SMART CITY DEVELOPMENT IN CHINA: A CASE STUDY OF URBAN MANAGEMENT OF SHANGHAI CITY

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ABSTRACT

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China has the largest number and size of smart cities in the world (Deloitte, 2018b). Relevant agencies formulate plans and conducted public hearings with all sectors. They have also drafted a white paper to serve as a guideline to be applied by cities in order for them to develop as smart cities. Thus, this study of the Chinese experience is beneficial for the development of smart cities in Thailand. This dissertation is aimed at 1) studying previous development of smart cities used by Shanghai City, China, such as background, process, steps and models; 2) studying the success factors, limitations, opportunities, challenges and solution approaches related to the development of Shanghai smart city in China in the past; 3) studying strategies and methods of the government of Shanghai City to promote and push smart city industries; and 4) applying information from the study to develop models of smart cities in Thailand in the future.

Shanghai City was selected for this study because it is a key economic city and was ranked second by the "Science Research Council of China" among "China's TOP 100 smart cities", after Peking. Samples in the research consist of qualified experts and academics in the public and private sectors related to Shanghai Smart City. Key information providers (30 people) were selected through specific random sampling. Semi-structured questionnaires were used by the researcher as a tool to collect data. The researcher used content analysis along with descriptive statistical analysis to analyze qualitative information. Major issues were taken into consideration in line with research objectives. Then, such issues were divided into sub-issues and linked to the arranged data in compliance with a specified conceptual framework. As for quantitative data, statistics and percentage were used by the researcher to analyze the received data. A triangulation technique was also used in this research to analyze both qualitative and

quantitative data.

The development of Shanghai Smart City became obvious in 2011 when the Shanghai Action Plan for Promoting Smart City Construction 2011-2013 was applied to transform it into a Smart City 1.0. In 2014, the Shanghai Action Plan for Promoting Smart City Construction 2014-2016 was put into action to create a livable Shanghai Smart City. In 2018, a three-year plan (2018-2020) was used to change and promote its technology, as well as upgrade the economic level of Shanghai City.

To carry out the strategic plans for developing Shanghai City, there were many limitations, e.g. inadequate cross-functional collaboration among public agencies, difficulties in fund raising, insufficient personnel development mechanisms, and indelicate specific technique standards. However, there exist opportunities for developing Shanghai City, such as central government support, country leaders with vision, new Chinese economic policies, awareness of sustainable city development protocols and outstanding large-scale information technology service providers. Challenges in the development of Shanghai City include insufficient proficiency among agencies responsible for data and digital networks, nontransparent public private partnerships (PPP), lack of personnel and experts, and data network security.

With respect to the strategy for pushing Shanghai City to become a smart city, in the beginning, between 2011 and 2013, the strategy was namely upgrading the information technology infrastructure and providing an outstanding identity, as well as projects stressing pilot projects at the district level. In the current period, strategies have been adjusted by developing them in accordance with plans and lessons learned from previous experience. The central government and local government cooperate in the planning, while the public and private sectors cooperate in development. Cross-organizational collaboration is promoted for sharing, while investment has increased using public policy as a supporting tool.

Smart city development guidelines in Thailand consist of the formulation of clear policies and regulations, design of standard and evaluation, support of public private partnerships, promotion of innovative creativity, development of information technology personnel, development of successful experimental project models, as well as provision of knowledge and understanding, along with public privacy.

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Samita Temphoemphoon

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CHAPTER 1

INTRODUCTION

1.1 Background and Study Concept

The path of urbanization around the world has direction to smart city. Thanks to technological innovations including the adventure of the Internet, big data, IoT, and AI etc. coupled with public policy like Industry 4.0 which advance rural areas to urbanization toward smart city. With respect to the United Nations study, more than half the current global population, or 54%, live in urban areas. It was forecast by the United Nations that the global population in urban areas will increase to 66% of the global population by 2050 (United Nations, 2014).

"Technology" has been created and developed by humans as global citizens. These new technologies appearing all the time have a direct impact on economic development and humans' livelihoods, leading to many changes over the last ten decades. It is evident that the rapid growth of technology enables economic and social development to be flexible and change rapidly, which results in globalization and connectivity among people and organizations, as well as the mobility of capital and development projects of public and private international organizations (capitalization). As a result of this technology growth and connectivity, and mobility of capital and the development projects of public and private organizations, various countries worldwide have rapidly and continuously been urbanized (Khatoun & Zeadally, 2016, pp. 46-57; United Nations, 2014, pp. 2-12) due to the expansion of business and industrial sectors.

However, due to this above-mentioned technology development, public agencies at the central and local levels of many countries have focused on urban design and development in compliance with technology changes and citizens' livelihoods in society, leading to the concept of the "smart city", which is used to manage cities influenced by urbanization. This concept is popular in numerous

countries in the 21st century (Lv et al., 2018, pp. 443-451; Yigitcanlar & Kamruzzaman, 2018, pp. 49-58).

The concept of smart city development is widely used in several countries around the world. One of the reasons is because of rapid and continuous urbanization (Albino, Berardi, & Dangelico, 2015, pp. 3-21; Khatoun & Zeadally, 2016, pp. 46-57; Meijer & Rodríguez-Bolívar, 2015, pp. 392-408; Przeybilovicz, Cunha, Macaya, & Albuquerque, 2018, pp. 2486-2495; Rodríguez-Bolívar, 2015, pp. 1-7; United Nations, 2014, pp. 2-12). Thus, the smart city concept, urban growth and economic and technological changes are unavoidable development issues (Lv et al., 2018, pp. 443-451). It may be stated that due to existing urbanization situations, smartness is necessary and cannot be avoided. With respect to the United Nations study, more than half the current global population, or 54%, live in urban areas. It was forecast by the United Nations that the global population in urban areas will increase to 66% of the global population by 2050 (United Nations, 2014, pp. 1-4). In addition, considering Chinese cases only, urbanization situations have changed and expanded rapidly, as seen by the continuous rising percentage of the population living in urban areas, while people living in rural areas have consistently decreased. In the next ten years, by 2030, the percentage of the population living in urban areas in China will be more than 70% of the total population, as seen in Chart 1, below.

Figure 1.1 Urbanization in China

Left figure: Trend and Percentage of Urbanization in China

Source: SMCSTD, 2016b.

Fig. 1.1 presents clearly that urban areas in China have expanded continuously across the country. Many people have come to make a living in the city areas. Currently, more than half of the China's population lives in urban areas (SMCSTD, 2016a). These conditions lead to the rising of various problems within the cities that policy maker should be concerned such as traffic congestion, crime, and sanitation. Thus, policy makers in China have to find out the solutions to help city to cope with those problems.

The idea of a "smart city" has been proven in many countries around the world as an effective approach to solve several problems occurred in urban areas. Therefore, "smart city" is an unavoidable development method in China where urbanization has increased consistently. Many cities in China have adopted smart city approach as effective tool to administrate their city.

The smart city concept has been developed in China since 2010. After only three years, Chinese public agencies announced the first 90 pilot smart cities. So far, the number of pilot smart cities nationwide has increased to 500 nationwide. The infrastructure investment to serve smart cities is worth more than 1 trillion yuan, or 5 trillion baht. The number and size of smart cities in China is ranked first in the world. Following data collection and domestic situation analysis, public agencies in China

formulated development strategies for each China Smart City in three major directions, namely Intellectual Technology Park, City Safety and Intelligent Transport System, to serve the demands of all smart city components.

To push smart city projects in China, Chinese public agencies set up the China Wisdom City Working Committee (CCIT) as an independent organization. The committee members include qualified experts from public and private sectors, including research institutes and associations. Its major missions include brainstorming ideas from a wide variety of specialists in order to define function pools in five dimensions: Standard Pool, Project Pool, Fund Pool, Technology Pool and Human Resource Pool. In order to support local public agencies to apply smart city principles to the operation, public agencies in China also established the National Standardization General Working Group On Smart City (SMCSTD) to draft "a white paper on China smart city development standards" in order to formulate guidelines, processes and standards, e.g. SO, IEC, ITU, so that smart city development in China is concrete.

Shanghai is a city that has utilized smart city approach to provide public services for its citizen. Information technology (IT) is an important instrument to assist the city to manage in several fields such as smart transportation, smart economy, and big data (SMCSTD, 2016b). One can say that Shanghai is one of the most successful in terms of implementation of smart city approaches in China. Therefore, the researcher pays attention to conduct the research relevant with the development of smart city projects in Shanghai. The results of the study, as a lesson learn, will be applicable for the other cities. Policy makers of other cities are able to applied policy implications suggested by the study to develop their smart city activities. This will bring about to build a better quality of life of their citizen.

1.2 Objectives

This study aims to study the development of Shanghai smart city. The key purposes for this study are:

1.2.1 To examine historical previous developments of the Shanghai Smart City in China, namely the background, process, steps and models.

1.2.2 To investigate the success factors, limitations, opportunities, challenges and solutions concerning previous development of the Shanghai Smart City in China.

1.2.3 To study strategies influenced the development of smart city industries of Shanghai City.

1.3 Research Questions

1.3.1 How Shanghai Smart City has been developed and what processes and models have been made in the Shanghai Smart City's recent development;

1.3.2 What are the key success factors, limitations, opportunities, challenges and solutions to development of the Shanghai Smart City in China;

1.3.3 What are the existing strategies and methods used by Shanghai City to promote and push smart city industries?

1.4 Scope of the Study

This study aims to study smart city development models in China. Shanghai is a successful city in China to implement smart city activities. Thus, the researcher selects Shanghai as the study area.

Due to the content of the study, researcher investigate the factors that are influenced the implementation of the smart city activities of Shanghai. Both key success factors and barriers affecting the operation are examined. The historical of the smart city development and also the strategies adopted by the city are also studied. Several smart city projects such as big data management and smart traffic are investigated.

To receive rigorous data, the persons who work with government agencies, research institute, and private companies are the target informants. All of them are the executive and have also to get involved with the smart city activities implemented at Shanghai. The research investigates the development of Shanghai Smart City from 2010 to 2020 under the Shanghai Smart City development three-year action plan released by the Shanghai municipal government.

1.5 Definitions

Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland, 1983 as cited in World Commission on Environment and Development, 1987)

Smart City is a model of the application of digital technology or information and communication technologies (ICTs) on the internet in order to increase the efficiency and quality of community services, and reduce costs and consumption while enhancing peoples' quality of life (Hamblen, 2015). A smart city also helps to collect peoples' demands regarding the management of infrastructure and public services in the city in order to respond to those demands in a comprehensive and direct manner (Shrestha, Castro, & Smith, 2016).

Public Private Partnership (PPP) refers to an arrangement to let the private sector invest in a public enterprise, or the permission, concession or rights of the private sector to carry out public commercial and social businesses. Such public businesses must belong to the public, state enterprise or other state agencies or local administrative organizations having due authority under the law. Such businesses must provide natural resources or assets to the government agencies, state enterprises, other government agencies or local administrative organizations (Secretariat of the House of Representatives, 2016 as cited in Parliamentary Budget Office, 2016).

Urban Management refers to management of city problems by local authorities who focus on managing important issues demanded by citizens. Local authorities must pay attention to those problems, especially when concerning economic development of that city (Van Dijk, 2006). Government services, including those managing the problems that citizens living in the city are faced with, are integrated to enhance competitiveness and equality, as well as create sustainable development for the cities where citizens live (van Dijk, 2008).

1.6 Expected Benefits

Academic wise, benefits of this study are to understand the development of Shanghai Smart City including the key success factors, limitations, opportunities,

challenges and solutions to development of the Shanghai Smart City in China. It also helps enhance knowledge in smart city implementation in current Thailand context.

Management wise, benefits of this study are the development and improvement of policy framework relating to Thailand's Smart City, as well as the recommendations for practical guidelines to enhance the effectiveness of smart city implementation that conform to the nation's development plans and Thailand 4.0 strategy.

CHAPTER 2

CONCEPTS, THEORIES AND RELVANT LITERATURE

The research on Smart City Development: A Case Study of Urban Management in Shanghai City involves the study of relevant concepts, theories and research in order to formulate guidelines for the study and its methodology, as well as an analysis and discussion of the study results, as follows:

2.1 Sustainable Development Concepts and Theories

2.1.1 Sustainable Development Background

In 1972 the United Nations organized the UN Conference on the Human Environment in Stockholm, Sweden. As a result, sustainable development trends have become a major concept of current social development. Later, in 1983 the United Nations established the World Commission on Environment and Development, or the Brundtland Commission, to study the balanced structure between the environment and development, and to publicize an article entitled “Our Common Future”, which campaigned to make people change their livelihood behavior to be more safe and conscientious toward the environment and more consistent with nature’s limitations. The importance of sustainable development intensified in 1992 when the United Nations held the UN Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil. The UN also signed Agenda 21, which was the master plan for sustainable development for 179 member countries who wished to formulate strategies for sustainable development in terms of economic, social and environmental dimensions in a balanced manner.

Afterwards, in 2002 the United Nations organized the first World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa, where member countries achieved an agreement on Millennium Development Goals (MDGs). In September 2015, the United Nations announced 17 agendas for the 2030 Agenda for

Sustainable Development, which are 17 agendas of the Sustainable Development Goals (SDGs). The member countries must apply the following agendas to their operations to attain these goals from 2015 to 2030.

1) No poverty
2) Zero hunger
3) Good health and well-being
4) Quality education
5) Gender equality
6) Clean water and sanitation
7) Affordable and clean energy
8) Decent work and economic growth
9) Industry, innovation and infrastructure
10) Reduced inequality
11) Sustainable cities and communities
12) Responsible consumption and production
13) Climate change
14) Life below water
15) Life on land
16) Peace and justice strong institutions
17) Partnerships for the goals

2.1.2 Definitions of Sustainable Development

The most widely accepted definition of sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1983 as cited in World Commission on Environment and Development, 1987). In other words, resources must not be used wastefully but conservatively and potentially for the benefit of current generations in terms of their economic, social and ecological aspects.

A Local Agenda 21 Committee was established in Thailand to brainstorm ideas in collaboration with the Thailand Environment Institute to define sustainable development as "sustainable development in the Thai context: a holistic view in all aspects must be considered based on natural resources, local wisdom and Thai culture

through the participation of all groups and respectful generosity to increase self-reliance and equal quality of life".

2.1.3 Main Components of Sustainable Development

John Elkington's concept of "Triple Bottom Line" was presented for the first time in a book called Cannibal with Forks (1997), which explained the relationship of the three main components, namely environmental, economic and social conditions, as well as success goals and organizational values from the point of view of sustainable development.

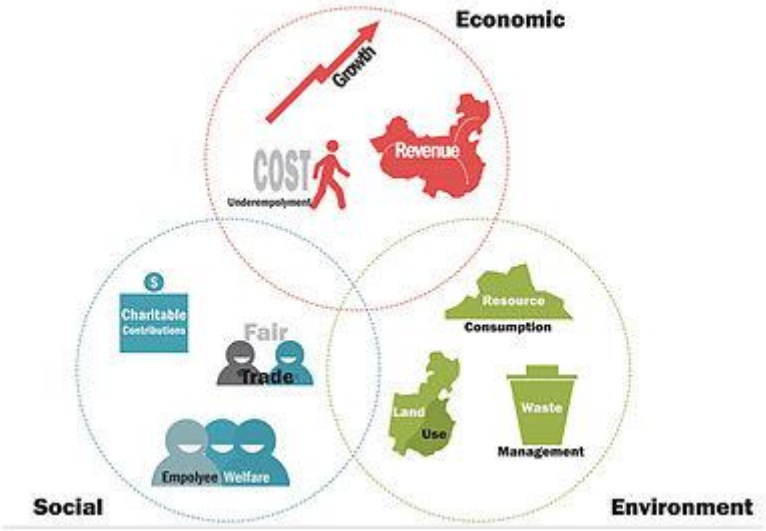

Figure 2.1 Conceptual Framework of Triple Bottom Line
Source: Elkington, 1997.

Triple Bottom Line (TBL) explained that organizations focusing on profits in the past should turn to emphasize people and the planet, or give more importance to the environment, society and the responsibility of its stakeholders. This concept is often linked to the success goals for sustainable development.

The main components used to evaluate the performance of organizational business consist of:

1) Economic – economic returns for organizations, including monetary and non-monetary turnovers that can be counted as economic value.

2) Social – businesses that bring about returns or social benefits, such as better livelihoods, better overall environment related to better social well-being, and decreasing expenses for the people in society.

3) Environmental – businesses concerned about benefits to the environment and natural resources, e.g., land, water, air, including plants, etc.,

However, Triple Bottom Line (TBL) also suggests transparent operation of their businesses with good governance. This can help organizations assess risks and respond to all stakeholders' demands, leading to organizational sustainability.

2.2 Smart City Concept

2.2.1 Background of Smart City

The concept of smart city was initiated during the world economic depression of 2008. During that time, many cities in the United States realized that their cities were in fierce competition with other cities. This had never happened before. Their cities did not compete only with nearby cities, but also with other regional and national cities. Due to the internet and networks serving the world, various cities worldwide competed among themselves. They competed against each other not only for investment and employment but also for the attraction of Y and Z generations. People expected that they would develop new economic strengths for their cities.

A city's interest in terms of smart city lies in the brand or image of the city and its potential for attracting new generations or creative classes because globalization has built a flat Earth. Because of this concept, some people have applied it to industries and products having special characteristics by creating high value so that cities are attractive. In the beginning, jobs are concentrated in small cities.

During the economic crisis of 2008, IBM Company started its work under the concept of smart city as part of work initiated under the name of "Smart Planet". Later, in 2009 this idea attracted thinkers from around the world. IBM Company applied information technology to make cities smarter. IBM's smart city strategies emphasized the analysis and management of data and technology. Analytical Algorithms and Data Processing is necessary to understand a large number of censor data.

2.2.2 Definition of Smart City

Hamblen (2015) defined smart city as an application model of digital technology or information and communication to increase efficiency and quality of community services, reduce costs and lower people's consumption, while increasing the efficiency or better quality of people's lives.

Numerous academics and organizations have defined and explained the definition differently. However, their comments are common in that smart city development stresses smart city development issues using many types of ICT to create smartness in terms of economic, social, transport, environmental and quality of life aspects (Bifulco, Tregua, Amitrano Cristina, & D'Auria, 2016, pp. 132-147; European Parliament, 2014, p. 2628; González & Rossi, 2011, p. 9; Harrison & Donnely, 2011, pp. 1-15; Hollands, 2008, p. 307; Lv et al., 2018, pp. 443-451; Nam & Pardo, 2011, pp. 282–291). Dameri (2013, p. 2545) and Lombardi, Giordano, Farouh, and Yousef (2012, p. 137) have the same opinions and a clear explanation that the "smart city concept was created by the application of technology to solve city problems".

Apart from the explanation of a smart city via the point of view of technology-driven methods, the essence of smart city creation focuses on solutions to social problems based on the participation of all sectors. As can be seen in the suggestion on the definition of "smart city" as explained by the European Parliament (2014: 9), a smart city is a city that tries to seek solutions to public problems through the application of ICT-based solutions on the basis of municipally based partnerships. City smartification is, therefore, not the public sector's responsibility only but also the role of the social sector, academic institutions and other relevant social institutions at the local level to drive policies of concrete city smartification.

Additionally, according to Zhihan Lv, who explained that smart city refers to development of cities initiated by the application of a digital city along with the internet of things (smart city = digital city + internet of things). Lv et al. (2018, pp. 443-451) pointed out that development of electronics operating systems and city internet network systems needs to be stable, and include infrastructure to serve and support digital technology operating systems to link the public and private sector's transactions, as well as people's daily living patterns in cities, which are major factors for city smartness and development.

However, the main goals of smart city development in several countries worldwide are to serve urbanization, develop city service systems to upgrade people's quality of life, and to develop and improve cities to be balanced with the ecosystem in terms of social, economic and environmental aspects. As explained by Doung Washburn, "smart city refers to the application of smart computing technologies to develop major infrastructure, improve city services covering city management, educational and health services, public security, real estate, transport systems and public utility system development to be interconnected and more efficient" (Washburn et al., 2010, p. 2). Thus, a smart city must be a city with potential for applying different types of technologies to develop people's livelihoods, solve the city's public problems and promote economic and industrial development in a balanced and effective manner (Correia & Wünstel, 2011, p. 9; European Parliament, 2014, p. 9; Giffinger, Kramar, & Haindlmaier, 2008; Lee, Hancock, & Hu, 2014, p. 82; Nam & Pardo, 2011, pp. 282–291).

Table 2.1 Definitions of Smart City

Definitions	
Hamblen (2015)	Smart city refers to an application model of digital technology or information and communication to increase the efficiency and quality of community services, as well as to reduce costs and people's consumption and to increase the efficiency so that people can live with better quality of life.
Lv et al. (2018)	City development using the application of different types of ICTs to create economic, social, transport, environmental and quality of life smartness.
Lombardi et al. (2012)	The concept of smart city was initiated by the application of technology to solve city problems.
European Parliament (2014)	Smart city is a city seeking to address public issues via ICT-based solutions on the basis of multi-stakeholders and municipality-based partnership.

Definitions	
Lv et al. (2018)	Smart city refers to a city developed by application of the concept of a digital city and the internet of things (smart city = digital city + internet of things).
Nam and Pardo (2011)	Smart city is a potential city, whereby many types of technology are applied to develop people's livelihoods, solve public problems and promote economic development and city industry in a balanced and efficient manner.

It is notable that city smartness relies on the application of capital in terms of physical capital and social capital along with modern information technology, as well as internet operating systems to create mobility at the physical and connectivity levels within economic and social systems. This results in agility in the public sector, a transaction in the business and private sectors, an upgrade of people's quality of life, as well as public city services, e.g. public transport systems, public health services, public utility systems, education and environmental management that can adapt to global changes and serve urbanization efficiently.

2.2.3 Smart City Components

Some academics have categorized smart cities into six components (Correia & Wünstel, 2011, p. 9; European Parliament, 2014, pp. 26-28; Giffinger & Gudrun, 2010, pp. 7-26; Giffinger, Kramar, Haindlmaier, & Strohmayer, 2014a; Giffinger, Kramar, & Strohmayer, 2007; Vanolo, 2014, pp. 883-898), namely 1) Smart Governance, 2) Smart People, 3) Smart Mobility, 4) Smart Living, 5) Smart Economy, and 6) Smart Environment, with the following details:

1) Smart Governance consists of the application of ICT to public administration at the local and central levels, promotion of interactions between the public sector or service providers and the people sector or service users, including supporting the public sector services to increase efficiency and effectiveness using ICT.

2) Smart People comprises the application of ICT to develop human resource potential in terms of educational development, training and the country's

human resource management in order to create an environment that promotes creativity and innovation.

3) Smart Mobility is comprised of the application of ICT to link data, such as transport, traffic, etc, and different information gathered as big data to serve as key information that can be analyzed to search for problems and suggestions to solve traffic problems.

4) Smart Living consists of the use of ICT in daily life, e.g. residential environment and communication devices, which are automatically managed by efficient, convenient, reliable and useful smart networks.

5) Smart Economy comprises the application of ICT to businesses in E-Business and E-Commerce to enhance manufacturing efficiency, delivery of products and services as well as the creation of economic innovation, smart cluster and eco-systems.

6) Smart Environment consists of preservation of the environment, forests, plants, ecology, agricultural promotion, city food sources, public parks, green areas, water management, water pollution, air pollution and urban heat islands.

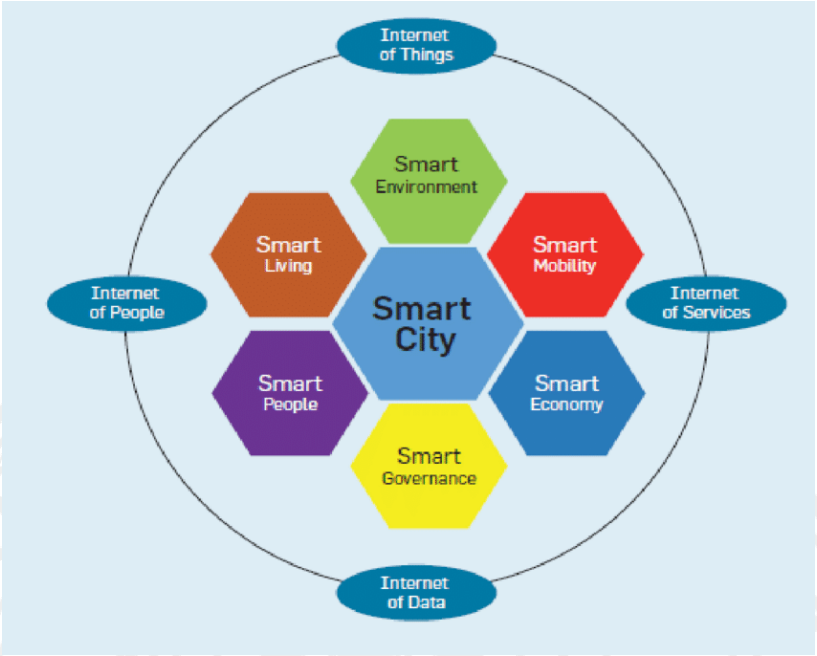

Figure 2.2 Smart City Components

Source: Modified from Albino et al., 2015, pp. 10-11;Giffinger et al., 2014; Albino et al., 2015, pp. 10-11.

