Research on Construction of the Smart City

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ABSTRACT

With the continuous improvement of technology, economy and society, the driving force of new generation informatic technologies is able to develop smart applications and establish a new and sustainable city model. This paperexamined the key factors involved in the construction of the smart city projects, evaluated the benefits of construction, and predicted the development trend of the project based on theoretical ideas and documentations issued by the government. The paper found that (1) the smart city project is divided into three major fields and two relatively new concepts: smart government, smart economy, smart society, the new generation of informatics infrastructure, and the development environment of a smart city. (2) The key technologies involved in the construction of the smart city are the Internet of Things, cloud computing, mobile Internet, big data, geo-informatics technology, and artificial intelligence. (3) The construction of the smart city project will bring great benefits, not limited to benefits to investors, but improving citizen's happiness, resolving or mitigating urban problems, promoting economic development and sustainability, and pushing forward the development of related industries and their development. And the findings related the definition and application of the smart city project to its development trend and provided policymakers with effective information to guide the design and construction of their localized smart city project.

Keywords: Smart City, Economy, Sustainability

1. INTRODUCTION

In facing the development of technology and the increasing understanding of the world people live in, people have gradually figured out the most basic daily needs, such as food, water, and electricity. When there are more products and services, people's desires are also expanding. They are no longer limited to addressing their daily physical needs, but looking for ways to improve their living conditions. However, given that there is no such thing as a free lunch, one has to make a trade-off between desire and opportunity cost. Among countless desires, considering the short-term and long-term value it can bring, the smart city project has emerged as one of many choices. Many studies have examined the definition and application of the smart city, but few related those ideas to the development trend. Because the smart city project in cities around the world is still in the theoretical and partially applicable phase, more studies are needed to help local government better determine the general mode and future formation of this project.

In this paper, aiming to provide useful information for investment groups and policymakers when making decisions in designing and constructing their localized smart city project, the paper examined the major factors involved in constructing the smart city project, evaluated the benefits of construction, and predicted the development trend of the project based on theoretical ideas and formal documentation issued by the government. Our findings linked the definition and implementation of the smart city projects to their development trends, providing useful data to policymakers as they plan the design and construction of their own localized smart city projects.

2. THE CONCEPT OF THE SMART CITY

In the past decade, the Internet of things, cloud computing, mobile Internet, big data and other new-generation information technologies have developed rapidly, and the construction and practice of smart cities around the world are also advancing. With the advancement of practice, the concept of a smart city is also evolving, but a unified definition and concept have not been formed all over the world. The concept of the smart city first appeared in the 1990s, when the idea

was to take the new information and communication technology as the necessary infrastructure for a modern city. Sam Palmisano, CEO of IBM, proposed the concept of the smart city that evolved from the smart earth[1]. A Smart city refers to improving the automation and intelligence level of urban planning, construction, management, service, production, and life through the wide use of new generation information technologies.

3. THE THREE MAJOR FIELDS OF THE SMART CITY

Traditionally, cities include three main aspects: politics, economy, and society. As a result, the three main areas of a smart city are smart government, smart economy, and smart society. Combining the two relatively new concepts of informatics infrastructure and urban development environment, a smart city can be further divided into five components: smart government, smart economy, smart society, new generation information infrastructure and the smart city development environment.

3.1. The Smart Government

With the rapid development of new generation information technologies, traditional government affairs are changing from e-government to smart government. The use of the Internet of Things, cloud computing, mobile Internet, artificial intelligence, data mining, and other technologies to improve the intelligence level of government office, supervision, service, and decision-making in order to form an efficient, agile, and convenient new government is referred to as smart government. Compared with traditional e-government, the smart government has the characteristics of thorough perception, rapid response, active service, scientific decision-making and so on.

3.2. The Smart Economy

The carrier of smart economy is smart industry. Smart industry is an industry with a high degree of index, networking, informatization, automation and intelligence. Smart industry is an intelligence intensive industry and technology intensive industry, not a labor-intensive industry. In June 2011, the U.S. government established a priority action plan in four aspects of smart manufacturing, including building an industrial modeling and simulation platform for smart manufacturing, affordable industrial data acquisition and management system, enterprise level integration of business systems, manufacturing plants and suppliers, and education and training of smart manufacturing[2]. In China, several opinions on accelerating the deep integration of information and industrialization were jointly issued by the Ministry of industry and

information technology, the Ministry of science and technology, the Ministry of Finance, the Ministry of Commerce and SASAC regard intelligent development and establishment of modern production system as one of the basic principles to promote the deep integration of informatization and industrialization[3].

