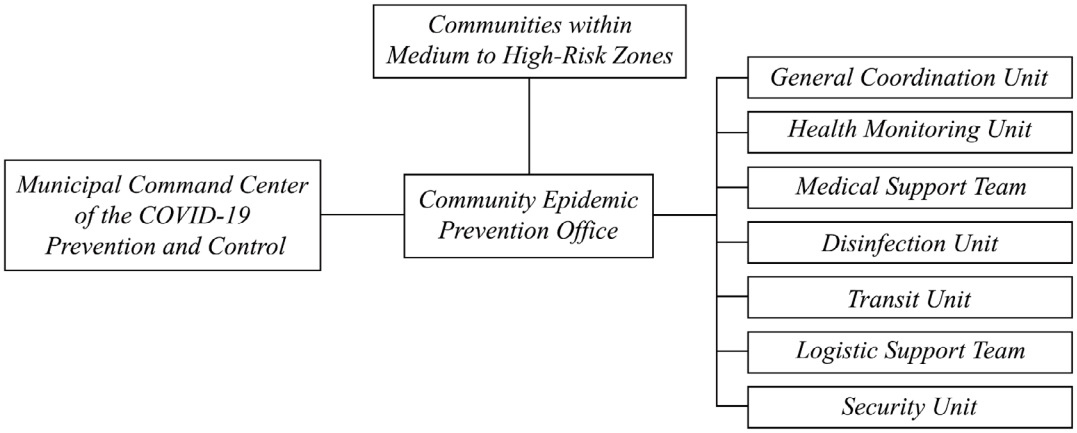


Figure 14 The COVID-19 prevention working mechanism of medium- and high-risk communities. Source: Sorted and drawn by the author.

example, for the direct expansion of public facilities, such as new construction or expansion, planning permission should be waived; for public expropriation and shared use of urban public space, institutional arrangements and management regulations should be made for legislative empowerment, reservation of property rights, and emergency responsibilities. In terms of securing emergency resources, the planning department, in cooperation with emergency management agencies, should provide policy guidelines for taking over and intervening in urban public space in a state of emergency. Laws, regulations and management processes should be improved to ensure the effective operation of urban "emergency flows" and "essential flows". During emergencies, policy tools are also needed to punish violations of public space guidelines. In the early stages of the pandemic, Singapore strictly enforced the law against those who failed to comply with mandatory leave orders and home quarantine orders, and New Zealand imposed severe fines for violating social distancing requirements. Therefore, the stable governance of urban public space can be secured by institutional redundancy from laws and regulations.

4.4 Using Smart Platforms to Take Measures Matching the Corresponding Levels of Emergency Response and Promote Smart Governance

Since the COVID-19 pandemic, digital technologies such as big data, artificial intelligence, and cloud computing have played an important role in epidemic monitoring and analysis, contact tracing, prevention and treatment, and resource allocation. Digital technologies have been deeply integrated with transportation, healthcare, education, and other fields to im-

prove the prevention and control efficiency of government departments at all levels and to protect the lives of citizens (Special Think-Tank for The Government Innovation and Development Platform for the Industry, 2020). For example, AI measurement systems are used in crowded areas such as airports, train stations, and subways to efficiently and accurately identify high-risk groups; Ali's "Health Code" and China Mobile's "Travel Log Search" provide itinerary information, which supports epidemic prevention of grassroots communities; and Baidu's "Epidemic Map" provides inquiries on places where outbreaks have occurred in the city, especially the crowded areas, helping residents plan travel routes and ensure travel safety. Technological innovation drives smart social governance and supports smart responses to public health emergencies in urban public spaces. To increase the rapidity of institutional resilience, all levels and departments should focus on the accumulation and application of basic data, and grassroots departments and community organizations should thoroughly collect basic information on community members to establish a comprehensive database. At the city level, a big data monitoring and analysis platform can be established to track the travel histories and contact histories of confirmed cases, thus locating and assisting health departments in analyzing routes of transmission and modelling and predicting epidemiological trajectories.

5 Conclusion

Urban public space is vital support for public health emergency responses, and a new paradigm should be established for the planning and governance of urban public space in response to the possible normalization of epidemics. Based on the concept of "resilient cities," this paper constructs an analytical framework for resilient urban public space and discusses strategies to enhance the resilience of urban public space from two levels. These include continuous optimization of urban planning design and intervention tools to cope with uncertainty and iterative improvement of urban social governance to face the "new normal" development of post-pandemic urban public space with "institutional resilience." In essence, the resilience of urban public space relies heavily on "social resilience," that is, the collective resilience of individuals and the public. When confronting a public health emergency, urban systems can only be truly resilient and achieve a higher level of self-improvement if citizens have sufficient emergency awareness and knowledge.

It should be noted that the COVID-19 pandemic has also brought the value of resilience in urban public spaces to life, including promoting the spirit of a shared community, advancing individual health development, and facilitating overall societal development. Therefore, the future planning and governance of urban public spaces should be conducive to citizens learning about public health, developing good hygiene habits, raising their awareness of prevention, and enhancing their ability to prevent and fight epidemics. Moreover, it should help enhance citizens' immunity and endeavor together toward a healthy city.