

Brief Review for Smart Cities of the Planet Research Report

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Smart City Basic Survey and Change Driven Analysis

Research Report

1 Overview of smart cities

New technologies push forward the development of smart cities. In 2008, IBM issued "smart earth", which aims to solve the problems faced in the development of global cities using new technologies. This proposal generated the concept of smart cities and was met with consensus across the world. In China, in 2012, the ministry of housing and urban-rural development proposed the smart city pilot project, marking the beginning of China's official movement on smart city construction. Regarding the definition of a smart city that is most widely accepted in China, Zhen Feng's(2014) article "**the application of big data in smart city studies and urban planning**", published in *International Urban Planning*, mentioned that smart cities are not only a certain field or a simple Informatization method, but rather rely on information technology to promote policies related to the urban social economy, the environment, space, multi-scale interconnection, interoperability and interaction, and the government in all aspects. Smart cities cannot be developed all at once, but should involve a process of continual updates, in which changes in the way society and the city operate are reflected in technology.

In 2008, according to the report "**Super Smart City**"¹, published by Deloitte Touche Tohmatsu Limited, of the more than 1000 smart city building projects in the world, China ranked the most with over 500. The construction of China's smart cities has entered a period of rapid development. In fact, the current smart cities have begun to take shape, and the "sports-style" construction method in the early stage has gradually slowed down. In the course of development, the government has gradually realized that government-based construction lacks sustainability and that smart city construction also requires the power of universities, enterprises and citizens. The government must clarify its role and relationship with other related forces and have them take part through policy guidance to achieve the goal of building a high-quality smart city based on advanced technology and high efficiency.

The challenges and opportunities for the construction of smart cities in China coexist. China is experiencing an unprecedented stage of rapid urbanization. China's cities have

¹ Deloitte, 2018, Super Smart City: Happier Society with Higher Quality.

huge room for development. However, although China's smart city construction is huge, it is still in its infancy, and its service content and operation models are still in the exploration stage.

This smart city research project starts with the overview, development background, history, main driving force, key role and influence of smart cities, and analyses domestic and international cases. We summarized the development characteristics of smart cities globally and in China, combined the characteristics of China's smart city development with the trend of China's urban development, analysed the vision of China's smart city development around 2035, and explored the potential opportunities in smart city development for **Hitachi** to clarify business entry opportunity points.

2 Smart City International Case Study

2.1 Smart city development background

Professor Shen Zhenjiang from Kanazawa University in Japan interviewed the China Urban Planning Network in May 2015. He took Japan as an example to analyse the development of smart cities. He pointed out that Japan began to promote the application of spatial information systems in the 1970s (Shen, 2015). By the 1990s, Japan's spatial information regulations were basically completed, and the foundation for smart cities was well established. In the 2000s, the government began GIS related to urban space. Statistical data have been used by universities and scholars for research. After 2010, under the all-around support of data, technology, and law, smart cities began to develop explosively.

It is generally believed that the model of beginning to construct smart cities was the European Union's launching of the Living Lab in Europe in 2006. Living Lab launched the European Smart City Network and proposed to be user-centred to help residents use information technology and mobile application services to improve their quality of life and solve social problems. In 2008, IBM released IBM's "Smart Earth, Next Generation Leadership Agenda" in New York, USA, proposing a smart earth concept of "making a new generation of information technology fully used in various industries." In 2010, IBM officially presented a smart city vision to the world. The smart city macrosystem involves six core areas: people and organizations, government, transportation, communications, water and energy (Caragliu, et al., 2016).

There is currently no clear definition of the concept of a smart city. However, as shown in Table 1, countries have arrived at a certain consensus (IBM, 2010).

Table 1 Definition of a smart city in different countries (Wang et al., 2018)

Country/Area	Definition	Consensus
Europe	<p>Smart city is an advanced city that concentrates on high technology; in cities, ICT connects people, information and various parts of the city to create a sustainable, green, competitive and innovative city with high quality of life;</p> <p>Whether a city is smart depends on that environment of human resources, as well as traditional (transport), modern (information and communication technology) exchange infrastructure investment can accelerate sustainable economic growth, improve the quality of life, promote intelligent management of resources, and promote city governance participation.</p> <p>Smart City is a city that gathers highly educated, knowledge-based work and innovative activities.</p>	<p>1. Based on information and communication technology</p> <p>2. The core of applied technology is to improve people's quality of life;</p> <p>3. Applications include human resources, government governance, resource and environment, mobility (transportation and communications), and serve specific policy objectives including resource optimization, sustainable development, and improved quality of life.</p>
US	<p>Smart cities optimize the utilization of electricity, transportation, and other systems by applying sensing and information dissemination technologies to urban infrastructure to improve the quality of life</p>	
Singapore	<p>Smart city refers to the application of ICT in real-time analysis at a community, city, regional or national scale to promote sustainable economic development.</p>	
Japan	<p>Japan has a theory for smart cities called “environmentally” related city. which believes that the true meaning of smart cities is to apply information and communication technology (ICT) in infrastructure and living facilities to improve efficiency and build a city that makes residents feel more convenient and comfortable</p>	