3.3. The Smart Society

Intelligent society refers to a highly intelligent society. Smart society mainly includes two aspects: first, the intellectualization of social undertakings, such as smart education, smart medical treatment, smart school, smart hospital; second, the intelligence of citizens' life, such as smart community and smart home. Smart society is an advanced stage of social information development. Building a smart society is an important part of ensuring and improving people's livelihood.

4. THE KEY TECHNOLOGIES OF THE SMART CITY

Internet of things, cloud computing, mobile Internet, big data, spatial information technology and artificial intelligence are the six key technologies of the smart city. By embedding and equipping sensors into buildings and intersections in every corner of the world and in the systems closely related to production and life, such as communication system, power supply system, water supply system and oil and gas pipeline, the Internet of things formed by them can be connected with the Internet, so as to realize the resource data integration of human society and physical system, making a city produce and live in a more refined and dynamic way.

4.1. The Construction of City Information Modeling (CIM)

If we take the smart city as the overall development goal of a city, an essential element is the construction of urban information infrastructure. In general, the construction of urban information infrastructure is based on and Geographic Information System (GIS), integrating wireless sensors, Internet of things, Internet and artificial intelligence, networking, digitization, visualization, and intelligence of all urban resources, in order to achieve a more agile perception and feedback of the city, thereby promoting urban economic transformation, and so on.

4.2. The Smart City System Framework Based on Digital Twin

Based on the construction of urban information infrastructure, we should also build a smart city system framework based on digital twins. Through the digital representation of the elements, processes and actions of

the physical space in the smart city, the adjustment, prediction, diagnosis, monitoring and control of the operation status, performance, activities, digital governance structure, service process and operation intelligent equipment of the physical entity can be realized. Based on the smart city, the physical space can interact with digital virtual platforms in real time to achieve joint optimization and continuous iteration. Therefore, the digital twin smart city architecture can be divided into physical perception layer, interaction layer, middleware layer, and application layer. The physical sensing layer primarily consists of intelligent sensors, micro transceivers, controllers, monitoring equipment, and so on; the interaction layer primarily consists of 5G (6G), Wi-Fi, transmission interface, and so on; the middleware layer primarily consists of resource pool, object pool, data console, and so on; and the application layer primarily consists of application programs, intelligent terminals, visual digital plating, and so on.

4.3. Data Collection and Analysis

With the deepening construction of urban information infrastructure and digital twin smart city architecture, relevant government departments and enterprises will accumulate massive big data resources. Using big data technology to process these data resources, data analysis, data mining and machine learning can further improve the administrative management, and public service level of government departments, the production, operation, and management level of enterprises, turning the massive data generated by smart cities into a great invisible wealth of society.

5. THE BENEFITS OF THE CONSTRUCTION OF THE SMART CITY

Building a smart city has a promising effect on investors. Based on the current construction of comprehensive economic and social benefit evaluation model, the probability of good benefits of the smart city project is 44.64%, and its general probability is 73.62%, indicating an acceptable financial profitability and project risk to the investment body[4].

Building a smart city is an important way to solve or alleviate various "urban diseases", promote urban economic development and social progress, and ensure urban sustainable development. By shaping the public value of the city through the smart city, it can provide citizens with a better urban life. Figure 1 shows that among all indexes, the human service has the most weight followed by citizen experience. The sum of them exceeds 50% while the weight of reform and innovation is minimal, demonstrating the fact that the construction of the smart city has important convenience value for the people[4].
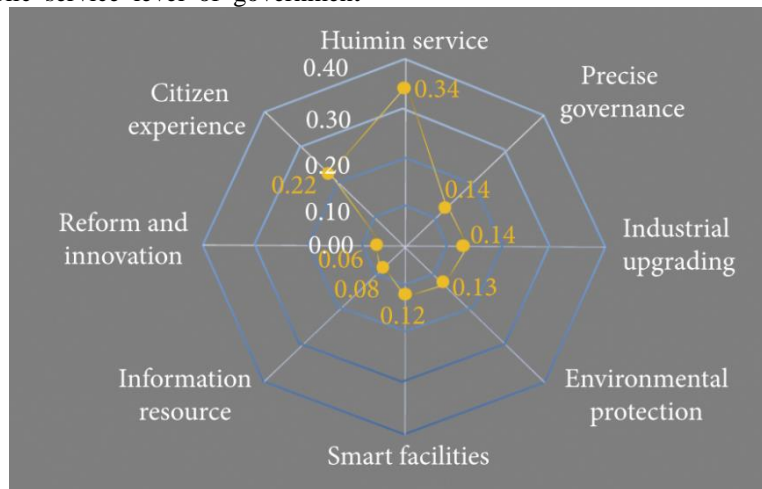

Figure 1. Radar Chart of Index Combination Weight in the Smart City

At the same time, building a smart city can promote the development of related industries and applications. Since the publication of the 12th Five Year Plan in China in 2011, the Internet of things industry related to people's livelihood has witnessed rapid development and growth, such as intelligent security, intelligent transportation, and other segments[5]. The development of the industrial chain provides a positive impetus for the development of the entire smart city, more effectively strengthening and deepening the citizens' sense of happiness for urban life.

