Advances in Social Science and Culture
ISSN 2640-9682 (Print) ISSN 2640-9674 (Online)
Vol. 7, No. 4, 2025
www.scholink.org/ojs/index.php/assc

Original Paper

Smart Governance for Mega-City Challenges: A Coordinated Approach to Beijing's "Big City Disease" under the Beijing-Tianjin-Hebei Strategy

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Received: June 18, 2025 Accepted: August 09, 2025 Online Published: August 23, 2025

doi:10.22158/assc.v7n4p135 URL: http://dx.doi.org/10.22158/assc.v7n4p135

Abstract

As one of China's national mega-cities, Beijing faces intensifying "big city diseases" characterized by overpopulation, traffic congestion, environmental degradation, and regional development imbalance. This paper adopts a "problem identification–cause analysis–dynamic linkage–strategy proposal" framework to systematically diagnose the root causes of Beijing's urban governance challenges and proposes intelligent, regionally coordinated governance pathways. Key innovations include shifting the governance focus from traditional urban planning to population and mobility management, promoting cross-regional functional dispersal through "urban cluster unit" thinking, and integrating policy and market mechanisms to enhance the attractiveness of sub-centers. Through empirical data, comparative international cases (Tokyo, Paris, Shanghai), and dynamic interaction modeling, the paper reveals that the crux of Beijing's "Big City Disease" lies in the vicious feedback loops formed among population pressure, infrastructural constraints, and environmental limitations. The study concludes by recommending a smart governance framework centered on big data-driven population regulation, rail-transit-oriented spatial coordination, and industrial synergy under the Beijing-Tianjin-Hebei collaborative development strategy. These findings offer theoretical contributions and practical insights for other mega-cities facing similar systemic challenges.

Keywords

Big city disease, Beijing-Tianjin-Hebei integration, smart governance, population mobility, regional

coordination

1. Introduction

As China's capital, a national mega-city, and the core of the Beijing-Tianjin-Hebei urban cluster, Beijing had a permanent population of 21.832 million by the end of 2024, its economy consistently ranks high nationally, with a 2024 GDP of 4984.31 billion yuan. The tertiary sector accounts for 85.3% of GDP (Beijing Municipal Bureau of Statistics, 2025). Its information technology sector provides a solid foundation for smart city development. However, the dense concentration of population and economic activity has caused "big city problems". Core urban population density exceeds 23,000 people per square kilometer(Beijing Municipal Bureau of Statistics,2014). Average road network speed during peak hours is below 25 km/h(Beijing Municipal Commission of Transport,2024). The annual average PM2.5 concentration, while reduced to 32 μg/m³ (Beijing Municipal Ecology and Environment Bureau,2025), is still over six times the WHO guideline value. The housing cost-to-income ratio remains chronically high at over 14:1 (E-House Research Institute, 2016). The conflict between resource use, environmental capacity, and urban function is becoming increasingly evident.

Since the launch of "Smart Beijing" in 2011 (Beijing Municipal People's Government, 2012), the city's development has entered the third phase of "integrating innovative solutions to urban development problems". The Beijing-Tianjin-Hebei coordinated development strategy has pushed the regional coordination index up to 139.7 (National Bureau of Statistics, 2025), and the "one-hour transportation circle" is largely in place. Against this backdrop, addressing "urban diseases" through smart city initiatives and integrating them deeply with the Beijing-Tianjin-Hebei coordinated development strategy have become key to improving the capital's efficiency and quality.

This paper focuses on these central issues, proposing a collaborative governance solution based on the "problem identification-cause analysis-dynamic linkage-strategy proposal" framework, using literature analysis, statistical data, and causal relationship diagrams.The research innovates by:

(1) Prioritizing population and mobility management over traditional planning limits;

(2) Establishing an "urban cluster unit" perspective for coordinated governance to promote cross-regional functional dispersal;

(3) Integrating policy and market mechanisms to boost the attractiveness of sub-centers. The study addresses Beijing's local governance needs and provides a replicable governance model for other large Chinese cities.

2. Identification and Analysis of the “Big City Disease”

Beijing's "big city disease" is not a single problem, but a systematic dilemma intertwined with multiple urban characteristics and development contradictions. Its root lies in the imbalance between the super-large population, the superposition of high-intensity functions and the carrying capacity of limited resources and environment, and the lack of regional development coordination.

