

Spatial-temporal performance of urban planning in the face of Covid-19:

A systematic review of Chinese methods

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Abstract

Covid-19 has spread with an incredible speed worldwide, causing a massive loss of both society and economy. Insufficient measures to cope with pandemics results in a large-scale infection. In this context, how to deal with the pandemic has become a hot point. The modern urban planning, derived from building a healthier and safer environment after pandemics (like cholera and "Typhoid Mary") in the last two hundred years (Banai, 2020), has been recognised as one of the most effective approaches to handle the pandemic.

In 2020, China was one of the countries suffered severely from the Covid-19 but the first country to take actions against this pandemic on 25th Jan 2020 and initially controlled the situation before March 2020 (Liu, Zhang & Song 2021). Up to 2021, many related Chinese publications have analysed the impact of the Covid-19 and put forward strategic urban planning methods to deal with the infection. However, classifications and evaluations of how Chinese urban planning has performed in this pandemic are insufficient. Consequently, scholars tend to discuss popular topics but may ignore some inconspicuous fields.

Therefore, this paper will study the roles of urban planning in different stages and spatial scales facing Covid-19 based on a systematic review of Chinese literature. The outcome of the review shows that urban planning may assist the policies and governance in the pandemic's Response and recovery stages in most cases but perform the leading role in the preparedness stage of the pandemic. However, further studies related to the stage of recovery and community-based planning still require exploration.

Keywords

Covid-19, urban planning, spatial-temporal strategies

1. Introduction

In 2020, the Covid-19 brought significant loss worldwide. According to WHO Coronavirus Disease (COVID-19) Dashboard (<https://covid19.who.int>), over 100 million cases were confirmed, and over two million were dead. Sharifi, A. and Khavarian-Garmsir, A.R (2020) indicated that cities, complexity with self-organising clusters of humans (Lai *et al.*, 2020), were the centre of the pandemic outbreak due to high concentration of population mobility and economic activities. Naturally, Chinese cities have suffered severely from the pandemic due to high population density and frequently socio-economic activities.

Therefore, the improvement of urban contexts with appropriate urban planning is essential in all stages of the pandemic to mitigate the socio-economic pressure brought by pandemics.

In 2020, countless studies related to urban planning have been published to analyse the impacts and solve the problems resulted by Covid-19 in China, covering various disciplines and directions. And this paper is written to classify Chinese literature published in 2020 related to urban planning in the pandemic. With a systematic review, the paper will analyse the strategies put forward by Chinese scholars and help us more clearly understand different roles of urban planning in and after the pandemic.

2. Methods

During the Covid-19, urban planning is appealed to participate in anti-epidemic (Duan *et al.*, 2020). To clarify the roles of urban planning mentioned and indicated in those publications, we performed a systematic review to classify and conclude the strategies and suggestions from relevant academic literature. On account that Covid-19 is widely discussed in 2020 while China was recognised to control the spread of the disease firstly, we decided to reveal the roles of urban planning in pandemics by reviewing Chinese literature related to Covid-19 and urban planning (they are also two key terms in the sample selection).

The review started on 1st Jan 2021 and lasted three weeks. CNKI (cnki. net), Chinese Web of Science, was selected as the literature source. The academic literature selected for the review is mainly published in 2020 for Chinese governance, but there is no written language limitation. Academic papers, official documents, reports, and written conversations are all included.

2.1. Sample selection

The key terms research is employed to sift out relevant literature. Based on the purpose of this review, the terms "urban planning" and "Covid-19" are selected to be the gist (Table 1). Urban planning relates to the strategic land using and spatial design, distribution of buildings, and sectoral planning* (* means all sectoral planning including urban, comprehensive transportation planning, urban disaster prevention planning, and urban infrastructure section planning). Therefore, the key terms under urban planning should be extended. The term pandemic refers to the virus and the event caused by the virus. Therefore, the terms Covid-19 (Covid-19 was one of the most frequent key terms in related literature. Therefore, it is individually listed), pandemic, epidemic, influenzas, public health issues* (* means related matters, like public health incident, public health risk, and public health emergency) will be used to search for related literature. Sixty-eight publications from the CNKI (Chinese Web of Science) met the criteria and their PDFs were collected for the full-text review.

