

Smart Cities and Economic Growth: Evidence from Singapore

Jiarui Zhang *

Faculty of Humanities and Social Sciences, University of Nottingham Ningbo China, Ningbo, 315100, China

* Corresponding Author Email: Hmyjz25@nottingham.edu.cn

Abstract. With economic development, more and more people choose to live in cities, which brings many problems to cities. The continuous progress of science and technology has led to the emergence of modern information and communication technology and data sharing, and the concept of smart cities has thus emerged. This article combines the definition, goals and impact mechanisms of smart cities, and takes Singapore as an example to analyze the specific impact of the development of smart cities on its economy. Then, according to the definition and goals of smart cities, the article focuses on analyzing the impact mechanisms through which smart cities improve productivity by optimizing resource allocation and industrial structure with big data. Finally, it takes Singapore as an example to analyze the specific impact of the development of smart cities on its economy. Moreover, the growth rates in the fields of technological innovation, information communication, and finance insurance have been even more significant. This demonstrates that the development path of smart cities has a positive impact on Singapore's economy.

Keywords: Smart Cities, Economic Growth, Singapore.

1. Introduction

With the continuous development of the economy, more and more people choose to live in cities, which brings many problems to cities. According to statistics, over half of the world's population now lives in cities and it is predicted that this figure will increase to 68% by 2050. This has led to problems such as insufficient resources, excessive population density and severe environmental pollution in cities. To achieve sustainable development in society, economy and environment, cities need to find a development path that conforms to the times. In recent years, with the continuous development of information technology, integrating information systems into urban planning has become a feasible solution. This article will combine the definition, goals and impact mechanisms of smart cities, and analyze the specific impact of the development of smart cities on the economy of Singapore as an example. Singapore was the first region to start developing smart cities, and since 2006, it has officially launched the Smart Nation initiative and entered the second phase in 2014. Nowadays, Singapore, as the economic center of Southeast Asia and with the potential to become a new technology hub, serves as an ideal case study for a comprehensive analysis of the data on the smart city development process and is highly representative. This research can provide development guidance for regions that are facing economic stagnation and have weak risk-resistance capabilities in the post-pandemic era. Drawing on these insights, other cities around the world can also learn and achieve sustainable development through smart cities.

2. Literature Review

2.1. Theoretical Connotations and Developmental Orientation of Smart Cities

Different scholars have different views on the definition of a smart city, depending on the development level and needs of the respective countries. For instance, Chinese scholars Xu et al. believe that a smart city refers to a city that, through the construction of information technology, simultaneously develops its technological capabilities and enhances the construction of humanistic and educational environments. This ultimately enables the city to evolve into a self-regulating and sustainable system [1]. However, foreign scholars Bhagya et al. defined smart cities as an urban

environment that utilizes information and communication technologies and other related technologies to enhance the operational efficiency of conventional cities and provide quality services to urban residents [2]. They mainly focused on how to intelligently support urban operations with the least human intervention. The differences in definitions between China and foreign countries reflect the varying stages of development and governance needs of different countries. In this article's research, a smart city refers to a development model that integrates new-generation information technologies with urban construction, achieving the best urban operational efficiency through intelligent computing and analysis, and benefiting the people.

Compared with traditional cities, the main difference of smart cities lies in the rational urban planning with advanced technologies and the management of resources with Internet of Things technology. In terms of urban planning, various geographic information collection and analysis technologies, including GIS technology, are used to make a unified plan for the entire city's three-dimensional structure. According to Zhu, such re-planning—encompassing underground geological conditions and pipelines, above-ground traffic, buildings and vegetation, as well as indoor facilities and population distribution—can optimize the allocation of spatial resources [3]. In 2011, Wuhan City completed three models of framework, current situation and underground pipelines covering an area of 8,494 square kilometers, 525 square kilometers and over 400 square kilometers respectively. This enabled the integrated management of the three-dimensional model of the above-ground and underground. Furthermore, the Internet of Things technology is the core technology that supports the construction of smart cities. By connecting various facilities and equipment in the city, it enables information perception, data interaction, and intelligent management. Currently, the Internet of Things technology is widely applied in multiple important fields such as intelligent transportation, smart security, and energy distribution. The Internet of Things and cloud computing have enabled the transformation of traditional industrial parks, where a smart management center coordinates the development and resource allocation of enterprises within the park. Data analysis of the real-time status of different types of road networks, such as route distribution and passenger flow, assists the traffic management department in implementing timely management [4].

A smart city is a development direction that cities must adopt at this stage in order to address their problems when they have reached a certain stage of development. In a smart city, the interaction patterns among city residents, enterprises and the government have changed. The city operates more efficiently, intelligently and conveniently, thereby improving the quality of production and life for enterprises and residents in the city. Xu Smart cities aim to achieve three goals: First, complete interconnection of the internal entities and resource elements of the city. Second, deep computing and intelligence of the city. Third, sustainable innovation centered on people [5]. In summary, it is necessary to achieve intelligent and sustainable development in terms of economy, society, and ecology [1].

