Analysis of Influencing Factors and Configuration Paths of Urban Resilience Construction from the Perspective of Disaster Prevention and Reduction

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Abstract. In recent years, resilient cities have gradually become a popular new concept of urban disaster prevention and reduction at home and abroad. The construction of resilient cities has created a systematic and digital urban disaster prevention and reduction system, and also laid a theoretical foundation for urban resilience.Based on a literature review, this article selects the four dimensions of resilient city characteristics as the research framework, takes 31 provinces in China as cases, and uses the fsQCA fuzzy set qualitative analysis method to explore the impact of different factors on urban resilience governance. The study found that the construction of resilient cities from the perspective of disaster prevention and reduction involves the linkage of multi-dimensional factors, among which balanced resource allocation and government policy support are key, but different regions should also adjust strategies according to their own economic, social and physical conditions to achieve Resilience goals.

Keywords: Urban resilience; Natural disasters; Qualitative comparative analysis (QCA); Influencing factors

1 Introduction

The World Bank stated in its "City Resilience Program" that as climate change intensifies, many cities face increased risks from disasters such as floods, droughts, earthquakes and rising sea levels. Therefore, improving urban resilience is increasingly important. As one of the countries with the most severe natural disasters in the world, China has many types of disasters, high frequency of occurrence, wide geographical distribution, and heavy disaster losses. Especially in highly urbanized areas, the impact of disasters may be amplified, resulting in huge economic losses, infrastructure damage, and casualties.The construction of urban resilience realizes the city's ability to maintain its basic functions, structure and identity in the face of external shocks and pressures. It is not just the resilience of a city’s physical structures and facilities, but also encompasses all social, economic and environmental dimensions. Therefore, this article starts from the four dimensions of urban resilience characteristics and uses the fsQCA fuzzy set qualitative analysis method to analyze the impact of multiple combinations of factors on urban resilience governance under different scenarios, providing valuable insights for urban planners and decision-makers.

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2 Literature review and framework research

2.1 Research progress on natural disaster management

From an academic perspective, the research on natural disaster management mainly includes three major fields: "technology and engineering", "organization and system" and "society and politics". In terms of technology: Tiedemann (1992) used disaster probability functions to calculate disaster risk coefficients for various natural disasters, which enhanced pre-disaster warning capabilities and reduced disaster losses. Pearson (1998) advocated the use of multi-dimensional interdisciplinary theory and big data technology to enhance disaster research, judgment and management.In terms of organization and system: Xue Lan and Zhong Kaibin (2005) emphasized that various sudden disaster events should be managed in different stages. Depending on the type and progress of the event, the government should take corresponding measures and build a governance system before, during, and after the disaster. In terms of society and politics: Scholars advocate making full use of social resources in disaster management, building a "comprehensive integration" emergency management framework, and emphasizing the potential contributions of social organizations and the public. Fernandez and Garcia (2019) analyzed the role of multi-sector collaborative participation in disaster response through a study of the 2015 Nepal earthquake, emphasizing the key role in disaster recovery and reconstruction.

2.2 Research progress on resilient city construction

In recent years, there has been an increasing number of discussions on resilient cities, with various localities and academic circles holding various opinions and practical methods. By definition, resilient cities focus on a city’s ability to recover quickly when faced with emergencies. Cathy (2012) pointed out that urban resilience is mainly reflected in a city's ability to maintain its original state and not suffer or minimize the impact when it suffers from external environmental shocks. However, Matsuko (2020) believes that resilience is not only a city's response when facing external shocks, but also a characteristic within the urban system that needs to be implemented throughout the entire disaster management cycle, from prevention, preparation, response to recovery. Use resilience.In terms of governance technology, A Ricciardelli et al. (2018) provide an exhaustive examination of the rebuilding efforts in the city of New Orleans after Hurricane Katrina. They found that the power of community is particularly critical during disaster recovery. Therefore, the perspective of building a smart community team is put forward. Li Ruichang and Tang Yun (2022) pointed out that digital technology empowering emergency management has become a new direction for resilient urban governance. The widespread application of information technology not only improves the speed and efficiency of emergency response, but also promotes collaborative linkage mechanisms in various regions, providing solid support for the national emergency management system.

3 Research methods

3.1 Qualitative comparative analysis of fsQCA fuzzy sets

fsQCA fuzzy set qualitative comparative analysis is a social science research method proposed by Charles Ragin in 1987. It is based on the "set theory" method to analyze the configuration relationship of dependent variables and causal relationships in the case.This approach uses qualitative and quantitative research to better capture the complexity of the real world by examining how different conditions combine to lead to an outcome. The advantage of using the fsQCA research method in this article is that by comparing the urban resilience levels of various provinces in China, we can determine the individual effects of each influencing factor and the interactive effects between factors. In terms of resource allocation: If the city's resources are limited, fsQCA's configuration analysis can determine which dimension is more important, and therefore can help decision-makers prioritize resource allocation to formulate more targeted strategies.In terms of conditional factor analysis: The construction of a resilient city is not the result of the independent development of one dimension. fsQCA can reveal this complexity and help us better understand the multidimensionality of urban resilience. In terms of urban development: Based on the research results of this article, customized policy recommendations can be provided to cities through different types of configurations.