Urban Planning	Covid-19
Strategic land using	Covid-19
Transportation	Pandemic
Spatial design	Influenzas
Sectoral planning*	Public health issues*

Table 1 Key terms for primary searching

We finally filtered out 68 publications (including 64 journal articles, 2 magazine articles, 1 newspaper article, and 1 conversation proceeding).

2.2 The framework for the literature review

Before the full-text review, we firstly classified the topics of selected publications by abstracts. The abstracts reveal that all publications tend to put forward strategies based on temporal and spatial classification. Usually, the temporal classification is based on various stages of the pandemic (Response, recovery, and preparedness) while the spatial classification is related to different scales of spaces in the city (the classification of space is divided into municipality and community. On account that the number of literature about spaces smaller than the community is few, spaces smaller than communities will be included in the category of the community). Table 2 is developed to analyse the quantitative distribution of different topics. "x" means a paper is not related to this topic while "o" means a paper is related to this topic. Table 2 will be used to conclude the quantitative distribution of the reviewed literature.

	Spatial scale	
	municipal	Community
Response	x	o
Recovery	o	x
Preparedness	x	x

Table 2 A review of quantitative distribution

Based on Table 2, a further developed review will be performed to conclude detailed strategies. Table 3 will be used to present detailed methods mentioned in the academic literature. Besides, we also defined roles that urban planning should act in various stage and scales.

		Spatial scale	
		municipal	Community
Response	Role 1	<ul style="list-style-type: none"> • Method1 • Method2 	<ul style="list-style-type: none"> • Method1 • Method2
	Role 2	<ul style="list-style-type: none"> • Method1 • Method2 	<ul style="list-style-type: none"> • Method1 • Method2
Recovery	Role 1	<ul style="list-style-type: none"> • Method1 • Method2 	<ul style="list-style-type: none"> • Method1 • Method2
	Role 2	<ul style="list-style-type: none"> • Method1 • Method2 	<ul style="list-style-type: none"> • Method1 • Method2
Preparedness	Role 1	<ul style="list-style-type: none"> • Method1 • Method2 	<ul style="list-style-type: none"> • Method1 • Method2
	Role 2	<ul style="list-style-type: none"> • Method1 • Method2 	<ul style="list-style-type: none"> • Method1 • Method2

Table 3 A review of detail strategy

3. Result

3.1 The context of the outcome

In summary (table 4), the 68 publications revealed that 92% of engaged publications (60 of 68) tend to discuss pandemics' preparedness (31 of 60 have discussed the strategy in community). Only about 4 of

those publications mentioned the response stage (2 of 4 have alluded to community) and 5 of them involved the recovery stage (1 of 5 have referred to community). On account that one paper's content may cover several categories provided in table 2, the summation of the number in table 4 will not equal 68. The literature related to urban planning in the pandemic preparedness is highly mentioned, while the literature related to the other two stages seems slight. The possible reason might be that in the stage of response and recovery, the governance may act as the protagonist while urban planning works as the assistance to help realise the policies.

	Spatial scale	
	Municipality	Community
Response	4	2
Recovery	5	1
Preparedness	58	31

Table 4 Quantitative distribution of the reviewed literature

3.2 The systematic review of Chinese urban planning strategies in the face of the pandemic

Table 5 indicates urban planning focus on various topics in different stages of the pandemic. At the response stage, urban planning can act as a controller of land using to maximise land use for emergencies. At the recovery stage, urban planning can perform as the assistant to help implement socio-economic resumption strategies. To prepare for the next pandemic (the preparedness stage), scholars suggest that urban planning may have the multi-functions to predict the next pandemic, locate appropriate infrastructures and open spaces, and intervene in residents' healthy lives.