2.2. Economic Impact Mechanism of Smart Cities

The impact of smart city development on the economy mainly lies in two aspects: productivity improvement and optimization of the industrial structure.

The enhancement of total factor productivity in smart cities mainly manifests in three aspects: first, the productivity effect; second, the economies of scale effect; and third, the effect of resource allocation [6]. Firstly, in terms of production efficiency, digital technologies are used to restructure the industrial collaboration processes and build industrial internet and supply chain collaboration platforms. This breaks down the information barriers among the upstream and downstream of the industrial chain, enabling real-time sharing of data such as R&D design, production manufacturing, logistics distribution, and market demand. Secondly, with respect to economies of scale, smart cities promote the shared utilization of intelligent facilities such as transportation, energy, and communication, attract related industries to cluster within the city. This attracts talents, reduces transaction costs, promotes technological collaboration, and lowers the prices of individual products and services. Finally, in terms of resource allocation, smart cities leverage big data and the Internet

of Things, real-time data collection is carried out in areas like production and consumption, and through intelligent analysis, dynamic resource allocation is achieved. For instance, large shopping malls determine the quantity of goods to purchase based on dynamic monitoring of inventory levels and customer demands, achieving "zero inventory". At the same time, the government uses data monitoring to guide resources to efficient sectors and improve resource utilization.

Smart cities not only promote the efficient development of the primary and secondary industries, but also facilitate the transformation of these industries into the tertiary sector. Machines have replaced a large number of workers in simple manufacturing industries. This has led to an increase in the development of less substitutable mental labor. A large number of laborers have flocked to the tertiary industry, significantly increasing the number of innovative talents. For the development of the tertiary industry, the increase in creative talents can effectively promote the transformation of the tertiary industry towards a knowledge-intensive and technology-intensive model, and enhance the value added of the industry. Secondly, the development of smart cities has promoted the formation of industrial clusters. The sharing of common infrastructure and the breaking down of information barriers have significantly lowered the threshold for the development of the tertiary industry. Driven by interests, innovative service industries have developed rapidly. This has promoted the optimization of the urban industrial structure and reduced economic development risks. Zhang et al. demonstrated through regression and analysis that smart cities have a significant enhancing effect on the upgrading of the industrial structure, and that smart cities mainly promote the upgrading of the industrial structure by enhancing the substantive technological progress of the city [7].

3. Case Study

In 2006, the Singaporean government proposed the "Smart Nation Initiative", and accelerated its implementation around 2014. This article collects and analyzes the changes in Singapore's manufacturing industry, service industry, new enterprise registration volume, and economic resilience as of 2014 (as a dividing point), and elaborates on the impact of Singapore's smart city plan on the economy.

The impact of smart cities on manufacturing is reflected in the optimization of resource allocation, which leads to an increase in productivity and a rise in the proportion of high-tech manufacturing. The average annual output value of the manufacturing industry has grown rapidly since 2006. According to statistics, from 2006 to 2014, during the initial stage of the Smart Nation initiative, Singapore's manufacturing industry developed vigorously, with an average annual growth rate of 6.5% in its gross domestic product. Moreover, even after being upgraded to a ten-year plan from 2015 to 2023, it has maintained a stable growth, with an average annual GDP growth rate of 3.2% [8]. Although the pace slowed, the sector is maintained resilience under global economic uncertainties. The Singaporean government's strong support for innovation has also driven the development of its high-tech industry. According to statistics, Singapore's number of innovations centered on capabilities and operations is 2.5 times and 4 times that of Hong Kong respectively [9]. The increase in investment in innovation and the large-scale introduction of innovative talents have led to a growth rate of 7.7% in the electronics manufacturing industry from 0.9%, an average annual growth rate of 9.4% in the biomedical manufacturing industry, and a growth rate of 4.7% in the precision engineering industry [10]. The increase in these manufacturing capacities is attributed to the macro-control of the intelligent core and the application of digital R&D technologies, and it has rapidly increased with the increase in the level of intelligence.

The development of smart cities has led to an increase in the proportion of the tertiary industry. Among the services, the sub-sectors closely related to information technology, such as information communication and finance insurance, have seen a rapid increase in their annual output value growth rate. Firstly, thanks to the widespread adoption of 5G networks and the expansion of data centers, the average annual growth rate of the information communication industry's output value has increased from 5.6% before 2014 to the current 12.8%. Secondly, due to the advancement of fintech and the

widespread adoption of digital payment, the average annual growth rate of the financial and insurance industries reached as high as 7.5% [11]. However, the competitive relationship among various industries led to a significant impact on the retail and wholesale industries from the e-commerce sector, resulting in a decrease in the growth rate from 3.7% before 2014 to 2.6% [12]. By leveraging information technology and massive data, the information communication industry and the financial insurance industry have gradually become the main driving forces for the growth of Singapore's service sector.

