Original Paper

Potential Issues and Countermeasures in the Development of Tianjin as a "Smart City"

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Abstract

This paper focuses on Tianjin Municipality, employing a combination of empirical and normative analysis to systematically examine its current development status and potential challenges in areas such as population growth, economic agglomeration, and public service provision. By analyzing government statistical bulletins, population censuses, and policy documents, the research identifies core challenges including an aging population structure, insufficient industrial innovation momentum, and uneven public service distribution. It subsequently proposes countermeasures oriented toward smart city development. The paper emphasizes that advancing urban smartification is an essential pathway for realizing Tianjin's strategic positioning. It delves into the critical role of smart cities in alleviating population pressures, optimizing industrial structures, and enhancing public service efficiency, aiming to provide academic insights and practical foundations for Tianjin's high-quality development and modernized governance.

Keywords

Tianjin, smart city, population structure, economic agglomeration, public services

1. Introduction

With the deepening of global urbanization and revolutionary breakthroughs in information technology, smart cities have emerged as a vital paradigm for advancing modern urban governance and sustainable development. Against this macro backdrop, Tianjin—a traditional economic hub in northern China and a key national strategic zone—faces multiple challenges including profound demographic shifts, pressure to transform economic drivers, and imbalances between public service supply and demand. Simultaneously, the national designation of Tianjin as a "National Advanced Manufacturing and R&D Base," "Northern China's Core International Shipping Hub," "Financial Innovation Operation Demonstration Zone," and "Pioneering Zone for Reform and Opening-up" demands that the city explore

high-quality development pathways within this new environment. Therefore, researching how to systematically address these structural challenges through smart city development is not only crucial for Tianjin's own transformation but also holds significant reference value for the modern governance of similar cities.

This paper focuses on Tianjin's current realities and potential issues across three dimensions: population growth, economic agglomeration, and public service provision. It aims to deeply analyze the inherent contradictions and development bottlenecks, proposing an integrated response strategy centered on smart city concepts. The core question addressed is: Can and how can smart city development help Tianjin effectively alleviate population pressure, optimize industrial structure, and enhance public service efficiency—thereby breaking through development bottlenecks and realizing its urban positioning?

2. Population Structure Changes and Challenges in Tianjin

2.1 Slowing Permanent Resident Growth and Concerns Over Human Capital

Population scale directly impacts urban ecological environments and underpins economic and social development. Comparing data from the Sixth National Population Census (2010) and the Seventh National Population Census (2020), Tianjin's permanent resident population reached 13.866 million in 2020. This represents an increase of 927,800 people (7.17%) over the 12.9382 million recorded in the 2010 census, with an average annual growth rate of 0.69%. As illustrated in the bar chart below, Tianjin's permanent resident population grew by 2.4765 million between 2010 and 2015. Population growth peaked particularly between 2015 and 2016 before beginning to slow. Following 2019, the permanent resident population showed a significant decline, decreasing by 23.66% by 2023—an average annual reduction of approximately 4.22%.
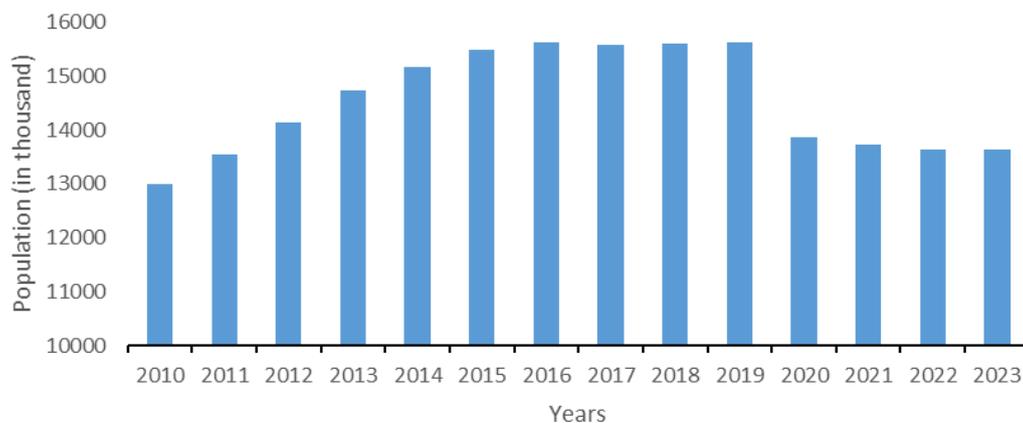
Figure 1. Trends in Permanent Population from 2010 to 2023

The root cause lies in Tianjin's sharp economic slowdown. Once ranked third nationally after Beijing and Shanghai, Tianjin's GDP fell out of the top ten in 2020, slipping to eleventh place. Its year-on-year GDP growth rate has consistently lagged far behind both the national average and the median growth rate of

China's new first-tier cities. While GDP is not the sole measure of urban development, it significantly impacts residents' quality of life and perceptions of Tianjin's future prospects, contributing to the city's diminished population appeal.