Apart from the six smart city components categorized by Giffinger et al. (2014a), a research study on smart cities by Lombardi et al. (2012, pp. 139-143) classifies smart city into the following five aspects, which are consistent with Giffinger's study results.

1) Smart governance relates directly to public participation.

2) Smart human capital relates directly to public development.

3) Smart environment relates directly to city natural resource management and development.

4) Smart living relates directly to development of the quality of life of people in the city.

5) Smart economy relates directly to city economic potential and competition.

Table 2.2 Major Components of Smart City Linked to Urban Development Issues

Components	**Related to urban management**
Smart governance	E-democracy
Smart human capital	Education
Smart environment	Efficiency and sustainability
Smart living	Security, safety and quality
Smart economy	Business and industrial sectors
Smart mobility	Infrastructure and logistics

Source: Albino et al., 2015, pp. 10-11; Lombardi et al., 2012, pp. 137-149; Giffinger et al., 2014a; Albino and Dangelico, 2013; Albino & Berardi & Dangelico, 2015: 10-11; and Suriyanon Pholsim, 2019.

Chourabi et al. (2012) explained smart cities in terms of management, policies and institutions. He also described the eight components of smart city (Chourabi et al., 2012, pp. 2291-2294): 1) management and organization, 2) technology, 3) governance, 4) policy, 5) people and communities, 6) economy, 7) infrastructure, and 8) environment.

Table 2.3 Smart City Components Compared by Giffinger, Lombardi and Chourabi

Giffinger (2014)	**Lombardi (2012)**	**Chourabi (2012)**
Smart governance	Smart governance	Governance
Smart people	Smart human capital	People and communities
Smart environment	Smart environment	Environment
Smart economy	Smart economy	Economy
Smart living	Smart living	Infrastructure
Smart mobility		Management and organization
		Technology
		Policy

Source: Modified from Lombardi et al., 2012, pp. 137-149; Chourabi et al., 2012; and Giffinger et al., 2014a.

It has been remarked that a smart city does not have only economic, infrastructure, quality of life and environmental smartness, but also management, social institutions, organizational management, operating systems, and working policies for the people involved. Development of smart cities requires smartness that is in line with urban development plans, which serve new operation plans taking place in the context of smart city.

2.2.4 Conceptual Relatives of Smart City

In order to explain the concept of smart city, conceptual relatives must be taken into account and analyzed. The study of conceptual relatives of smart city was classified by Nam and Pardo (2011) into the following three dimensions:

2.2.4.1 Technology Dimension

Digital city – Service-oriented infrastructure, innovation services and communication infrastructure. A digital city is a community that is linked by broadband communications, which is an open system where people can share information and ideas all the time. As a result, public services through service-

oriented computing are flexible and consistent with the public, private and people's demands (Yovanof & Hazapis, 2009).

Information city – A city with data collection and publication via public websites. Citizens can carry on with their lives and work via the internet because they can get information from the information technology infrastructure. They can also share information and their opinions. It serves as a tool to connect between the private and public sectors (Sairamesh, Lee, & Anania, 2004; Sproullv & Patterson, 2004).

Intelligent city – Research and technology provide innovation supporting learning and the innovation process. This concept is created in a social context, where knowledge, learning and creativity play a great role. Human capital is also a valuable resource for Intelligent Smart city, which is a radical innovation rather than a gradual innovation, due to much effort in using ITs to change daily lives (Komninos & Sefertzi, 2009).

Ubiquitous city (U-city) - Anthopoulos and Fitsilis (2010) states that U-city is linked to technology networks at any time and any place. It can greatly facilitate humans, e.g. receiving and transmitting information in the form of multimedia or electronic devices that can transmit and receive information and will be developed to be more efficient.

2.2.4.2 People Dimension

Creative city – A cooperation between local communities and the public sector in creating a city via development of the environment, social structures, economic structures and integration of cultural, historical and traditional local assets, as well as modern technologies leading to a business city or creative industry. To create a creative city, city components such as city cultural identity, diversity and an open society are necessary to exchange cultures, resulting in new creativity and a gathering of talent/creative resources in order to collect creative people to participate in city management (Florida, 2002; Hall, 2000).

Learning city – A city or community that organizes a wide variety of activities to support learning. It gathers knowledge and work experience, as well as shares knowledge continuously at the personal, group and organizational levels in order to change communities to the desired direction based on processes developed by

learning, organizations, personnel and technology (Campbell, 2009; Coe, Paquet, & Roy, 2001).

Knowledge city – This is like a learning city. It refers to “a city designed with the objective of supporting knowledge existence”. The concept of a knowledge city can replace an educational city or a smart city at a certain level. However, a knowledge city has a close relationship with knowledge economy development. Its difference is its importance to innovation. Knowledge-based urban development has become a key mechanism for developing knowledge, which is vital to city development in terms of smartness, potential, creativity, networks and the city’s competitive advantages (Dirks & Keeling, 2009; Edvinsson, 2006).

2.2.4.3 Community Dimension

Smart community – Community members, including local administrative organizations, the business sector, educational institutions, public health institutions and the general public can access information technology’s potential and build a relationship using technology to develop and better change communities. Because of complete driven cooperation, communities can use resources through development projects in order to develop and maximize benefits from existing telecommunication infrastructure in the city. This can make city lifestyles change radically in all aspects. Thus, people increase their options, convenience, living standards, working conditions, public management, education, etc. (Coe et al., 2001; Eger, 2000; California Institute for Smart Communities, 1997 as cited in San Diego State University, Center for International Communications, & Department of Transportation, 1997).

Table 2.4 Dimensions and Concepts Related to Smart City

Dimensions	**Concepts**	**Factors Relatives**
Technology Dimension	- Digital city (Yovanof & Hazapis, 2009) - Information city (Sairamesh et al., 2004; Sproullv & Patterson, 2004) - Intelligent city (Komninos & Sefertzi, 2009) - Ubiquitous city (U-city) (Anthopoulos & Fitsilis, 2010)	- Physical infrastructure - Smart technologies - Mobile technologies - Virtual technologies - Digital networks
People Dimension	- Creative city (Florida, 2002; Hall, 2000) - Learning city (Campbell, 2009; Coe et al., 2001) - Knowledge city (Dirks & Keeling, 2009; Edvinsson, 2006)	- Human infrastructure - Social capital
Community Dimension	- Smart community (Coe et al., 2001; J. M. Eger, 2000; California Institute for Smart Communities, 1997)	- Governance - Policy - Regulations/directives

Source: Modified from Nam and Pardo, 2011.

It is noted that conceptual frameworks relating to smart cities consist of technology, which must integrate information technology to be a connected system. It

relies on inclusive and complete information technology infrastructure. As for the human concept, an open atmosphere can promote a diverse society full of creativity, as well as support knowledge exchanges at all levels, and support learning activities and let people realize the importance of knowledge that can change communities to become sustainable smart communities.

2.2.4.4 Smart City Standard or Smart City Framework (SCF)

As development of a smart city becomes a national strategy of many countries that wish to upgrade more smartness and have clear development, international environmental analysis, research and development, development of community of practice and issuance of a white paper to guide the direction and methods necessary for development, were all carried out (BSI, 2014).

In May 2014, the British Standards Institution (BSI) hosted the drafting of a smart city framework (SCF) developed by the brainstorming of experts from the public, business and industrial sectors, as well as NGOs.

1) Content of SCF

The BSI's SCF consists of four major components, as follows:

(1) Guiding principles include the qualifications of leaders who have to make decisions in the context of many stakeholders who relate to a city development strategy for the long term. They must be visionaries, citizen-centric for digital society development, and open and collaborative for the development of all parties.

(2) Key cross-city governance and delivery processes include three key management processes, namely 1) Business management that is able to prepare a roadmap and a smart city by integrating business strategies and city components to lead business to its goals, 2) Citizen-centric service management, an international principle of modern public services, and 3) Technology and digital asset management and application to service-oriented architecture (SOA), which is flexible and applicable to a wide variety of systems to serve the diversity of the city.

(3) Benefit realization strategy: To encourage the private sector to prepare for smart city policies, let it realize the benefits that organizations will receive and see the overall country's development. There are three

steps in preparation of the private sector's willingness: 1) benefit mapping, 2) benefit tracking, and 3) benefit delivery.

2) Service Innovation

BSI (2014) identifies that the concept of service innovation is a key mechanism for development in accordance with the SCF. In other words, stakeholders will take part in formulating development models and designing services and city applications. As for public services in particular, the heart of the matter is this: "People and stakeholders must participate in developing a smart city". Public agencies have to adjust their original or individual work styles to form a collaboration that promotes integration.

Makoto Yusui (2012) summarized the definition of service innovation as new services that are reformed by former ones. They are initiated by the concept that having a life is just a starting point, it takes into account social factors and the existing system structure, as well as focuses on humans. It means that new technologies are applied to meet the demand and satisfaction of customers, as well as upgrades service efficiency and adds value to business. This is similar to public services. The response to city residents in terms of convenience and quickness in public service access is a current public service approach based on New Public Management (NPM).

Henderson and Clark (1990) studied various kinds of innovation and found that most innovation depends on knowledge from different sources and types in terms of technology and marketing. To manage innovation successfully, knowledge must be managed to create innovation at the component level. These components must be combined in order to change the architecture. This adds to what BSI has stated - that collaboration is a key mechanism to develop smart cities by letting people and all stakeholders participate in data sharing and an integrated design. People will use tools and personal media, as well as provide services by the people and for the people, including a determination of commercial application development by stakeholders (British Standards Institution, 2014).

BSI (2014) also defines SCF based on three basic development principles, as summarized in the following:

(1) Internal cultural changes through partnerships, internal data, data management criteria, data asset layout, roadmaps for data disclosure, publication and pilot team development.

(2) Open data platform development, which includes service-oriented architecture (SOA) activities, open data standards and standard accounts for searching and Web-API.

(3) Development to promote market demand, consisting of development activities of clear policies, business models in the form of plug and P\play, development of data models and tools for developing applications, as well as initial stimulation of the market in whatever model suits the situation.

It is obvious that successful smart city development must take into account an integration of public work culture, which requires open collaboration, technology development that can serve big data from all sectors of people and stakeholders, as well as market demand promoting the private sector to be willing to voluntarily collaborate based on benefit realization.

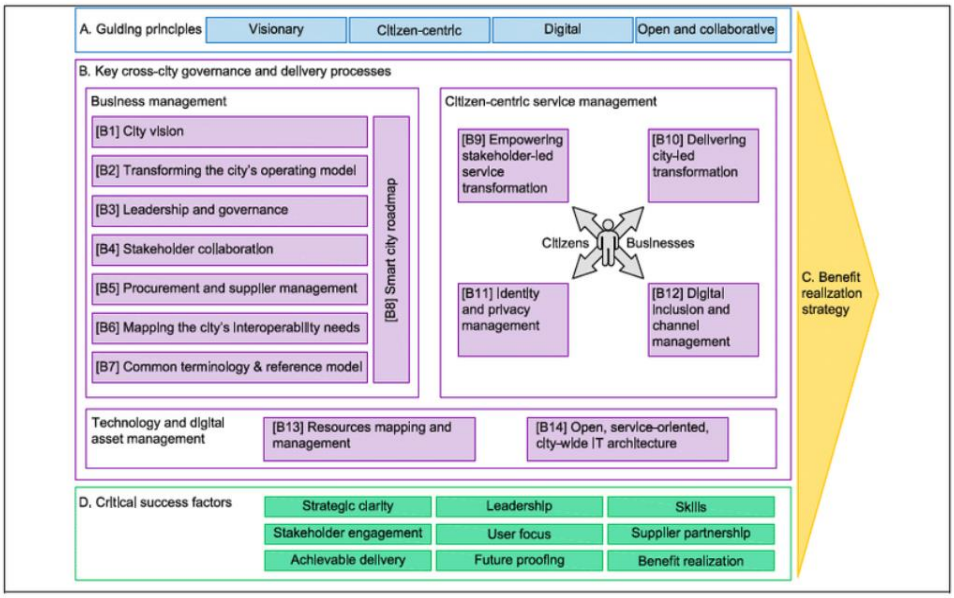

Figure 2.3 A High-level Structure for the Smart City Framework

Source: British Standards Institution, 2014.

2.2.5 Critical Success Factors

Key success factors for smart city management were analyzed by academics and agencies in different contexts. Relevant factors comprise technology, human capital, communities, strategies, public policies, etc.

According to a BSI study (2014), nine factors were specified – strategic clarity, leadership, skills, stakeholder engagement, user focus, supplier partnership, achievable delivery, future proofing and benefit realization.

Harms (2016) stated that strategies for smart city should determine how cities use limited resources to lead to or achieve their missions. It is necessary that cities formulate their vision to specify smart city characters, and assess strengths and weaknesses resulting in the formulation of the strategy framework of smart cities.

Stakeholders of all sectors also play a key role in driving the development of smart cities, such as local government who collects resources and said stakeholders, as well as in formulating regulations to monitor the businesses which produce the technologies to meet marketing demand. Knowledge institutes have a duty to support innovation in necessary technology research and development. Citizens not only submit a proposal to the public sector, but also take part in pushing smart city projects in communities (Harms, 2016).

In the research of Chourabi et al. (2012), it was stated that key success factors for smart city initiation consist of eight factors, namely 1) management and organization, 2) technology, 3) governance, 4) policy, 5) people and communities, 6) economy, 7) infrastructure and 8) natural environment.

Chourabi emphasized 1) management and organization, because they have a context relating to the success of the E-government Project and IT Projects (Gil-García & Pardo, 2005). Most pilot smart city projects rely on government support and benefits from ITC projects, e.g. an upgrade in the quality of public services (Chourabi et al., 2012).

Key success factors for the Pilot Smart City Project relating to management and organization include both strategies and challenges.

Table 2.5 Strategies and Challenges on Management and Organization Affecting Smart City Projects

Strategies	**Challenges**
Skills and expertise of management team	Project sizes
Acceptable leaders with IT expertise	Attitudes and behaviors of project supervisors
Clear and possible goals	Diversity of users and organizations
Clearly specified stakeholders	Lack of clear organizational goals
User participation (the civic sector)	Diverse and contradictory goals
Definite and measurable planning	Anti-changes
Good internal and external communications	Boundary conflicts
Improvement of business processes that were previously used	
Adequate training	
Sufficient innovation fund	
Regular review of current practices or best practices	

Source: Modified from Gil-García and Pardo, 2005.

2) Technology is referred to by Chourabi as a "new generation of integrated hardware, software, and network technologies that provide IT systems with real-time awareness of the real world and advanced analytics to help people make more intelligent decisions about alternatives and actions that will optimize business processes and business balance sheet results" (Washburn et al., 2010). Thus, ICT integration is a driving mechanism for developing smart cities, which leads to changes in the urban landscape, as well as the potential and opportunities resulting in an upgrade of city management and operations. However, to apply technologies to develop smart cities, there are the following challenges, e.g. 1) IT Skills, e.g. adequate IT training programs must be provided by agencies to offset a shortage of experts in

ICT skills, 2) Organizations still lack experience in cross-sectorial cooperation and inter-departmental coordination, and possess an unclear IT management vision, including unfavorable policies and organizational culture (Ebrahim & Irani, 2005).

As for 3) governance, several cities have proposed major goals for pilot smart city projects, e.g. providing better public services to people and upgrading people's quality of life (Odendaal, 2003). Such projects must relate to multiple stakeholders. Thus, cities are required to have more efficient governance in order to manage those projects. Scholl, Barzilai-Nahon, Ahn, Popova, and Re (2009) said "Stakeholder relations" are one of the key success factors for pilot e-government projects. The following topics must be considered: the ability to cooperate among stakeholders; the support of leadership; the structure of alliances; and be able to work under different jurisdictions (Scholl et al., 2009). When it is believed that the integration of ICT will result in better governance, then smart governance refers to ICT-based governance, which covers technology, humans, policies, action plans, resources, social norms and information that affects each other concerning the support of city governance activities (Belissent, 2011). Other academics have also suggested their points of views about governance. For example, Mooij (2003) stated that leadership is the most important foundation for good governance, while Lam (2005) emphasized humans who cooperate with all stakeholders. Some researchers have the view that smart governance is a key characteristic of smart cities based on citizen participation (Giffinger, Fertner, et al., 2007) or private/public partnerships (Odendaal, 2003). Johnston and Hansen (2011) mentioned that smart governance relies on the operation of a smart governance infrastructure that should be accountable, responsive and transparent (Mooij, 2003). In addition, its structure needs collaboration, data exchange, service integration and communication (Odendaal, 2003).

Table 2.6 Factors of Smart Governance

Factors	**Academics**
Collaboration	Lam (2005) / Landsbergen Jr. and Wolken Jr. (2001) / Scholl et al. (2009)
Leadership	Lam (2005)/ Mooij (2003)/ Scholl et al. (2009)
Participation and partnership	Giffinger, Fertner, et al. (2007) / Odendaal (2003)
Communication	Odendaal (2003)
Data-exchange	Landsbergen Jr. and Wolken Jr. (2001) / Nfuka and Rusu (2010)
Service and application integration	Nfuka and Rusu (2010) / Odendaal (2003)
Accountability	Johnston and Hansen (2011) / Mooij (2003)
Transparency	Johnston and Hansen (2011) / Mooij (2003) / Nfuka and Rusu (2010)

Source: Modified from Chourabi et al., 2012.

4) Policy: Cities which have changed from those with general administration to smart cities usually consist of political and institutional components affecting technology components (Mauher & Vanja, 2006). Political components are comprised of public agencies at all levels, e.g. town municipalities, provincial public agencies or local policies and local politics that affect pilot IT projects (Rocheleau, 2003). Institutional preparedness, such as eradication of legal obstacles and regulations is vital to initiate smart cities to operate smoothly.

The importance of policy factors on smart city development includes an “understanding of suitable information system applications”. In other words, changing the original city governance model to a smart one cannot occur if there are no policy changes, which must be specified in city regulations or policies (Eger &

Maggipinto, 2009). However, the policy context implies specific city characteristics in terms of institutional units and city problems that are not related to technology and can be applied to further determine the direction of city development (Yigitcanlar & Velibeyoglu, 2008).

Chourabi et al. (2012) stated that pilot city projects must face challenges related to a policy context, such as laws, regulations, institutional units and the external environment, which affect the success of smart city e-government initiation. In brief, policy factors have an impact on the determination of directions and planning of pilot smart city development projects as policy makers, as well as scope and development framework determiners. Those responsible for projects must use regulatory limitations to evaluate decision-making in those IT projects.

5) People and communities are stakeholders who play the greatest role in pilot smart city projects because the main goal of smart city management is to upgrade the quality of life of people and communities, such as reducing disparities in the access of information, upgrading the education level and increasing participation at the civic and community sectors (Chourabi et al., 2012). Agencies responsible for pilot smart city projects should support city groups who take part in monitoring city governance and management. This will enable city development to meet the highest demand of civic service users. The challenges in civic and community factors for pilot smart city projects include balancing a wide variety of needs among different communities within the city (Chourabi et al., 2012).

Various academics have analyzed the importance of public and community factors related to the initiative of smart city projects in different dimensions. Following a review of relevant academic reports, the following interesting examples are cited:

Table 2.7 Factors Relating to People and Communities Affecting Smart City

Factor	Academic
Digital divide	Barzilai-Nahon (2006) / Norris (2001) / Scholl et al. (2009)/ Servon (2002)
Participation and partnership	Giffinger, Fertner, et al. (2007) / Odendaal (2003)
Communication	Castells (1996) / Odendaal (2003)
Education	Dirks and Keeling (2009) / Giffinger, Fertner, et al. (2007) / Washburn et al. (2010)
Quality of life	Florida (2002) / Giffinger, Fertner, et al. (2007) / (Rios, 2008)

Source: Adapted from Chourabi et al., 2012.

6) Economy is a significant driving factor for initiating a Smart City Project and a Competitive City Project. This reflects how it is just one of the qualifications for smart cities. However, one of the key factors to measure city competitiveness includes city potential as an economic driver (Giffinger et al., 2008). Giffinger, Fertner, et al. (2007) defined smart economy as a smart economy consisting of factors related to the competitiveness of the economic system, e.g. innovation, business operators, trademarks, productivity and flexibility in labor markets, as well as global markets.

The IBM's study indicates that the business sector is one of the systems that drives smart cities because it is comprised of sub-systems, such as a city services system, citizens system, business system, transport system, communications system, water system, and energy system (Dirks, Keeling, & Dencik, 2009). The application of ICT to the business sector's operations will enhance competitiveness. Thus, the design of the Pilot Smart City Project should take into consideration ICT infrastructure that must facilitate the business sector to benefit from the development and improvement of business activities, resulting in future industrial reforms (Cairney & Speak, 2000) and economic results, e.g. new businesses, new occupations, development of labor quality or upgrade of business sector efficiency, etc.

7) Infrastructure: Readiness for the use and quality of ICT infrastructure is essential for smart cities. Because of networks linking ICT systems, smart cities in theory become livable and existing cities (Vasseur & Dunkels, 2010). ICT infrastructure consists of two major parts: wireless infrastructure, e.g. fiber optic channels, Wi-Fi networks, wireless hotspots and kiosks; and service-oriented information systems (Anthopoulos & Fitsilis, 2010)

The operation of ICT infrastructure is a basis for smart city development. In particular, it depends on readiness for the use and efficiency of such infrastructure. However, the initiation of a Smart City Project faces many challenges relating to ICT infrastructure, divided into three main categories: IT structure, security and privacy, and operational costs (Ebrahim & Irani, 2005).

Table 2.8 Challenges Relating to ICT Infrastructure

Dimension	**Challenge**
IT infrastructure	• Lack of integration across government systems
	• Existing internal systems have restrictions regarding their integrating capabilities
	• Lack of knowledge regarding interoperability
	• Availability and compatibility of software, systems and applications
Security and privacy	• Threats from hackers and intruders
	• Threats from viruses, worms and Trojans
	• Privacy of personal data
	• High cost of security applications and solutions
	• Accessibility
Operational cost	• High cost of IT professionals and consultancies
	• High cost of IT
	• Cost of installation, operation and maintenance of information systems
	• Cost of training

Source: Adapted from Ebrahim and Irani, 2005 and Chourabi et al., 2012.

8) Natural environment: The occurrence of smart cities highly relates to the natural environment in the future, because one conceptual framework of smart cities is to benefit from technology to create sustainability and to better manage limited natural resources (Nfuka & Rusu, 2010). An interesting issue is the protection of natural resources and infrastructure in relevant smart cities, such as waterways, drainage pipes, green areas, etc. (Hall, 2000). The design of a Smart City Project should, therefore, consider factors related to the natural environment.

According to the above key factors, Chourabi et al. (2012) developed a concept to explain the relationship and influence of these factors and success in smart city initiatives. Each factor is vital to assess the scope and check the smart city's project initiative. Such factors can be used as a basis for comparing the success of smart cities and to realize the challenges they face in the different contexts and objectives of each city, as shown in Figure 2.4.