The development of smart cities has driven the wave of technological entrepreneurship, bringing new vitality to Singapore's economic growth. Around 2014, both the number of new enterprises and their contribution to output value in Singapore saw significant increases. Firstly, the number of enterprises grew by an average of 3.2% annually [13]. The distribution of key industries shifted from the previous 35% share of retail and wholesale to information communication and professional technology service industries accounting for more than half of the new enterprises. Based on the data, it can be observed that the semiconductor industry in Singapore has grown by 2.7 times over the past decade. The growth rate of new enterprises' production value has exceeded that of mature enterprises by nearly double. The innovative driving effect brought about by digital technology has become a decisive factor for the sustainable development of Singapore's economy.

The greatest benefit brought by smart cities is that it has enhanced Singapore's economic resilience. According to statistics, the recovery speed of Singapore's manufacturing and service industries after the 2020 pandemic (with a GDP growth of 10% in 2021) was much faster than that after the 2009 financial crisis (with a GDP growth of 0.18%) [8]. On the demand side, digitalization shifted consumption from offline to online when physical interactions were restricted, thereby sustaining the economic chain. On the supply side, cloud computing and remote collaboration tools enable manufacturing and services to be operated remotely. At the same time, big data predicts demand fluctuations, enhances supply chain transparency, and reduces the risk of disruptions.

4. Conclusion

Smart cities are the inevitable path for future urban development. They mainly achieve this by optimizing resource allocation to enhance manufacturing productivity and by attracting human resources into the tertiary industry through substitution effects, thereby facilitating industrial structure transformation. Moreover, currently, the most significant factor is the reduction in production costs brought about by the shared use of information and communication facilities, as well as the breaking down of information barriers between industries due to the sharing of big data. As a pioneer in the development of smart cities, Singapore has attracted a large number of domestic and foreign technology companies to invest and settle down by virtue of its early intelligent development. The resulting large number of technology clusters have attracted a large number of innovative talents and promoted Singapore's economic development. This has already formed a positive feedback loop for the economy and continues to benefit Singapore. However, Singapore still faces problems such as resource scarcity, severe population aging, and a small land area with high urban density. Firstly, in response to the situation of scarce resources, Singapore should leverage its status as a major global port to enhance its foreign trade transactions with other countries. At the same time, it is essential to utilize cloud computing to further optimize and recycle domestic resources. For these specific scarce resources, the Singaporean government should increase investment in research and development for resource allocation to create distinctive systems specifically tailored for these resources. Secondly, in response to the issue of population aging, Singapore has been focusing on enhancing preferential treatment for international students to attract a large number of talents. But more importantly, efforts should be made to develop machines to fill the labor gaps in the primary and secondary industries and to improve the national pension system. Finally, in response to the issues of Singapore's small land area and high urban density, the Singapore government can utilize technologies such as GIS to assist in reasonable land reclamation and focus on rebuilding the urban structure of Singapore and

integrating it with intelligent facilities. The development of smart cities is in its infancy, and there is still a long way to go. Not only Singapore, but also all countries and cities around the world should actively invest in the research and development of new technologies and gradually evolve into a new era of smart cities dominated by digitalization.

References

- [1] Xu Qingrui, Wu Zhiyan, Chen Litian. The Vision and Architecture of Smart Cities (Doctoral dissertation), 2012.
- [2] Silva, B. N., Khan, M., Han, K. Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities. *Sustainable cities and society*, 2018, 38: 697-713.
- [3] Zhu Qing. Three-dimensional GIS and Its Application in Smart Cities. *Journal of Geospatial Information Science*, 2014, 16 (2), 151-157.
- [4] Sun Zhongya, Zhen Feng. Review of Research and Planning Practices in Smart Cities. *Planners*, 2013, 2: 32-36.
- [5] Xu Yan. (2023). Current Situation of Smart City Development and Related Suggestions. *Sustainable Development*, 13, 1676.
- [6] Xuan Yang, Zhang Wanli. Smart Cities, Economic Agglomeration and Green Total Factor Productivity. *Modern Economic Research*, 2021, 9:12-25.
- [7] Zhang Acheng, Wang Qiao, Wen Yonglin. Smart City Pilot Projects, Technological Progress and Industrial Structure Transformation and Upgrading. *Economic Issues Exploration*, 2022,3:158-175.
- [8] Singapore Department of Statistics. Key Data of Gross Domestic Product in Chained (2015) Dollars, 2025, <https://tablebuilder.singstat.gov.sg/table/TS/M01591>.
- [9] Ang-Tan, R., Ang, S. Understanding the smart city race between Hong Kong and Singapore. *Public Money & Management*, 2022, 42 (4):231–240.
- [10] Singapore Department of Statistics. Index Of Industrial Production by Industry Cluster, 2025, <https://tablebuilder.singstat.gov.sg/table/TS/M355321>.
- [11] Singapore Department of Statistics. Business Receipts Index for Services Industries, 2025, <https://tablebuilder.singstat.gov.sg/table/TS/M602021>.
- [12] Singapore Department of Statistics, Retail Sales Value (Based On 2017=100 Index) – Estimated, 2025, <https://tablebuilder.singstat.gov.sg/table/TS/M601741>.
- [13] Singapore Department of Statistics. Enterprise Landscape by Ownership, 2025, <https://tablebuilder.singstat.gov.sg/table/TS/M601511>.