From a population economics perspective, sluggish population growth will weaken the accumulation of human capital in the city, constraining sustained and healthy economic development. Therefore, enhancing population attractiveness and driving population growth have become critical issues for Tianjin's future development.

2.2 Deepening Population Aging and Increasing Social Burden

Since China entered an aging society in 2000, its population aging issue has drawn attention from numerous scholars both domestically and internationally. Tianjin ranks among China's earliest cities to enter this demographic transition. Census data reveals that Tianjin's population distribution is as follows: 13.47% aged 0–14, 64.87% aged 15–59, 21.66% aged 60 and above, and 14.75% aged 65 and above. According to the United Nations' classification criteria for aging, when the proportion of a country or region's population aged 65 and above reaches 14%, it signifies that the country or region has entered a deeply aged society. Based on this criterion, Tianjin has crossed the 14% threshold and entered a deeply aged society [11].

Compared with the 2010 Sixth National Population Census, Tianjin's 2020 population saw a 3.67 percentage point increase in the 0-14 age group, a 12.31 percentage point decrease in the 15-59 age group, an 8.64 percentage point increase in the 60 and above age group, and a 6.23 percentage point increase in the 65 and above age group.

Compared to the previous decade, the increase in the proportion of those aged 65 and above accelerated by 4.97 percentage points, reflecting Tianjin's accelerating aging process. The growing share of the elderly aged 65 and above is heightening the challenges Tianjin faces in addressing aging [12].

As the aging process progresses, the old-age dependency ratio is also rising, placing an increasingly heavy burden on the younger generation for eldercare. Families must allocate more wealth to support the elderly, while the government must provide greater resources for eldercare [7]. Beyond altering income distribution patterns and increasing societal burdens, shifts within Tianjin's age structure may also lead to unmet labor demands in emerging industries and high-tech enterprises, driving up labor costs. Despite implementing delayed retirement policies, older workers' slower adaptation to new technologies compared to younger employees reduces efficiency in product development and technological innovation, hindering labor productivity growth. Under these circumstances, how Tianjin's various sectors respond to the aging wave will have differing impacts on potential economic growth and other aspects.

2.3 Population Policy Considerations in the Context of Smart Cities

The theory of secular stagnation suggests that slow population growth and aging may trap economic growth persistently below its potential rate, leading to economic shocks [11].

To address challenges posed by demographic shifts, Tianjin should leverage smart city development to

implement the following strategies:

In the short term, promote "secondary human resource development" by enhancing vocational skills training for older workers and retirees to improve labor force quality. Leverage smart employment service platforms to achieve precise human resource matching and extend the service lifecycle of top talent.

Long-term, optimize the education system structure by universalizing senior high school education and improving basic education quality; encourage universities to deepen industry-academia-research collaboration [15] and build high-level applied universities; expand vocational education scale and promote school-enterprise collaborative talent cultivation to foster high-caliber scientific researchers and skilled professionals for socioeconomic development.

3. Current Status, Potential Issues, and Countermeasures for Economic Agglomeration in Tianjin

3.1 Enhanced Economic Agglomeration and Rapid Development of High-End Industries

In 2006, the State Council approved Binhai New Area as a national comprehensive reform pilot zone. Binhai New Area officially became a new economic growth pole driving regional development, following the Shenzhen Special Economic Zone and Shanghai Pudong New Area.

Currently, Tianjin Binhai New Area has evolved into one of northern China's largest advanced manufacturing bases and strategic emerging industry hubs. To address issues of industrial dispersion and homogeneity, Tianjin adopted a supply chain mindset starting in 2018, shifting from isolated operations to clustered development. By defining leading industries and focusing on sectors like intelligent technology, medical devices, and new energy, it has established a diversified "1+3+4" industrial cluster [5]. In 2020, the added value of strategic emerging industries grew by 4.4%, outpacing the growth of above-scale industrial enterprises by 2.8 percentage points, with their contribution to the total industrial output reaching 26.1%.

Following the formation of industrial clusters, Binhai New Area prioritized industrial restructuring throughout the 13th Five-Year Plan period, with continuous industrial transformation and upgrading. By 2020, the tertiary sector surpassed the secondary sector to become the largest industry in Binhai New Area [8]. Tianjin Phytium and Tianjin Kylin, with their independently developed Phytium CPU and Kylin operating system, are leading enterprises in Binhai New Area's smart economy. The area has attracted over 1,000 enterprises in the new-generation information technology sector, collectively building a hub for this industry and supporting the development of Tianjin's smart city initiatives.