2.2 The main driving force for the development of smart cities

Population and energy are two major, common problems for cities today but are also the initial reason for the development of smart cities around the world. Different countries have also proposed their original intention of developing a smart city based on their own national conditions and the actual problems they face in development (Hong Kong Central Policy Unit, 2015). For example, the reasons for the development of smart cities in Japan are the country's high urban population density, aging infrastructure, and tight resources. The reason for Singapore's development of smart cities is that the land area is small, and it is plagued by a shortage of resources and the ageing of the population.

ICT technology is the basic support system for smart cities. It is integrated in different departments to achieve transparency and efficiency. It can be used to improve power usage and distribution, ensure a 24/7 water supply, improve mobility through traffic management, enhance automatic monitoring and security systems, and provide Wi-Fi-powered open spaces and homes for businesses. The spatial scope and application areas that ICT can integrate are basically infinite and comprehensive, and the results of its implementation largely depend on the reasons driving the country and the city to build a smart city, as well as the available budget.

The main ways of developing smart cities include top-down and bottom-up types. The top-down development approach represents a strong government-led role and a relatively complete macro top-level design. The government is in charge of policy formulation, financial support, and other aspects and cooperates with universities, enterprises and non-governmental organizations to jointly develop smart cities. London, United Kingdom and Seoul, South Korea belong to this type of smart city. The bottom-up development mode means that enterprises have a relatively strong information technology foundation. Universities have research advantages, and civil organizations have a strong will to solve social development problems. These roles are more self-organizing and autonomous, and the government plays roles such as coordination and organization. New York, United States and Amsterdam, Netherlands are bottom-up smart cities.

2.3 Main areas of smart cities

Based on the concept of the smart city wheel, we summarized the development trends from 7 areas:

Smart government: Make full use of new-generation information technologies, such as the Internet, cloud computing, big data analysis, and mobile Internet, to strengthen the platform structure of government agencies and realize the refinement, intelligence, and

socialization of government management of public services. For example, the Chief Information Officer (CIO) in Seoul, South Korea is responsible for policy planning and promotion of information services and dealing with issues related to information systems (Seoul Program Management Office, 2016). Based on digital technology, the UK has initiated the transformation of internal governance, focusing on users such as citizens to optimize government business processes.

Smart transportation: The earliest development area of global smart cities. In recent years, the transportation field has mainly focused on traffic model analysis, route optimization and driverless vehicles. For example, Singapore developed a public shuttle bus that automatically identifies transport needs, and Seoul combined big data with the operation of night-time buses to improve night transportation.

Smart security: Global attention is on a wide range of areas, including aging care, student supervision, and urban management (police, fire, environmental sanitation, etc.). Smart cities aim to guarantee urban security by establishing medical research centres and urban smart control centres. Many cities in China are also paying attention to this area.

Smart education: In the field of education (education management, teaching, and scientific research), modern information technology is used to promote the process of education reform and development. In addition, smart education also involves the education of smart cities, emphasizing that citizens become smart users of the city. For example, London conducts smart city training to compensate for citizens' technical shortcomings; the Singapore government launched an extensive open online course on data science to promote the development of talent in this field.

Smart life: Most cities adopt the concept of public participation, and enterprises provide a solution to the strategic plan. The enterprises try to pursue a more convenient, more comfortable and more environmentally friendly life in cities. For example, the Smart Screen City 24/7 programme in New York, USA, converts old payphone kiosks into a Smart Screen with touch audio and video functions so that the public can access information at any time (IHS Market Technology, 2018).

Smart environment: Most governments and enterprises cooperate to propose smart environmental solutions, improve the urban environment through innovative technologies, and adjust the smartness of urban infrastructure to combat climate change and propose renewable energy research and development. It is also the most important area to study in order to solve current urban problems. For example, New York built a smart waste treatment system based on underground pneumatic tubes.

Smart economy: Mainly focus on creating a smart platform. By preferential policies and government investment, enterprises are encouraged to develop smart and innovative solutions for citizens and to improve the urban environment so that the city is driven by the economy. For example, London launched the Smart London Innovation Challenge to provide affordable, ultra-high-speed broadband for SMEs, showcase investment opportunities, and attract global technology and creative talent.

2.4 The key role of smart city development

In smart city development, there are different important roles for cities. These can be summarized into the following three types: (1) the citizen as the main body; (2) public-private cooperation; and (3) government-led (Hong Kong Central Policy Unit, 2015).

The citizen as the main body:

The development of smart cities starts with citizens, which means their opinions are very important. For example, the Amsterdam City Government has established a smart city platform, and the citizens spontaneously propose solutions that are practised by enterprises and managed by the government.