3.2 Theoretical basis

This article starts from the four dimensions of resilient city characteristics. Sample selection and evaluation are carried out from the four dimensions of physical, organizational, economic and social dimensions as shown in Figure 1. [1]

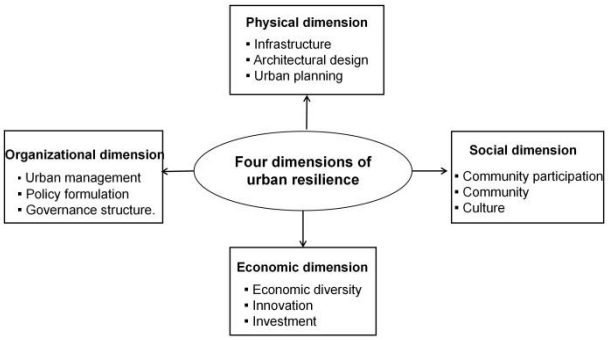

Fig. 1. Four-dimensional map of resilient city characteristics

4 Research design

4.1 Case selection

In order to meet the different resilience governance strategies and effects due to differences in geography, economy, culture and social structure, this article selected 8 factors as variables in 31 provinces in China in 2021 or 2022. In order to ensure the comprehensiveness, diversity and effectiveness of the data, Accuracy, the condition variables and outcome variables of this

article are obtained from official data websites (National Bureau of Statistics website, National Statistical Yearbook, provincial emergency management bureaus). The specific sources are detailed in Table 1.

4.2 Variable selection and explanation

Based on the four-dimensional framework of resilient city characteristics mentioned above, this article selects 7 condition variables and 1 outcome variable as research variables related to urban resilience construction from the perspective of disaster prevention and reduction. Values are assigned through fuzzy set and clear value methods, and strict variable calibration (Table 1) ultimately ensures the accuracy and consistency of the results.

4.2.1 Conditional variables

Rescue and recovery funds: At the economic level, the economic level, as the driving force for urban development, directly affects urban infrastructure investment, disaster reduction and relief investment, and industrial structure, etc., which in turn affects the city's pre-disaster early warning, disaster response and post-disaster recovery capabilities, and rescue-related Budgets can help cities better mitigate disaster risks and ensure the safety and well-being of residents.[2] This article uses provincial fiscal public security expenditures as the evaluation indicator, and the data comes from the 2022 China Fiscal Yearbook.

Data and information management: With the development of big data, digital intelligence technology and innovation provide more comprehensive services for the entire process of urban emergency management. Through data-driven methods, cities can manage and develop more flexibly, efficiently and sustainably, and improve the quality of life and safety of residents. This article selects the amount of fixed asset investment in information transmission, computer services and software industries as measurement dimensions, which can be compared The investment intensity of digital services in each province is determined to determine the level of urban resilience. The data comes from the 2022 China Statistical Yearbook.

Socioeconomic status: Socioeconomic status is used to describe the overall status and performance of the social and economic aspects of a country, region, city or community. People's living standards, social well-being, economic activities and wealth distribution can be assessed to a certain extent. [3]This article uses the Gini coefficient of each province in China in 2021 as a variable. If the Gini coefficient is close to 0, it means that the province’s wealth or resource distribution is more equal, and the province’s ability to respond to various disturbances is stronger. When a disaster strikes, it will have a stronger The more resilient a city is, the stronger its social resilience will be.

Government policies and related plans: Emergency policies and plans are the direct basis for emergency response and determine the quality of emergency response [4]. By issuing policies and related plans, the government can effectively carry out crisis management, disaster response, resource allocation, cross-sector cooperation and long-term urban planning, which has strengthened urban resilience to a certain extent. The data comes from statistics on the number of disaster emergency policy documents issued by the official emergency management bureaus of 31 provinces.

Level of social governance: Cross-sector collaboration and social governance are key factors in improving urban resilience when cities face natural disasters. It promotes the effective use of resources, the smooth transmission of information, and coordinated actions, and helps mitigate the impact of natural disasters. [5] This factor is measured using the four-value fuzzy method (0, 0.33, 0.67, 1). According to the document issued by the Ministry of Civil Affairs of China,Provinces with more than 50,000 social organizations are assigned a value of 1, provinces with 30,000 to 50,000 are assigned a value of 0.67, provinces with 10,000 to 30,000 are assigned a value of 0.33, and provinces with less than 10,000 are assigned a value of 0.

