The Public Finance Coordination Mechanism in the Construction of Smart Cities in the Guangdong-Hong Kong-Macau Great Bay Area

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Abstract. The Guangdong-Hong Kong-Macau Greater Bay Area (GBA) achieves the goal of integration and sustainable development of all regions through the creation of comprehensive smart cities. Leveraging the smart city effect plays a crucial role in the development of the GBA. However, the key to creating a good smart city in each region lies in whether the region's public finance system can be effectively utilised to achieve the fundamental objective of promoting smart city development through the key role of digital technology for governance, infrastructure and innovation. This study examines findings on local development disparities in the GBA and their impact on infrastructure, public services, and industrial innovation, and proposes measures to improve cross-regional fiscal coordination. The measures are developed through case studies and policy comparisons, with a focus on Shenzhen's intelligent transport. Recommendations include the establishment of a joint municipal financing mechanism, the promotion of inter-city co-operation, and the enhancement of private sector participation through a public-private partnership model. The paper highlights the importance of establishing institutionalised fiscal relations to ensure the building of equitable and efficient smart cities in the GBA.

Keywords: smart city, public finance, coordination mechanism, Greater Bay Area

1. Introduction

The Guangdong-Hong Kong-Macau Greater Bay Area (GBA) is one of China's most ambitious national development initiatives, with the goal of transforming an 11-city cluster into a world-class bay area economy. With a combined Gross Domestic Product (GDP) of more than $2 trillion and a population of over 86 million, the GBA is envisioned as a centre for innovation, finance, trade, and sophisticated urban government [1]. This idea revolves around the creation of "smart cities"—urban environments that use digital technologies to improve service delivery, environmental sustainability, economic competitiveness, and quality of life.

Smart city development reflects a global shift towards data-driven decision-making, interconnected infrastructure, and citizen-centered governance. Cities around the world, from Singapore to Amsterdam, have used smart techniques to optimise resource use, reduce emissions, and improve public service efficiency [2, 3]. Since 2013, China's State Council has prioritised smart

city development, with pilot programs in over 300 cities. In this context, the GBA stands out for its economic potential and variety, but it also faces great difficulties in integrating financial, technical and institutional resources from outside the municipalities.

Public finance is the basis on which smart cities are created. It funds the infrastructure that enables digital transformation, such as broadband networks, sensors, data centres, and mobile platforms. It also helps to modernise public services, such as e-health, smart education, and e-governance platforms. However, smart city development is not distributed equitably across the GBA. Major cities such as Shenzhen and Guangzhou have abundant budgetary resources and institutional capabilities to plan and implement complex smart initiatives. In contrast, smaller towns such as Zhaoqing, Jiangmen, and Zhongshan frequently struggle to fund even the most basic levels of smart infrastructure [4].

This budgetary disparity has led to uneven development trajectories, fragmented innovation ecosystems, and ineffective regional planning. Furthermore, despite policy frameworks such as the GBA's 2019 Outline Development Plan, city-level financial coordination remains restricted. Municipalities frequently compete rather than collaborate, which reduces overall regional competitiveness. This leads to an important research direction, which is how to co-ordinate public funding for the purpose of promoting the balanced, efficient and inclusive development of smart cities in the GBA.

Although there is significant research on smart city design, governance models, and digital infrastructure, less attention has been dedicated to the intergovernmental fiscal mechanisms required to promote cross-regional smart city growth [3, 5]. This paper tackles that issue by looking at how public finance is currently organised within the GBA and proposing new coordination mechanisms to better align fiscal policies with regional smart city goals. It focuses on three interrelated domains: infrastructure investment, public service delivery, and industry innovation. This paper provides insights into accelerating the development of the GBA as a global smart city region through case studies and comparative research, using Shenzhen as the main case study analysis.

2. Overview of the Greater Bay Area

The GBA encompasses nine cities in Guangdong Province—Guangzhou, Shenzhen, Zhuhai, Foshan, Huizhou, Dongguan, Zhongshan, Jiangmen, and Zhaoqing—as well as the Special Administrative Regions of Hong Kong and Macau. As a national strategic project, the GBA aims to boost economic integration, scientific innovation, and worldwide competitiveness by capitalising on the comparative advantages of its constituent cities. These cities differ greatly in terms of economic size, industrial structure, and governance capabilities, resulting in fiscal fragmentation.

According to the 2023 Guangdong Statistical Yearbook, Shenzhen alone accounted for more than 23% of the region's total public budget expenditures in 2022, with a sizable amount allocated to smart transit, artificial intelligence (AI) applications in public services, and industrial digitalisation. In contrast, Zhaoqing's investment in smart infrastructure accounted for less than 1% of the region's total, indicating a significant financing deficit.

GBA's smart city building activities focus on collaborative governance, digital infrastructure development, and innovation-driven growth. Despite the clear objectives of this policy, its implementation varies greatly from one jurisdiction to another due to circumstances such as fragmented financial powers and poor financing channels, leading to unsatisfactory final results. In the absence of a unified coordination system, each city builds its own smart city, which also results in duplication of efforts and wasted funds.