3.2 Regional Strength Deficiencies and Lack of Small and Medium-Sized Enterprises

In 2021, Tianjin ranked near the bottom nationally in both GDP and year-on-year GDP growth rates, placing last among China's four directly administered municipalities. Historically, due to its proximity to Beijing and the absence of distinctive competitive advantages, Tianjin has been dominated by state-owned enterprises and heavy chemical industries. The scale and number of private enterprises remain relatively small, hindering economic restructuring and institutional reforms under the market

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economy. This has impacted the growth of social wealth and the equitable distribution of development benefits among the populace.

Despite significant efforts by the Binhai New Area to foster emerging industries—including attracting high-end startups and building ecosystems for large enterprises [20] —its comprehensive strength still lags considerably behind hubs like Beijing's Zhongguancun and Shanghai's Pudong. In 2019, strategic emerging industries in Tianjin accounted for a low proportion of industrial output value from enterprises above designated size. No Tianjin-based companies were included in the 2020 China Top 100 Strategic Emerging Industries list. Tianjin's PCT international patent applications fell below 1,000 in 2019. Both the scale and quality of Tianjin's strategic emerging industries require further enhancement.

3.3 Structural Imbalances in Innovation and Entrepreneurship Factors

Tianjin faces shortcomings in high-end talent, technology finance, and innovation platforms. Premium educational resources are skewed toward Beijing, resulting in insufficient reserves of high-end talent. Technology enterprises lack strong core competitiveness, and there is a scarcity of internationally oriented, multidisciplinary innovation talent. Financial capital provides limited support for technological innovation, and there is a lack of globally influential innovation platforms.

4. Optimization of Public Service Provision and Smart Governance in Tianjin

4.1 Current Status of Tianjin's Public Service System Development

The Tianjin municipal government places high priority on developing its public service system. The "14th Five-Year Plan for Establishing Tianjin's Basic Public Service Standards System," issued in 2021, established 94 basic public service standards centered on the "Seven Guarantees" objectives and outlined 40 key tasks. Tianjin has continuously increased fiscal investment in public services, steadily enhancing the level of inclusive and fundamental livelihood infrastructure.

4.2 Potential Issues in Public Service Provision

In recent years, while the social benefits of public service provision in Tianjin have improved, the city still faces structural challenges stemming from insufficient endogenous momentum. On one hand, the provision of public services relies excessively on a single entity—the government—making it difficult to effectively respond to residents' growing demand for diversified, high-quality services. On the other hand, although coverage for some public services has reached a basic level of guarantee, their quality and operational efficiency still fall short of public expectations, reflecting a lag in shifting from a "supply-oriented" to a "demand-oriented" approach. Specifically, in the realm of public infrastructure, despite near-universal coverage, issues such as inconsistent service quality and weak emergency response capabilities remain prominent. Regarding the allocation of educational resources, significant urban-rural disparities persist, with urban areas still far surpassing rural regions in resource investment and development levels for both general and vocational education. This highlights that mechanisms for equalizing public services have yet to be fully established.

5. Smart City Development Drives High-Quality Urban Growth

5.1 Smart Aging Care Addresses Deepening Population Aging

In recent years, Tianjin's smart elderly care initiatives have demonstrated robust development momentum. Existing "Internet Plus Elderly Care" practices in Tianjin include: the Hedong District Senior Care Center, the Binhai New Area Smart Elderly Care Demonstration Zone, and the Lemon Tree Elderly Care Model in the Development Zone. Among these, the Hedong District Senior Care Center has established a regional elderly care system. The Binhai New Area Smart Elderly Care Demonstration Project stands as one of Tianjin's distinctive smart elderly care initiatives, achieving personalized care services. It has been featured in media outlets such as the official government website and Xinhua News Agency.

Compared to other provinces and municipalities, Tianjin's smart elderly care industry excels in its emphasis on engaging social entities. The Binhai New Area care base, for instance, delivers services through capital investment. Additionally, Tianjin has introduced collaborative entities from Japan, Germany, Singapore, and other regions, with elderly care projects operated by external social forces.

Tianjin should leverage these strengths by fully utilizing social capital and forces in practical implementation. The government should enhance top-level design for smart elderly care, centralize management of various enterprises, and ensure rigorous oversight. Given the current lack of a scientific quality assessment system for smart elderly care services in Tianjin, establishing a unified public service data development and integration platform is crucial—while ensuring data security—to scientifically evaluate and supervise enterprises' smart elderly care outcomes through deep integration and analysis of elderly care big data.