The rationality of urban planning: The rationality of urban planning is an indicator to judge urban development and construction and the sustainable development of the city. This indicator involves the coordination and balance of various urban elements, including land use, transportation systems, housing, green spaces, infrastructure, environmental protection, cultural heritage protection, etc. The data in this article comes from the Didi "Urban Development Index" report, which was jointly released by the Didi Policy Research Institute and the School of Architecture of Tsinghua University. The data is based on 20 indicators covering more than 200 cities and has a strong reference value.Health Facilities and Resources: Health facilities and resource levels are critical to a city when natural disasters strike, playing a key role in mitigating casualties, providing first aid and long-term recovery, and maintaining public health. This article uses the number of medical equipment and beds in each province to measure the level of urban medical material reserves and supply chain management medical services. The data is taken from the 2022 China Urban Statistical Yearbook.

4.2.2 Outcome variables

The outcome variable that this article focuses on is the level of local government emergency development. The measurement standard is based on 78 original documents in Chinese and English. After screening and integration, 35 core indicators were determined, which are divided into three sub-dimensions: urban social disaster tolerance, urban resource endowment, and urban resource allocation. And obtained from statistical yearbooks and various publicly published reports.[6]

Table 1. Variable indicator description and calibration anchor point

Type	Indicators dimension	Name of indicator	Data sources	anchor point		
				Fully affiliated	Intersection	Not affiliated at all
Conditional variable	Economic resilience	Fiscal public safety expenditures	"China Fiscal Yearbook 2022"	818.905	308.94	98.16
		Investment in digital services	"China Local Government Data Openness Report 2022"	749.191	257.738	33.8711
	Social resilience	GINI coefficient	"China Statistical Yearbook 2022"	0.50358	0.44989	0.356995
		Government Policies and Related Plans	Official websites of provincial government emergency	1	0.33	0

			management bureaus			
	Organizational resilience	Total number of social organizations	China Civil Affairs Database	1	0.33	0
	Physical resilience	Rationality of urban planning	Didi “Urban Development Index” Report	5.7125	4.495	4.19365
		Medical equipment and resource level	"China Statistical Yearbook 2022"	506094	184925	25518.5
Outcome variable	Local government urban resilience level	Urban social disaster tolerance	"China Urban Statistical Yearbook", "Civil Affairs Statistical Yearbook", "China Statistical Yearbook", "China Urban Housing Vacancy Analysis Short Version", "China Government Data Governance Report"	79.36	58.03	43.585
		Urban resource endowment				
		Urban resource allocation				

5 Analysis of empirical results

5.1 Single factor necessity analysis

This study used fsQCA3.0 software to conduct a truth form factor necessity analysis. As shown in the results in Table 2, although a variety of conditions affect urban resilience, no single condition reaches the necessity value of 0.9, which means that there are no absolutely necessary conditions to ensure successful governance. Therefore, improving the city's resilience in the face of disasters is a complex issue, and its configuration effects need to be explored.

Table 2. Single factor necessity analysis

Antecedent variables	High urban resilience		low urban resilience	
	Consistency	Coverage	Consistency	Coverage
a	0.813581	0.868241	0.524626	0.500946
~a	0.532364	0.555875	0.862012	0.805348
b	0.820305	0.845098	0.452217	0.416850
~b	0.433959	0.469608	0.831956	0.805543
c	0.806247	0.684180	0.833322	0.632728
~c	0.567203	0.791809	0.584056	0.729522
e	0.798057	0.867459	0.474418	0.461400
~e	0.504492	0.517557	0.863720	0.792827
d	0.860278	0.819601	0.568823	0.484889
~d	0.459324	0.543502	0.788374	0.834671
f	0.632724	0.754959	0.493203	0.526546
~f	0.603203	0.570859	0.770476	0.652418
g	0.800135	0.830594	0.518478	0.481568
~g	0.500581	0.537437	0.817611	0.785419

Note: a:fiscal public security expenditure; b:investment in digital services,;c:socioeconomic status,;d:the total number of social organizations in each province; e:the number of government policies and related plans; f:the rationality of urban planning,;g:medical resources and level.

5.2 Conditional configuration analysis

In this study, due to the limited case size, we set the following parameters: frequency threshold as 1, raw consistency threshold as 0.8, coverage threshold as 0.5, and PRI consistency threshold as 0.70.[7] The fsQCA3.0 software was used to analyze the configuration paths of condition variables related to urban resilience management under natural disasters.As shown in Table 3, the paths leading to a high level of urban resilience governance under natural disasters are diversified, with a total of 6 conditional configuration paths. The consistency of the solution is 0.927974, which shows that among the urban cases that meet the six configurations, 92.8% of the cities show a high level of resilience management in disaster prevention and reduction. The solution coverage reaches 0.712671, indicating that these six condition configurations can cover 71.27% of urban governance paths with high resilience. The conditional variable configuration analysis can further identify the differentiated adaptation relationships among economic resilience, social resilience, organizational resilience and physical resilience in promoting urban resilience governance to respond to natural disasters.Through the configuration analysis of conditional variables, the differentiated adaptation relationships of the four dimensions of economy, society, organization, and physics in the construction of resilient cities under natural disasters can be further identified. This article selected the following four representative paths from the six paths for classification analysis.