From the perspective of population, super-large scale and spatial distribution imbalance constitute the core pressure. By the end of 2024, Beijing's resident population far exceeding the standard of mega-cities, which is lower than the historical peak, but still far exceeding the international livable level. This centralization stems from the superposition of Beijing's core functions of politics, culture, international exchanges and scientific and technological innovation as the capital, leading to a continuous influx of population, while the lack of spatial matching of public service resources (such as education and medical care) further aggravates the pressure on the central urban area. The proportion of migrant population is 37.7 per cent (Beijing Municipal Bureau of Statistics, 2024), and the separation of jobs and housing is prominent, which not only increases the traffic load, but also increases the difficulty of equalization of public services.

It is another prominent contradiction that the carrying capacity of resources and environment approaches the limit. Beijing's per capita water resources are only 150 cubic meters, which is less than 1/10 of the national average, and far below the "extreme water shortage" standard (500 cubic meters). Although the water consumption per 10,000 yuan of GDP has reached the lowest in the country (Beijing Water Authority, 2025), population and economic activities The high intensity still makes water resources a rigid constraint. Industrial emissions, motor vehicle exhaust and insufficient regional joint prevention and control together constitute the causes of pollution. The imbalance between supply and demand in the housing market is manifested in the fact that the housing income ratio is higher than 14:1 for a long time. The high housing prices in the core area contrast with the insufficient supporting facilities in the peripheral areas, which intensifies the pressure of social governance.

The over-concentration of functions and the imbalance of regional development further amplify the difficulty of governance. The non-capital functions and core functions carried by Beijing overlap, resulting in scattered resource allocation and limited promotion of core functions. Although the coordinated development strategy of Beijing, Tianjin and Hebei promotes the decongestion of non capital functions, Beijing's "siphon effect" is still stronger than its radiation capacity. In 2024, the total economic volume of Beijing, Tianjin and Hebei will reach 11.5 trillion yuan, and Beijing's GDP will account for more than 43% (Beijing Municipal Bureau of Statistics, 2025). However, the industrial structure dominated by Hebei's secondary industry and Beijing's service economy are not connected enough. The attraction of sub-centers (such as Shijiazhuang, etc.) to population and industry is limited, and effective diversion has not been formed. This lack of regional coordination makes it difficult for Beijing to cure the "big city disease" by adjusting within the administrative boundary alone, highlighting the necessity of cross-regional coordinated governance.

To sum up, Beijing's "big city disease" is a concentrated embodiment of multi-dimensional contradictions such as population size, functional density, resource constraints and regional collaboration, and its governance needs to break through the single city framework and shift to a systematic solution of "smart city + regional collaboration".

3. Beijing's "Big City Disease": Dynamic Interconnections and Key Driving Factors

The emergence and spread of Beijing's "urban diseases" result from the dynamic interplay of factors like population, traffic, and the environment, creating a mutually reinforcing negative feedback loop between them. To understand the core driving mechanisms, it is essential to examine the roots of population congestion, the impacts of regional development imbalance, the formation logic of traffic congestion, and the systemic causes of environmental pollution, all of which contribute to the complex causes of "Big City Disease".

3.1 Causes and Core Drivers of Population Congestion

The fundamental cause of Beijing's excessive population concentration stems from its functional superposition and resource agglomeration effect as the capital. As a national political, cultural, international exchange and scientific and technological innovation center, Beijing has gathered the best public service resources in the country. Top universities such as Tsinghua University and Peking University, and well-known medical institutions such as Union Hospital have formed a strong "magnetic field" and continue to attract population inflows. Although the resident population at the end of 2024 was 21.832 million, a decrease of 26000 from the previous year, achieving negative growth for six consecutive years, and the "14th Five-Year Plan" of Beijing clearly controlled the resident population within 23 million, but the super-large population base and The problem of spatial distribution imbalance is still prominent.

Another driving force behind population concentration is the industry's "siphon effect." With the service sector accounting for 85.3% of its economy, Beijing has fostered the clustered development of high-end industries like information transmission, software, and IT services, creating numerous high-value-added jobs that further enhance its population attraction. This positive cycle of "resources - industries - population" not only drives urban development but also increases the pressure on the central districts, making it a core driver of "Big City Disease".