3. Analysis of public finance coordination mechanisms

One of the most critical factors in the development of GBA smart cities is public finance coordination, which is related to balanced development and smooth integration between cities. Given the vastly different focus-development areas and differences in financial distribution among cities, there is a need to establish a collaborative mechanism to pool resources and maximise the impact of the advantages of public finance by leveraging the strengths of each city and complementing each other's strengths. This section focuses on three key areas of public finance coordination: infrastructure, public services and industrial innovation.

3.1. Infrastructure

In creating a smart city, infrastructure is as important as a cornerstone and is fundamental to development. Making full use of the financial capacity and investing in smarter infrastructure to serve the people are the enabler on the road to development. In Shenzhen, for example, the use of 5G networks, self-driving car infrastructure and intelligent traffic management systems to enhance the people's life experience and sense of well-being is even more important to improve transport efficiency. Shenzhen has continuously allocated more than 10 billion yuan between 2018 and 2022 to enhance intelligent upgrades in transport, including but not limited to AI public transport optimisation and integrated transport data platforms [6].

However, it is only a handful of cities that can manage to allocate so much to upgrading their infrastructure; smaller cities such as Huizhou and Jiangmen are not able to sustain upgrading their high-end digital infrastructure due to differences in fiscal revenues. The reason for this discrepancy is not only in the different aspects of development in each city, but also can be traced to the independence of the municipal governments with respect to the budget process and the lack of a regional financing mechanism that can unify the allocation of resources. In contrast, the Yangtze River Delta has implemented a joint regional infrastructure fund supported by the provincial and municipal governments, which helps to jointly coordinate the financing of smart facilities across regions and to better balance the development of municipalities [7].

In order for more cities to develop more efficiently, these successful experiences can be taken into account, and the GBA can use this to establish a regionalised infrastructure coordination platform, and, with the help of this intermediary, oversee and manage the distribution of the smart infrastructure pooled fund to improve efficiency. This fund will be used to support expenditures to serve multiple cities and data-sharing systems that meet the needs of cities to promote connectivity.

3.2. Public services

When it comes to the core of smart cities, there is no escaping the conversation about public services such as healthcare, education and elderly care. Under the guidance of smart cities, smart services such as e-healthcare systems, digital education platforms and smart elderly care have brought more convenience to citizens, and these services not only improve operational efficiency but also promote social inclusion. However, there are still significant differences in the development and delivery of smart public services across cities in the GBA. In Guangzhou, for example, the city has taken the lead in successfully establishing a city-wide smart education system and using financial subsidies to ensure education coverage in suburban and rural areas, thus narrowing the education digital gap and bridging regional inequalities [8]. In contrast, cities such as Zhongshan and

Zhaoqing lack the dedicated funding or institutional infrastructure to implement similar platforms, and therefore can be relatively lacking in education.

This imbalance between cities can lead to unequal access to basic services, exacerbating not only the gap between different cities but also the distance between urban and rural areas. Public services in the areas of education, health care and pensions have a "ripple effect" on regional development. For example, smart education systems improve the mobility of human capital, enabling students in less developed regions to access quality teaching resources within the region, thus promoting balanced development across regions, reducing the incidence of one party dominating the other, and achieving greater equity for ordinary students. E-healthcare platforms can be utilised to provide remote diagnostic and telemedicine services, thereby reducing the burden on urban hospitals and enabling smaller cities or remote rural areas to be integrated into regional healthcare networks. Similarly, smart ageing solutions can reduce the costs of an ageing population and increase labour market flexibility by reducing the burden of care on families in today's ageing society.

Despite these advantages, the independence of financial planning in the GBA remains one of the main challenges to be addressed. Most cities operate their public service systems independently, leading to duplication of platforms, inconsistent quality standards and limited interoperability. To address this issue, the GBA should consider adopting a "shared services model" financed by a regional public service pool, guided by harmonised technical and service standards. This model would achieve resource sharing and cost efficiency while promoting consistency of services across jurisdictions.

Inter-city co-operation can be modelled on measures taken in the Nordic countries, where inter-city co-operation in the areas of education and health has led to increased service coverage and reduced duplication [9]. Similarly, GBA could benefit from the establishment of a smart governance framework for public areas that allows cities to jointly design, procure and manage digital public services. Such an approach would reduce financial redundancy and expand the coverage of smart services across socio-economic and geographical boundaries.

3.3. Industrial innovation

The direction of public finances will also promote the development of industrial innovation, especially in the field of high technology, and whether or not a certain amount of money is invested in incentivising the development of individual enterprises is an important step towards achieving results. Dongguan has successfully used municipal financial resources to incubate more than 7,000 national high-tech enterprises, many of which are involved in the fields of robotics, AI and materials engineering [10].

Despite these achievements, the lack of inter-city collaboration in innovation funding often results in duplication of research and development (R&D) investments and fragmented supply chains. To address this, the GBA could establish a Cross-Boundary Innovation Fund (CBIF) jointly financed by participating cities and guided by a regional innovation board. The CBIF would support joint ventures, shared laboratories, and collaborative innovation clusters. Evidence from the European Union's Horizon 2020 framework suggests that regional innovation ecosystems perform better when co-financed across jurisdictions and aligned with shared industrial priorities [11].

