ISSN: 2710-0588

Research on Urban Physical Examination from the Perspective of Resilient Cities

Yang Li, Jiefang Tian

School of civil engineering, North China University of Science and Technology, Tangshan 063000, China

Abstract

Against the backdrop of global climate change and the accelerated urbanization process, cities are confronted with multiple risks and challenges such as natural disasters and public health events. The construction of resilient cities has become a key path to enhancing urban safety and sustainable development capabilities. This study conducts urban health check research from the perspective of resilient cities, aiming to establish a scientific, systematic, and practically guiding urban health check index system to provide precise diagnosis and optimization directions for urban resilience construction. The article screens and constructs an urban health check assessment system from five dimensions: economic resilience, social resilience, infrastructure resilience, ecological environment resilience, and institutional resilience. Through empirical analysis of typical cities, the effectiveness of this index system in identifying urban resilience shortcomings and quantifying urban resilience levels has been verified.

Keywords

Resilient city; Urban health check; Urban safety; Sustainable development.

1. Introduction

With the intensification of global climate change and the rapid advancement of urbanization, cities have revealed numerous vulnerabilities under the impact of multiple risks such as natural disasters and public health crises. Against this backdrop, the construction of resilient cities has become the core path to ensure urban safety and sustainable development.This study innovatively integrates the theory of resilient cities into urban health check work. From five dimensions, namely economic resilience, social resilience, infrastructure resilience, ecological environment resilience, and institutional resilience, a systematic and scientific urban health check evaluation index system has been established.

The research results not only deepen the theory of urban governance but also provide a powerful practical basis for urban managers to formulate strategies for enhancing urban resilience and promoting high-quality urban development.

2. Principles Followed in Urban Health Check

2.1. Scientific Principle

Scientificity is the foundation of urban health check. It requires the application of scientific theories, methods, and technical means throughout the entire health check process to ensure that the evaluation results are objective, accurate, and reliable. In terms of indicator selection, it is necessary to screen out indicators that can accurately reflect the operation status of the city based on urban development theories, urban scientific research achievements, and in combination with the actual development needs of the city. For example, scientific methods such as the entropy method and the analytic hierarchy process are used to determine the weights of indicators to avoid subjective arbitrariness. In terms of data collection, with the help

ISSN: 2710-0588

of technologies such as Geographic Information System (GIS) and big data analysis, multi-source data are obtained, such as traffic flow data, air quality monitoring data, etc. Through scientific statistical analysis methods, the various aspects of the city are quantitatively evaluated to provide a scientific basis for urban development.

2.2. Systematic Principle

The city is a complex giant system that covers multiple subsystems such as the economy, society, ecology, and infrastructure, and these subsystems are interrelated and influence each other. The systematic principle emphasizes that when conducting an urban health check, the relationships among various elements of the city should be comprehensively and comprehensively considered, and it is necessary to avoid looking at a certain field or a certain problem in isolation. For example, when evaluating the urban ecological environment, not only natural ecological indicators should be paid attention to, but also the impact of the ecological environment on urban economic development and the quality of residents' lives, as well as the feedback effect of urban construction on the ecological environment should be considered. By constructing a systematic indicator system, all aspects of the city are incorporated into a unified evaluation framework, and the synergy and conflict points within the system are analyzed, so as to provide systematic solutions for the overall optimization and sustainable development of the city.

2.3. Problem-oriented Principle

One of the core objectives of urban health check is to discover the existing problems and shortcomings in urban development, so the problem-oriented principle runs through the whole process. Before the health check work is carried out, it is necessary to comprehensively sort out the prominent problems faced by the city in the development process, such as the aging of facilities in old residential areas, frequent urban waterlogging, and the uneven distribution of educational resources, etc., through means such as on-site investigations, data analysis, and case studies. Guided by these problems, the health check indicators and evaluation methods are designed in a targeted manner, and the root causes and scope of influence of the problems are deeply analyzed. During the health check process, these key problems are continuously focused on, and through means such as data comparison and trend analysis, the severity and change trend of the problems are accurately grasped, laying the foundation for formulating precise and effective solutions subsequently.