6. THE DEVELOPMENT TREND OF THE SMART CITY

According to IDC FutureScape: Worldwide Smart Cities and Communities 2021 Predictions, the investment related to smart cities and smart communities in China will exceed 230 billion yuan, with emphasis on public safety, smart transportation, smart politics, smart environmental protection, smart emergency, and other fields by 2014. By then, 40% of cities will integrate the physical world and the digital

world through technologies such as the Internet of things, artificial intelligence, and digital twins to improve the remote management level of key infrastructure and digital services and enter the IOE era of interconnection of all things[6]. The development potential and challenges of smart cities also coexist. Yang Xueshan, Vice Minister of the Ministry of Industry and Informatics Technology, pointed out that the construction of China's smart city is facing four major challenges: the challenge of information technology; the challenge of improving ability; the challenge of understandings, habits, and systems to adapt to the smart city; the adjusted legal environment[7].

7. CONCLUSION

The smart city is a developing concept and a product of urban informatization to a certain stage. With the continuous improvement of technology, economy, society, and new technologies such as big data, cloud computing, Internet of things, geographic information and mobile Internet, smart applications and a new and sustainable urban model can be established. There are three major fields of the smart city: the smart government, the smart economy, and the smart society. Among these fields, with the help of new technologies and algorithms, the government can execute its function more effectively and efficiently; the smart economy can be based on a more integrated informatic industry; and the society can reach the intellectualization of social undertakings and the improvement of people's living conditions. They key technologies of the smart city include Internet of things, mobile Internet, big data, spatial information technology, and artificial intelligence. The integration of these key technologies and data analysis makes it possible to construct BIM and GIS, achieving CIM and digital-twin-based smart system as the final goal to promote urban economic transformation and development. The construction of the smart city project has great potential: its probability of good benefits is 44.64%, and general probability is 73.62%, guaranteeing an acceptable risk and profitability to the investment body[4]. Its construction can also solve many long-established social problems and therefore improve urban life.

These findings provide useful information for the investment group and policymakers to make decisions in the construction of the smart city project. Meanwhile, our findings offer insights for decision-makers to further consider and develop the major fields and key technologies of the smart city construction and adjust them based on their local situations. There is no single model for the construction of the smart city. What remains constant is that smart cities should use data as the primary resource, design systems around it, encourage the development of new generations of

informatics infrastructure and six key technologies, improve the diverse participation of urban governments, businesses, research institutions, and citizens, collaborate to build an urban innovation ecosystem, and realize the sustainable development of cities. Because this paper is mainly based on theoretical ideas and official documentation issued by government, it has few quantitative analyses. Thus, further researches are needed to add on quantitative analysis.

REFERENCES

[1] Palmisano, S. J. (2010, June). Building a smarter planet, city by city. Retrieved September 27, 2021, from https://www.ibm.com/smarterplanet/us/en/smarter_cities/article/shanghai_keynote.html

[2] President obama launches advanced manufacturing partnership. (2011, June 24). Retrieved September 27, 2021, from https://obamawhitehouse.archives.gov/the-press-office/2011/06/24/president-obama-launches-advanced-manufacturing-partnership

[3] Some Opinions on Accelerating the Deep Integration of Informatization and Industrialization. (2011, April 21). Retrieved September 27, 2021, from http://www.gov.cn/zwgk/2011-04/21/content_1849320.htm

[4] Zhao, Z., & Zhang, Y. (2020, November 10). Impact of smart city planning and construction on economic and social benefits based on big data analysis. Retrieved September 27, 2021. https://www.hindawi.com/journals/complexity/2020/8879132/#copyright

[5] Circular of The State Council on Printing and Distributing the 12th Five-Year Plan for the National Basic Public Service System. (2012, July 19). Retrieved September 27, 2021, from http://www.gov.cn/zhengce/content/2012-07/19/content_7224.htm

[6] Yesner, R., Arcaro, M., Brooks, A., Claps, M., & Wang, G. (2020, October). IDC FutureScape: Worldwide Smart Cities and Communities 2021 Predictions. Retrieved September 27, 2021, from https://www.idc.com/research/viewtoc.jsp?containerId=US45831620

[7] Lu, W. (2012, October 29). Yang Xueshan: Four Major Challenges in the Construction of Smart Cities in China. Retrieved September 27, 2021, from https://china.gov.cn.admin.kyber.vip/jrzg/2012-10/29/content_2253159.htm