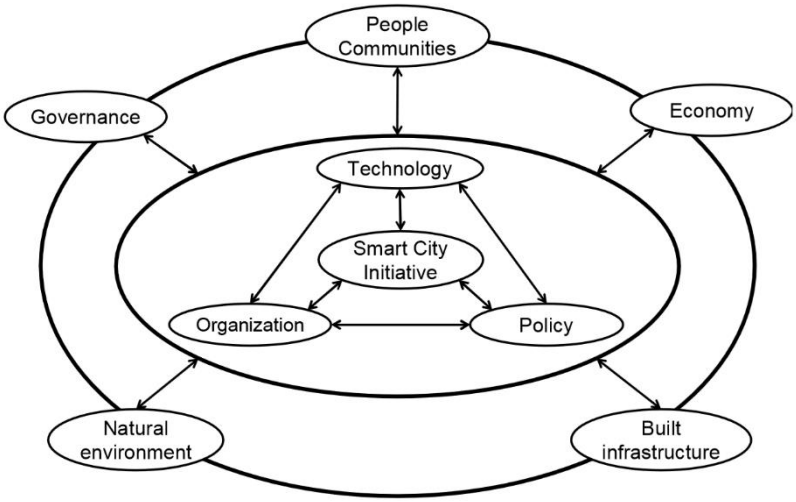

Figure 2.4 Smart City Initiatives Framework
Source: Chourabi et al., 2012.

Chourabi explained that all factors have an influence in two directions in the Smart City Project in each period and in each changing context. Each factor may exert influence according to the situation. Additionally, Chourabi classified

factors in two categories – internal factors comprising technology, management and policies; and external factors, e.g. governance, people and communities, natural environment, infrastructure and economy. However, Chourabi emphasized that technology is a meta-factor for initiating a Smart City Project because of its impacts on other factors. Many successful smart cities have applied technology to intensively drive cities.

2.2.6 Examples of Successful Smart Cities

Smartness consists of the following basic characteristics: (1) cities with ICT infrastructure that have common components or cross-cutting, (2) cities with many sectors that have interactions or coordination, and (3) cities that benefit from big data, which means a large amount and a wide variety of information with high speed exceeding the ability of the traditional database to manage because the government will know more about people's demands from different data. This can solve problems concerning city management, such as traffic, water management, communication technology, smart electricity grid, public health, transport and others more quickly. Various cities have put an effort in making their cities smart so that they can be developed efficiently and sustainably.

1) Milton Keynes, United Kingdom (Open University, 2017)

Milton Keynes is a city in the south of England. It received the Smart Cities UK Award 2017 on data, communication and energy. Its strength is the construction of a Data Hub which collects key information of the city, namely economic, social, transport, water consumption, energy and satellite data. There are more than 700 sets of data for developing city resources, all of which can be accessed by its people.

A motion map application tool is used to explain the real-time motion of people and vehicles across the city and includes information on timetables, parking lots, road routes and traffic assessment of vehicle routes in the city.

Concerning energy, Milton Keynes uses solar cell-based electric cars. There are programs using information collected to efficiently help people analyze energy use in each area in the community. There are plans to reduce air pollution and the consumption of fuel.

In addition, the city allows people to share their concerns for the city by using a Quick Chat application that collects the discussions and comments of city residents and serves as a channel for people to report on events so that they can be used to develop their city and be more livable.

2) Amsterdam, the Netherlands (Amsterdam Smart City Academy)

Their Smart City Project was initiated in 2009. There are more than 170 projects based on public private partnerships. The main objectives are to solve traffic problems and develop safe energy and public safety for its residents.

The City-Zen Project encourages cities to use clean energy, e.g. solar, wind, biomass and geothermal, in order to manage cities, houses, buildings and the people's daily lives, with programs such as solar energy storage plans and excess energy sale plans, etc.

The Circular Amsterdam Project involves rotation of the city's economy in order to reduce waste and pollution through the recycling of resources, e.g. a rainwater turned into beer project, the design of existing packages to become new styles to be more efficient. City residents can follow up on the details of various projects, including operators, targets, through monitoring and participation via the city website.

3) Stockholm, Sweden (Stockholms Stad, 2014)

Stockholm is outstanding in ICT and has the most networks and connectivity because of its fiber network and IT operations that link data for developing a sustainable society. The connectivity of city networks consists of the public, business and people sectors in terms of communication, economic cooperation, etc.

Their Green IT Project involves the integration of technology operations to mitigate impacts on the environment, such as an Energy Saving Building Project that decreases heating costs, inspects traffic conditions and develops e-service systems to reduce paper use, etc. Additionally is their e-Stockholm public service that prioritizes demand and facilitates city residents, e.g. services for elderly people, permit issuance, trip planning, etc. In Stockholm, an area called Kista Science City is a source of leading ICT in the world, where public agencies and private

companies cooperate in developing information systems and communication technology under the Smart City Project of this city.

4) Barcelona, Spain (Ajuntament de Barcelona, 2018)

Barcelona was targeted to become a digital city using digital technology to improve people's lives, especially with investments in basic digital infrastructure. There are three city strengths:

(1) Digital transformation or the application of technology and data to provide services to people, create transparency related to monitoring government operations, and public participation in city development, such as Ethical Mailbox to complain about the corruption of public agencies, or Open Budget that allows people to audit the public sector's budget use, etc.

(2) Digital innovation refers to the application of technology innovation to improve the resident's quality of life, such as censor technology using public parks water systems, bus network technology to lessen traffic problems or smart traffic technology, etc.

(3) Digital empowerment refers to the application of technology to build a good society and community and push for education, such as the Technology Training and Program Dissemination Project, the Fab Labs Project to offer public services so that people can learn the science of digital production, including democracy channels for people to suggest policies to the public sector.

5) Fujisawa, Japan (Fujisawa SST Council, 2017)

Fujisawa, or Fujisawa Sustainable Smart Town (Fujisawa SST) in Kanagawa Prefecture, is a public-private partnership that supports smart city projects. There are 1,000 houses in Fujisawa. The city's vision is to develop infrastructure with high technology that can be adjusted to the city residents' daily lives.

Solar cells and reserve batteries have been installed on house roofs. Electricity is mainly generated for use in each household. Excess electricity is sold to electricity business operators. In addition, public places are also installed with solar cells. Thus, Fujisawa can generate enough reserve energy for at least three days.

As for water use, rainwater is stored for use. Concerning vehicles, clean energy is used, such as electric cars and bicycles. Energy can be charged at each house and in public places. The objective of the city environment is to reduce carbon

dioxide and water use, as well as promote renewable energy, etc. Regarding the safety and property security of Fujisawa residents, CCTVs and security systems have been installed throughout the city to oversee people's lives.

6) Singapore (Smart Nation Digital Government Group, 2018)

Singapore has set its target to become a smart nation using IT to create jobs and generate income. Its aim is to become a cashless society based on e-payment systems covering all businesses. The Intelligent Nation 2015 Master Plan will be used to develop Singapore's latest Infocomm called iN2015 (Intelligent Nation 2015) Master plan comprising the following strategies to drive and develop people's quality of life.

(1) Installation of infrastructure plus inclusive, wise and reliable information technology with high speed internet.

(2) Development of information technology that is competitive at the global level.

(3) Development of information technology experts and manpower, who are competitive at the global level.

(4) Changes in the major economy, government and society through the application of modern and new information technology.

In 2012 the Singapore government supported a fund to provide high-speed internet networks nationwide by service providers. As a result, more than 90% of residential areas and workplaces have been connected with high-speed internet (1 Gbps). Since July 2013, Ulternet has widely provided internet services and supported people's requests for access to high-speed internet at their houses via Fiber to the Home (FTTH).

In 2006, Singapore carried out the Wireless@SG Project, which provided high-speed internet using Wi-Fi technology (up to 2 Mbps) free of charge in public areas. In addition, M1, in collaboration with IDA, managed public agencies to provide access to high-speed internet in non-buildings, such as bus stops, public parks and junctions, quickly and cheaply. Censor technology is necessary for smart cities because it can be used to measure air and noise pollution, as well as energy use. Above Ground Boxes (AG Boxes) were installed in necessary areas.

The Smart Nation Project in Singapore is in charge of public health systems, people's health and transport. In its aging society, health technology will facilitate elderly people. Concerning medicine, telehealth technology is used so that patients always have access to Singapore's health systems.

Concerning development of Singaporean quality of life in all aspects, the Singapore government has developed several applications, e.g. Health Hub to record health information, My Responder that basically helps cardiac patients and calls ambulances immediately, MyTransport.SG that shows timetables or vehicle routes, as well as an application that reports events or accidents in order to take care of people's safety, etc.

2.3 Public and Private Partnership Concept

2.3.1 Definition of the Public Private Partnership

Public Private Partnership (PPP) refers to the allowance of private sector investment in public business, including permission, concession or privileges to the private sector to carry out public businesses in commercial and social businesses. Such public businesses must belong to the state, state enterprises, public agencies or local administrative organizations, which are legally authorized, or such businesses shall provide natural resources or assets of the state, state enterprises, other public agencies or local administrative organizations (Secretariat of the House of Representatives, 2016 as cited in Parliamentary Budget Office, 2016).

The International Monetary Fund (IMF) stated that a public private partnership is an agreement that the private sector shall provide assets and deliver infrastructure services, which the government had done in the past. In addition to the private sector's operation and funding, there are two significant features, namely the private sector shall be both the provider and investor in public services, plus risks shall be transferred from the public to private sectors.

The World Bank defined PPP as a long-term agreement on services that are under the responsibility of the private sector. As a result, the private sector has to bear the risks and responsibility for managing projects in order to deliver public services or public infrastructure and focus on efficiency.

2.3.2 Types of Public Private Partnerships (PPP)

The types of public private partnerships are broad in accordance with the relevant levels and risk born by the private sector, which are clearly specified in the contract. The World Bank summarized the types of PPP as follows:

1) Utility Restructuring, Corporatization and Decentralization
2) Civil Works and Service Contracts
3) Management and Operating Agreements
4) Leases/Afterimage
5) Concessions, Build-Operate-Transfer (BOT), Design-Build-Operate (DBO)
6) Joint Ventures
7) Divestiture
8) Contract Plans and Performance Contracts

2.3.3 Advantages and Limitations of PPP

Public private partnerships let the private sector share the public sector's efficiency enhancement to provide services to people and better meet the people's demands. However, a PPP has both advantages and limitations for all stakeholders, as summarized below (Parliamentary Budget Office, 2016).

2.3.3.1 PPP Advantages

1) Advantages for the public sector – The private sector can apply its experience and competitive advantage to design project management to save costs and make projects financially feasible. The public sector does not have to bear the costs while waiting for construction to be completed. Risk management is shared to the private sector who has more experience and knowledge. Additionally, the public sector can also better manage its budget and can allocate that budget to invest in other necessary projects of the civic sector. It can also reduce delays in project construction because the private sector must complete the construction within the period specified in the contract to avoid increasing expenses and interest.

2) Advantages for the private sector – The private sector has an opportunity to efficiently provide public services to the people sector. During an

economic downturn, this can stimulate the country's economy through investment in public projects.

3) Advantages to the civic sector – The civic sector will receive efficient and standard public services at a reasonable price through a combination of expertise from the civic and private sectors. The civic sector has a duty to monitor the operation, while the private sector will provide efficient and reliable services, as well as fix a price mechanism suitable for the civic sector.

2.3.3.2 PPP Limitations

1) There may be complications monitoring investment in the form of PPP – Monitoring is important to ensure that PPP projects are fair to all parties and the criteria are clear regarding contributions to private sector investment, especially risk transfers between the civic and private sectors. In the case of unsuitable risk transfers, PPP projects could fail or become inefficient. In addition, monitoring must provide benefits to the civic sector in terms of efficient services at a reasonable price. PPP projects must be carried out transparently and value for money must be taken into account.

2) There are many risks in a PPP which must be considered. The IMF (2006) studied and explained the limitations as follows:

(1) Construction risks, e.g. design problems, costs exceeding the forecast and delayed project construction

(2) Financial risks, such as exchange rates and interest rates

(3) Availability risks, e.g. the private sector cannot continue conducting projects because of lack of resources or factors necessary for project operation

(4) Demand risks, such as consumer demand in services

(5) Residual value risks, e.g. asset market prices in the future

2.3.4 Collaborative Governance Theory

Gray's article (1989) sparked interest in collaboration by emphasizing that collaboration is "a new social norm". He presented principles of collaboration to serve as a solution to problems arising from the original management of public services.

The concept of collaborative governance has been developed into an idea that is now commonly mentioned. For example, practical application in the United States and interagency collaboration has become an excellent standard of public affairs management. Ansell and Gash (2007) addressed this, pointing out that major factors affecting the success of collaborative governance comprise past conflicts or collaboration, collaborative incentives, power and resource imbalances, leadership, institutional design, etc.

Significant concepts

The major contents of collaborative governance involve 1) collaboration, 2) collaborative governance, 3) collaborative public management, 4) collaborative advantages and 5) collaborative managers.

1) Collaboration is defined as cooperation and collaboration to achieve common goals while working across boundaries in multisector relationships. Such collaboration is based on the value of reciprocity (O 'Leary, Gerard, & Bingham, 2006) and the processes concerning interdependence (Gray, 1989), creativity (Gray, 1989) and collective decision-making (Gray, 1989). Thus, it can be summarized that collaboration refers to the processes whereby various actors are related to each other and make independent collective decisions in creating, or not creating, dependent activities, under restrictions.

2) Collaborative governance refers to governance when one or more public agencies directly collaborates with non-public agencies in a formal decision-making process through consensus and consultation. Its objective is to formulate or implement public policies into practice, or manage projects or public assets (Ansell & Gash, 2007). Additionally, Amsler and Nabatchi (2016) stated that collaborative governance involves institutional establishment that expands its interest to not only public managers or public sectors, but also public and social participation with continuous systems and processes.

3) Collaborative public management refers to “the concept explaining the process of facilitating and operating in multiorganizational arrangements to solve problems that cannot be solved, or easily solved, by a single organization” (Agranoff & McGuire, 2003). This concept focuses on public managers and innovations arising from collaboration. It is, therefore, a conceptual framework for analyzing decision-making mechanism in collaboration with different agencies for managing public services.

4) Collaborative advantage refers to benefits from the synergy between collaborating organizations (Huxham, 1996) and Himmelman (1996). Both were of the view that these benefits are one component of the collaboration process. Vangen and Huxham (2013) concluded with the following collective benefits – 1) access to resources: various organizations collaborate to overcome resource constraints, 2) shared risks, especially very high risk projects, 3) efficiency in operations and size-saving, etc. 4) cooperation and seamlessness to better facilitate service users, 5) learning among collaborative organizations, and 6) moral imperatives or new perspectives of solutions to complicated problems.

5) Collaborative public managers play a large role in collaboration. McGuire (2006) categorized collaborative public manager skills as follows: 1) activation refers to the identification of personnel and resources required to achieve common goals, 2) framing refers to facilitation resulting in common agreement on management’s role, 3) mobilizing refers to the building of engagement in collaborative operations and seeking support from both supporters and collaborators, and 4) synthesizing refers to the building of interactions among actors with clear visions and objectives, as well as the building of relationships leading to trust and information exchange.

Collaboration can be either dyads, or two-party collaboration between international worldwide networks (Huxham & Vangen, 2010). Collaboration can be carried out on numerous topics, such as education, community development, economic development, smart city development, etc. Collaboration can be found in different forms, e.g. interstate collaboration, public private partnerships, etc.

2.4 Urban Management

2.4.1 Origin of the Urban Management Concept

Urban refers to areas with growth in all aspects, namely politics, administration, economy, business, technology, arts and culture, as well as the center of human activities, etc. (Muneeroh Yeedum, Chanikan Polcharoen, & Phichitchai Kingphuang, 2016).

Urban has been important for people's livelihoods since the birth of society as a way of coexistence under public administration. The government plays a role in managing social order, administration and public services for its citizens. In addition, the emergence of civilization across the world was the beginning of urbanization. Thus, the formulation of urban policies and administrations to meet the citizens' demands is unavoidably significant and challenging in all ages because cities are areas that serve dynamic and changing lives (Muneeroh Yeedum et al., 2016). However, there are many perspectives in each science relating to urban explanation and importance.

Urban in terms of planning and urban design or architecture is defined as an excellent artificial or manmade environment for the reason of complexity and habitat of human beings, who are different in terms of economy and society but gather in a city (Pranom Tunsukanan, 2016). Urban is also a geographic area comprising organizations performing their economic and managerial functions as necessary. In other words, cities are areas with a concentration of power and community culture (Kostof, 1999). Cities reflect the characteristics of people living in those areas, e.g. their demands and activities. This shows people's values and dreams, including a city's confusion and conflicts (Middleton, 1987).

Urbanization refers to a process whereby communities become cities, or people's relocation, or of their businesses, into cities causing the expansion of cities, which increases the population and creates more activities (The Royal Institute, 1982).

Since the foundation of cities as centers of growth from the beginning of civilization, to a phenomenon that occurred quickly around the world in the urbanization process of the 1880s, especially after the industrial revolution, in

transport and communication, growth in trade, investment and technology has been exchanged between great and powerful countries, e.g. USA and colonies in the age of imperialism. During globalization in the 1990s, due to exponential city growth, cities have become the center of growth in all states (Rimmer & Dick, 2009). Urbanization is a process that unavoidably takes a long time, from past to present, and into the future. Thus, significant issues for current and future urbanization include the government's operations concerning the formulation of policies to administer cities that are vital to local people's ways of life.

2.4.2 Definition of Urban Management

Urban management refers to city administration based on concepts and practices with the main objective of meeting the demands of community residents by emphasizing the importance of the target setting process (Damrongsak Jantotai, 2014).

Urban planning is the effort to determine systems for solving problems or improving the quality of decision-making based on connected areas and social complexities, because if there is no society, or communication between people in society, planning may not be necessary (Levy, 1994).

In the perspective of public administration, it could be stated that the study of urban management is a system-based study starting from inputs; e.g. city problems, people's claims and other city necessities; outputs, e.g. city management guidelines to impacts, such as organizations or major institutions related to urban management. The study also includes details or content in urban areas (Damrongsak Jantotai, 2014), such as the study of urban structures and political behaviors, as well as urban community administration, urban problems at the regional, national and international levels, as well as urban community development approaches, etc.

As for the policy formulation process, it starts by determining the goals for urban planning. One significant step during this process is the participation or role of local citizens, because urban administration under the people's demands and movements only can push for the success of concrete urban management. People who are interested in and cooperate in participation in various city activities, as well as check and monitor the operation of organizations, agencies and people who are

responsible for management and good governance which can satisfy and upgrade their quality of life (Muneeroh Yeedum et al., 2016).

In general, in the researcher's point of view, actors, relevant people or those who have a role in urban management include citizens in three groups: upper class, middle class and lower class. These groups take part in managing cities (Damrongsak Jantotai, 2014), as shown in Figure 2.5.

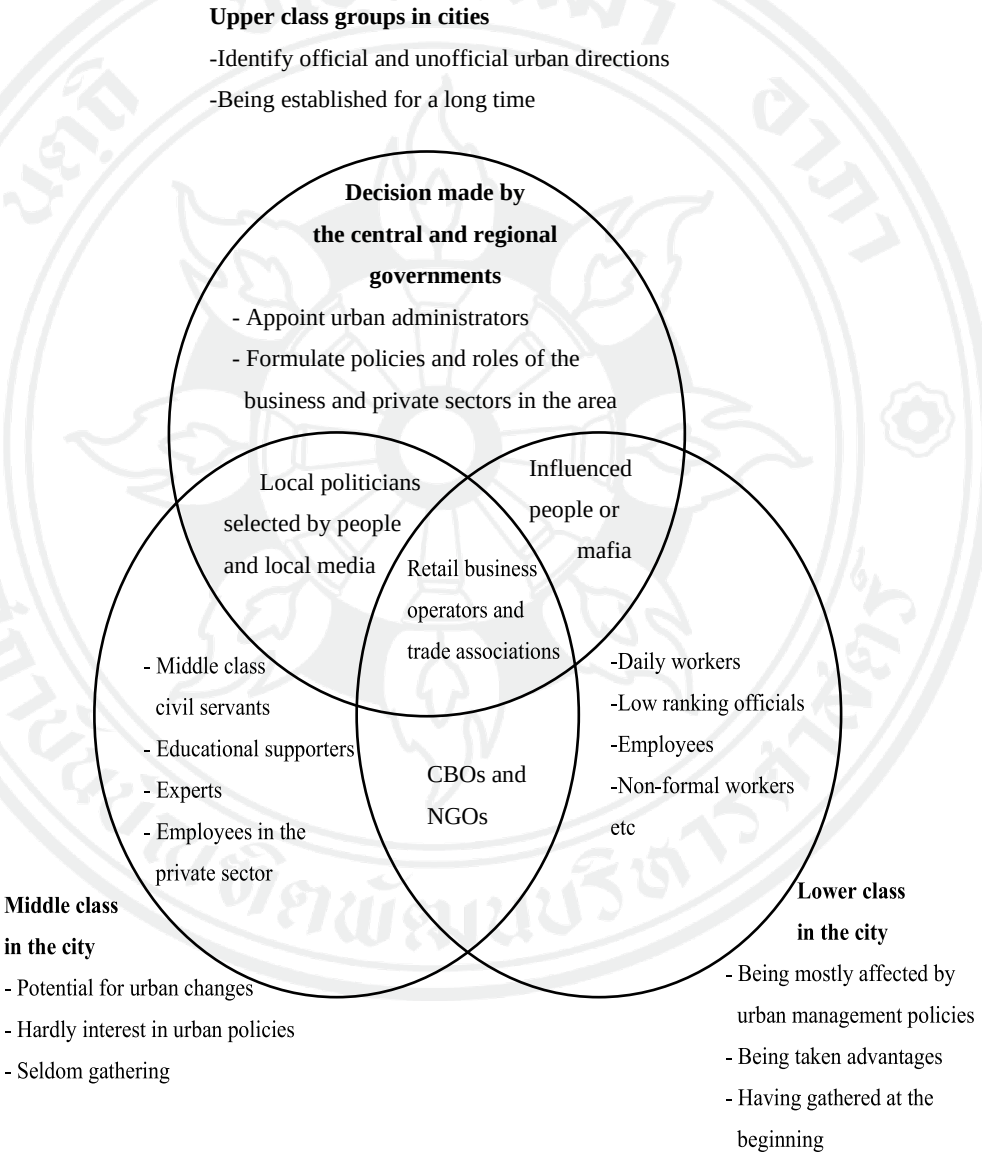

Figure 2.5 Actors in Urban Management

Source: Damrongsak Junthothai, 2014, p. 18.

People who have roles or are concerned with cities include social classes relating to cities:

Group 1 is the government or upper classes in the city, who have a role in making decisions for urban management, city administrator appointments, including policy formulation and implementation.

Group 2 includes the middle class, who is related to cities in terms of potential for urban change, e.g. support or resist public policies and resource use due to urban development. This group can gather roughly. This may affect the decision-making in urban management policies of the upper class.

Group 3 refers to the lower class, which is mostly affected because it only slightly affects policy-based decision-making for urban management of the public sector or the upper class (Muneeroh Yeedum et al., 2016).

2.4.3 Concept of Urban Management Using Urban Development Policies

All cities under efficient urban management start from planning and determining goals to meet people's livelihoods in urban society. Levy (1994) viewed how most urban development consists of four major plans: 1) basic concept systems and urban planning directions, 2) political relationship systems and administration at different levels, 3) socio-economic planning, and 4) land use planning and zoning maps.

Examples of management concepts using development policies are known as urban development plans, which stress development for socio-economic growth under various names, such as development plans, urban plans, master plans and policy plans. In addition, in the case of urban physical development plans, they are known as city plans or growth management plans, etc. (Sitthiporn Piromruen, 2000).

The above management use planning usually has concrete guidelines aimed at serving urban management in the form of action plans, e.g. an urban design emphasizing development of an urban landscape in terms of structural policies in accordance with the urban development vision, e.g. the City Green Area Project, etc. (Muneeroh Yeedum et al., 2016).

The importance of urban planning refers to strengthening urban development in a proper and orderly direction by encouraging to the proper use of land, including

improving public utility infrastructure in line with national and regional plans. A mechanism is built in related to land use control, zoning, urban facility improvement and urban development projects as a mechanism for urban development to achieve goals. Tools are usually used for driving urban development to achieve maximum results in the form of ordinances or regulations on urban development plan management, for example, city planning laws, urban building laws, housing area improvement laws, etc. Details of area development are specified for public service activities to promote the economy, e.g. unused land uses promotion, public recreation, rail transportation, etc. (Damrongsak Jantotai, 2014).

It is remarkable that urban management based on urban development policies focuses on the public and private economy, as well as development to facilitate local people, such as urban connectivity in terms of transport to better access the use of urban areas or development of public utilities to be sufficient and effective in order to stimulate tourism and the economy, etc. (Muneeroh Yeedum et al., 2016).