Public-private cooperation:

Governments and companies work in partnership, providing enterprises with key technologies and smart city programmes. The citizens will provide feedback. For example, Japan is a pioneer country in private enterprises and promotes smart cities through the market. Private enterprises, including Toyota, Matsushita Electric, Hitachi, Toshiba Group, and Mitsui Real Estate, all enhance the development of smart cities. For example, Matsushita Electric's sustainable smart city built in Teng-ze City, Toyota's smart low-carbon demonstration community built in Toyota, and the Bai-ye Smart City built by Mitsui.

Government-led:

The construction of smart cities has the government at its core and the government manages the overall planning and layout. Enterprises and universities cooperate with each other. For example, Singapore's government is proposing development strategies and plans to integrate the resources of all parties and promote the development of smart cities.

2.5 Smart city impact and effectiveness

2.5.1 McKinsey Report

McKinsey & Company (MGI), a management consulting firm, announced the slogan "Smart city: digital technology create a liveable home". The quality of life of urban residents has been improved after adopting the smart city programme, and the city could save

energy, reduce the cost of living and increase the performance of residents and other aspects more substantially (McKinsey Global Institute, 2018).

Specifically, in terms of smart transportation, the development of smart cities can shorten the daily commuting time and reduce the anxiety caused by commuting. In terms of smart security, the city's medical care level has been greatly improved, and medical difficulties and daily medical care for residents have been greatly improved. In terms of the smart environment, smart cities could provide a cleaner and more sustainable environment; in the field of smart life, smart cities have created a new type of digital city community that strengthens the social connections of residents. In terms of the smart economy, although smart city technology cannot create or eliminate jobs in large numbers, it can improve the efficiency in seeking the job.

2.5.2 International smart cities impact and effectiveness

In a previous study, we investigated four smart cities and three cases at a country scale to understand the development status and main areas of concern of smart cities. The four cities' common features are the combination of the application of ICT technology and the establishment of the data platform. Under the mode of cooperation between government departments, enterprises, universities and the public, the city adapts and grows continuously, reaching certain achievements in application in different areas.

3. Overview of the development of smart cities in China

3.1 The background of the development of China's smart city

Overall, the development of China's smart cities is driven by the four dimensions of politics, economy, society and technology. **At the political level**, China has incorporated the construction of smart cities into its national strategy. On August 27, 2014, the National Development and Reform Commission, the Ministry of Industry and Information Technology, the Ministry of Science and Technology, the Ministry of Public Security, the Ministry of Finance, the Ministry of Land and Resources, the Ministry of Housing and Urban-Rural Development, and the Ministry of Transport issued eight ministries and commissions to promote "Guidance on promoting healthy development of smart cities"². **At the economic level**, the primary task of China's current economic development is to

² http://www.ndrc.gov.cn/gzdt/201408/t20140829_624003.html

optimize and upgrade the economic structure, from factor-driven and investment-driven to innovation-driven. China's GDP growth rate has started to fall since 2012, stopping the high-speed growth of approximately 10% per year over the past 30 years, and the Chinese economy has shown a "new normal" pattern. **At the social level**, the continuous advancement of urbanization brings more challenges and pressures to urban planning, construction, management and development. China's urbanization rate exceeded 50% in 2011. In 2016, China's urbanization rate reached 57.3%, which is a solid foundation for developing smart cities. **At the technical level**, with the rapid development of China's information industry, Narrow Band Internet of Things (NB-IoT), 5G, big data, artificial intelligence, blockchain, smart city platform and OS are providing an important technical impetus.

3.2 The main driving force for the development of smart cities in China (country and cities)

First, we selected the cities as the research object of this report. Combining the existing smart city evaluation indicators with the actual situation of each smart city's development, we select five first-class evaluation indicators: economic level, environment, infrastructure, technological innovation, and talent reserve, and use the principal component analysis and entropy method to evaluate. Comprehensive analysis was conducted in 10 cities, such as Shanghai and Beijing, to identify key factors affecting the construction of smart cities. The results show that there are many factors affecting the construction of smart cities. Among them, economic strength, talent support and technological innovation ability are important factors; Beijing, Shanghai, Guangzhou, Shenzhen and Hangzhou have achieved remarkable results (Zhang and Sheng, 2018). In addition, Xiong'an New District is an important policy-driven city in the country and would build a future smart model city. Therefore, we select six cities: Beijing, Shanghai, Guangzhou, Shenzhen, Hangzhou and Xiong'an.

Second, the combined study of countries and cities illustrates the main driving force for developing smart cities in China. National policy is the most important reason for promoting the development of smart cities in China. By combining the factors of different cities' economic levels, infrastructure and talent reserves, the speed and sequence of smart city development are determined. In terms of policy, China has incorporated the Smart City Initiative into its national strategy. There are complete policies to promote the development of smart cities, including national policies, ministry policies and local policies, to ensure the development of smart cities. Under these circumstances, smart city pilots

began to appear. The smart city pilots launched in 2012 and reached 686 in 8 categories (as of the end of March 2015), with considerable influence and representativeness³.