		Municipality	Community
Response	Transformative land use	<ul style="list-style-type: none"> Use vacant land and proper public constructions to build or transform into temporary hospitals. Temporary parking space 	
	Temporary regulating of spaces	<ul style="list-style-type: none"> Slow traffic is a proper method to replace public transportation. The transportation of emergency supplies should be a priority. The planning of specific space for reception, treatment and triage is vital to avoid superinfection 	<ul style="list-style-type: none"> Temporary stations for storing and allocating supplies. Temporary testing and isolation points
Recovery	Socio-economic recovery	<ul style="list-style-type: none"> Help the stalls operated in order and confirm the proper site and density of stalls on the streets. Combine with the construction of Smart City 	
	Psychological intervention		<ul style="list-style-type: none"> Green spaces in communities should focus on sensory design and therapy. A 'green medicine' with therapeutic horticulture
Preparedness	Antivirus-built	<ul style="list-style-type: none"> Networked, grouped, and multi-centred 	<ul style="list-style-type: none"> A cluster form of the community

environment	<ul style="list-style-type: none"> urban context with defence units. The land using with potential contamination should be separated from the residential areas with proper green isolation. An immune corridor combined with green space. Urban ventilation is based on buildings' density and height, the extension of green spaces, and open spaces. Healthy transportation with a priority of slow traffic system Sufficient vegetation can filter the air and hinder the spread of the virus. Healthy hydrology 	<ul style="list-style-type: none"> with a series of independent units Small open spaces with flexible enclosure and independence Open space with good ventilation and sunlight Regeneration of old blocks and rational planning of new residential areas Infrastructures related to health, sport, isolation, and domestic should be improved to guarantee residents' daily life. A 15 minute-walking living area Municipal planning should consider carefully testing the sewage from communities before draining into city pipes.
Tactical use of urban space	<ul style="list-style-type: none"> Redundancy space Take resilient land use into consideration to prepare for unexpected emergencies with a war-peace combined situation 	<ul style="list-style-type: none"> Specific buildings like schools, hotels and stadium can be employed as medical space when the pandemic happens. Some storage space can typically perform as commercial warehouses and change into medical warehouses in the pandemic
Equitable distribution of medical facilities for infectious diseases	<ul style="list-style-type: none"> Classification of medical facilities should be based on an administrative level. Specific medical facilities for infectious diseases are suggested to be allocated by population. The city's medical facilities should keep a close connection with each level and flexibly dispatch the staff. A safe network to disposal medical waste The medical facilities for infectious diseases should locate in the site with unobstructed transportation and away from the site with a high population 	<ul style="list-style-type: none"> Specific medical facilities for infectious diseases are suggested to be allocated by population. Clinics and health service stations are suggested to be set with a systematic network. The city's medical facilities should keep a close connection with each level and flexibly dispatch the staff. A safe network to disposal medical waste The medical facilities for infectious diseases should locate in the site with unobstructed transportation and away from the site with a high population
Early warning mechanism	<ul style="list-style-type: none"> Simulation and modelling based on big data can effectively arrange the location and number of requisite facilities in advance and balance the resource allocation in the pandemic. Multi-level engagement in the smart city 	<ul style="list-style-type: none"> Engaged in the modelling and simulating system to calculate the chance of a pandemic outbreak. Multi-level engagement in the smart city