However, the concept of urban development has both strengths and weaknesses. The strengths include the formulation of policies and management for local area growth, including convenience, such as public utilities, infrastructure and transportation development. This affects urban and the country's image, which attracts investment and economic development. As for weaknesses of urban development in the long term, cities stressing development may have a wide variety of contexts and complicated problems arising, e.g. environment, urban deterioration, residential areas. These issues must always be solved by administrators concerned enough to stay abreast of urban changes (Muneeroh Yeedum et al., 2016).

According to Haruna's concept of urban development planning at the regional level, existing basic facilities in the cities must be considered, such as urban plans and public utility systems that contribute to urban changes. Urban people's livelihoods, e.g. traditions or local people's familiarity must be also be taken into consideration. If policies can be formulated based on basic issues, this can result in establishing goals and easier development. For example, in the case of urban development as the center of business or industry, urban areas with large and good public utilities should be planned. This should also be consistent with regional plans so that they are similar to

development of urban clusters at the same regional level (Damrongsak Jantotai, 2014), as shown in Figure 2.6.

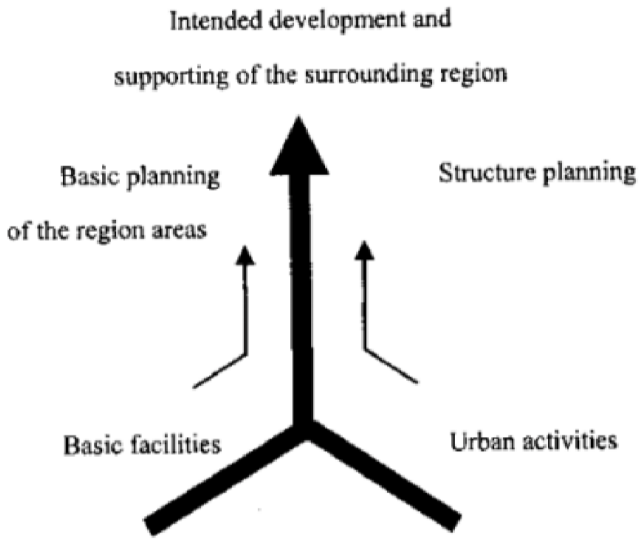

Figure 2.6 Function Planning Theory
Source: Damrongsak Jantotai, 2014, p. 155.

Urbanization and challenges to public agencies must be realized to serve urbanization, because urbanization will affect changes in various dimensions, e.g. population, physical features, demand for new public services and people gatherings. New technologies and urban lifestyles reflect urban administration requirements that respond to such changes. As for the new administration of local administrative organizations, it is necessary to study public issues related to urbanization and formulate policies and strategies that are consistent with outstanding urban features.

However, urbanization and urban growth have both positive and negative impacts on people. Concerning positive impacts, socio-economy and politics will be developed, people will have better quality of life and be more employed, and there will be new innovations. In case of urban growth without direction and good management, it can lead to numerous problems currently faced by many large cities worldwide, e.g. slums, inadequate infrastructure, traffic and environmental problems that affect quality of life and stop economic development. The public sector should

issue modern urban guidelines and management to prevent and deal with urban problems efficiently. In addition, cities should be developed as an engine of growth and social quality (Orathai Kokpol, 2016).

2.4.4 Challenging Issues Caused by Urban Phenomenon

In case of increasing urban changes and more density of population per area caused by population relocation into cities to seek opportunities, these affect cities in terms of physical, livelihood and lifestyle, public services requirements that are thorough and meet the demand for access to opportunities, resources, life and asset safety, and others. Key challenging impacts comprise the five following topics:

2.4.4.1 Urban growth and expansion

As a result of scores of people moving into cities, 43% of the total global population lived in urban areas in 1990. Later, in 2015 it had increased to 54% of the total population of the world (United Nations, 2016) and tends to rise continuously. Cities have expanded to serve people working and living in urban areas. Urban growth has gradually expanded to upcountry areas resulting in residential areas, factories, commercial companies, department stores and other facilities. The most obvious changes are physical changes in high-rise buildings, infrastructure, roads, bridges, transport systems, etc, which are constructed to replace existing ones, especially green areas replaced by structures and buildings. Regarding urbanization, the most distinguishing change is urban growth and expansion, which has made physical features of those areas and surrounding areas change (Orathai Kokpol, 2016).

2.4.4.2 Family lifestyle changes

The housing environment in society is one of the impacts on people's livelihoods in society. Urban characteristics also affect residents' ways of life. Urbanization leads to more individuality because of urgent ways of life and adherence to regulations or social systems rather than rural assistance. Thus, urban people tend to be single and delay marriage. Additionally, based on population statistics, there is a relationship between urbanization and fertility. Countries with poor people and little urbanization have higher fertility rates and higher birth rates. For instance, low urbanization is found in African countries but the fertility rate is high, while urbanization in Europe, Japan and North America is high but the fertility rate is low.

People in the countries with high urbanization will be provided with good health care systems, as well as higher educational and occupational opportunities. People in these countries are likely to delay marriage and children, as well as have fewer children (Orathai Kokpol, 2016).

Because of changing family lifestyles, as well as delays in having children and fewer children, the ageing population increases and people of working age gradually decrease, leading to an ageing society. Over 10% of the population in the entire country are 60 years old or higher, 7% of the country's population is more than 65. In the current global situation, populations aged more than 60 are increasing (3.26% per year). These groups accounted for 12% of the total global population in 2015 (United Nations, 2016).

2.4.4.3 Slum Increase

From 1960 to 1970, international organizations such as the World Bank and the UN-Habitat were interested in the impacts of urban growth concerning management of residential areas and public basic services being sufficient for people. High urban growth has been caused by rural to urban resettlement and adequate housing management in many countries. The more urban growth, the more crowded communities. Houses will not meet standards and lack safety. At present, slums increase in accordance with urban growth. The slum problem reflects disparities in urban people's opportunities to access city resources (Orathai Kokpol, 2016).

2.4.4.4 Increasing Insecurity

Urban areas are more prone to crime than rural areas despite better security systems in urban areas. The safety of people's lives and assets cannot be taken care of thoroughly. Currently, the world is facing terrorism, which is an issue that is difficult to cope with. Terrorism takes place in public urban areas where large numbers of people live, such as department stores, hotels, public transport stations, schools, etc. The goal of terrorism includes the loss of many lives and a terrified society, where people do not dare to live their normal lives for social, political or economic benefit. Terrorism is difficult to prevent because terrorists hide themselves among the general population (Orathai Kokpol, 2016).

2.4.4.5 Challenges to public service provision

Urbanization also causes the spread of disease. For example, the SARS outbreak in China a few years ago was because of convenient and borderless transport. Due to crowded people in urban areas, disease infection is easier. Safety in various issues must be arranged in urban areas. This is one of the challenges of urban administrators (Orathai Kokpol, 2016).

2.5 Smart City Development in China

2.5.1 Background of Smart City Development in China

The smart city trend began during an economic crisis. In 2008, IBM Company started its operation with the concept of a smart city as one of its works that had started under the name of “Smart Planet”. In February 2009, IBM opened its annual meeting in Peking and proposed a strategy entitled “Breakthrough Smart City in China” and signed a contract on the construction of smart cities in collaboration with other cities in China. After that, the concept of “Smart Planet” and “Smart City” became an issue of interest. However, the objectives and strategies related to each smart city in China are different in accordance with its industrial characteristics (Yuan, Wang, Skibniewski, & Li, 2012). The most important event that has led China to smart city development is the fast growth of urbanization. According to China’s statistics (Ying CUI, 2017), the urbanization rate in China in 2011 amounted to 50%. When one point is increased, that implies a rural population of 14 million will become urban.

Urbanization has led to problems affecting the quality of people’s life and the well-being of Chinese people. There are two types of problems – sustainable development and equality in country development at the regional level, rural cities and social groups.

Table 2.9 Urbanization Problems in China

The Sustainable Development	**The equity of development**
Extensive economy growth mode	The quality of living
The shortage of resources: water, land and energy	Public services
Ecological environmental degeneration	Opportunities for development
Lack of social capital: social trust, community spirit and community attachment	
City management and public services	
Traffic jams	

Source: Adapted from Ying CUI, 2017.

The previous development of smart cities in China was classified according to topography into three major cities, namely coastal cities near the Yellow Sea that are along the northern sea of Eastern China; Bohai Sea, which is a gulf southeast of China, and the Yangtze River Delta in the east of China. Cities of different sizes proposed their smart city development plans by determining smart city development frameworks consisting of social management, application services, infrastructure, smart industry, security and standard systems. Examples of interesting smart city development plans include the “Wisdom Beijing Action Plan” of Beijing, the capital city of China in 2012. Two significant agendas were identified: major missions in Beijing smart city development plans, and indicators for developing a Beijing smart city “Action Plan 2011-2013 of Shanghai Municipality for Building Smart City” of Shanghai in 2011, “Smart Hangzhou Master Plan (2012-2015)” of Hangzhou in 2012 and “Smart Nanjing 12th Five-Year Plan” of Nanjing in 2011, etc.

Development plans for each smart city were caused by the analysis of specific characteristics of areas and development directions of diverse industries in each city. Thus, development goals, key issues and measures were also varied. At the same time, they were similarly related to many types of “urban problems” and important

agendas faced by many cities. However, numerous experts believed the keys to success of smart city development did not involve production of large numbers of ITs for constructing a digital city, but rather the ability to integrate a lot of information in the city via IT systems efficiently (Ying CUI, 2017) in order to create cooperation in sharing cross-functional and cross-industry data, including urban delicacy governance.

Based on information in 2018 (China Academy of Information and Communications Technology, 2018b), from 2012 to the present, the Ministry of Industry and Information Technology (MIIT) and the National Development and Reform Commission (NDRC) approved 542 pilot projects related to smart city development of agencies and various types of industries. Since 2011, 99 smart cities increased to 500 in 2016, in which 95% are cities at the sub-provincial level and 76% are prefectural-level cities.

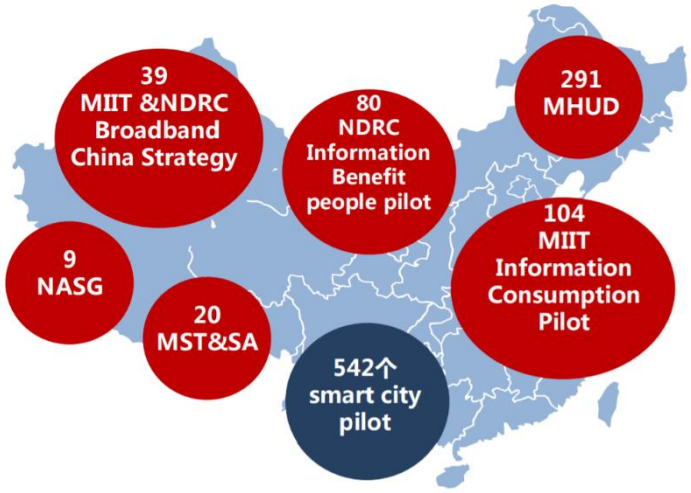

Figure 2.7 The Total Pilot Status of Smart Cities in China

Source: China Academy of Information and Communications Technology, 2018b.

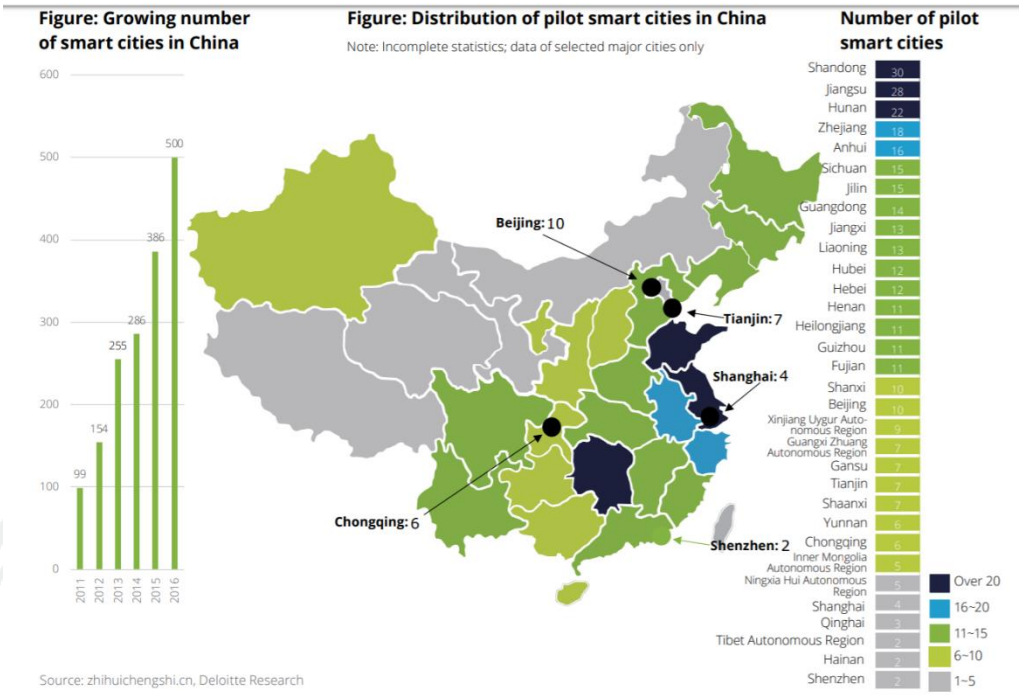

Figure 2.8 The Number of Smart Cities in China in 2018
Source: Deloitte, 2018a.

Since the Thirteenth Five-Year Plan for National Economic and Social Development, smart city investment projects in China are valued at 43.1700 billion yuan (about 1.813 trillion baht) in 2014 and increased to 65.0400 billion yuan (around 2.731 trillion baht), or 34% in 2018 (China Academy of Information and Communications Technology, 2018b).

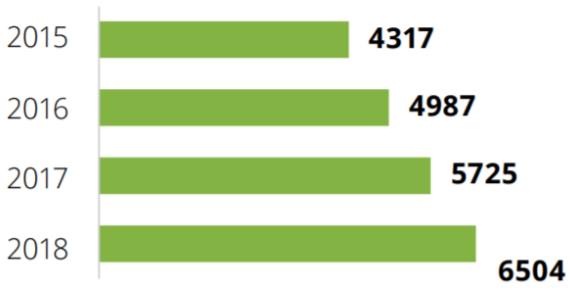

Figure 2.9 Market Size in Smart Cities in China (RMB100 Million)
Source: China Academy of Information and Communications , 2018b.

The development of smart cities in China involves geography. Most development of smart cities in China is concentrated in the east and expanding to the west because of three major reasons: 1) most cities were developed through an advanced economy that had enough capital for development projects, 2) talented people and experts in technology supporting project initiation, and 3) open-minded, so people were willing to accept new concepts (Ying CUI, 2017).

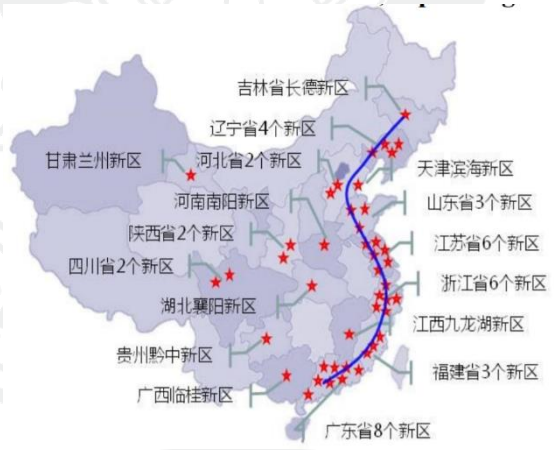

Figure 2.10 The New Towns and New Districts of Smart Cities in China
Source: Ying CUI, 2017

1) Smart city development evolution in China

There are four major stages in the evolution of development of smart cities in China, as follows:

(1) 2012 – The first batch of national wisdom city pilot list

Chinese local governments announced the first batch of national wisdom city pilot list of 90 cities in total comprising 28 key cities at the provincial level, such as Beijing, Shanghai, Tianjin, etc.

Table 2.10 2012 List of Provinces and Special Administration regions in the Pilot Smart City Project in China

Province and special administration region	**City**
Beijing	Beijing Dongcheng District, Beijing Chaoyang District, Beijing Future Science City, Beijing Lize Business District
Tianjin	Tianjin Jinnan New District, Tianjin Ecological City
Hebei	Shijiazhuang City, Qinhuangdao City, Langfang City, Handan City, Qian'an City, Beidaihe New District
Shanxi	Taiyuan City, Changzhi City, Pingzhou District, Zhangzhou City
Inner Mongolia Autonomous Region	Wuhai City
Liaoning	Hunnan New District, Shenyang City, Dalian Ecological Science and Technology New City
Jilin	Liaoyuan City, Panshi City
Helongjiang	Zhaodong City, Wuyuan County, Huanan County
Shanghai	Shanghai Pudong New Area
Jiangxu	Wuxi City, Changzhou City, Zhenjiang City, Taizhou City, Nanjing Hexi New City, Suzhou Industrial Park, Yancheng Chengnan New District, Kunshan Huaqiao Economic and Technological Development Zone, Kunshan Zhangpu Town

Province and special administration region	**City**
Zhejiang	Wenzhou City, Jinhua City, Zhuji City, Shangcheng District of Hangzhou City, Zhenhai District of Ningbo City
Anhui	Wuhu City, Tongling City, Handan City, Huainan City
Fujian	Nanping City, Pingtan City, Cangshan District, Fuzhou City
Jiangxi	Pingxiang City, Hongchang Beach New District, Nanchang City
Shandong	Dongying City, Weihai City, Dezhou City, Xintai City, Shouguang City, Changyi City, Feicheng City, Jinan West District
Henan	Zhengzhou City, Hebi City, Luohe City, Jiyuan City, Xinzheng City, Luoyang New District
Hubei	Wuhan City, Wuhan City Jiang'an District
Hunan	Zhuzhou City, Shaoshan City, Zhuzhou City Yunlong Demonstration Zone, Liuyang City, Baijia Town, Changsha City, Meixi Lake International Service Area
Guangdong	Zhuhai City, Panyu District of Guangzhou City, Luogang District of Guangzhou City, Pingshan New District of Shenzhen, Shunde District of Foshan City, Lecong Town of Foshan City
Hainan	Wanning City
Chongqing	Nan'an District of Chongqing City, Liangjiang New District of Chongqing City
Sichuan	Ya'an City, Chengdu Wenjiang District, Ji County
Guizhou	Tongren City, Liupanshui City, Wudang District, Guiyang City
Yunnan	Wuhua District, Kunming City
Tibet Autonomous Region	Lhasa City

Province and special administration region	**City**
Shaanxi	Xianyang City, Yangling Demonstration Zone
Ningxia Hui Autonomous Region	Wuzhong City
Xinjiang Uygur Autonomous Region	Korla City, Kuitun

Source: Ministry of Industry and Information Technology, 2015.

(2) 2013 – List of National Smart City Technology and Standards Experimental City

The Ministry of Science and Technology of the People's Republic of China and Chinese Standardization Administration. (SAC) identified a list of 20 national smart city technology and standards experimental cities consisting of Jinan, Qingdao, Nanjing, Wuxi, Yangzhou, Taiyuan, Yangquan, Dalian, Harbin, Daqing, Hefei, Wuhan, Fuyang, Shenzhen, Huizhou, Chengdu, Xi'an, Yan'an, Yangling Demonstration Zone and Karamay.

The identification of experimental locations relates to "technology" and "standard" of smart cities as a key strategy for driving the development of smart cities in China as a foundation for sustainable development. It also supports and promotes smart city innovation that suits the situation in China, smart city technology and standards that are intellectual rights, including Chinese identities to serve as a pillar to support science for constructing smart cities in China.

(3) 2014 - Guide of Sustainable Development of Smart Cities

The State Council of the People's Republic of China approved and instructed eight ministries and committees, namely the National Development and Reform Commission, the Ministry of Industry and Information, the Ministry of 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 to jointly draft and publish a guide of sustainable development of smart cities to be delivered to agencies concerned with various areas across the country. This guide specifies different missions carried out by the government and local agencies in order to achieve the specified goals so that smart city development in China is systematic and sustainable.

(4) 2016 – China's Construction of New-type Smart Cities

President Xi Jinping of China addressed an opening speech at the World Internet Conference at Wuzhen City, Zhejiang Province on December 16, 2015. He mentioned four principles of a "Global Internet Governance System" and five initiatives of a "Cyberspace Shared Future Community", which are significant strategies for new development of smart cities in China to enter the internet age, especially a proposal to accelerate the construction of infrastructure networks to push for the Innovation of Internet Economy and emphasize network security. The vision of Chinese leaders prioritizes the construction of smart cities in China. In the same period, the Chinese government issued many key strategies relating to development of smart cities in China, such as an "Internet+" Strategy, Big Data Strategy, etc.

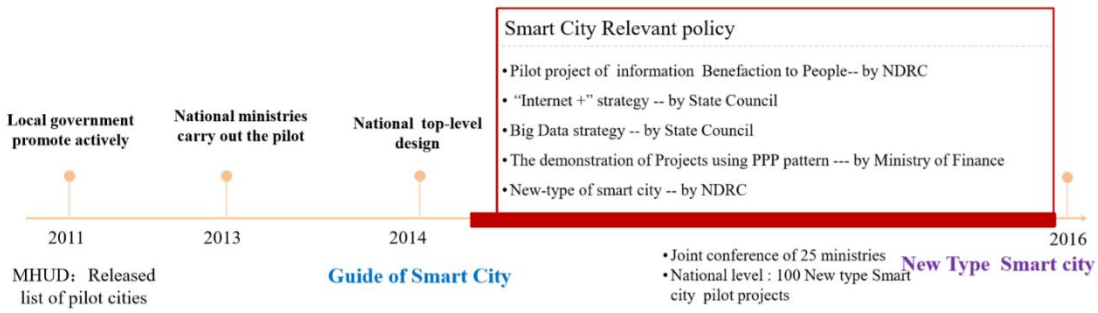

Figure 2.11 Smart City Development Evolution in China

Source: China Academy of Information and Communications Technology, 2018b.

2.5.2 Policies and Agencies Relating to Smart City Development in China

2.5.2.1 Chinese industrial development evolution

China is one of the world's largest producers and exporters of industrial products. China used to be a great industrial manufacturing company in the past, until the industrial revolution in England in 1760, when western power countries turned to manufacturing machines. As a result, the original manufacturing standard in China dropped swiftly. However, China became big again after the economic reform, to become a "Socialism with Chinese characteristics market economy" in 1978. The significant evolution of new age industrial development in China is as follows:

The People's Republic of China was established between 1949 and 1953. After the establishment of the People's Republic of China in 1949, China turned to renovating its industry by developing a Soviet-style, highly centralized planned economy and determining the direction for development of a new generation of Chinese industry, focusing mainly on heavy industries. China was supported by the Union of Soviet Socialist Republic at that time. This was an important foundation for the industrial structure in all types of manufacturing. During this time, China successfully produced their first car and airplane.

Great Leap Forward's Policy (1958-1960) – Chairman Mao Zedong put his efforts into changing the agrarian economy to a communist society through the establishment of people's communes. He announced a policy to enhance the potential for agricultural products and bring the industry to rural areas. However, the implementation of this policy led to a mega disaster in China when there was an imbalance of the agricultural and industrial sectors, particularly with an emphasis on steel production. A lot of labor was moved from the agricultural sector to the industrial sector. Agricultural land and environmental conditions were damaged so much that agricultural products decreased by more than 30%. At that time China experienced a drought, leading to a famine situation (1958-1962) throughout the country. This resulted in the loss of more than 30 million Chinese people. However, despite the termination of the Great Leap Forward Policy in 1961, President Lie Shaoqui harshly blamed such policies. This upset Chairman Mao, leading to the "Socialist Education or Four Cleanups Movement" (1962-1965) and the "Great

Cultural Revolution" (from 1966 to 1976) led by the Gang of Four. This is regarded as the dark age of economic and cultural recession in modern Chinese history.

Chinese economic reform (1978-2012) – the Socialism with Chinese characteristics market economy, was initiated by Former President Deng Xiaoping in 1978. After the Great Cultural Revolution and the collapse of the Gang of Four, China had wanted to revitalize its economic recession for decades. However, due to China's Soviet basic industrial structure, which was obsolete and inefficient in those days, the country had to be opened up to attract foreign investment and modern technology to help reform its economy. Later, in 1985 China was successful in its economic reform. Its industrial value soared by 25 times compared to that in 1952. China became an industrial country, which produced coal, textiles and bicycles. China also expanded its industry to coastal Southern China, known as the "Pearl River Delta Economic Zone".