5.2 Smart Port Development Enhances Regional Competitiveness

As a domain of multi-industry clustering and government-enterprise collaboration under government intervention and market leadership, the smart industrial economy serves as a pillar for information exchange and innovation in smart city development.

In Tianjin's latest Master Plan for Territorial Space, the city is focused on building a "One City, Two Centers" development model. "Jincheng" thrives on canal transportation, while "Bincheng" develops through maritime resources. Consequently, 'Jincheng' prioritizes modern services and advanced manufacturing, with "Internet+ Collaborative Manufacturing" forming a comprehensive service center befitting its status as a modern metropolis. "Bincheng," now the Binhai New Area, maintains its position as China's third-largest smart port, integrating port, industry, and city to become a regional innovation engine.

As a national advanced manufacturing base, the core area for international shipping in northern China, and a demonstration zone for financial innovation and operations, Tianjin can leverage the shipping advantages of Tianjin Port in the smart industrial economy sector. It will attract traditional enterprises to upgrade and transform through encouraging policies. Simultaneously, it prioritizes smart port development by advancing automated terminal construction to enhance port capacity; deepening integration of new technologies like internet, big data, and AI across port operations to foster a

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harmonious port ecosystem; strengthening regional connectivity through logistics; and driving industrial growth via port smart manufacturing. As a government-guided, enterprise-led public-private partnership, the smart port initiative stands as a flagship project in Tianjin's smart city journey.

5.3 Smart Transformation of Public Services

In 2015, Tianjin launched a three-year action plan for smart city development, laying out a digital social service system covering both urban and rural areas. By the end of 2021, the Tianjin Municipal People's Government issued the "Tianjin Smart City Development Plan for the 14th Five-Year Plan Period." These top-level designs only outline final construction goals, lacking specific requirements and evaluation metrics for each sub-sector.

In public service sectors affecting people's livelihoods, the Tianjin municipal government should fully incorporate public feedback to holistically plan the framework, key tasks, and evaluation system for smart public service development, striving to narrow the urban-rural service gap. Simultaneously, it should actively promote multi-stakeholder participation and leverage public-private partnerships—such as jointly developing smart apps and advancing applications like smart lampposts and intelligent manhole covers—to enhance the intelligence of infrastructure and public services.

For smart public service development, the digitization of infrastructure and smart devices forms the foundation. To elevate the level of smart public service construction, it is essential to establish underlying data channels, aggregating and connecting data from various aspects of urban operation, governance, and services—including public services—to create a distinctive, integrated database for Tianjin. The government must recognize that whether in e-government, big data governance, smart communities, or smart facility construction, data connectivity is a means to an end—the core lies in data application and development. The critical function of a public service system database is to put data to use. Therefore, it is essential to establish a comprehensive data analysis system and governance framework based on strengthened integration and sharing of foundational information resources across departments. Enhanced data sharing and collaboration will enable data to serve the enhancement of public service capabilities and urban governance efficiency, ultimately driving regional economic development in Tianjin.

6. Conclusion

Smart city development represents a strategic pathway for Tianjin to overcome current development bottlenecks and achieve high-quality growth. Facing multiple challenges—including an accelerating aging population, insufficient economic growth momentum, and imbalances between public service supply and demand—Tianjin urgently needs to undertake systematic digital transformation. This involves deeply integrating next-generation information technologies into core scenarios of economic development and public services.

In the demographic sphere, leveraging smart platforms to advance "secondary human resource development" enables precise matching and skill enhancement for older workers. Concurrently, an

intelligent education system optimizes talent cultivation structures, accumulating human capital for the city's sustained growth. Economically, smart ports and intelligent manufacturing serve as breakthrough points to accelerate industrial clustering and capacity upgrades. This cultivates the core competitiveness of the "1+3+4" modern industrial system, propelling Tianjin's transformation from a traditional manufacturing base to an innovation hub. In public services, establishing city-level data hubs and intelligent governance platforms will overcome structural challenges such as single-provider systems, low efficiency, and urban-rural disparities, achieving a profound shift from "supply-oriented" to "demand-oriented" service delivery.

Through the systematic application of new technologies and methodologies, Tianjin can establish a virtuous cycle mechanism that balances population pressure management, economic vitality stimulation, and service efficiency enhancement. This approach not only addresses current structural challenges in urban development but also fundamentally strengthens the city's comprehensive governance capabilities and sustainable competitiveness. It provides robust support for Tianjin to fulfill its positioning as "one base and three zones" and build itself into a modern international metropolis.

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