Beijing - Based on the status of capital city, policy-led⁴. Beijing is the capital city of China. It has been a symbolic city in terms of economics, politics and culture. As the political centre of the country, the society is stable, and its policy-led strategy is clear. The construction of Beijing's smart city is mainly the result of policy promotion, but the introduction of the policy is based on Beijing's status in terms of economy, transportation and talent.

Shenzhen - an innovative pilot city, policy boost⁵. The development of smart cities in Shenzhen benefits from high-quality geographical location and policy support. Shenzhen has become one of the first pilot cities in the country and has quickly established a leading position in the fields of Internet popularization and the digital economy.

Shanghai - The economic foundation determines the development of smart cities⁶. Based on its status in relation to the national economy and its position as a financial centre, Shanghai's smart city development is based on policy promotion, so that the Internet can better serve the development of the economy and society.

Hangzhou-National Policy promotes the development of leading Internet companies and promotes the construction of smart cities⁷. The rapid development of the economy, with the opportunity for major summits in Hangzhou, has driven smart city development under the policy-driven and technical support of China's top Internet company – Alibaba. Smart city development in Hangzhou has been relatively rapid recently.

Guangzhou - high-tech enterprises gather, market-led⁸. Guangzhou has strong economic strength and a relatively complete information infrastructure. At the same time, the Internet industry and sensor companies and other computer-related industries, such as RFID chip and card reader companies, satellite positioning and navigation companies, have been quite massive and well developed in Guangzhou. According to incomplete statistics, there are currently 222 patents related to the Internet in Guangzhou, 141

³ http://www.mohurd.gov.cn/wjfb/201212/t20121204_212182.html
http://www.mohurd.gov.cn/wjfb/201308/t20130805_214634.html
http://www.mohurd.gov.cn/wjfb/201504/t20150410_220653.html

⁴ <http://bj.people.com.cn/>

⁵ <http://www.sz.gov.cn/cn/>

⁶ <http://www.sheitc.sh.gov.cn/>

⁷ <http://finance.people.com.cn>

⁸ <http://finance.people.com.cn>

software copyrights, 10 standards, and 425 patent applications.

Xiong'an – driven by strong policy, based on technology and innovation⁹.

Xiong'an New District is a state-level new district created by the Central Committee of the Communist Party of China and the State Council in April 2017, emphasizing the establishment of a new city. Strong policy support and impetus means that the construction of Xiong'an smart city will be realized efficiently in a short period of time.

3.3 The industrial chain of China's smart cities

There are five components in the smart city industry chain: government, equipment providers, application providers, service providers, and users (Liu, 2018). **(1) Government:** As the initiator and manager of smart city construction, the government plays a decisive role as a leading force in the construction of smart cities. Through system planning and policy formulation, it guides enterprises to participate and extend markets. **(2) Device providers:** Including sensing layer terminal device providers, application layer application device providers, and network layer network device providers. The terminal equipment includes sensing devices such as sensors, RFID chips, and Narrow Band (NB) modules. **(3) Application providers:** including software and content providers, big data/cloud computing platforms, and system integrators. Among them, content providers mainly provide rich content and applications for smart cities, including industry and localized applications, providing customized services for users, product promotion and marketing by service providers and channel partners. **(4) Services Provider:** The service providers include network service providers and operation service providers. The network service providers are mainly data transmission bearer network service providers, including the Internet and communication network, mainly for the three major operators. **(5) The user:** users of smart cities include governments, businesses, and citizens. Through the construction of smart cities, the government can provide services to the public more conveniently, enterprises can further enhance their competitiveness, and urban residents can improve their quality of life.

3.4 Main areas and development characteristics of China's smart cities¹⁰

Smart government: The main content of smart government development is Internet + government affairs. The purpose of development is to simplify the government affairs

⁹ http://www.hcgy.com.cn/news_ct.php?id=2200

¹⁰ <http://www.chinasmartcity.org/>

process and increase the efficiency of processing. Based on the general trend of 2014 to 2019, the initial development of smart government is characterized by the establishment of a comprehensive "e-government" platform. The current development of smart government is to establish a more specific area platform, such as "tax" and "police". The development is towards the refined direction.

Smart Transportation: Smart transportation is mainly concentrated on public transportation. The purpose of smart transportation development is to reduce the congestion of the city and to promote the smooth flow of urban traffic through the "vehicle networking". From the development trend between 2014-2019, we can see that the initial development involves bus payment, bus waiting, public parking, etc. with the goal of reducing the two major problems of public transportation and parking difficulties. In recent years, the application of big data has helped with the management and control of urban traffic, and new technologies, such as driverless vehicles, are also being applied in urban traffic with the goal of improving the efficiency of urban traffic operations and to solve big city problems caused by traffic jams in large cities.