After the 1990s China relied on many advantages, namely 1) cheap labor with basic education, 2) an easy land purchase policy, 3) large-scale domestic markets, 4) a stable society, etc. China attracted manufacturing companies worldwide to set up production bases in China for low value products, e.g. from ready-made clothes and dolls to high-value products, such as computers and 3G devices. Thus, the percent of products manufactured in China consistently increased until 2010, when China became the world's biggest manufacturer, whose industrial export was valued up to 70% (Bo, 2007). Thus, China was named "the World's Factory". However, the label "Made in China" in the global marketplace had a cheap and low-quality image, because 1) recent industrial research and developments relied heavily on technology, machinery and foreign experts, 2) most types of production mainly involved outsourcing and copying, as a result, China's ability in creating innovation and its brand quality were low, and 3) the basic level of material and part production and production techniques were low.

Chinese economic reform (2012-present)) – The implementation of Chinese economic reform has led to its exponential economic growth, which has led China to become the world's second economic power country. Due to rapidly increasing production costs, e.g. land, labor, resources and environment, its industries have faced increasing competitiveness. Its industrial type must be reformed and

changed by applying advanced technology as a strategy to enhance efficiency and to reduce operation costs.

China switched to pay serious attention to technology when the Chinese government realized that the major reason why China lacked its own technology was because of a lack of cooperation between research institutions and manufacturing companies. Although the number of S&T research findings from 1979 to 1984 rose from 2,790 to 10,000, most of that research would not be used. Most company executives still focused on the determination of production quotas more than technological innovation. In 1985, CPC made an announcement called “Resolution on the Reform of the Science and Technology Management System”, which stressed cooperation between research and manufacturing. CPC also believed that S&T would serve as a key to the transition of Chinese industry and economy. This maintained the intention in accordance with Deng Xiaoping’s “China’s Four Modernization” (1978). Science and technology were introduced to develop economic growth in terms of agriculture, industry, national defense and S&T.

In 1995, the Chinese government announced that S&T development was the national restoration strategy. Later, in 2015, Chinese Premier Li Keqiang announced the “Made in China 2025” policy in order to prepare China’s approach to the S&T revolution and industrial transformation, a new wave that is going to occur in the world.

2.5.2.2 Chinese economic reform

Due to China’s rapid social and economic development since its open-door policy, according to the economic system reform policy to become socialism with Chinese characteristics under the leadership of Deng Xiaoping in 1978, China has become the world's second largest economic power with an average GDP increase of 8.5% per year (Scissors, 2009).

Market- oriented economic reform started in 1978 comprising two phases: in the first phase at the end of 1970s to early 1980s, the agricultural sector was transferred to people and individuals had an open-door policy to welcome foreign investment and allow business operators to own their businesses. However, the Chinese government still owned most local industries. During the second phase, at the end of 1980s to the 1990s, public businesses were transferred to the private sector. A

contract was made to let the private sector operate businesses owned by the government, including cancellation of product price control measures, business protection policies and many regulations. However, these measures remained in the banking and petroleum businesses. As a result, private sector business grew to 70% of gross domestic product by 2005 (Engardio, 2005). Between 1978 and 2013, the Chinese economy grew as it never had before. However, after 2005, the government led by Mr. Hu Jintao and Mr. Wen Jiabao switched to better monitor and supervise the economic system, this could therefore offset some reforms.

Due to these policies and economic initiatives, there was a big change to Chinese society. Large-scale projects planned by the government, along with open markets, helped China reduce much poverty. At the same time, economic disparity and incomes became larger. However, such policies were key to China's open door, including technology and innovation development in China in later periods.

Because of economic reform policies, urbanization expanded at an exponential rate. In 2009, urbanization in China rose to 46.6% (National Bureau of Statistics of the People's Republic of China, 2010) and has grown at 100% per year since 2007. This reflects how urbanization has become a main model for developing the economic and social structures of China. The city development model consists of large cities as the center of the system, surrounded by small and medium cities of multi-level urban systems (Yuan et al., 2012). The rapid growth of urbanization in China has led to problems in the social and public sectors, e.g. insufficient public services, lack of education and employment, lack of public health systems, traffic jam problems, life and property safety problems, environmental problems, energy savings and carbon dioxide emissions, which result in decreasing happiness of its citizens living in urban communities.

1) "Made in China 2025" (2015-2025)

China's 10-year strategic plan, driven by Chinese Premier Li Keqiang in May 2015, was drafted by the Ministry of Industry and Information Technology of the Chinese government, aimed at transitioning China from the "World's factory", which focused on cheap and low-quality products due to low labor costs, to the "Strong Manufacturing Nation". Higher-value products and services have upgraded the production of Chinese industry into a technology-intensive powerhouse,

especially for advanced technology industries such as the pharmaceutical industry, automotive industry, aerospace industry, semiconductors, IT and robotics. The Chinese government has invested approximately 300 billion US dollars to achieve the "Strong Manufacturing Nation" by 2025. By 2035 China also aims to develop its manufacturing industry at a more exponential rate than Germany and Japan (Ministry of Industry and Information Technology, 2014).

The Chinese government has focused on 10 types of industries to step up to global leaders in the future, namely Information Technology (AI, IoT, smart appliances), Robotics (AI, machine learning), Green energy & green vehicles, Aerospace equipment, Ocean engineering & high tech ships, railway equipment, power equipment, new materials, medicine & medical devices and agricultural machinery (State Council of China, 2015).

Premier Li Keqiang (2015) stated that advanced standards of industries are an important driver to promote innovation and eradicate bottlenecks in the industrial development process because the middle-class in China is growing rapidly. These people require better quality products and services. Thus, it is necessary to accelerate quality development and product innovation in China in order to compete with foreign countries, this is called "China's quality revolution". This relies on entrepreneurs who are at the heart of entrepreneurship and craftsmanship. Several companies in China are known as key leaders in these technological industries.

Table 2.11 Technological Industries in China

Company	**Industries**
Baidu	AI, autonomous vehicles
Alibaba, Tencent	E-commerce
DJI	AI, drones
BAIC, Geely, BYD	New energy vehicles
Huawei	Semiconductors, telecommunications and consumer electronics
Xiaom, BBK Electronics	Consumer electronics

Source: Zenglein and Holzmann, 2019.

2) Thirteenth Five Year Plan **(2016–2020)** (National Development and Reform Commission of China, 2016)

The 13th Five-Year Plan for National Economic and Social Development (2016–2020) is a national economic and social development plan in China initiated at the 12th Chinese People's Political Consultative Conference (CPPCC) with the objective of responding to challenges in changing economic models according to new economic situations in the world. At the same time, another objective is to get per capita income of Chinese people to overcome the middle-income trap and attain the goal of a moderately prosperous society by 2020, including sustainable environmental policies (National Development and Reform Commission of China, 2016).

The essence of this development plan is as follows:

(1) Innovation: Move up in the value chain by abandoning old heavy industry and building up bases of modern information-intensive infrastructure.

(2) Balancing: Bridge the welfare gaps between countryside and cities by distributing and managing resources more efficiently.

(3) Greening: Develop environmental technology industry, as well as ecological living and ecological culture.

(4) Opening up: Deeper participation in supranational power structures, more international co-operation.

(5) Sharing: Encourage people of China to share the fruits of economic growth, so as to bridge existing welfare gaps.

To achieve the goals as planned, the government formulated major policies as follows:

2.5.2.3 Innovation and entrepreneurship

H.E. Mr. Li Keqiang, Chinese Prime Minister, addressed a statement in the government's performance at the annual central government meeting in 2015, " Everyone is an entrepreneur, creativity of the masses", which was a key strategy for driving the Chinese economy in a new age, promoting entrepreneurs to upgrade themselves and reform industries using innovation. Export-focused industries with low costs were switched to service-based and cultural-based industries, including providing experimental locations for free economic zones in many cities in order to get rid of difficulty and delay in the registration process of new entrepreneurs to start their businesses.

The plan also contained "the innovation and entrepreneurship demonstration base project" which will be developed to support new entrepreneurs to start up businesses, e.g. funds, technology, start-up training, fund provision supervision, etc.

Another policy that promotes Chinese government business initiatives includes "the replacement of a business tax with value-added tax". It is a financial and tax reform policy concerning the country's structural tax reduction measures, which is very important to China. Entrepreneurs have to pay value added taxes, replacing business taxes to the government as usual. Based on the principle of input tax deduction, duplicated taxation is mitigated to reduce the burden of entrepreneurs' tax payments. This measure has been effective since May 1, 2016 and has been used with high-technology service industry businesses, such as R&D and technical services, information technology services, cultural and creative services, logistics support services, tangible movable property leasing services, and forensic consulting services. Later, it was expanded to other businesses, e.g. real estate, construction, finance and consumer services.

Because of such measures, including the tax rate paid by business operators being changed from the business tax of 20% to a value added tax 6%, it was expected by the Chinese government that these measures would reduce the national net tax income by 100 billion yuan (4.2 billion baht) and could stimulate GDP to increase by 0.5%. In addition, they could increase export value by 0.7%. At the same time, up to 700,000 local people would be employed (China State Administration of Taxation, 2016). It is remarkable that these reduced taxes would become profits for entrepreneurs, as well as funds and incentives to upgrade and strengthen pilot innovation industries.

1) "Internet Plus" Initiative strategy -- by State Council

The "Internet Plus" Initiative strategy was suggested for the first time by H.E. Mr. Li Keqiang, Prime Minister of China, at the 12th National People's Congress to report the government's performance in 2015. Guidelines were also proposed at the congress to promote the integration of information technology, e.g. mobile internet, cloud computing, Big Data, IoT and new industries, as well as promote sustainable development in e-commerce, industrial internet and internet banking, and guide Chinese internet entrepreneurs focusing on international markets.

H.E. Mr. Li Keqiang, Prime Minister of China, stated that "Internet Plus" is an evolution of new development of the internet based on Innovation 2.0, which is modern information technology consisting of the Internet of Things, cloud computing, social computing and Big Data.

Various Chinese academics believe that the "Internet Plus" policy will be the most important tool for developing the Chinese economy in the future using "innovation". This will promote the informatization and push for industrialization in China in order to attain the Chinese economic goals of transforming the new economy from moderate and high speed growth to moderate and high quality. This could lead to the national targets that drive China to become a powerful industrial country.

There are many development scopes and models of the "Internet Plus" policy in many areas, e.g. Internet plus Manufacturing Industry, Internet plus Finance, Internet plus Medical System, Internet plus Government and Internet plus Agriculture.

2) Big Data strategy – by State Council

Chinese President, Xi Jinping addressed at the 2018 China International Big Data Industry Expo, “We adhere to the development concept of innovation, coordination, green technologies, openness and sharing. We focus on building a strong Internet power, a digital China and smart society, fully implementing the National Big Data Strategy and promoting the shift of China’s economy from rapid growth to high-quality development.”

The Chinese Big Data strategy policy was formulated as the first national strategy at the third Plenary Session of the 18th CPC Central Committee and the China State Council. The action plan for developing Big Data was also established in the same year.

The essence of the Thirteenth Five-Year Plan for National Economic and Social Development of China (2016-2020) states that Big Data is a basic strategic resource that must be developed and applied. The National Big Data Center and platforms shall be established as a pillar for support, especially development of necessary and relevant innovation and technology, such as data collection, storage, cleansing, analysis, mining, visualization, security, privacy protection, etc.

Many local agencies responded to such policies by establishing specific organizations to promote the development of Big Data, e.g. Beijing Institute of Big Data Research, Shanghai Data Exchange Center and Guangdong Big Data Bureau (Zhexue Huang, 2016).

Afterwards, the Nation Development and Reform Commission had a memo on the establishment of the Big Data Development Promotion Project. A scope of promotion consisting of four aspects was identified, namely the Big Data applications pilot project, Big Data sharing, Big Data infrastructure development, and the Big Data standards and exchange system (Zhexue Huang, 2016).

However, the policy is aimed at upgrading the quality of public services to become equal, widespread and convenient, covering education, employment, social security, public health, housing and transportation, and at efficiently solving poverty, as well as environmental problems (Xi, 2017).

3) Agencies formulating policies and directions for developing Chinese smart cities

(1) The Ministry of Industry and Information Technology of the People's Republic of China (MIIT)

Founded in March 2008, the Ministry of Industry and Information Technology of the People's Republic of China (MIIT) is in charge of industry and information industry under the supervision of the China State Council. It was initiated by the Ministry of Information Industry and the Commission for Science, Technology and Industry for National Defense (COSTIND).

Its mission includes: 1) prepare and abide by industrial plans, 2) formulate industrial policies and standards, 3) monitor and audit the operation of the industrial sector, 4) promote and develop technology and innovation, 5) manage transport and communication industry, 6) give advice and promote the invention of information technology, and 7) coordinate and maintain security of national information.

Major agencies under its supervision comprise: 1) Electronic Information Division, 2) Science and Technology Department, 3) Information and Software Services Division, 4) Information Communication Development Division, 5) Information and Communication Administration, 6) Cyber Security Authority, 7) National Radio Management Office, and 8) Energy Conservation and Comprehensive Utilization Division (Ministry of Industry and Information Technology, 2019).

(2) Nation Development and Reform Commission (NDRC)

The Nation Development and Reform Commission was established in 2003. It is responsible for monitoring the management of the Chinese macro economy, which is under the State Council. Its function is to manage and plan the quality control of the overall national economic direction. Its role is similar to that of “the Economic Ministers” or called the “mini-state council”.

Its major missions include: 1) draft, formulate and carry out national economic and social development strategies, as well as annual plans, 2) formulate macro-economic policies, 3) follow up and forecast trends of macro-

economic and social development, as well as be responsible for early warning and suggesting information to the government, 4) be in charge of processing the overall operation of social security funds in terms of financial and fiscal aspects, take part in formulating fiscal, financial, land and price determination policies, and 5) promote the adjustment of structural-based economic strategies for developing hi-tech industry and support development of strategic emerging industries, as well as promote the use of technology devices at a large extent.

Key agencies under its supervision include: 1) Development Strategy and Planning Division, 2) Regional Economic Division, 3) Infrastructure Development Division, 4) Innovation and High Technology Industry Division, and 5) Resource Conservation and Environmental Protection Division.

(3) Standardization Administration of the People's Republic of China (SAC)

Founded in 2001, its head office is in Beijing. It is an organization for developing standards, which are directly assigned by the Chinese State Council. It is responsible for monitoring and coordinating all standard systems in China, organizing activities for the China National Committee for ISO and IEC standards. In addition, it is authorized to approve and promote international cooperation, as well as organize the exchange of projects on standards. This agency has a role in designing and defining the framework for developing Chinse smart cities, covering all relevant information technologies, such as Iot, Cloud, 5G, Big Data, as well as information safety standards.

Its key missions include: 1) draft and specify the direction, policies and regulations on the national standard system, 2) monitor the national information standard, 3) be in charge of ISO and IEC regulations of the Chinese National Commission, and 4) monitor technology standardization.

Agencies under its supervision concerning information include: 1) National Information Technology Standardization Technical Committee and 2) China Wireless Telecommunication Standards working Group.

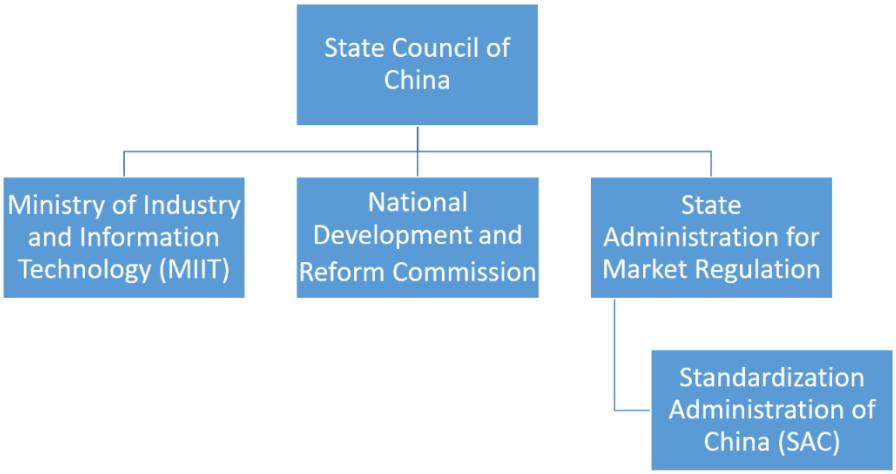

Figure 2.12 Agencies Relating to Smart City Development in China
Source: State Council of China, 2019.

(4) National Standardization General Working Group on Smart City (SMCSTD)

SMCSTD was founded in 2014 under the supervision of the National Standards Commission and other ministries related to smart city development. The commision was establisehd by a team of experts selected from professions related to standard evaluation and comprised of experts and academics from various areas in order to support SMCSTD's operations, particularly the evaluation of application operations, operation and testing of standard indicator systems, etc. Currently, the committee is comprised of members from 120 agencies covering science research institutes, private companies, business alliances, Standards Developing Organizations (SDOs) and local government, e.g. Beijing University of Aeronautics and Astronautics, Research Center of the Ministry of Industry and Information Technology, the China Urban Design Research Center, Telecommunications Research Institute, Huawei, ZTE, China Mobile, China Unicom, China Telecom, etc.

Its major missions include: 1) participation in setting international standards on smart cities and exchange of local and international

research, 2) planning and standardization of national smart city standards, and 3) planning and developent of smart city technical standards.

The committee consists of the four following working groups:

(4.1) Standard Coordination Working Group. Comprised of Basic Standards Expert Group, Technology Support and Platform Expert Group, Application and Service Expert Group, Safety and Security Experts Group

(4.2) Evaluation working group

(4.3) International Standardization Working Group

(4.4) Application Promotion Working Group

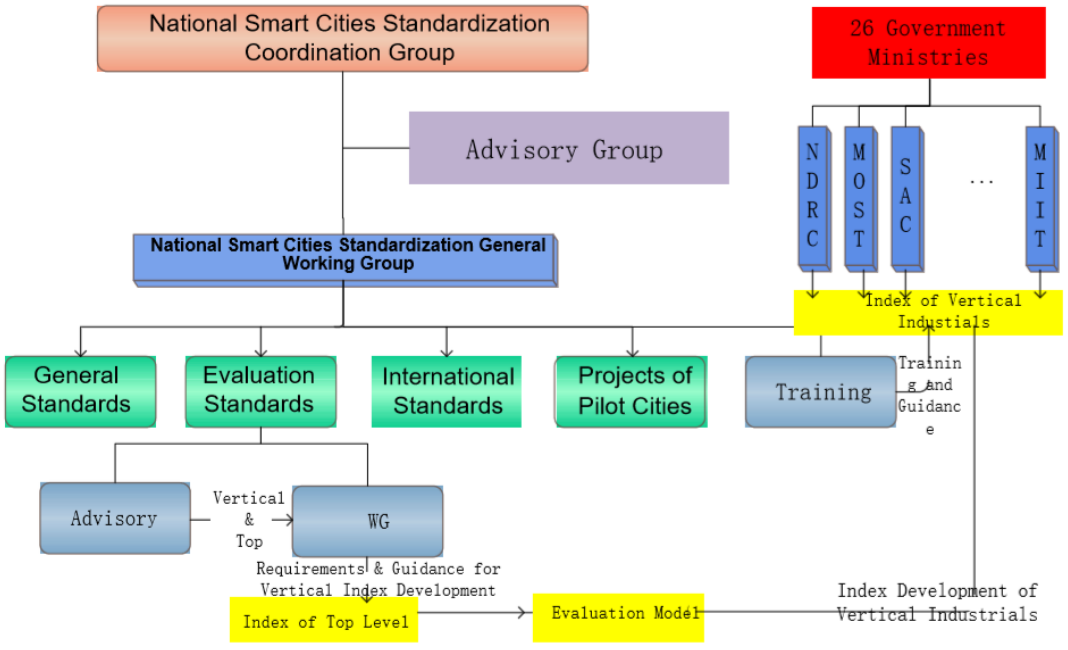

Figure 2.13 SMCSTD Organization Chart

Source: SMCSTD, 2019b.

The committee outlined seven smart city standards as follows: General Standards, Support Technologies Infrastructure, Construction and Applications, Management and Service, Industry and Economics, and Security.

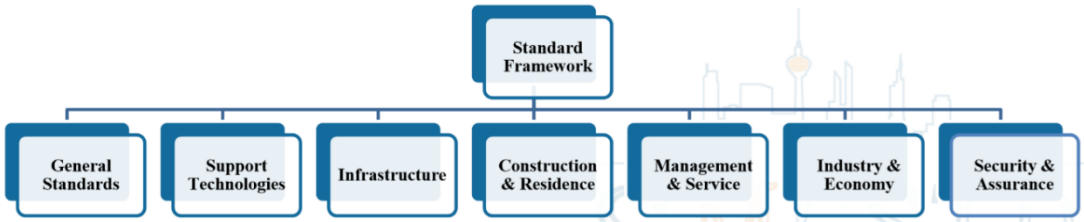

Figure 2.14 Systematic Viewpoint of Standards for Smart City
Source: SMCSTD, 2019b.

2.5.3 Chinese Smart City Development Models

Referring to the China National Information Technology Standardization Network (NITD) under the supervision of the Ministry of Industry and Information Technology of the People's Republic of China (MIIT), a data survey was conducted among samples from public agencies and large-scale information technology business operators across the country in 52 cities, namely Beijing, Shanghai, Wuhan, Nanning, Chengdu, etc. The results of the survey reveal the following:

1) Key smart city components of China include smart medical care, smart government, smart education, smart industry parks, smart transportation systems, smart tourism, smart manufacturing, smart logistics and smart public services. The most important smart city components for samples of the public and private sectors include smart government, smart public services and smart transportation systems, respectively (China Electronics Standardization Institute, 2013b).

Figure 2.15 China Smart City Components

Source: Adapted from China Electronics Standardization Institute, 2013a.

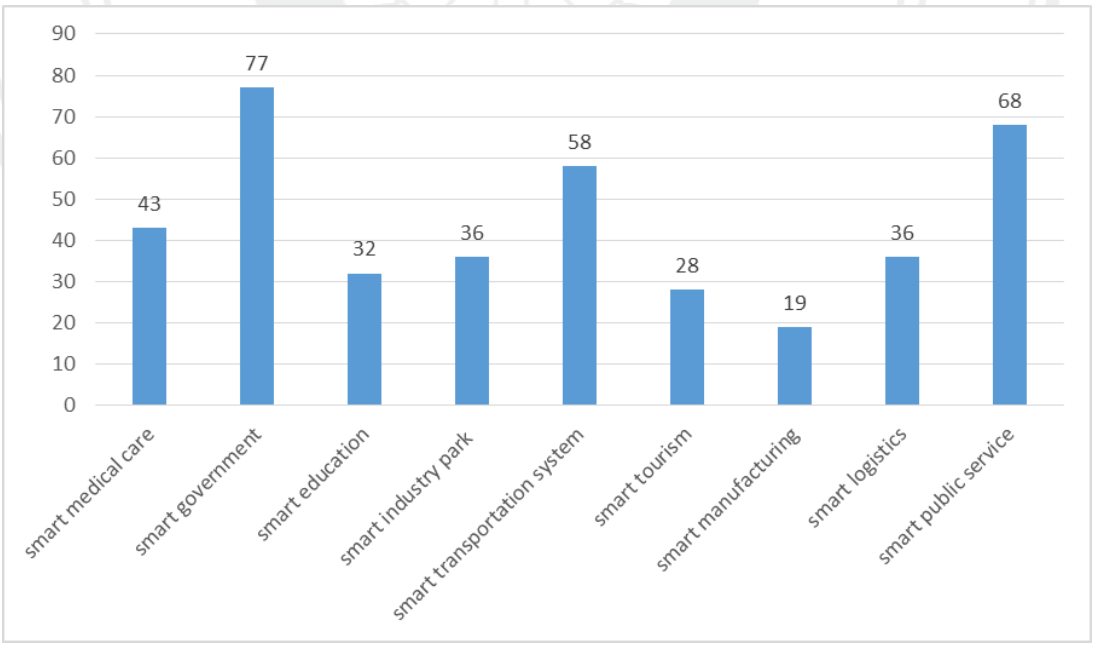

Figure 2.16 China Smart City Component Prioritization

Source: China Electronics Standardization Institute, 2013a.