3.2 Regional Development Imbalance and Population Dispersal Challenges

The imbalance in the development of the Beijing-Tianjin-Hebei region is a deep structural cause of the excessive population concentration in Beijing. From an economic development perspective, in 2024, Beijing's per capita GDP is expected to reach 228,000 RMB, while Hebei's per capita GDP is only about 72,000 RMB (Hebei Provincial Bureau of Statistics, 2024). This vast economic gap creates a one-way population flow pattern from the periphery to the center, leading to a continuous population inflow into Beijing. Although the Beijing-Tianjin-Hebei coordinated development strategy has been underway for years, Beijing's "siphon effect" remains stronger than its regional influence.

The insufficient coordination of regional functions further limits the effectiveness of population dispersal. Beijing's efforts to relocate non-capital functions and Hebei's capacity to absorb them are mismatched. Cities in Hebei, like Shijiazhuang, as potential sub-centers, lag behind Beijing in terms of public services and industrial support capabilities, making it difficult to attract population effectively. This regional development imbalance means that Beijing cannot rely solely on administrative measures

to control its population size. To fundamentally alleviate population pressure, it must improve the comprehensive carrying capacity of surrounding regions and create a "multi-polar support" urban agglomeration structure.

3.3 Traffic Congestion Formation Mechanism and Systemic Connections

Traffic congestion is a concentrated manifestation of the imbalance between population size, urban planning, and infrastructure supply. Beijing now has over 6 million vehicles, while its subway system will have only about 879 kilometers of operational track by early 2025. Although the total length of the rail transit system is planned to reach 1,600 kilometers by 2025, the supply-demand conflict remains highly evident in the short term. In the first half of 2025, the average road traffic index during peak hours in the central urban areas will be 5.64. Although this represents a 6.47% decrease year-on-year and a reduction of 17 days of moderate congestion, and the tidal flow characteristics of traffic are significant (Beijing Municipal Commission of Transport, 2025).

The deep logic of traffic congestion lies in the mismatch between job and housing locations. High-end industries and public services are concentrated in the central urban areas, while the population has spread to the suburbs, creating a spatial pattern of "working in the core area, living in the outskirts." The commuter traffic during peak hours exacerbates road congestion. Meanwhile, although the intercity transportation network in the Beijing-Tianjin-Hebei region has been formed, the efficiency and connectivity of cross-regional commuting are insufficient, failing to effectively reduce traffic pressure on the central areas. As a result, traffic congestion shows a pattern of "local improvement, overall pressure."

3.4 Multidimensional Causes and Feedback Loops of Environmental Pollution

Beijing's environmental issues exhibit a dual characteristic of "air pollution and water scarcity", and the two are systematically linked. From January to May 2025, the average PM2.5 concentration dropped to 29.6μg/m³ (Beijing Municipal Ecology and Environment Bureau, 2025), showing continuous air quality improvement. This progress is attributed to industrial structure adjustments and regional joint prevention and control efforts. However, the regional transmission of air pollution still makes it vulnerable to emissions from surrounding areas, causing fluctuations in the effectiveness of pollution control.

Water scarcity is a more severe and rigid constraint. In 2025, Beijing's per capita water resources will still be below 150 cubic meters, only 5% of the national average and far below the internationally recognized severe water scarcity line of 500 cubic meters (Beijing Water Authority. (2025, February). This extreme shortage results from a combination of insufficient natural resources and an excessively large population—over 20 million people with water demand clashing with limited local water resources and external water supplies. Water scarcity not only limits industrial development but also forces excessive groundwater extraction, worsening ecological degradation and creating a vicious cycle of "water shortage-restricted development-rising governance costs" alongside population and industry.

The systematic characteristics of Beijing's "big city disease" can be presented intuitively through the

dynamic correlation model, which takes the excessive concentration of population as the core driving force and forms a mutually reinforcing feedback loop through three key paths, which aggravates the dilemma of urban governance, as shown in Figure 1.

Path A: Housing Chain Reaction and Social Problems Caused by Population Overcrowding

Path B: Congestion leads to the coordinated deterioration of traffic and environment

Path C: Population crowding increases resource consumption and ecological overload.