Smart healthcare: Smart healthcare is mainly used to improve medical standards. From the perspective of the development of smart medical care from 2014-2019, the early development of smart medical care is mainly focused on building an online medical platform and increasing the convenience of medical treatment for residents. The development goal of smart medical care in the medium-term is to apply the advanced technology of artificial intelligence to assist with medical diagnosis and improve medical care and scientific precision. The current smart medical care is mainly reflected in the planning and establishment of the medical cloud platform, which enables residents to find early treatment and access to their own personalized treatment plan. The development and progress of smart medical care is faster today, and the specific reason is that Chinese people pay more attention to their own health problems following the elevation of their economic status.

Smart education: Smart education is mainly focused on improving the level of education and reducing the difference in education levels between regions. From the developmental history of smart education from 2014-2019, the developmental characteristics of smart education are mainly the establishment of online educational platforms. China has a vast territory, and the degree of development varies among different regions. There are also differences in education levels between different regions. The establishment of an online platform helps to fill the gaps in education levels between

different regions.

Smart Building: Smart buildings are mainly about making buildings greener. From 2014-2019, the early smart buildings explored the energy-saving technologies of buildings and reduced the daily energy consumption during both the daily use and the construction process. In general, it is developing towards a greener, more convenient daily life.

Smart environment: Environmental protection is an important task for the development of China's cities. After decades of extensive development, effective improvements need to be proposed for air, water, and soil quality. From 2014-2019, the developmental characteristics of the smart environment were focused on the real-time monitoring of various environmental indicators to realize the reasonable use of resources to achieve the goal of a harmonious environment and sustainable development.

Smart economy: At the beginning, the smart economy was mainly for online services launched by banks, such as “e-banking” and “smart banking”. With the progress of technology, such as blockchain, artificial intelligence and other technologies, the smart economy has begun to be applied in finance, investment, risk control, and consulting.

3.5 The key role of China's smart city development

In the development of smart cities in China, different cities have different roles. Therefore, we summarized the roles as belonging to the following three types: government-driven, university-enterprise cooperation types, represented by Beijing; public-private partnerships, represented by Shanghai; and types of development with enterprise-led smart cities, represented by Hangzhou and Shenzhen.

3.5.1 Enterprise-led smart city development

In the development of smart cities, enterprises mainly promote the development direction of smart cities, and the government acts as a guide. For example, **Alibaba** is the leading Internet company in Hangzhou and is building a smart brain for Hangzhou. In terms of smart transportation, Hangzhou City Brain took over the signal lights of 1,300 intersections in 2017, and the video of 4500 roads scattered throughout Hangzhou city in traffic management. The tens of billions of data in public service and other fields have been gathered together to build a complete, dynamic urban traffic network, accurately cope with complex traffic conditions, and finally achieve the optimization of traffic. Shenzhen has the advantages of Internet technology companies such as **Tencent** and **Huawei**, building urban big data centres and smart city operation management centres, building the brains and hubs of smart cities, creating an information open integration environment to support

application system integration and cross-sectoral, cross-domain information sharing coordination for businesses.

3.5.2 Enterprises-government cooperation

Enterprises and the government enter into a partnership. By signing smart city development strategies and contracts, government and enterprises promote the process of smart cities together. For example, in the construction of smart cities, Xiong'an has already settled in 100 cities. It adopts the government's guiding plan and the enterprise to cooperate with the smart construction. Xiong'an New District will build a smart city as the model of the future; Shanghai and Alibaba signed some strategic cooperation, and Shanghai government hopes to level up the city by using the technological capabilities of Alipay to jointly build the "one-hour smart life circle" in the Yangtze River Delta.

3.5.3 Government-driven types of university cooperation

Beijing and Guangzhou mainly rely on political force to drive their smart cities, and there are many colleges and universities in the two cities to cultivate outstanding talents. Two big names in Beijing are Tsinghua University and Peking University. There are Zhongshan, South China Institute of Technology and other outstanding talent reserves in Guangzhou. These institutions provide technology and ideas in line with the development of smart cities and cooperate with the government.

3.6 Impact and effectiveness of China's smart cities

In general, most cities have made progress as smart cities, but improvements in innovation and development planning are still needed.

(1) In terms of technological application, due to favourable policies, China has accumulated certain experience in big data management and application and promoted the development of "Internet+".

(2) In terms of hardware infrastructure, fibre-to-the-home has been widely used in urban areas, and Internet penetration has increased significantly;

(3) In the specific implementation strategy of smart cities, most Chinese cities have formulated overall planning, but due to the lack of specific implementation plans and close cooperation between various departments, the expected results have not been achieved at this time.