3. Urban Health Check Evaluation System

The framework of the urban health examination evaluation indicator system is shown in Table 1.

3.1. Economic Resilience Dimension

Economic resilience refers to the ability of a city to maintain stable economic operation, achieve rapid recovery, and promote transformative development when facing external shocks. Under this dimension, the following key indicators are selected:

Degree of Industrial Diversification: Measure the richness of the city's industrial structure by calculating the number of different industrial types and the proportion of each industry in GDP. The higher the degree of industrial diversification, the stronger the city's ability to withstand risks associated with a single industry.

Enterprise Risk Resistance Capacity: Evaluate enterprises' ability to cope with risks such as market fluctuations and technological changes using indicators such as asset-liability ratio, cash flow stability, and the proportion of innovation investment.

ISSN: 2710-0588

Employment Elasticity Coefficient: Reflects the sensitivity of employment volume to changes in economic growth. A higher coefficient indicates that the city has a stronger ability to absorb and stabilize employment during economic fluctuations.

Table 1. Urban Health Examination Evaluation Indicator System Framework

Dimension	Secondary Indicator	Calculation formula/Measurement method	Data Source	Weighting Method
Economic resilience	Industry Diversification Index	$D = 1 - \sum_{i=1}^{n} (S_i)^2$	Statistical Yearbook	Entropy Method
	Employment Elasticity Coefficient	$\eta = \frac{\Delta L/L}{\Delta GDP/GDP}$	Human Resources Department Data	Analytic Hierarchy Process
Social resilience	Community Self-Governance Index	A=0.4V+0.3O+0.3D	Community Survey	Principal Component Analysis
	Emergency Knowledge Popularization Rate	$K = \frac{N_K}{N} \times 100\%$	Sample Survey	Equal Weight Method
Infrastructure	Transportation Network Redundancy	$R = \frac{E_{alt}}{E_{total}}$	GIS Road Network Data	Data Envelopment Analysis Model
	Power Supply Reliability Index	$P = \frac{T_{total} - T_{outage}}{T_{total}}$	Electricity Company Records	Entropy Method
Ecological Environment	Ecosystem Integrity	$EI = \sum (W_i \times F_i)$	Remote Sensing Monitoring	AHP-TOPSIS
	Green Space Connectivity Index	$GCI = \frac{C_{actual}}{C_{potential}}$	Spatial Syntax Analysis	Spatial Econometrics
Institutional Resilience	Preparedness Completeness Index	$E = \sum_{K=1}^{5} \frac{S_k}{S_{max}}$	Policy Text Analysis	Delphi Method

Core calculation formula:

1. Herfindahl-Hirschman Index (HHI):

$$HHI = \sum_{i=1}^{N} (S_i)^2 \times 10000$$

Where S_i represents the proportion of the output value of the i-th industry in GDP

2. Employment elasticity coefficient:

$$\eta = \frac{dL/L}{dY/Y}$$

where L is the number of employed persons and Y is the total GDP

ISSN: 2710-0588

3.2. Social Resilience Dimension

Social resilience emphasizes the ability of a city's social system to maintain social order, ensure residents' livelihoods, and promote social unity in the face of crises. The main indicators include:

Community Self-governance Capacity: Measure the community's self-management and self-service capabilities through indicators such as the proportion of community residents participating in community affairs decision-making, the size of community volunteer service teams, and the number of community self-organizations.

Social Security Coverage Rate: Covers the participation rates of various social insurances such as endowment insurance, medical insurance, and unemployment insurance, reflecting the level of basic living security provided by the city to its residents.

Popularization Rate of Residents' Emergency Knowledge: Evaluate the basic ability of urban residents to respond to emergencies by surveying the proportion of residents who master emergency escape skills, first-aid knowledge, etc.