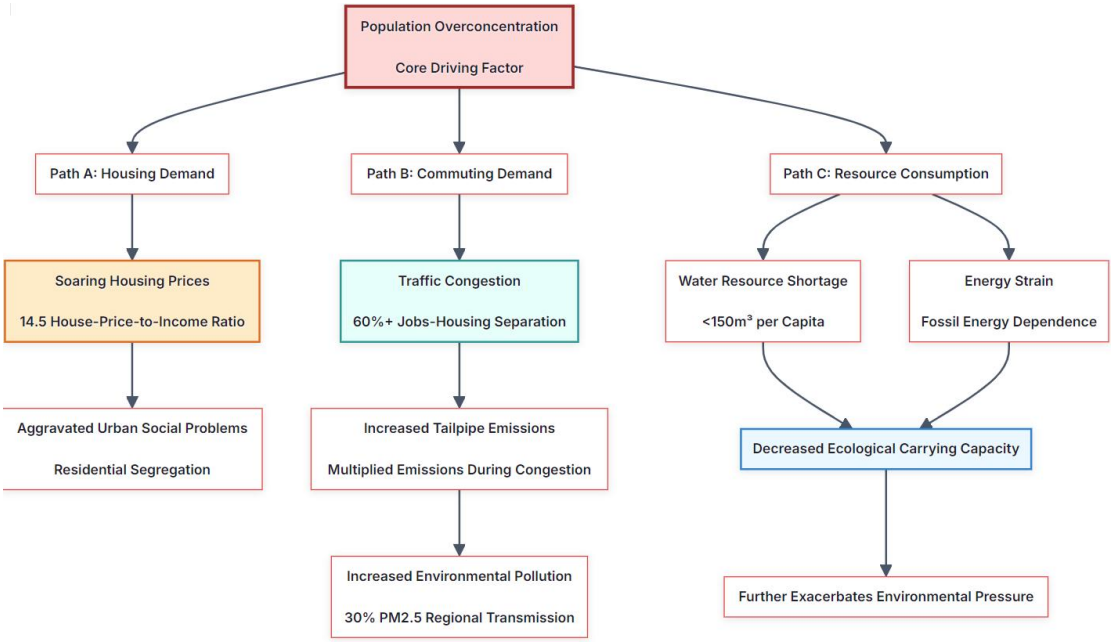

Figure 1. Dynamic Linkage Model of Beijing's "Big City Diseases"

4. Intelligent Governance Pathways

4.1 Typical Models from International Smart City Construction

The practice of addressing "urban diseases" through intelligent means in international metropolises offers multiple references for the coordinated development of the Beijing-Tianjin-Hebei region. The core experience focuses on the coordination between spatial layout optimization and transportation support systems.

The Tokyo metropolitan area adopts a multi-center model driven by rail transit as its core strategy. Through the construction of a high-density rail network totaling 2,710 kilometers (including subways, private railways, and JR lines), Tokyo connects sub-centers such as Shinjuku and Shibuya into a system of complementary urban nodes (Ministry of Land, Infrastructure, Transport and Tourism of Japan, 2024). By relying on the Transit-Oriented Development (TOD) model to balance work and residential distribution, Tokyo keeps the average commuting time at approximately 40 minutes, effectively alleviating pressure on the central city. This provides valuable insights for the Beijing-Tianjin-Hebei region: strengthening the density of the rail transit network especially around sub-centers and border

areas of Hebei is essential to improve the efficiency of cross-regional public transportation.

The Paris Region addresses the issue of functional over-concentration by relocating industries and equalizing public services. It has planned the La Défense Business District to absorb financial and corporate headquarters, and, through the "Paris Region Master Plan",has relocated administrative and industrial functions. Simultaneously, high-quality education and healthcare resources have been developed in new cities such as Marne-la-Vallée, thereby reducing dependence on the central city. This offers an important lesson for the Beijing-Tianjin-Hebei region in relieving non-capital functions: it is essential to improve public service levels in Hebei's undertaking areas and enhance their attractiveness for population settlement.

Shanghai's "one core and multiple sub-centers" spatial structure is also instructive for developing an integrated transportation model. Sub-centers such as the Hongqiao Business District and Zhangjiang Science City have clearly defined functions and are connected via city and intercity railways to surrounding cities such as Suzhou and Jiaxing, thus facilitating the flow of resources in the Yangtze River Delta. This suggests that, Beijing should clarify the functional division of these areas and strengthen cross-regional transportation connectivity.

4.2 The Intelligent Governance Path of the Coordinated Development of Beijing-Tianjin-Hebei

Base on both domestic and international experience, the Beijing-Tianjin-Hebei region needs to build an intelligent collaborative system across three dimensions: population, transportation, and industry.

Smart population management needs to establish a regional unified population big data platform, integrate household registration, social security, employment and other data in the three places, realize dynamic monitoring of population mobility and job-residence matching analysis, promote mutual recognition of residence permits and cross-regional sharing of public services, and guide the population to distribute reasonably with functional relief.