4 Summary and discussion

4.1 Summary of the development characteristics of smart cities and China's differences

From the perspective of the development of smart cities, smart cities are the product of the advanced stage of industrialization. Whether it is Germany's "Industry 4.0", the U.S. "Industrial Internet" or Japan's "Social 5.0", it is essentially a continuation or advanced stage of industrialization. However, the problem of coexistence is now that most cities are still in the stage of informatization and digitization and have not yet reached the high-end "smart" stage. In recent years, China's data-related industries have developed rapidly and have high real-time performance. The collected data and the training of algorithms can assist the future intelligent decision-making of urban governance. At the same time, in 2015, the State Council of China issued the **"Made in China 2025"** (2015) plan to build a world manufacturing powerhouse, which also played a role in stimulating the development of smart cities.

From the perspective of the development mode of smart cities, smart cities are mainly divided into top-down and bottom-up modes. For the top-down mode, the government first locates and formulates relevant plans and then cooperates with enterprises, civil organizations, and the public to realize the establishment of the smart city, such as in London, Seoul, South Korea, Beijing, Shanghai, and Shenzhen. This model provides better quality public goods through new technology, solves urban problems, and enhances competitiveness and attractiveness. For bottom-up modes, enterprises and non-government organizations spontaneously cooperate with the government and take the lead in the deployment of related facilities and form a certain cooperation platform, such as in New York, Amsterdam, the Netherlands, Hangzhou, and Shenzhen. This model emphasizes efficiency and quality optimization, providing value-added services that meet higher demands. The top-down model is more like a public product, and the bottom-up model is more like a value-added service.

According to the publicity and value-add of products, the existing smart city service types can be divided into four levels¹¹. (1) **"Infrastructure"** – the most public, mainly government-controlled, data platforms and urban networks; (2) **"General public service"** – strong publicity, while showing certain value-adds, mainly public resources, urban planning and construction, municipal facilities, smart security; (3) **"Derived public**

¹¹ This information is collected by interviewing an expert Wanli Fang in World Bank.

services" - strong value-add, while reflecting a certain degree of publicity, mainly for community services, traffic management, energy use, data sharing, etc.; (4) **"Commercial application and living services"** - the most value-added, mainly for the sharing economy, smart business, smart healthcare, smart homes and so on.

There are four major key roles: government, enterprises, university research institutes and citizens. (1) The government is the manager and guide of smart cities, representing the public interest of society, mainly formulating development orientation, top-level design and comprehensive control. The government participates in all levels of macro-, meso-city and micro-regions; 2) Enterprises are the main providers of smart city platforms, technologies and services, mainly driven by projects, focusing on ICT facilities construction and data collection, platform construction cloud computing, intelligent transformation and scenario application. The enterprise participants in China's smart cities are mainly traditional intelligent integrators, traditional telecom operators, large Internet companies, and real estate developers. (3) University research institutes are participants and promoters of smart city innovation and social innovation. Responsible for standard setting, construction evaluation, innovation research, etc., including universities, institutions and research institutes, etc.; (4) Citizens are the main users of smart cities, helping to provide feedback and evaluate.

Overall, the government decides the priority and speed of development of smart cities. Enterprises decide the scale, quality and type of smart cities. University research institutes determine the innovation of smart city development. Citizens decide the stability and sustainable development of smart cities. However, in western countries, university research institutes and companies have a higher passion for participation and cooperation with each other. In China, the government has a strong leading role, and the enterprises independently communicate with the government, thus promoting fewer cases of policy formulation. In recent years, the participation of enterprises has increased, the effect of the role has gradually increased in recent years, the cooperation between universities and enterprises has also increased, and the participation of citizens has been continuously improved¹².

From the perspective of the operation mode of smart cities, there are currently three main modes of smart cities: **single dominant**, **cooperative** and **multi-participating** (iResearch Inc, 2019). (1) **Single dominant type** directly constructs, maintains, and

¹² This information is collected by interviewing an expert Zhenjiang Shen from Kanazawa University.

operates a smart city in the form of government financial allocation or enterprise funding. The service content and mode are led by the funder. The service enterprise provides services and products as required and as applicable to public infrastructure and basic public needs. The service project is characterized by fast landing speed and strong controllability. (2) **Cooperative** introduction of external capital investment construction, returning to the government or enterprises after a certain period of stable operation, or jointly funded by the government and enterprises for continuous operation, is applicable to a smart city project with operation, characterized by high operational efficiency, it has great potential for value-added operations and a variety of sources of funding. (3) **Multi-participation type** is jointly funded by the government and enterprises, or multiple other parties, to jointly establish a smart city operation company responsible for the daily construction and operation management of smart city projects, applicable to smart communities and park projects involving multiple roles, characterized by strong public participation, multiple sources of funding, and social innovation incubation. Currently, the single dominant market accounts for a larger proportion, followed by the cooperation type, and the multi-participating type accounts for the least. With the shift of smart city services to value-added and the increasing participation of enterprises and universities, in the future, multi-party cooperation is expected to become the main operating mode in developing smart cities.