3.3. Infrastructure Resilience Dimension

Infrastructure is the material foundation for the normal operation of a city, and its resilience is related to the city's ability to maintain and restore functions during disasters or crises. The relevant indicators are as follows:

Redundancy of Transportation Network: Evaluate the city's transportation network's ability to maintain traffic flow through alternative routes when some road sections are damaged. This can be measured by calculating indicators such as the number of backup roads and road connectivity.

Reliability of Energy Supply: Use indicators such as the average annual failure duration of the city's power supply, gas supply, and heating systems, and the reserve volume of emergency backup energy to reflect the energy supply system's ability to resist risks and ensure continuous supply.

Stability of Information and Communication Systems: Includes indicators such as communication base station density, network interruption recovery time, data backup, and disaster tolerance capabilities, reflecting the city's ability to respond to risks of communication interruptions caused by cyberattacks, natural disasters, etc. in the information age.

3.4. Ecological Environment Resilience Dimension

Ecological environment resilience refers to the ability of an ecosystem to maintain structural and functional stability and achieve self-repair in the face of external disturbances. The core indicators are:

Ecosystem Integrity Index: Evaluate the proportion of areas, connectivity, and biodiversity of ecosystems such as urban forests, wetlands, and rivers to measure the integrity of the ecosystem structure.

Self-purification Capacity of Pollutants: Evaluate through monitoring the natural degradation ability of environmental elements such as water bodies and soil to pollutants, as well as the buffering and regulating effects of the ecosystem on environmental pollution.

Connectivity of Green Space System: Calculate indicators such as the number and length of connection channels between urban parks and green spaces to reflect the effectiveness of the green space system in improving the urban ecological environment and providing ecological service functions.

Ecosystem Service Value Assessment Model:

$$ESV = \sum_{i=1}^{n} (A_i \times VC_i)$$

ISSN: 2710-0588

Among which:

A_i = Area of Class i ecological land

VC_i= Ecosystem service value coefficient per unit area

3.5. Institutional Resilience Dimension

Institutional resilience is reflected in the adaptability, flexibility, and innovativeness of urban management systems in responding to crises. The specific indicators are as follows:

Perfection of Emergency Response Plans: Evaluate the integrity, operability, and update frequency of emergency response plans formulated by the city for various emergencies such as natural disasters and public health incidents.

Inter-departmental Coordination Efficiency: Measure the collaborative ability of government departments in responding to crises through indicators such as response time and task completion rate in inter-departmental joint emergency drills.

Policy Innovation Capacity: Examine the number and implementation effects of innovative policies and measures formulated by the city during crisis response and urban development, reflecting the adaptability and forward-looking nature of the urban management system.

4. Conclusion

This article focuses on the urban development issues against the backdrop of global climate change and urbanization, and conducts research on urban health checks based on the theory of resilient cities. The research follows principles such as scientificity, systematicness, and problem-orientation, and constructs an urban health check evaluation system from five dimensions: economy, society, infrastructure, ecological environment, and institutions. Through empirical analysis of typical cities, the effectiveness of this system in identifying the weaknesses in urban resilience and quantifying the level of urban resilience has been verified. The research results have deepened the theory of urban governance, providing both theoretical and practical basis for urban managers to enhance urban resilience and promote high-quality development, and are of great significance for strengthening cities' ability to withstand risks.

References

[1] Sun Jianping: Resilience Construction of Mega Cities (Shanghai People's Publishing House, China 2023).

[2] Zhang Wenjia; Chai Yanwei: Research on Urban Spatiotemporal Behavior Planning (Nanjing Southeast University Press, China 2022).

[3] Li Nan; Wenjia: Research on Micro Renewal Strategies for Public Spaces in Old Urban Communities (Yunnan University Press, China 2021).

[4] Yang Jianqiang: Urban Renewal (Nanjing Southeast University Press, China 2020).