Firstly, smart government is the foundation and core for smart city development, who is responsible for supporting other smart city components. City administrators in the public sector know the demand of citizens and outline strategies and action plans suitable for specific characteristics of each city. Secondly, smart public services relate to city safety management, environmental management, municipal structure construction, etc. Thirdly, smart transportation systems include key issues, e.g. "China T – Union" sold by China Transport Telecommunications & Information Center (CTTIC, 2013) and providing both land and water transport services. The service areas cover 31 provinces and 245 cities in China. It also relates to "Intelligent Traffic Management"", "Smart Bus System" and "Intelligent Electronic Charges", which are smart transport systems that help mitigate severe traffic jams in urban areas (China Electronics Standardization Institute, 2013b).

2) Projects on Chinese smart city components: The results of the survey indicate that the types of the largest number of smart city projects in China include smart government, smart transportation systems and smart public services, respectively.

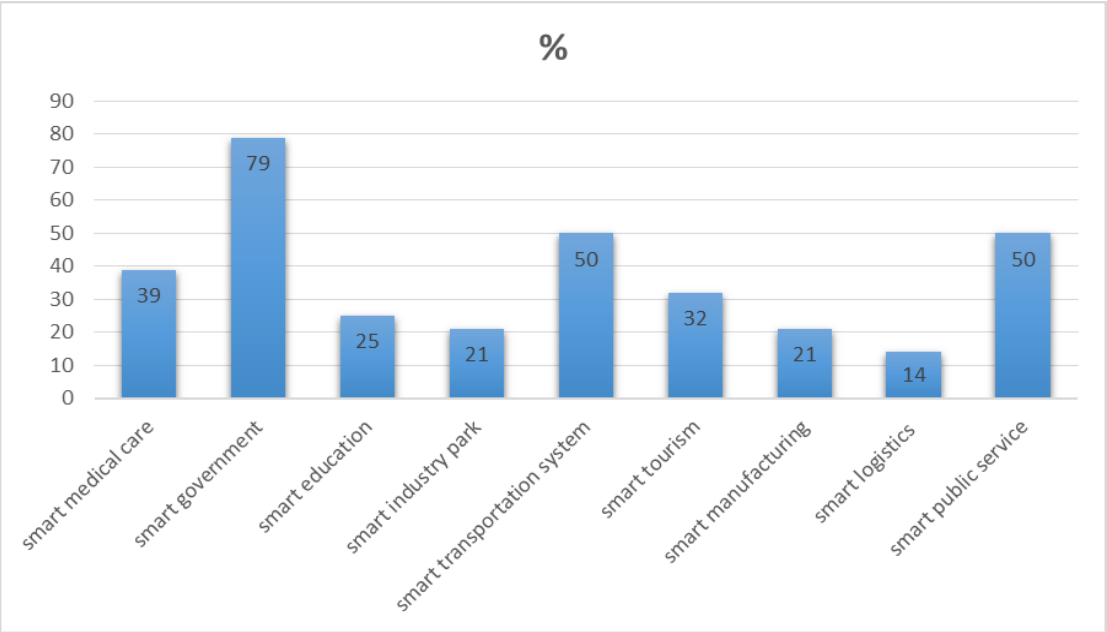

Figure 2.17 Types of the Largest Number of Smart City Projects
Source: China Electronics Standardization Institute, 2013a.

In the past few years, many local governments in China have established local government information systems via the e-government, and built digital cities, such as the collection and exchange of information of the city/sub-district government and subordinate units, as well as the reduction of public service use procedures from "One Stop Public Service" to "Zero Stop Public Service", increased people's idea sharing channels, inspection and prevention of public official corruption, etc. In brief, the local government designed and determined Chinese smart city development plans, strategies and directions by taking into account varied identities according to local regions. The local government also focused on exchange of experience among local governments in order to develop smart cities quickly and efficiently (China Electronics Standardization Institute, 2013b).

3) Key construction projects

As for the construction of smart cities in China, administrators and relevant teams have to study large amounts of information on social sciences, science, technology, etc, and use them to plan and set the standard practices for key projects. The results of the survey indicate that key pilot projects during the Chinese smart city

construction step include “integration and sharing information resources” and creation of “intelligence applications in construction”. In particular, the government is interested in sharing information and integrating data, as well as using information efficiently, including business cooperation in cross-organizational businesses. Additionally, the public sector emphasizes other pilot projects, namely data gathering and collection, as well as network infrastructure construction, respectively.

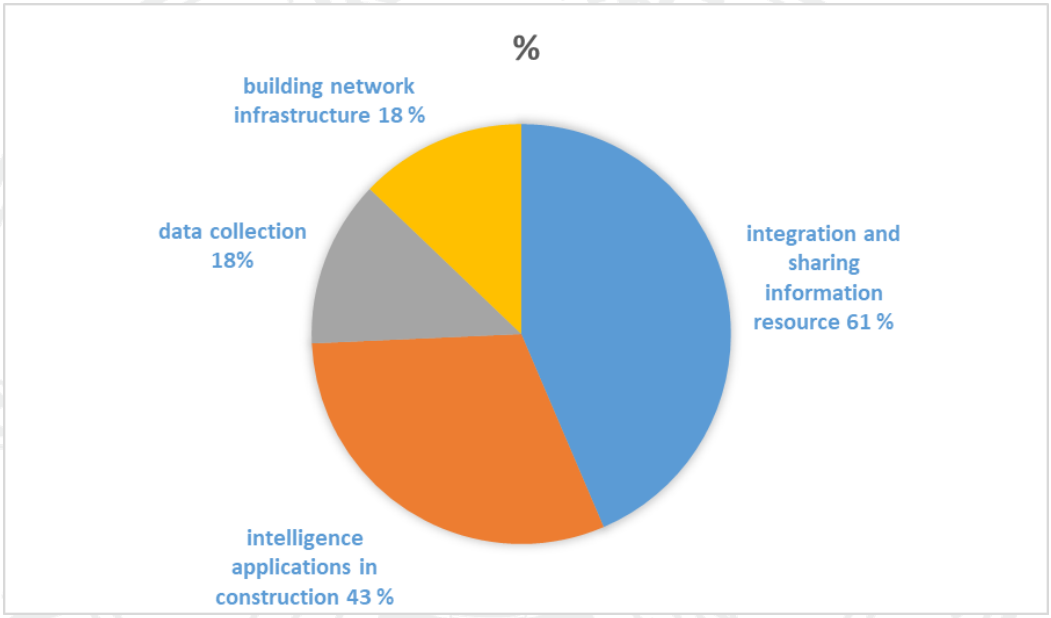

Figure 2.18 Key Pilot Projects for Chinese Smart City Construction
Source: China Electronics Standardization Institute, 2013a.

4) Technology business operators for Smart City Projects in China

Currently, there are various technology business operators related to smart city projects, both international and Chinese companies. The scope of relevant technology business mostly offers technological services, such as Big Data, IoT, Cloud, AI, etc.

In the beginning, multinational companies played a great role in developing Chinese smart cities, such as IBM, Microsoft, Oracle, etc. Because of cutting edge technology development and the Ministry of Industry and Information Technology’s promotion, many of these companies that provide information

technology services stepped up at the front row, not only in China but also to other countries.

The survey revealed that the Chinese companies that have played a role in driving the development of smart cities in China include China Telecom (CTCC), Digital China (DC), China Mobile (CMCC), China Unicom (CUCC) and Huawei. They provide relevant design and solution services, as well as assist companies in the planning and installation of systems. However, most large companies in China currently install new information systems to provide their business with competitive advantages and are ready to step into the digital economy and Internet 2.0 eras of China.

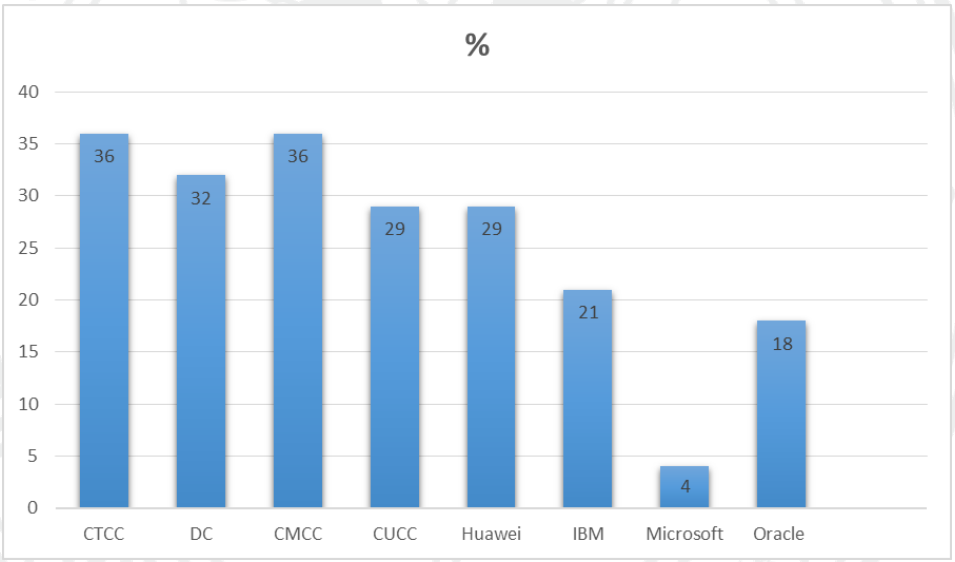

Figure 2.19 Companies Playing a Role in Driving Smart City Development
Source: China Electronics Standardization Institute, 2013a.

Most companies that provide the above information technology in China have provided smart city business services and cooperated closely with the local government in pushing for the overall planning of smart cities or conducting projects through projects related to smart cities. The survey indicated that projects operated by Chinese service providing companies have supporting strengths

according to topography, use devices and major interests. To create an understanding, the examples in the table below were given to explain, as follows:

Table 2.12 Strengths of Services Provided by Information Technology Service Companies in China and Importance to Smart City Development

Company	**Type**	**Business strength**	**Importance**
China Telecom (CTCC), China Mobile (CMCC), China Unicom (CUCC)	Tele-communication service providers	Creating 5G mobile network	1. Create a business platform that covers smart city development areas 2. Create and operate infrastructure for urban informatization
Digital China (DC), Chinasoft International (CSI)	System integrators	Overall planning and operation of information system services	Link external industrial chains and internal resources via smart city projects
Huawei	Information and solution products	Internet of Things Communication network Internet convergence technology	1. Create a digital city to have interactions and diverse control methods 2. Create a comprehensive ecological urban system

Source: Adapted from China Electronics Standardization Institute, 2013b.

5) Models of key smart city prototypes in China

Models of smart city development in China vary according to the different goals and industries in each city. The key prototypes of smart cities in China have different strengths, as follows: (Deloitte, 2018b).

Smart Living: Wuhan stresses the promotion of interaction between the public and private sectors and improvement in the standard of living through transfer systems and efficient response to threats to city information. Tianjin strives to initiate

their e-government, data access systems and information hardware, as well as promotes construction of smart cities.

Information technology & smart infrastructure: Chongqing emphasizes the promotion of improving data infrastructure, censor infrastructure across the city and public information platforms, as well as potential for network coverage, while Shanghai aims to promote information infrastructure and cyber security, as well as promote the collection of real time public transport data.

Internet of Things (IoT): Shenzhen focuses on the application of IoT technology to different projects in local administration in order to promote public services to be more convenient, e.g. access to the public data center or identification card issuance.

Internet of Things (IoT) & Big Data: Hangzhou aims to push for the establishment of a specific agency to monitor six areas of information, namely cloud computing, a Big Data industry center, the IoT, internet finance, smart logistics and digital contents industries.

Smart Transportation: Guangzhou stresses the creation of a smart transportation system sensor platform installed to cover all key areas along primary and secondary roads, including city entrances and exits in order to check real time traffic data and control passenger flow at the center of city transport. Chengdu aims to improve smart transport networks and develop tourism in collaboration with the business sector, e.g. DiDi and Microsoft is expected to benefit from technologies, such as cloud computing and IoT technology.

Big Data & Smart Economy: The prevalence of broadband facilities and applications working on the smart IT-based system promotes the development of information technology and IoT networking in Beijing, as well as boosts Beijing’s economic growth.

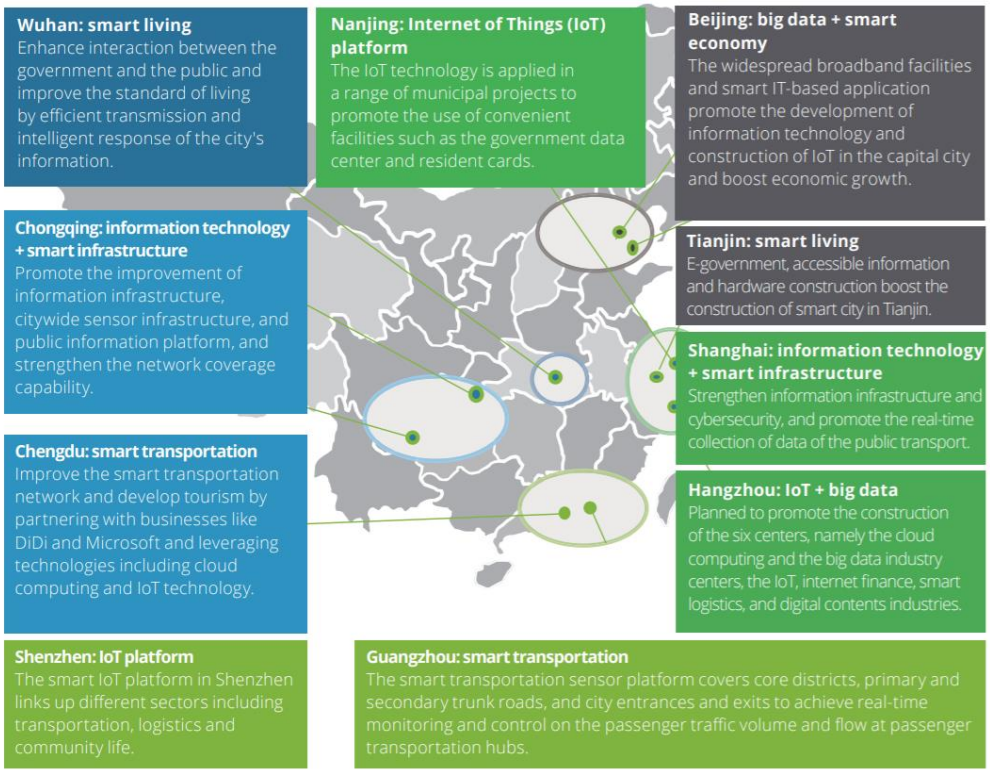

Figure 2.20 Prototypes of Major Smart Cities in China
Source: Deloitte, 2018a.

2.5.4 China's New-type of Smart City

Urban administration and management is not only a key component of the country's administration system but also a significant leader in monitoring the Global Internet Governance System. It is also a foundation of the Cyberspace Shared Future Community. In a period of almost ten years, China has created more than 500 pilot smart city projects nationwide to improve public service levels to become more efficient, upgraded the public management and promoted urban economic development (H.E.Li Yuanchao, Vice President of the PRC at the Opening Ceremony of the 2016 China International Friendship Cities Conference).

Because of the advancement of the regulating system and the ability of good governance to continuously develop China's modernization according to the slogan of the Chinese government's new economic development guidelines on "innovative, coordinated, green, open, and inclusive growth', as well as national strategies, such as

a national cyber development strategy, national Big Data strategy and internet plus initiative, cities have been redefined and their needs are set to push for smart city evolution from the original dimension to new smart city models, and create opportunities and challenges to developing new types of smart cities in China.

President Xi Jinping of the People's Republic of China addressed the concept of China's new type of smart city for the first time during the opening ceremony of the World Internet Conference at Wuzhen, Zhejiang Province on December 16th, 2015, especially the "four principles of Global Internet Governance System" and five claims of the "Cyberspace Shared Future Community", which are significant policies to guide the direction of new smart city development in China which will approach into the Internet Age. In particular are suggestions to accelerate speed for the construction of infrastructure networks to push for development of The Innovation of Internet economy and prioritize network security (China Academy of Information and Communications Technology, 2018a).

The essence of the new Chinese smart city concept is "to let people be the center of public services. The main goal is to promote efficient and systematic city management, disclose information, integrate and use common information, develop cities in accordance with a green economy policy and upgrade security on cyberspace through a system planning mechanism, which contains information and innovation to drive the integration of modern information technology and develop city modernization, leading to regional coordinated development between the country and its cities" (China Academy of Information and Communications Technology, 2018a).

1) Three key characteristics of the new-style innovation smart city (China Academy of Information and Communications Technology, 2018a).

(1) Openness, contribution and sharing principle

The government has to prepare city development plans and data, as well as disclose them to people to create understanding of the government's overall planning and share their views to attain social consensus.

(2) More equitable access to services

In the past, smart city public services were aimed at satisfying people by mainly increasing IT ability. However, the new style of smart city strives to get rid of gaps to access information as much as possible. The objective is to help

disadvantaged communities be provided with better public services without relying only on high technology.

(3) More distinctive characteristics

The construction and development of original smart cities has often started in large cities. However, information technology development in small and medium-sized cities cannot simulate the model completely. Thus, the construction of new style smart cities will emphasize the promotion of cities based on more distinctive characteristics, as well as promote economic development at the local level through distinctive projects, such as construction of small cities which have distinctive characteristics, etc.

2) Five goals of the new-style smart city (China Academy of Information and Communications Technology, 2018a).

The Chinese government's new-style smart city policy has the major goals of efficiently improving public services and improving management potential, as well as promoting city economic development. Social and economic targets are as follows:

(1) mprove quality of life

As for smart public services systems, the objective is to disclose, share and integrate information relating to smart public services, including health care, employment, public safety and education.

(2) Improve governance efficiency

To make use of information for city administration and promote governance modernity using information technology and producing complete city information platforms.

(3) Develop green economy

To provide sustainable green ecology and lead to joint economic development, especially environmental protection and energy management.

(4) Opening and integration of data

To create an information sharing platform to the public sector with the purpose of breaking an information wall among different sectors, e.g. education, transport and economy, resulting in data connection.

(5) Improve cyber security

To provide safe data transmission by utilizing a Next Generation Network which can provide a wide variety of telecommunication services and work on the high-speed network infrastructure that supports service quality, including government internet networks, public internet networks and IoT, which will be linked in the future.

3) The “Six One Model” new smart city construction concept (China Academy of Information and Communications Technology, 2018a).

The Chinese new-style smart city model or “Six One Model” consists of six major components:

(1) One open architecture: The system setting rule is based on systems engineering in order to create an open information system structure based on a concept designed to share and integrate data, as well as allow the use of applications in order to guide the creation and development of new-style smart city development.

(2) One grid of heaven and earth: City Information Service Grid is the foundation of new-style smart city development, leading to accurate urban sensing that links between the information network and public services that provide maximum benefits.

(3) One universal functional platform: A functional platform is created to support smart city administration and public services, to carry out outage management and integrate service encapsulation based on information resources from various sources so that the public sector can manage basic city data resource efficiently and enhance system efficiency.

(4) One data set: Open data systems are created to share information through the collection, classification and integration of data, leading to the sum of data. This will increase efficiency in using data to support decision-making for city administrations.

(5) One urban operation center: A highly efficient centralized smart city operational center is established to cooperate in sharing city resources and coordinate with cross-functions. This will help the public sector to perceive possibilities and solve problems quickly, e.g. public infrastructure, public safety, environmental ecology, macro-economy or citizens’ opinions.

(6) One set of standards: Creating a standard system in all aspects for smart cities is an important guarantee for sustainable city development. The public sector has to play a role in guiding, setting a direction, strategic policies and rules to serve as a main guideline, combined with distinctive characteristics of each region, including planning according to classification of types and components in each construction project in order to form standard systems covering construction standards and smart city evaluation.

After defining the framework for new-style smart city construction, the Chinese government will designate key construction areas of new smart cities in four areas, namely 1) Internet of Things open architecture, 2) Urban open information platform, 3) Urban operation command center, and 4) Cyberspace security system, which are consistent with the “Six One Model”.

2.5.5 A Conceptual Framework of China Smart City Development

1) Smart City Standardization Roadmap

During the process of China smart city development, the Chinese government has prioritized standardization related to China smart city development. The Ministry of Industry and Information Technology of the People's Republic of China and the Standardization Administration of the People's Republic of China (SAC) determined a smart city standardization roadmap with the following steps:

(1) Apply relevant theories and lessons from existing practice to analyze current situations related to systematical smart city development in terms of technology and standard situations in order to create and determine a technical development framework and a standard system development framework concerning smart city development

(2) Gather groups involved in smart city development in order to brainstorm ideas to draft a white paper on the standard, e.g. a Technical Committee, alliances, stakeholders and standardization organizations, etc., to brainstorm ideas and experience in drafting the white paper on smart city standards.

(3) After drafting the white paper to serve as an operation guide, analyze the overall situation at the national level in order to set specific standards and

suggest recommendations about key requirements and job characteristics necessary for smart city development

(4) Finally, determine a standardization roadmap to be used for laying out standard system structures and formulate key standard research and development plans for the country.

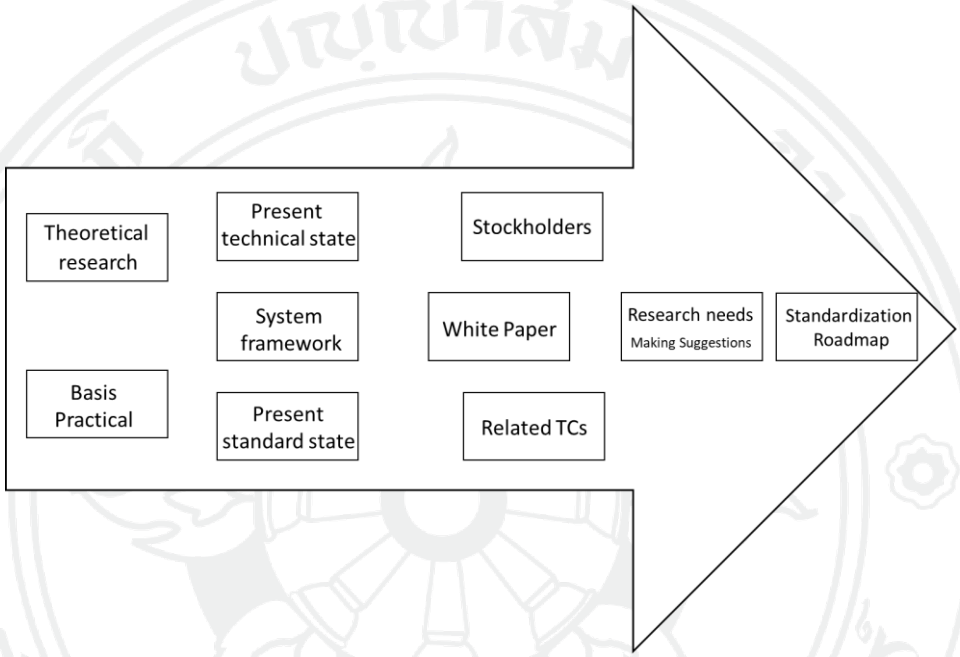

Figure 2.21 Smart City Standardization Roadmap
Source: Adapted from China Electronics Standardization Institute, 2013b.

2) A Conceptual Framework of China New-Style Smart City Standard Systems

The China new-style smart city standard system comprises seven major standards, namely 1) general standards, 2) supportive technology standards, 3) infrastructure standards, 4) construct and living standards, 5) management and service standards, 6) industry and economy standards and 7) security standards (SMCSTD, 2015) with the following contents:

(1) General standards consist of reference model, terminology, evaluation metrics and general guidance of standards.

(2) Supportive technology standards comprise IoT & sensor network, data fusion, service fusion, business cooperation, communication, computing & storage, domain knowledge model, public platform and public operation center.

(3) Infrastructure standards are comprised of transportation, environment protection instrument, ICT, water and energy.

(4) Construct and living standards consist of plan & design, implementation, environment and operation management.

(5) Management and service standards comprise e-gov, market regulations, public safety, emergency, logistics service, education service, culture service, social service, housing service, financial service, e-commerce, land management, population management, community management, real estate management, transportation service, energy mannagment service, medical service, labor service, pension service and travel service.

(6) Industry and economy standards are comprised of industry plan, new industry and industry promotion.

(7) Security standards consist of data security, system security, security management, technology testing, safety protection and system testing.