From the perspective of the industrial chain and specific participants of smart cities, the smart city industry chain is mainly composed of **top-level design, hardware providers, software providers, system integrators, operation service providers and application service providers**. The first three layers are upstream. The industry and the latter three are downstream industries. (1) The participants in top-level design mainly include general contractors, government agencies, design institutes and research institutes; (2) hardware providers mainly include perceptual hardware equipment providers, network transmission equipment providers, display hardware equipment providers, and chip manufacturers, etc.; (3) software providers include application software providers, information service providers, etc.; (4) system integrators are mainly for operating service providers, mainly telecom operators, data operators, and content operators; (5) application service providers mainly include smart government, smart transportation, smart finance, smart building, smart medical care, smart education and the smart environment. Alicloud, Huawei, Jingdong and Tencent have projects in both the upstream and downstream industries, and their internal industry chain has strong integrity.

Judging from the development of various fields in China's smart cities at present, the focus of China's smart development is on informationization, digitization, and platform construction. At the same time, smart transportation, smart government and smart security have achieved certain results. However, a real problem that should not be ignored is that China's industrialization and urbanization are still in progress, and the areas related to the material space of urban entities are still weak, such as smart medical care, smart living, and the smart environment. This was also confirmed in our interview with professor Shen Zhenjiang in March 2019. He highlighted the lack of industrialization and education of China in the construction of physical space (construction of buildings, etc.).

Through the comparison of Chinese and foreign cities, it can be seen that the type of city also determines the development path of smart cities. (1) Beijing and Singapore belong to the political centre-led government. As the political centre of the country, they have the advantages of government coordination and leading promotion; therefore, they have great advantages in the top-level design of smart cities and in the construction of digital platforms. (2) Guangzhou and Chicago belong to the manufacturing industry and trade. The manufacturing industry is strong, and there are many high-tech enterprises and students in their schools. Moreover, they also have advantages in the technical field. (3) Shenzhen and Silicon Valley are the leaders of science and technology innovation, and the proportion of urban youth in these locations is large. With leading enterprises, these locations have great advantages in innovative R&D; (4) Shanghai and New York are commercial and financial centres. As a national economic and financial centres, they have important opportunities for enterprises to promote smart public service; (5) Tianjin and Philadelphia belong to the regional sub-centre independent manufacturing type, as independent cities around the big city, and on the one hand they have a strong manufacturing base, while on the other hand, they have more policy support; (6) Xiong'an New District and Washington, DC are policy-driven types of new district construction, at a country district level, with policy support, planning and design advantages, reflecting planning in advance and the wisdom of building characteristics.

Overall, China's smart cities have achieved massive success in the development process and exposed certain problems. Its primary achievements are mainly reflected in the smart city concept becoming the consensus in the urban planning field, and there are most pilot cities in China. Also, the cities' smart and digital management level are improving quickly, and some leading enterprises are reaching the international leading level in model innovation. The main problems at present are reflected in the importance of urban

management smartness and the ignoring of smart urban construction; the urban smart construction system is not perfect, and there are fragmentation and islanding phenomena; smart city facilities production and spatial city construction cannot match each other. The existing smart city construction model is not affordable enough to contain all four aspects.

4.2 China's smart city development trend

Based on the characteristics of smart cities and China's identification, this study further judges the development trend of China's smart cities and point out three main trends.

First, in terms of urbanization, China's urbanization level is constantly approaching the level of developed countries in East Asia, and the speed of development has gradually transformed from high speed to medium speed. The focus of urban construction has shifted from incremental development to stock development, and people's demand for refined urban governance has increased.

Second, from the perspective of urban development, the development of information technology will change the urban form, type and core competitiveness of smart cities. On the one hand, technology will increasingly change production relations and people's lifestyles, and even subvert the original urban layout and operational mechanisms. For example, self-driving vehicles will affect the urban road network. The Internet will put forward new requirements for urban infrastructure. AR, VR and other technologies will promote the formation of interactive spaces, and new retail will also affect the city's commercial space. On the other hand, the direction of smart city development is highly related to the characteristics of the city itself. The city can even screen the city's occupants by shaping its own characteristics. For example, industrial cities emphasize the improvement of industrial interconnection, and service-oriented cities emphasize the improvement of living quality. University-intensive cities emphasize support for the sharing economy, and shrinking cities emphasize the reshaping of space in the process of urban transformation.

Moreover, smart cities will be applied to more aspects of urban construction and people's lives and can significantly improve urban competitiveness and people's quality of life. For example, smart cities can make public services more convenient, reduce people's living costs, provide quality jobs, create attractive public spaces, and provide more venues for cultural and leisure activities.