Table 5 Different roles of urban planning in a different stage and spatial scale

3.3 The detailed analysis of roles that urban planning may act in the face of the pandemic.

3.3.1 Response

Transformative land use

During the Covid-19, many cities used vacant land and proper public constructions to build or transform into makeshift hospitals to contain more patients (Xia, Liu & Wu, 2020; Zhang, Wen and Chen, 2020; Lu *et al.*, 2020). At the beginning of 2020, when the Covid-19 started to break out, Wuhan also opened two makeshift hospitals called Huo Shen Shan and Lei Shen Shan for treatment and isolation (figure 1 and figure 2). According to Cai and his colleagues (2020), makeshift hospitals' use contributed to a significant decrease in the mortality of COVID-19 cases in Wuhan, Hubei. Transformative land use in the pandemic did not merely service for anti-epidemic but also an orderly life. In Covid-19, more people preferred private cars than public transportation, resulting in a tight space for parking. Therefore, the planning of a temporary parking space with unused land can accommodate more vehicles (Li and Zhang, 2020). The strategies of transformative land use are mostly about municipal scale. The reviewed literature has not mentioned methods or put forward suggestions on a community scale.



Figure 1 Huo Shen Shan Hospital, Wuhan, 2020

Source: <http://www.xinhuanet.com>

Temporary regulating of spaces

Urban planning is supposed to rearrange virtual spaces to assist in anti-epidemic activities. During the Covid-19, transportation and delivery should be prioritised for the pandemic (Yuan, Zhang and Chen, 2020). An anti-epidemic corridor is temporarily planned to transform patients, supplies and contaminated object (e.g., Li and Zhang, 2020). Away from urban daily life, the planning of specific space for reception, treatment and triage is vital to avoid superinfection (e.g. Li and Zhang, 2020). In communities, the allocation of supplies is essential during the pandemic. Temporary points in schools, stadiums, and squares for storing and allocating supplies are required (e.g. Yuan, Zhang and Chen, 2020). To deal with another potential outbreak brought by population mobility, temporary testing points (figure 3) were set regularly among communities and necessary blocks (Xia, Liu and Wu, 2020).



Figure 2 Temporary testing points in a community, Wuhan, 2020

Source: <http://www.cnhubei.com>

3.3.2 Recovery

Socio-economic resumption

Urban planning is essential in assisting the implementation of the management though socio-economic recovery more relates to financial activities and management (Jin, Huang and Kong, 2020; Lai *et al.*, 2020; Shi, 2020). To recover quickly, China has advocated a stall economy (e.g. Gao, 2020). Urban planning was engaged to help the stalls be operated orderly and confirm the proper site and density of stalls on the streets (e.g., XU and Yu, 2020) (figure 4). Jin (2020) and his colleagues also suggested that returning to work should start in order. Tang (2020) indicated that the recovery of socio-economic situation should also combine with Smart City's construction. Big data and simulation employment can effectively avoid a potential outbreak of the pandemic under work resumption. However, temporarily there is no paper has talked about how to recover the social-economic from community scale.



Figure 3 The stall economy Shandong, 2020

Source: <http://www.gov.cn>

Greening planning for therapy

The planning of green spaces can contribute to residents' mental recovery after the pandemics (Liu, Shen and Li, 2020). Research on residents' mental health isolated at home reveals that older people were severely influenced by the pandemic (Liang *et al.*, 2020, Cai, Wang and Chen, 2020). Meanwhile, Xu and his colleagues (2020) suggested that proper greening planning can release anxiety and provide a safe and healthy space for physical activities (figure 5). The higher density of greening can filter the hazard and

benefit the mental health of residents. Therefore, after the pandemic, green space planning should consider the accessibility and enhance the quality (e.g., Bao, Zeng and Zhao, 2020).

Mainly the planning of greening space is focused on communities. Green spaces in communities are supposed to focus on sensory design and therapy. A 'green medicine' is suggested to be employed with therapeutic horticulture in communities to enhance the people who might be easily infected (e.g., Liu, Shen and Li, 2020).