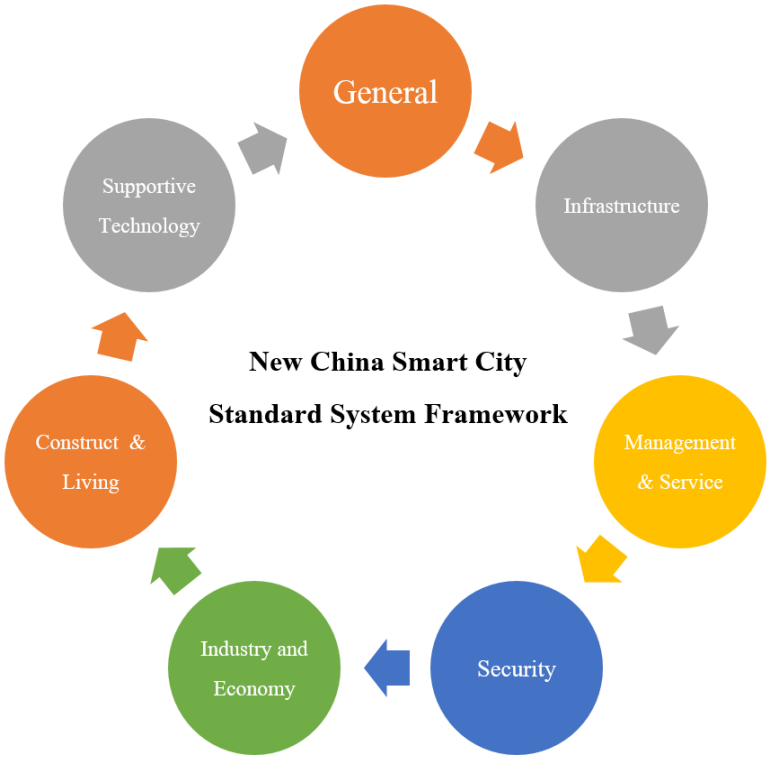

Figure 2.22 A Conceptual Framework of China New-Style City Standard Systems
Source: Adapted from the SMCSTD, 2016b.

When comparing the original standard system structure and the new-style smart city standard system, it is notable that there are new standard systems, namely the basic structure standard and industry and economy standard. This indicates that China smart city development is carried out at the city administration level, as well as economic development, which the Chinese government pays attention to with the digital economy and green economy concepts based on the idea of sustainable development.

At the same time, due to the progress of information technology in China, information technology was previously applied to few basic public services, but it is currently used to improve the quality of public services to be more inclusive. As a result, people are provided with public services more conveniently, quickly and fairly.

In addition, the Chinese government lets business operators and people search data about standards from the website of SMCSTD via http://www.smcstd.cn/index in order to use information for their businesses in relevant industries. This is a strategy to promote knowledge and give advice to entrepreneurs who play a great role in driving the development of smart cities, as well as to provide people with information to monitor public sector operations.

3) China Smart City Development Technology System Framework

The China smart city development technology system framework (Y. Li, Lin, & Geertman, 2015) has been proposed as follows: Service users are grouped into three groups: citizens, businesses and the government. The data access channels are different. The external environment, which is the source of all information that must be integrated into the system, includes climate, water, electricity, gas, electricity poles, roads, cars, humans, structures, houses, etc.

As for overall smart city development, major components of information systems are classified into four levels of key elements and three support systems for the smart city development framework. Horizontal components relate to and depend on each other. Vertical support systems also relate to constraint relations with the above four levels.

The content of the structural framework is as follows:

(1) The four levels of key elements are comprised of an IoT level, network communication level, data & service support level and intelligent application level.

The IoT level has the function of providing cognitive intelligence to the external environment. Internet technology is the key. Other tools such as SIM, Sensor, RFID, CCTV, etc. are used to categorize, collect, censor and control data from different sources in smart cities, e.g. infrastructure, environment, buildings, area safety, etc.

The network communication level has the function of constructing a network communication infrastructure that is widely and conveniently used and has high speed to provide a flow basis with basic flow, and shares and uses city level information. The heart of this level is the integration of internet, telecommunications networks and broadcasting networks, e.g. mobile internet so that smart cities have

optical networks with high capacity, high bandwidth and high reliability, including wireless broadband networks that cover all areas across the city.

Data & service support level has the function of collecting, sharing and using information from a wide variety of sources in the city and to support intelligent application programs. This is the most important key for the smart city development project. Currently, data & information are strategic resources, 3 types similar to physical materials, structures and people's wisdom in the city. The key to the city smartness level relies on integration of data and the sharing of information supported by technology, namely Big Data, SOA and the Cloud.

Data & Information Resources include a basic information repository, information sharing & exchange, information application fields, internet information resources and data warehouses from all agencies and all industries in the city, including the Internet Data Center (IDC) and safety infrastructure.

Basic Information Repository refers to the general basic data about smart city creation comprising population, company juristic person, natural resources and land, as well as a macro- economic data repository.

Information sharing & exchange refers to the sharing and exchange of information between agencies, organizations and information systems to gain benefit from the shared and exchanged data to create international standards and systematically organize data leading to cooperation in exchanging cross-area and cross-organization information.

Information application fields refer to specific information resources, as well as the collection and classification of information resources in each industry so as to be systematic so that external agencies can access data and be provided with such information services needed for making decisions in planning and determining the goals and directions for complete city management.

Internet information resources refers to the internet, which covers all aspects of daily lives among city people. This reflects a brief simulation model of information society, as well as processing the efficiency of the internet so that it has a high impact on the allocation of city resources.

Data Integration: Data integration steps are comprised of data convergence and storage, data fusion processing and intelligent mining analysis.

Data convergence and storage refers to the collection, management and analysis of a large amount of distributed data that is important to the operation of smart city administration. Therefore, a smart city data repository must be highly efficient to converge and store gigantic data.

Data fusion processing refers to storing, transferring, integrating, screening and processing beneficial data from various sources, including managing and coordinating information from data sources, platforms and a wide variety of user systems to ensure connection and in-time communication between data processing units and the data collection center so that they can operate consistently.

Intelligent mining analysis refers to self-analyzing, self-classificating, self- summarizing, self-discovering and describing trends and unusual things from enormous amounts of information in order to apply valuable data and knowledge to further develop intelligent applications.

Service integration: Several types of data are used to develop service platforms that support applications for all service sectors, which rely on the operation of technology, SOA and cloud, such as cloud service, etc. Data integration consists of service development, service management, cooperative accessing and city common services.

Service development refers to support for the invention, experiment and planning of services to service developers in order to upgrade the quality and potential for delivery, as well as decreasing the delivery costs of developers.

Service management refers to organizing service resources, supporting maintenance, monitoring and managing services operating on such platforms.

Cooperative accessing refers to participation in managing problems via computer networks so that computers can send and receive data to each other to share resources.

City common services refer to the integration of data and services, which includes information on general public data provided to all sectors in smart cities, e.g. a location service, VOD service, social networking service and virtual

reality service, etc. as a database for supporting public services and applications for use in all industries.

"Intelligent application level" has a function to apply data to various suitable types of work. After data analysis, statistical calculation, forecasts and simulation, it leads to intelligent applications, which are then used to satisfy the users' needs in the people, business and public sectors. They also help to increase the quality of public services. The creation of intelligent applications is vital to developing and driving informatization and digitization in various industries in the cities, e.g. smart government, smart transportation, smart education, smart medical, smart home, smart industry, etc. It could be stated that it is the mechanism for driving the development of smart cities that will support smart city administration and promote efficient social management, including being able to enable public services to have broad access to all sectors in society.

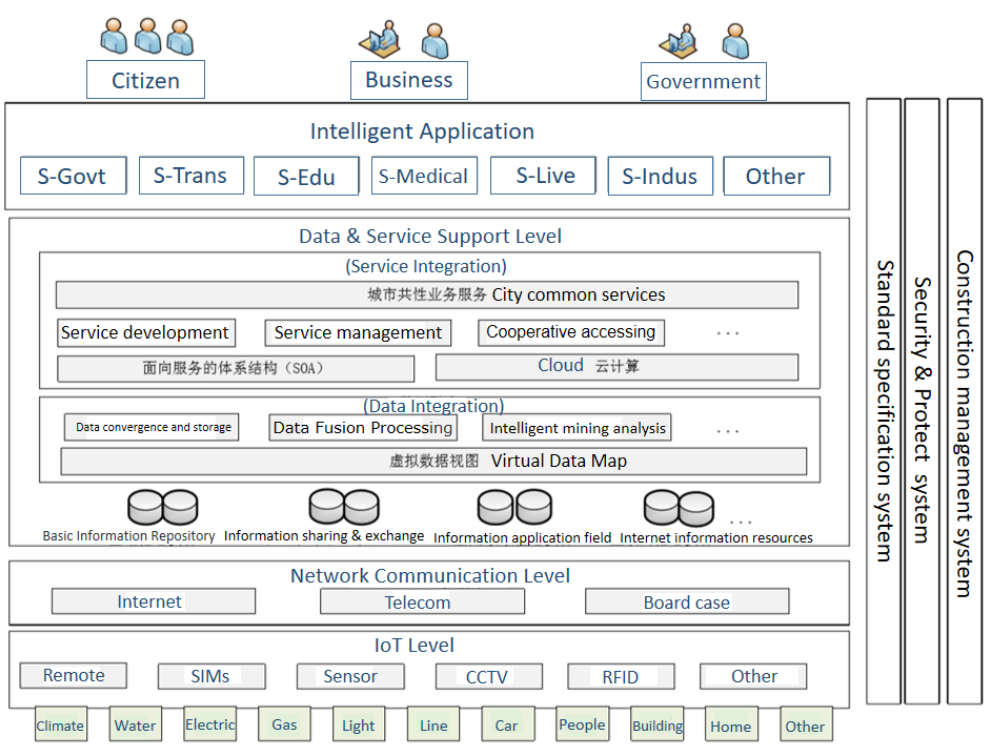

Figure 2.23 China Smart City Development Technology System Framework

Source: China Electronics Standardization Institute, 2013a.

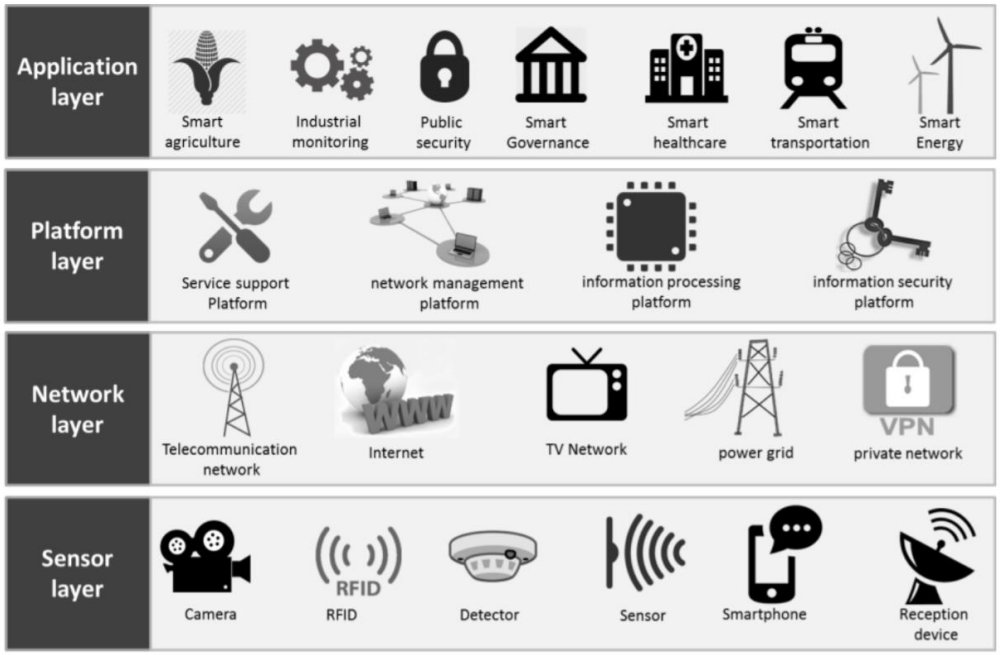

Figure 2.24 Four Layers of China Smart City
Source: Y. Li et al., 2015.

(2) Support systems comprise standard specification systems, security & protect systems and construction management systems.

Standard specification systems refers to standardization related to smart city creation to formulate guidelines and standards for the overall picture of all smart cities in order to maintain an open, flexible and agile atmosphere for developing the project.

Security & protect systems refers to smart city management that requires inclusive security systems of information and upgrading the potential for controlling the security of basic data networks, major information and data systems to make the environment in the data systems highly reliable.

Construction management systems refers to the creation of systems guaranteeing that construction projects in smart cities can be carried out smoothly. They comprise construction management and operation management. The issues relate to smart city projects, e.g. planning, design, operation, management, quality control, standardization, process and pattern methods during the initiation of construction projects, etc.

4) A conceptual framework on actors of each layer

There are different actors in each layer in the conceptual framework for smart city development. Key actors includle the public, market business and social sectors, which have the following major roles:

(1) Government

The government and market sectors are key stakeholders in developing smart cities. Since 2008 IBM has suggested the concept of "Smarter planet" and "Smarter City" and the Chinese government approved the 2008–09 Chinese economic stimulus plan for the investment of 4 trillion yuan (16 trillion baht) for the development of infrastructure and social welfare. Since then, the government and all levels of China state enterprises have foreseen development opportunities and participation in smart city creation (Wang, 2013). Since 2010 China has initiated smart city projects. At the end of 2018, more than 500 cities took part in establishing smart cities. The investment of infrastructure, e.g. communication networks and data platforms were valued in 2018 up to 650.4 billion yuan (2.731 trillion baht) (China Academy of Information and Communications Technology, 2018a). The smart city project became one of the most important measures for the operation in accordance with the policies of the Central Committee of the Communist Party of China (CCCPC) and the State Council of the People's Republic of China in order to apply innovations to drive national development, promote a new style urbanization and create a society of well-being in all aspects. In addition, smart cities are a model of economic strategies of four new modernizations of Chinese government: industrialization, agricultural modernization, urbanization and informatization (Y. Li et al., 2015).

(2) Market

The market sector plays a key role in this process. A lot of local and foreign business operators have participated in developing smart cities in order to expand their businesses. The statistics reveal that three large-scale Chinese telecommunication business operators signed a strategic cooperation agreement on smart cities with the provincial-level government and the prefecture-level government. The percent of cooperation was higher than 85% (Y. Li et al., 2015). The three large-scale telecommunication business operators not only applied their smart

city strategies but also devoted themselves to creating telecommunication networks for their cities, as well as distributing a cloud computing center throughout the country with the objective of expanding their market shares in the data service business. At present, the number of domestic and international information entrepreneurs participating in smart city business is increasing. There are 33 smart city business companies registered in China. Companies registered doing business relating to smart cities have increased to 229 companies, such as IoT, cloud computing, Big Data, smart grid, intelligent medical and others. In addition, there are more than 30 foreign large-scale entrepreneurs entering the Chinese smart city business market (Y. Li et al., 2015).

(3) Society

Apart from the government, many public agencies have taken part in developing smart cities, e.g. colleges, universities, hospitals and the Police Department, etc. These agencies took part in developing smart cities indirectly and cooperating with the government and business sectors in buying products and services to provide smart city services. For example, China Mobile cooperated with schools in launching an education informatization project, which is a three-in-one educational project comprising educational informationalized equipment, an educational informationalized application platform, a computer equipment network and expert management teams. Various schools and educational service agencies have installed fiber optic systems to provide video surveillance systems (Mobile, 2013).

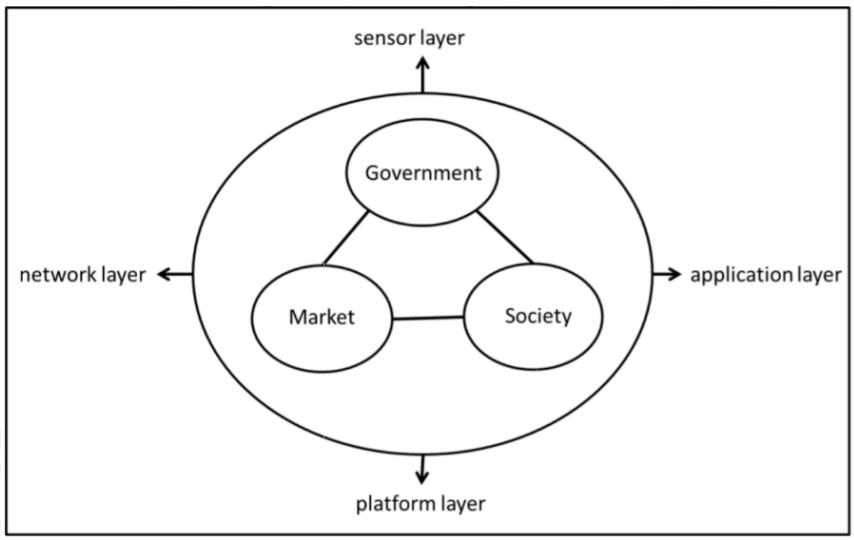

Figure 2.25 Actors in Smart City Development Framework in China
Source: Y. Li et al., 2015.

2.5.6 Chinese Smart City Development Indicators

Chinese smart city development indicators have been designed into two indicators: 1) capability indicators, and 2) performance indicators (SMCSTD, 2016a) as follows:

1) Capability indicators are comprised of four indicators with the following details:

Table 2.13 Chinese Smart City Capability Indicators

Capability indicators	Details
Information resource	• Opening Information resource
	• Information resource sharing
	• Information resource exploitation & utilization
Cyber security	• Cyber security management
	• Detection warning and emergency
	• Secure and controllable

Capability indicators	Details
Innovation capacity	• Urban ecological environment livable
	• Innovation model
	• Technology R&D
	• Scientific research transformation
Guarantee mechanism	• Plan & construction
	• Standard system
	• Policy & regulation
	• Financial & investment system
	• Organization management system

2) Performance indicators consist of five indicators as follows:

Table 2.14 Chinese Smart City Performance Indicators

Performance indicators	Details
Infrastructure	• Information infrastructure
	- Urban public information platform
	- Boardband development
	- City sensoring coverage
	• Public service infrastructure
Social management	• Urban informationization management
	• Public security
	• Market supervision
	• Emergency management
Public service	• Service convenience
	• Service coverage
	• Service satisfaction
Industrial system	• Industrial informationization
	• Modernaization service

Performance indicators	Details
Ecological livable	• Environmental protection • Energy saving • Community management & service

Source: Adapted from SMCSTD, 2016b.

The design and standardization of smart cities in China is a major pillar for smart city development in order to be sustainable and consistent with urban requirements. The determination of indicators for smart city assessment is aimed at 1) determining assessment indicators in terms of scientific principles and possible implementation for public agencies and relevant business operators, 2) forming a foundation for supporting smart city development, 3) serving as a guideline to guide the direction of smart city development and 4) supporting and pushing for development of relevant industries.

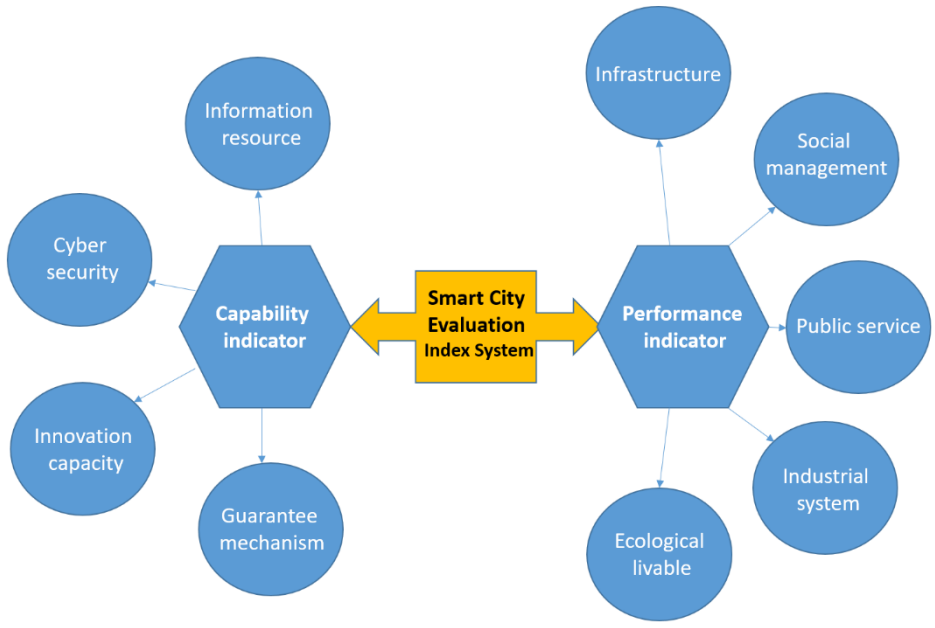

Figure 2.26 Smart City Evaluation Index Framework in China

Source: SMCSTD, 2016b.

2.5.7 Strategy Analysis Theories

Strategic analysis involves analysis of the organizational environment: external and internal environmental factors, which have direct and indirect impacts on organizational management. Although the organizational environment changes all the time, according to social dynamics, the analysis can help to determine the direction of organizational management to be effective.

2.5.7.1 SWOT Analysis

Albert Humphrey's SWOT analysis (2005) is a tool of strategic analysis comprising external and internal environmental analysis. People involved in formulating strategies must understand the relationship and trends of the external and internal business environment. The key objectives of the strategic analysis are to forecast factors affecting organizations, which may be positive impacts that provide opportunities, or negative factors that provide threats to organizations. The results of strategic analysis consist of opportunities and threats caused by external factors, as well as strengths and weaknesses caused by internal factors.

S stands for strengths, referring to strong points arising from internal factors that are advantages coming from the internal organizational environment, e.g. ingredient, financial, production and human resource strengths. Organizations have to benefit from these strengths to draw up strategies.

W stands for weaknesses, referring to weaknesses arising from internal factors that are problems or failures caused by the organizational environment, which must be solved by organizations.

O stands for opportunities, referring to opportunities arising from external factors that contribute to or promote the operation of organizations. They differ from strengths as they are caused by the external environment, while strengths are caused by the internal environment. Good managers must always search for opportunities and benefit from them.

T stands for threats, referring to obstacles arising from external factors, which are threats caused by the external environment. Organizations have to adjust marketing strategies and try to get rid of them.

TOW Matrix is a matching of strengths, weaknesses, opportunities and threats derived from the analysis of the external and internal organizational

environment (SWOT Analysis). The TOW matrix is divided into Strengths and Opportunities (SO), Weaknesses and Opportunities (WO), Strengths and Threats (ST) and Weaknesses and Threats (WT).

2.5.7.2 Diamond model

Porter (1990) presented a diamond model based on the diamond model of national advantages. He mentioned environmental factors in the industry, each of which relates to each other and affects increasing business competitiveness and operations. The determinants comprise 1) factor conditions, 2) demand conditions, 3) related and supporting industries, and 4) firm strategies, structure and rivalries.

Porter emphasized the government roles that have direct and indirect adverse impacts on the four environmental factors in the diamond model. They affect factors or contribute to or restrict the efficient improvement of companies in the networks of such industries.

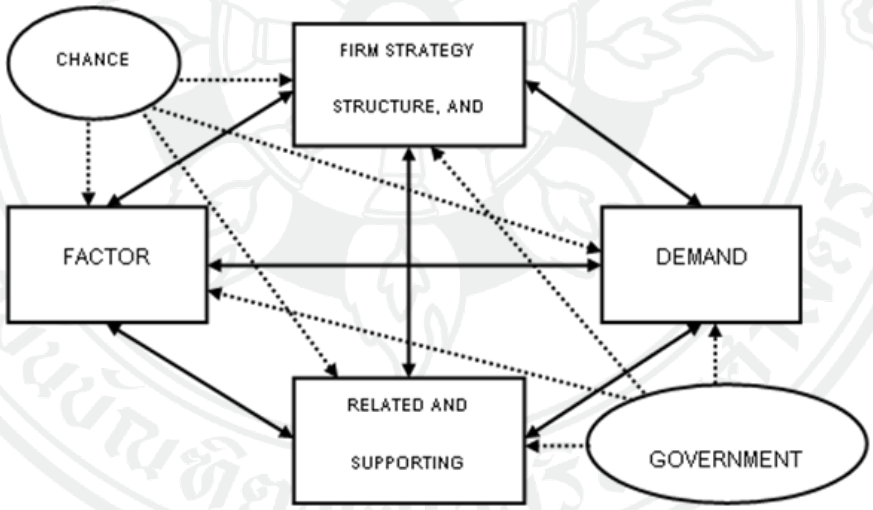

Figure 2.27 Elements of the Diamond Model
Source: Porter, 1998.