Finally, from the perspective of new industries related to smart cities, the industries that are currently developing rapidly are mainly divided into four types. **(1) Communication network infrastructure industry**, responsible for providing mobile communication

technology and optimizing network conditions. Since this industry is a monopoly industry and requires a large amount of technology for capital accumulation, there are fewer investment opportunities. (2) **Hardware equipment manufacturing industry**, responsible for the manufacture of terminal equipment and hardware, has certain requirements on the technology and scale of production of related products and is a capital-intensive industry. Your company has the possibility to enter this industry. (3) **Software and integrated technology provision industry**, providing technical support for smart city related software, and responsible for the integration of cloud platforms. It is a knowledge-intensive, labour-intensive industry, still in a period of rapid development, and still has great development potential. It is difficult for your company to enter this industry, as well as it is difficult to become the leader of this industry. (4) **Consulting services or talent training industry**, responsible for providing new methods of smart city application, comprehensive solutions to related problems, and personnel training services, belonging to knowledge-intensive industries and having a high economic return rate. It is easier for your company to enter this industry and there are many opportunities in the future.

5 Potential opportunities for smart city development

5.1 International vendor participation

At this moment, international manufacturers exert influence in China through various means (iResearch Inc,2019).

(1)**Direct participation method** : International manufacturers are less likely to participate directly in the construction of smart city projects, and more likely to enter smart city construction through consulting research, project incubation, and joint labs. For example, **IBM** provides consulting advice on the construction of the smart city in Foshan. **Microsoft** and the Ministry of Housing and Construction set up a joint lab and established an incubation base with Chengdu.

(2) **Supply chain support and cooperation methods**: By partnering with integrators and platform-based manufacturers to provide smart city-related products and technical support, such as **Cisco** becoming **Tencent's** strategic partner in network solutions, Intel supports the **Ping An** smart medical platform.

(3) **Investment and incubation, indirectly entering the domestic market through investment-related industries and manufacturers**: For example, Intel invested more than \$1.9 billion in China, focusing on smart hardware, the Internet of Things and cloud services.

(4) **Idea innovation:** International manufacturers have rich international experience and broad vision, and they still have influence over the concept of the smart city. For example, IBM's "**Smart Earth**" and "**Cognitive Computing**" have had a deep impact on industry development.

5.2 The combination of smart city and urban construction

Due to the rapid development of Internet companies and greater international competitiveness, China's smart city development is much stronger in terms of informationization, digitization and platform construction, such as smart transportation, smart government, smart security, and smart finance and economy. However, as China's industrialization development and urbanization construction stage have not yet been completed, the areas related to the spatial space of urban entities are weak, such as smart medical care, smart living, smart environment, etc. In addition, there is insufficient industrialization and smart in the construction of urban spatial space. Therefore, according to the current situation of urban development in China, the combination of smart cities and urban construction can be divided into four categories:

(1) The construction of the new district emphasizes the top-level design, smart city industrial planning, urban infrastructure systems, and Internet of Things space platforms; (2) Stock planning and reduction planning emphasize urban, operational efficiency improvement, space quality improvement, refined urban governance, and smart community construction; (3) Local urbanization and new urbanization emphasize urban function reshaping, smart property operation, value-added living services, and smart community construction; (4) The old city district update emphasizes the renovation of old-age communities, the renewal of old buildings, the renewal of old facilities, and the matching of smart hardware.

Reference

- [1] Andrea Caragliu , Chiara Del Bo, & Peter Nijkamp. (2016). Smart Cities in Europe.
- [2] Hong Kong Central Policy Unit. (2015). Smart city report .
- [3] IBM . (2010).IBMs Smarter Cities.
- [4] IHS Market Technology . (2018).US Smart City 2018
- [5] iResearch Inc. (2019.)2019 Report of Development of China's Smart Cities.
<http://www.iresearchchina.com/index.html>
- [6] Liu Y. (2018). Operator development strategy from the perspective of smart city industry

chain. China telecom industry, (02): 75-77.

[7] McKinsey Global Institute. (2018).MGI Report.

[8] Seoul Program Management Office. (2016). Seoul E-government Website .

[9] Shen Z. (2015). Interview with the Smart City of the 17th China Association for Science and Technology Annual Meeting.

[10] The State Department. (2015). Made in China 2025. http://www.gov.cn/zhengce/content/2015-05/19/content_9784.htm

[11] Wang Bo, Qi Feng, &Lu Pei-ying. (2018). The Enlightenment of the US Science and Technology and Future Cities Report on the Construction of Smart Cities in China[J]. Science & Technology Review, 36(18): 30-38.

[12] Zhang N, Sheng W. (2018). Research on the status quo of smart city development based on principal component analysis and entropy method. City journal, 39(03): 30-35.

[13] Zhen F, Qin X. (2014). The application of big data in smart city smart city research and planning. International urban planning, 29(6), 44-50.