Figure 4 people were enjoying the green space in the community when Covid-19 was under control in Xinjiang, 2020

Source: <https://www.sohu.com>

3.3.3 Preparedness

The Antivirus-built environment

As pointed out by Wang (2020), immune planning is based on evaluating the potential infection outbreak. At the municipal level, the immune planning relates to a more targeted distribution of medical facilities and advocates a networked, grouped, and multi-centred urban context with defence units (Han, Li and Wu, 2020; Dai, Zhu and Lyu, 2020; Duan *et al.*, 2020). The land using potential contamination should be separated from residential areas with proper green isolation (Yang *et al.*, 2020). An immune corridor combined with green space is suggested for emergencies which should be differentiated from daily use to ensure efficiency. Green space is also vital in urban immune planning to separate, control, and defuse the contamination (Han, Li and Wu, 2020; Wang, 2020, Yang *et al.*, 2020; Liang *et al.*, 2020). Chinese scholars also highly mention urban ventilation. Though firstly put forward to deal with SARS in 2003, ventilation is still a popular topic to deal with the pandemic. Based on buildings' density and height, the extension of green spaces, and open spaces, urban ventilation aims to build a wind corridor to drift virus away (Duan *et al.*, 2020; Shi, 2020; Liang *et al.*, 2020; Liu and Liu, 2020). Ge (2020) and his colleagues indicate that healthy transportation with a slow traffic system's priority can reduce the risk of traffic tie-up. Ecological improvement can also contribute to building an immune city (Yuan, Zhang and Chen, 2020; Liu, Shen and Li, 2020). Sufficient vegetation can filter the air and hinder the spread of the virus. Healthy hydrology in the city can also reduce the possibility of carrying and spreading the virus (Liu, Shen and Li, 2020).

At the community level, a cluster form of the community with a series of independent units of open spaces enclosed when the pandemic happens is suggested for the preparedness (Dai, Zhu and Lyu, 2020; Duan *et al.*, 2020; Yang *et al.*, 2020). Small scales with flexible enclosure and independence might become new contexts of open spaces to avoid future infection (Dai, Zhu and Lyu, 2020; Duan *et al.*, 2020;

Wang and Gan, 2020). A proper open space with good ventilation and sunlight can reduce the risk of the pandemic (Li, Wang and Zhang, 2020; He and Zeng, 2020; Li and Yao, 2020), which requires regeneration of old blocks and rational planning of new residential areas (Lyu, 2020; Ling and He, 2020). Infrastructures related to health, sport, isolation, and domestic should be improved to guarantee residents' daily lives when the pandemic breaks out. A 15 minute-walking living area is frequently mentioned to effectively reduce the range of population mobility meanwhile ensure the daily necessity when the city locks down (K. Wang, 2020; Tang, 2020; Zhao and Geng, 2020; Chen *et al.*, 2020; Wang and Gan, 2020; L. Wang, 2020). The disposal of sewage and waste in communities should also be improved. (Han, Li and Wu, 2020; Wu, 2020). Sun (2020) suggested that municipal planning consider carefully testing the sewage from communities before draining into city pipes.

Tactical use of urban space

Flexible land use is one of the strategies to help the city handle emergencies more rapidly. "Redundancy Space" is suggested for emergent and temporary isolation, evacuation and supplies storage (Zhou and Sang, 2020; Liang *et al.*, 2020; Wu, 2020; Yang *et al.*, 2020; Huang, 2020). The "Redundancy Space" is suggested to be distributed and polycentric (Deng, 2020).

Many scholars advocated that urban planning should also consider transformative constructions like schools, stadiums, and factories, which can be changed into temporary settlements for patients or supplies (Liang *et al.*, 2020; Sun *et al.*, 2020; Deng and Wang, 2020; Zhou and Sang, 2020). The flexible land use and transformative constructions can be performed in a war-peace combined situation to both guarantee daily use and emergent use (Che, Qiu and Wang, 2020; Deng and Wang, 2020; Zhou and Sang, 2020; Chen *et al.*, 2020; Cao, 2020; Yuan, Zhang and Chen, 2020).