3.4. Case study: Shenzhen's smart transportation system

Shenzhen has emerged as a national benchmark for smart mobility and digital infrastructure. Between 2018 and 2022, the city invested more than 50 billion yuan into smart transportation,

including AI-powered traffic lights, real-time bus dispatching systems, and autonomous vehicle trials [6]. Notably, 100% of Shenzhen's public bus fleet is electric, and the city operates one of the world's most advanced intelligent traffic management platforms.

The success of Shenzhen's smart transportation lies in its integrated funding model. The city uses a "government-led, market-supported" strategy that combines public finance, public-private partnerships (PPP), and innovation funds. At the top-level design, Shenzhen has established a three-dimensional support system of "special fiscal funds + government bonds + special zone legislative guarantees." For five consecutive years, the municipal government has listed smart transportation as a key livelihood project, allocating no less than 3 billion yuan of fiscal budget investment each year, and innovatively issued the country's first "smart transportation special bond." In 2021, it leveraged 12 billion yuan of social capital by issuing 3 billion yuan of project revenue bonds [7]. For example, Shenzhen Metro Line 14 was developed through a PPP model, attracting over 20 billion yuan in private capital [12]. Moreover, the city established a Smart City Development Fund in 2020 to co-finance pilot projects in urban mobility and digital governance.

The model also provides three lessons for other GBA cities to learn from. The first is that it demonstrates the importance of strategic planning and long-term public investment, which other GBA cites also need to focus on. Shenzhen passed the "Regulations on the Promotion of Smart Transportation in the Shenzhen Special Economic Zone," which clearly stipulates that fiscal funds should be tilted towards key technology research, new infrastructure and public service platforms, and established a state-owned enterprise assessment mechanism of "R&D investment is regarded as profit," which promoted state-owned enterprises such as Shenzhen Bus Group to invest 8% of their annual revenue in smart transformation [11]. The second is that market mechanisms can complement public finance without compromising governance, properly utilized to the extent that market mechanisms are positive for cities. Finally, a dedicated institutional platform, such as the Smart Mobility Coordination Office, is needed to co-ordinate stakeholders through an independent platform that is open and transparent, and at the same time serves as a watchdog.

3.5. Policy recommendation

Based on the above analyses, the following policy recommendations can be made to enhance fiscal coordination in the construction of smart cities in the GBA. Firstly, the establishment of a GBA smart city financial coordination platform helps to unify control. The main way to do this is to set up various specialised and independent platforms under the guidance of the provincial or national level, responsible for overseeing the allocation of funds, project monitoring and inter-city coordination of major smart city projects. Secondly, local development could be coordinated through the establishment of a common fund for regional smart infrastructure. The fund should prioritise support for cross-border digital infrastructure such as data centres, 5G corridors and mobile transport platforms. Co-financing by multiple cities could narrow the financial gap. Thirdly, the establishment of an intercity innovation partnership system is essential for urban development. Cities should co-manage innovation funds, share R&D facilities and encourage joint patent applications to avoid duplication and accelerate technology diffusion. Fourthly, there is a need to promote smart governance through the harmonisation of standards. The GBA could try to standardise the digital governance system using common technologies, as well as ethical and security standards, to ensure operability and citizen trust in the implementation of policies. Finally, regional guarantees can be provided through the use of PPP models. Municipalities could also provide collective credit guarantees to encourage more private capital to invest in regional smart city projects, thereby facilitating financial flows.

4. Conclusion

The Guangdong-Hong Kong-Macau Greater Bay Area has achieved these key steps towards regional integration, economic growth and sustainable urbanisation on the flip side of smart city development. This study highlights the critical role of public finance in coordinating the cities of the GBA in an equitable yet efficient manner, further contributing to the implementation of a comprehensive smart city programme. By analysing the fiscal asymmetries, infrastructure investment patterns, public service delivery systems and industrial innovation ecosystems of the cities in the GBA, this paper reveals the disparities in resources and management capabilities that still exist between large cities such as Shenzhen and smaller cities in the GBA such as Zhaoqing. The research findings concluded that the GBA could address these imbalances by establishing a cross-regional financial mechanism. Key recommendations include the establishment of a GBA smart city financing coordination platform, the creation of a regionalised infrastructure fund, the establishment of a system of intercity innovation partner relationships, the promotion of harmonised governance standards, and the use of regionally-guaranteed PPP models. These recommendations focus on how to achieve the goal of promoting balanced development across cities, achieving a one plus one effect, maximising the impact of the public market, and ultimately turning the GBA into a cluster of smarter cities with a more global reach.

Although this study attempts to explore a comprehensive view about the GBA, there are some limitations. The first lies in the fact that this study relies mainly on secondary data and individual case studies, and is unable to explore too closely the dynamics and evolutionary features of fiscal policies and smart city projects in the GBA. At the same time, this study focuses more on fiscal and institutional aspects, and has not yet explored much about other important factors affecting smart cities, such as socio-cultural and environmental aspects. Finally, a comparative analysis of the GBA with other smart city regions around the world could provide more perspectives and ideas for solutions, which were not addressed in this study.

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