Table 3 Conditional configuration analysis

Antecedent conditions	High urban resilience					
	configuration1	configuration2	configuration3	configuration4	configuration5	configuration6
a	ⓧ	-	●	-	●	ⓧ
b	-	ⓧ	-	●	●	●
c	●	●	●	●	●	●
d	ⓧ	●	●	●	●	-
e	●	●	●	●	●	ⓧ
f	●	●	ⓧ	ⓧ	●	●
g	ⓧ	ⓧ	●	●	-	●
consistency	0.9597	0.9815	0.9533	0.9291	0.9938	0.9383
Rawcoverage	0.2621	0.2312	0.4518	0.4182	0.3951	0.2323
Uniquecoverage	0.050	0.010	0.035	0.008	0.092	0.036
Explain the case	Tianjin Hainan	Shanghai Chongqing	Hubei Anhui	Henan Hunan	Guangdong Beijing	Hangzhou Sichuan
Solutionconsistency	0.7127					
Solutioncoverage	0.9280					

Note: - indicates that the condition variable is optional;●=Core conditions exist;●=Edge conditions exist;Ⓧ=Missing core conditions

First, economic resilience is the dominant type. Reference path 5: a1*b1*c1*d1*e1*f1. The representative cities are Guangdong and Beijing. This path points out that in terms of economic resilience, the government's financial expenditure on public security and Smart cities built with digital and information technology are crucial to the city's resilient governance. As the economic centers of China, Guangdong and Beijing have a strong economic foundation and advanced information technology support. It also confirms that adequate financial investment when disaster strikes is part of the construction of resilient cities.

Second, social resilience-led type, reference path 3: a1*c1*d1*e1*~f1*g1, the representative cities are Hubei and Anhui. This path points out that in the case of less government financial support, good Resource allocation, government policies and plan releases, and urban infrastructure improvement are all necessary conditions for building a resilient city. These provinces have been hit by numerous natural disasters in the past, such as floods, droughts and typhoons. For these disasters, good urban cohesion and clear policy guidance are very important.

Third, organizational resilience-led type, reference path 2: ~b1*c1*d1*e1*f1*~g1, the representative cities are Shanghai and Chongqing. This path shows that even under the conditions of poor regional economic conditions, there are Urban resilience governance will also show better results when more social organizations collaboratively participate in resilient urban governance and when government policies attach greater importance. As municipalities directly under the central government, Chongqing and Shanghai have greater autonomy in organizational resilience, resource allocation and policy formulation. When disaster strikes, these social organizations can provide critical support and resources to cities.

Fourth, the physical resilience-dominated type, reference path 6: ~a1*b1*c1~e1*f1*g1, the representative cities are Hangzhou and Sichuan. This path shows that the city's spatial planning, infrastructure construction and medical level have an important impact on resilience. Urban construction plays a big role. Under the combined effect of economic resilience and physical resilience, the city's resilience is stronger. As the capital of Zhejiang Province, Hangzhou has a developed economy, advanced science and technology, and reasonable urban planning. As of 2022, Hangzhou's underground space Its comprehensive strength ranks fourth in the country, and its underground space management system and construction indicators rank first in the country. As an area prone to earthquake disasters, Sichuan Province's investment in seismic design of urban infrastructure and medical care has also greatly improved urban resilience in the face of natural disasters.

6 Conclusions

This study focuses on the construction of resilient cities for disaster prevention and reduction under the compound influence of multiple factors. Using fsQCA, we use 7 conditional factors in 31 provinces in my country as samples to explore the configuration behind the construction of resilient cities from the perspective of natural disasters through the four dimensions of urban resilience characteristics. Path, the following conclusions are formed: (1) The

construction of resilient cities from the perspective of disaster prevention and reduction not only involves economic and social factors, but also is related to organizational and physical conditions. It is the effect produced by the linkage of various dimensional factors, and there is no single necessary condition. (2) Balanced resource allocation and government policy support are key steps in almost all paths, indicating that they play a central role in strengthening urban resilience. (3) Different provinces and cities have their own unique resilience building paths. Economically developed areas can enhance urban resilience by improving urban infrastructure construction, while less developed areas must increase financial investment and attention. Each region needs Make strategic adjustments based on its own conditions and actual circumstances.

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