In the communities, specific buildings like schools, hotels and stadium can be employed as medical space when the pandemic happens (Zhang, Zhang and Guo, 2020) while some storage space can typically perform as commercial warehouses and change into medical warehouses in the pandemic (Wu, Xu and Li, 2020; Jin, Huang and Kong, 2020).

Equitable distribution of medical facilities for infectious diseases

Insufficient medical facilities with inefficient use are reported to make the epidemic out of control (Jiao, 2020). The importance of medical facilities planning has been recognised by scholar after the SARS in 2003 and reemphasised after the outbreak of Covid-19 (Zhou, Zhang and Guo, 2020; Li and Zhang, 2003). Classification of medical facilities based on an administrative level is recommended for developing healthy cities (Zhou, Zhang and Guo, 2020; Wu, 2020; Wang and Shi, 2020; Li *et al.*, 2020; Ling and He, 2020). Specific medical facilities for infectious diseases are suggested to be allocated by populations and the scale of residential areas to help patients get the treatment as fast as possible (Jiao, 2020; Zhang, Wen and Chen, 2020; Zhao and Geng, 2020; Lu *et al.*, 2020).

Notably, in communities, clinics and health service stations are suggested to be set with a systematic network to mitigate the stress of medical service (Zhang, Wen and Chen, 2020). The city's medical facilities should keep a close connection with each level and flexibly dispatch the staff (Deng, 2020; Xiao and Song, 2020; Tang, 2020). Zhang and his colleagues (2020) also emphasised that a safe network for disposal of medical waste is essential. The medical facilities for infectious diseases should locate in the site with free transportation and away from the site with a high population (Zhou, Zhang and Guo, 2020).

Early warning mechanism

On account of the development of big data and 5G, planning gradually relies on the sharing and analysing statistics from various departments, also known as Smart City (Xue *et al.*, 2020; Wang, 2020; Zhu, 2020). Simulation and modelling based on big data can effectively arrange the location and number of requisite facilities in advance as well as balance the resource allocation in the pandemic (Zhou, Long and Huang,

2020; Li, Wang and Zhang, 2020; Li and Zhang, 2020; Liang *et al.*, 2020). The early warning mechanism based on the Web of Things, cloud computing, big data and GIS can predict the tendency of morbidity and help city managers take actions accurately (Yang *et al.*, 2020).

Communities should be engaged in the modelling and simulating system to calculate the chance of pandemic outbreak (Zhou, Long and Huang, 2020; Zhang, Wen and Chen, 2020) to hinder the spread of the virus as soon as possible. Multi-level engagement in the smart city can effectively simulate and predict pandemics' occurrence and help city and community managements react quickly and systematically. However, the strategy is still in a stage of hypothesis and requires more detailed implementations.

4. Conclusion

Based on a spatial-temporal classification, we concluded that most papers tend to discuss strategies in preparedness stage on municipal scale, covering from urban structure transformation to specialized planning. This review has shown how Chinese scholars use urban planning to deal with pandemics at different stages and spatial scales. Against the national policy call, urban planning in China focuses on achieving an antiviral-built environment in the face of the pandemic. At the early stages of the pandemic, urban planning took the responsibilities to make temporary space for makeshift hospitals, testing points, and delivery points to reduce infection possibilities. When the pandemic was preliminarily controlled, urban planning assists the socio-economic resumption with some a proper spatial planning of economic facilities and green public space. Urban planning is widely suggested to participate in the preparedness of the pandemic with an antiviral-built environment, tactical land using, distribution of medical facilities and early warning of the pandemics. However, the limitation still exists. The literature about how urban planning is engaged in the recovery stage and community scale is less found in the reviewed literature. Besides, the mentioned strategies in preparedness are not fully implemented. Though Chinese urban planning strategies may become a reference for worldwide, this paper reveals that Chinese urban planning has ignored several points. Therefore, more researches are still required in the future.

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