The core of intelligent transportation development lies in building a "Beijing-Tianjin-Hebei on the Track" system. This includes accelerating the operation of intercity railways such as the Jingxiong and Jingtang lines, developing a cross-regional traffic perception network, enabling traffic forecasting and intelligent scheduling through big data.

Smart industrial collaboration should follow development framework to support the intelligent upgrading of industrial parks. This includes building an industrial Internet platform to promote integration across the three industrial chains, breaking down administrative barriers through data sharing, and enabling the precise alignment of Beijing's technological innovation resources with the manufacturing capacities of Tianjin and Hebei, as shown in Figure 2.

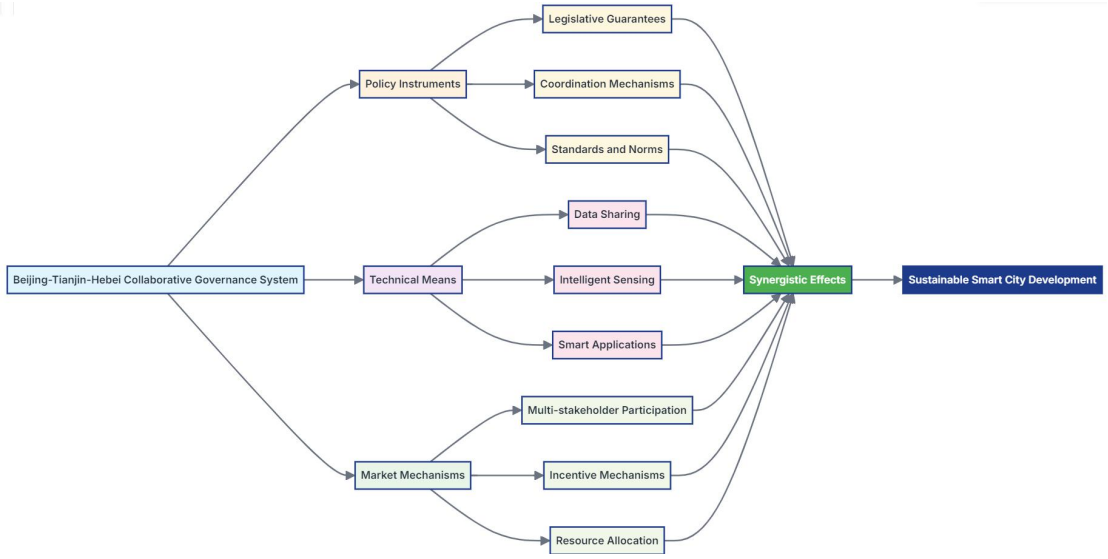

Figure 2. Integrated Policy Instruments and Market Mechanisms Framework

In summary, intelligent governance in the Beijing-Tianjin-Hebei region should be driven by the dual engines of spatial coordination and technological empowerment. By integrating international experience with local practices, the region can build a cross-regional collaborative innovation system to support the development of a world-class urban agglomeration.

5. Conclusion

This study investigates the underlying mechanisms of Beijing's "Big City Disease" and proposes a smart, cross-regional governance framework under the Beijing-Tianjin-Hebei integration strategy. Utilizing a "problem identification–cause analysis–dynamic linkage–strategy proposal" approach, the research reveals a reinforcing feedback loop among population pressure, traffic congestion, and environmental degradation. Its core contribution lies in constructing an intelligent governance model focused on population regulation, transit-oriented spatial coordination, and regional industrial synergy.

Compared with international cases such as Tokyo's multi-core rail-driven structure and Paris's functionally dispersed development, this study identifies distinct constraints in Beijing's context. These include insufficient public service capacity in surrounding regions, industrial mismatches, and weak integration between policy and market mechanisms, all of which limit the effectiveness of sub-center development and regional dispersal. While the overall governance direction aligns with global practices, this study uniquely adapts smart city principles to China's institutional and spatial realities, offering a localized and operable model.

By grounding international concepts in domestic governance conditions, the study provides practical strategies for managing mega-city challenges and serves as a reference for other large urban regions in China undergoing similar transformations.

Acknowledgement

The paper was financially supported by the Beijing International studies University (Project ID: KYZX24A007) and Beijing Association of Higher Education (Project ID:MS2024422) Research Project.

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