1) Determinant components

(1) Factor conditions

Factor conditions can be divided into generalized and specialized factors. Generalized factors refer to roads, funding sources (debts),

personnel with Bachelor's degree or lower, who are not limited to any specific industry. Specialized factors refer to personnel with graduate degrees or specific training, which are usually those graduated with higher than a Bachelor's degree, infrastructure for specialized purposes and advanced knowledge for specialized use, etc. These specialized factors can be used in some industries only.

(2) Demand conditions

Local demands affect models considered by companies and meet the buyers' demands. Countries have competitive advantages in the industry or its parts that have clearer buyer demand models than other countries.

(3) Related and supporting industries

Countries with related and supporting industries, which have international competitive advantages, are beneficial to bringing about international competitive advantages of related and supporting industries.

(4) Firm strategy, structure and rivalry

Countries tend to succeed internationally in an industry that originates competitive advantages in accordance with management systems. This means the selection of strategies and structures that reflect the unique characteristics of specialized innovation of that country. Apart from the four determinants in the diamond model, there are the following external factors that have a role in the country's competition.

Government is an institution that has positive and negative impacts and is simultaneously affected by the four determinants, e.g. domestic production factors affected by public policies on the stock exchange, education, government grants, etc. The government can promote or obstruct creation of the country's competitive advantages, but cannot create them directly because they belong to the private sector's role.

However, there are comments concerning the diamond model related to the number of hypotheses that support theories, because Porter summarized experiences only from North American and European countries, as well as Japan, not from developing countries in the developed regions of the world. Davies and Ellis (2000) explained that sustainable prosperity may be created without becoming a country that "is innovation-driven". A country with direct foreign

investment does not indicate a lack of competitiveness or a country that has low productivity.

2.5.8 Relevant Technological Evolution Theories

2.5.8.1 Moore's Law

G. E. Moore (1965) described the trend of computer hardware development in the long term, maintaining that the quantity of transistors on integrated circuits will double every two years and its capacity or speed will double every 18 months in the following decade. Nowadays, it indicates processing power that doubles rapidly and lower production costs.

However, this law has been proved consistently for over half a century. The ability of many electronics devices obviously follows Moore's law, such as in processing speed, ram capacity, censors or the number of pixels of digital cameras. When they have more processing ability to support a greater variety of applications, their usage will be increased.

Due to laws related to digital technology, it is evident that the readiness of technology that has been rapidly developed requires the application of digital in order to drive the operation. Organizational digital transformation is more important. Organizational management models are changed, from an emphasis on low-cost labor to one of high-skilled labor and increasing efficiency by means of digital technology. This leads to business opportunities for new competitors, e.g. startups that use digital to enhance their business' competitive advantage.

2.5.8.2 Murphy's Law

Murphy's Law was conceived by Murphy (1949), who was an engineer at an air base in the United States. During the aviation industry period, after World War II, aviation engineers at that time tried to break the sound barrier with accelerated speed. In this endeavor, new technologies were often designed that couldn't pass the test.

Currently, rapid innovation growth means that innovation may be used before all its risks are found. Murphy's' law has influenced the creation of technological innovation. Murphy's Law states that "anything that can go wrong, will go wrong". Its significant meaning means events can occur that often are not as

expected, or fail because the mathematical concept states that events, which rarely occur, are certain to occur because the possibility is more than 0.

Murphy's Law warns that the more technology grows, the more complicated problems become, because accidents and mistakes tend to take place all the time. Prudent and cautious technological risk prevention measures can, therefore, prevent losses caused by unintentional human errors, especially technological risks that occur immediately. When such risks are possible to take place even less than 1%, they become hidden dangers.

2.5.8.3 Diffusion of Innovation Theory

Roger (1995) proposed the diffusion of innovation theory, which stressed the belief that social and cultural change occurs because of the diffusion of new things from one society to the other. New things are called innovation, which includes knowledge, concepts, techniques, methodology and new technologies. He explained that this theory has four main elements in the diffusion of innovations:

1) Innovation or new ideas that will spread to society. In general, distributed and acceptable innovation consists of two major parts – concepts and objects. In addition to concerning receivers, social systems and received communication, any innovation itself that will be accepted or not is important.

2) Communication is made through any type of communication, so that people in society are aware of communication systems. Communication refers to communication between the messenger and the receiver via any media, in which innovation distributes from the source to users or innovation receivers.

3) Time or rate of adoption: To enable people in society to know about innovation, new concepts or the utilization of available objects in a new form for economic benefit, the process of innovation distribution requires time and steps so that people can adapt themselves and accept innovation or new ideas.

4) Social systems through the spread into social members – Social systems influence innovation distribution and acceptance. In other words, social systems in modern society contribute to innovation adoption in terms of speed and rate of adoption, because of the adoption of social norms and values that support social and cultural change. Thus, in the case of the spread of new things, they will be

easily accepted, while an ancient society or society adhering to beliefs will adopt innovation more slowly and less, or may not adopt it at all.

Roger also created an S-curve of innovation to explain the phenomena of technology or innovation in society, where the Y axis represents the efficiency or the number of users in society, and the X axis represents time.

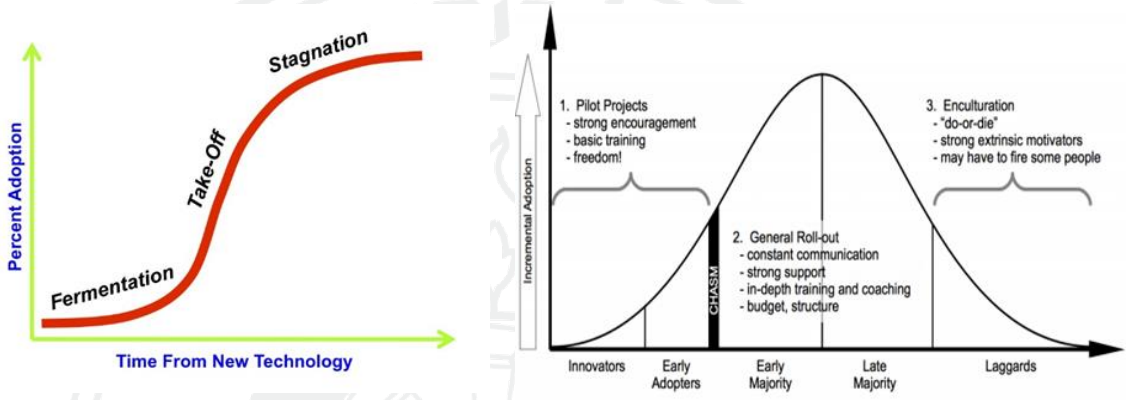

Figure 2.28 S-Curve of Technology and the Chasm Model
Source: Roger, 1995 and M. H. Moore, 1995.

Step 1: Fermentation is the period of innovation until the success appears and market testing starts.

Step 2: Take off is the period when technology or innovation interacts with people in society so that they realize that the technology exists, society then learns about this technology until it is accepted by the people in society and becomes innovation business that grows quickly. Technology that is rapidly developed along with increasing numbers of users is the most suitable period for business. Everyone wishes to do business during this period. Of course, those with new innovations should enter the market at this time.

Step 3: Stagnation is the time when technology is saturated and the efficiency of technological development reaches a maximum level of resources produced which can no longer be further developed. The efficiency of technology will remain without being further developed until new technology replaces it and it disappears from society.

It is notable that Roger explained the S-curve of technology with a clear picture of occurrence, popularity and dispopularity in accordance with its efficiency. This is consistent with the spread of such technology in society via each group of people in society. G. A. Moore (1991) adopted Roger's theory and developed it further into the Chasm Model, which stresses innovation adoption in early adopters, and has a great influence on innovation, whether it exists or not in society. It is comparable that this group having a chasm, which must make innovation be in line with the demands of society until they are accepted. Finally, if innovation passes this chasm, such innovation will be accepted and will bring about overwhelming commercial benefits to society. This period is called business take off, which will yield maximum interest.

2.5.8.4 Dynamic Systems Theory

Jay Wright Forrester, a computer engineer and systems scientist founded the Dynamic Systems Theory, which simulates an interaction between objects in the feedback control system applied to research related to the explanation of organizational systems operations or social systems. In 1969, Forrester presented his research report "Urban Dynamic", to explain the evolution of urban development pertaining to the interaction of social units comprising population, housing and the business sector. This drives economic and social growth. The results of an economic downturn will lead to unemployment. Later, in 1971 Forrester proposed a book entitled "World Dynamics" describing a city simulation model consisting of complicated interactions of the economy, population and global ecology, which will lead to global sustainable development problems.

The principle of the Dynamic Systems Theory comprises the four following parts:

1) Information feedback – The information system within the environment affects policies and results of policy implementation that will influence the environment. Environmental systems caused by changes will create new information and affect policy-based decision-making until it becomes a cycle of information feedback.

2) Decision-making processes – The decision-making process is often influenced by the surrounding environment. As a result, the quality of

decision-making may not be controlled by free will. We can use this benefit to determine the decision-making process and influence the environment. Dynamical Systems Theory emphasizes that the future success of organizations depends on the policy design at the organizational level.

3) Cybernetics – The measurement of organizational efficiency usually starts from the determination of goals, operational structures and models to achieve such goals. Then, it is evaluated by the difference between actual performance and goals.

4) Simulation – A mathematical experiment is adopted to produce a model to explain the cause and effect relationship of dynamic changes in dynamic systems behavior, which can be monitored to have a clear understanding. The calculation of complex formulas relies on advanced computer technology, which has been more adopted to management.

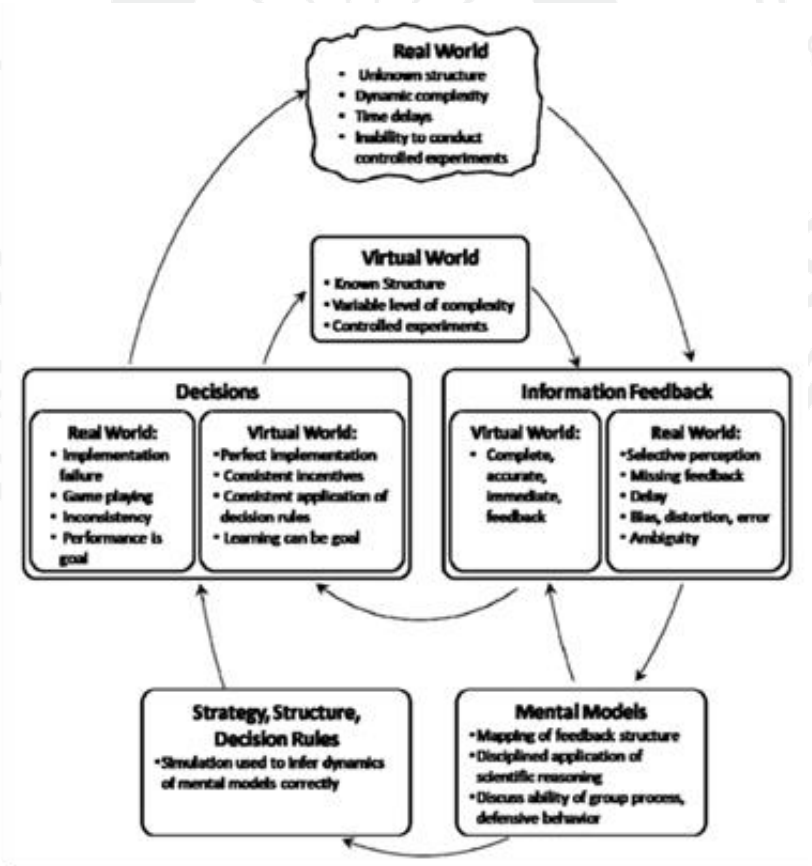

Figure 2.29 Systems Thinking Model

Source: Sterman, 2000.

The study of smart city development using the Dynamical Systems Theory can start from the creation of a smart city model by determining sub-units of the city ecology first. Then, the major components are defined as variable factors in order to study the interaction between variables in the sub-systems. This will enable us to understand the interaction of the integrated systems more clearly. There are both positive and negative causal feedback loops of different factors. Positive causal feedback loops will lead to changes that create reinforcement. As a result, a target rehearsal phenomenon will appear. However, negative causal feedback loops lead to the adaptation of stable status. Most systems are caused by a combination of both positive causal feedback loops and negative causal feedback loops. After adaptation and refinement, system behaviors occur in various forms of urban development, e.g. stability, growth or recession. We can use the dynamic system model for the study of complex smart city factors, such as the relationship between public expectations, sensing quality and public satisfaction, or the relationship between public satisfaction, city image and public trust (Zou, Cao, Guo, & Wen, 2018).

2.5.8.5 Toffler's Wave Theory

Toffler's Wave Theory was presented in a book called The Third Wave written by Alvin Toffler in 1980. In Toffler's book, he tried to explain changes in country development evolution from an industrial society, called the "Second Wave" to "Third Wave", which is an information age. Toffler (1987) described society in three types according to the wave concept. Each wave pushed society and existing traditions. Alvin Toffler's concept in the book entitled "The Third Wave" is summarized as follows:

The First Wave refers to agricultural society, which has existed for thousands of years. Humans stopped hunting and switched to cultivation and animal farming. This was the transition of human livelihood that stopped wandering and turned to farming. This led to grouping lifestyles resulting in society and cultural development and economic wealth.

The Second Wave was the industrial age society. Its emphasis was on production and large-scale markets using machines to increase productivity in the logistic sector, and distributing products to various channels. This wave was the

period when trade and economic growth expanded considerably under the force of technology and machinery.

The Third Wave is the information age society. It is an era of data connection and access from everywhere. Supported by basic technological components in terms of computers and telecommunication structures, it has become a network community where people from every corner of the world can access information and services linked together through the internet. It is a starting point of change and a new economy that is driven on the network. Additionally, it is connected and has evolved to include other developments and lifestyles.

China is entering the transition to the age of information technology. The current policy of the Chinese government that pushes China into the "China New Economy" is a change of economic structure to a value-based economy or an economy driven by innovation. The basic concept is a switch from production of "commodities" to "innovation-based products", and from driving the country by its industrial sector to driving it by technology, creativity and innovation. Its emphasis has also changed, from product manufacturing to more service sectors. The adoption of the basic concept from Alvin Toffler's book in this era is, therefore, the most suitable. When most people have more access to technology and the internet in a society that consumes news, people who use more information to persuade more customers will gain a competitive advantage.

2.5.9 Conceptual Framework

The conceptual framework is created as the instrument to help study Shanghai Smart City Development. The researcher reviews three important concepts. These concepts are brought about to the ideas of the researcher and created it as the useful framework of the study. The significant concepts are as follows.

Firstly, the researcher uses a conceptual framework of smart city components developed by Rudolf Giffinger et al. to the analysis and explanation of smart city development in each aspect of Shanghai Smart City. Some academics have categorized smart cities into six components that are as follows.

1) Smart Governance consists of the application of ICT to public administration at the local and central levels, promotion of interactions between the

public sector or service providers and the people sector or service users, including supporting the public sector services to increase efficiency and effectiveness using ICT.

2) Smart People comprises the application of ICT to develop human resource potential in terms of educational development, training and the country's human resource management in order to create an environment that promotes creativity and innovation.

3) Smart Mobility is comprised of the application of ICT to link data, such as transport, traffic, etc, and different information gathered as big data to serve as key information that can be analyzed to search for problems and suggestions to solve traffic problems.

4) Smart Living consists of the use of ICT in daily life, e.g. residential environment and communication devices, which are automatically managed by efficient, convenient, reliable and useful smart networks.

5) Smart Economy comprises the application of ICT to businesses in E-Business and E-Commerce to enhance manufacturing efficiency, delivery of products and services as well as the creation of economic innovation, smart cluster and eco-systems.

6) Smart Environment consists of preservation of the environment, forests, plants, ecology, agricultural promotion, city food sources, public parks, green areas, water management, water pollution, air pollution and urban heat islands.

Secondly, the researcher reviewed the Diamond model (Porter, 1990) to analyze the competitive environment of Shanghai smart city. This model mentioned environmental factors in the industry, each of which relates to each other and affects increasing business competitiveness and operations. The determinants comprise 1) factor conditions, divided into generalized and specialized factors. Generalized factors refer to roads, funding sources (debts), personnel with Bachelor's degree or lower, who are not limited to any specific industry. Specialized factors refer to personnel with graduate degrees or specific training, that are usually those graduated with higher than a Bachelor's degree, infrastructure for specialized purposes and advanced knowledge for specialized use, etc. These specialized factors can be used in some industries only 2) demand conditions, Local demands affect models considered by

companies and meet the buyers' demands. Countries have competitive advantages in the industry or its parts that have clearer buyer demand models than other countries. 3) related and supporting industries, Countries with related and supporting industries, which have international competitive advantages, are beneficial to bringing about international competitive advantages of related and supporting industries, and 4) firm strategies, structure and rivalries, Countries tend to succeed internationally in an industry that originates competitive advantages in accordance with management systems. This means the selection of strategies and structures that reflect the unique characteristics of specialized innovation of that country. Apart from the four determinants in the diamond model, there are the following external factors that have a role in the country's competition.

Thirdly, with respect to a relevant literature review, the researcher has used the integrative framework of smart city that developed by Chourabi et al. to analyze the factors affecting key success for developing Shanghai Smart City. Key success factors for smart city management were analyzed by academics and agencies in different contexts. Relevant factors comprise technology, human capital, communities, strategies, public policies, etc.

According to a BSI study (2014), nine factors were specified – strategic clarity, leadership, skills, stakeholder engagement, user focus, supplier partnership, achievable delivery, future proofing and benefit realization.

Harms (2016) stated that strategies for smart city should determine how cities use limited resources to lead to or achieve their missions. It is necessary that cities formulate their vision to specify smart city characters, and assess strengths and weaknesses resulting in the formulation of the strategy framework of smart cities.

Stakeholders of all sectors also play a key role in driving the development of smart cities, such as local government who collects resources and said stakeholders, as well as in formulating regulations to monitor the businesses which produce the technologies to meet marketing demand. Knowledge institutes have a duty to support innovation in necessary technology research and development. Citizens not only submit a proposal to the public sector, but also take part in pushing smart city projects in communities (Harms, 2016).

In the research of Chourabi et al. (2012), it was stated that key success factors for smart city initiation consist of eight factors, namely

1) Management and organization have a context relating to the success of the E-government Project and IT Projects (Gil-García & Pardo, 2005). Most pilot smart city projects rely on government support and benefits from ITC projects, e.g. an upgrade in the quality of public services (Chourabi et al., 2012). Key success factors for the Pilot Smart City Project relating to management and organization include both strategies and challenges.

2) Technology is referred to by Chourabi as a "new generation of integrated hardware, software, and network technologies that provide IT systems with real-time awareness of the real world and advanced analytics to help people make more intelligent decisions about alternatives and actions that will optimize business processes and business balance sheet results" (Washburn et al., 2010).

3) Governance of several cities have proposed major goals for pilot smart city projects, e.g. providing better public services to people and upgrading people's quality of life (Odendaal, 2003). The following topics must be considered: the ability to cooperate among stakeholders; the support of leadership; the structure of alliances; and be able to work under different jurisdictions (Scholl et al., 2009).

4) Policy: smart cities usually consist of political and institutional components affecting technology components (Mauher & Vanja, 2006) that affect pilot IT projects at all levels of public agencies (Rocheleau, 2003). And related to a policy context, such as laws, regulations, institutional units and the external environment (Chourabi et al., 2012).

5) People and communities are stakeholders who play the greatest role in pilot smart city projects

6) Economy is a significant driving factor for initiating a Smart City Project and a Competitive City Project.

(7) Infrastructure and ICT infrastructure are essential for smart cities. Because of networks linking ICT systems, smart cities in theory become livable and existing cities (Vasseur & Dunkels, 2010).

8) Natural environment is related to smart cities management. Since conceptual framework of smart cities is benefited by advanced technologies to create sustainability and to better manage limited natural resources (Nfuka & Rusu, 2010).

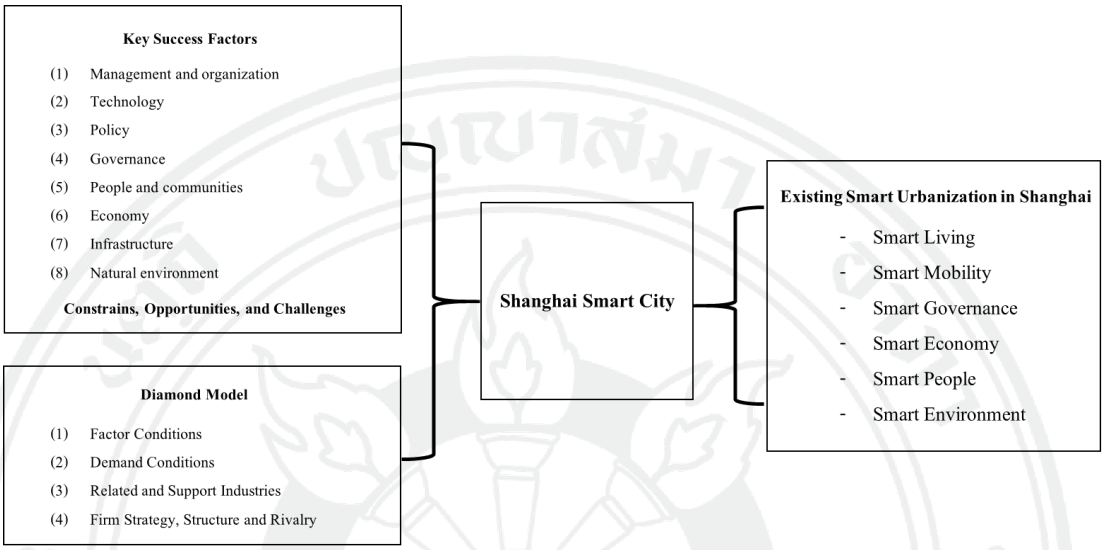

Figure 2.30 Conceptual Framework

The figure 2.29 presented above is the conceptual framework of the study. The framework is invented according to the three important concepts as mentioned above. It is able to help research to explore the factors influenced the operation of smart city concept by Shanghai government. The findings of the study investigated by this framework can lead the researcher to understand the conditions happened in Shanghai city. It is very useful because researcher can turn the findings of the study to be suitable plans and policies. These suggested policies are valuable for policy makers in other cities who are desired to apply concept of smart city in increase quality of life of their people.

CHAPTER 3

RESEARCH METHODOLOGY

This research on Smart City Development: A Case Study of Urban Management in Shanghai City, is aimed at studying the development, challenges and opportunities for urban development in Shanghai City. The mixed method research was conducted by combining both quantitative research and qualitative research. The research methodology consists of steps, methods, population and samples analysis, construction and testing of research tool quality, tool quality control, scoring criteria, data collection and data analysis.

In this research, qualitative data was collected from research tools, which includes documentary research and structural in-depth interviews supported by a survey and questionnaire as the tools for collecting quantitative data.

3.1 Research Timeline

To know factors influenced the implementation of smart city concept, Shanghai was selected as the study area. This is because Shanghai is one of the most successful of smart city initiative in China. Before going to Shanghai, a plan was created to help finish the processes of the study that was able to be separated into four steps. The first step, researcher developed the questionnaires (semi-structured interview) by reviewing several documents related to the issues of smart city such as barriers and drivers influencing the implementation. After that the questionnaire pretesting method were practiced. The second step was the data collection. The step of data collection was very important, so researcher had to spend four months to collect the data. Interviewing technique and observing were utilized to help collect the data at the city and also relevant documents were gathered. After the data were collected completely, the third step, the researcher spent two months to analyze both qualitative and quantitative data. Writing the report was the fourth step. Several

techniques such as triangular technique and content analysis were applied to help interpret all data. Lastly, the researcher spent 14 months to complete the whole processes of the study from April, 2019 to May, 2020. The steps and the overall timeline are as follows:

Table 3.1 Research Timeline

Task	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
PLANNING & DESIGN														
Conduct literary review														
Develop research questions, determine the study sites and the sample														
Research tools development and adapt interview guides														
Pre-test interview guides														
DATA COLLECTION														
Select and obtain consent of informants														
Transcribe interviews														
DATA ANALYSIS														
Qualitative analysis														
Quantitative analysis														
DISSEMINATION														
Write report														
Journal articles														

3.2 Scope of the Research

As for the scope of the research, the researcher selected study areas using a purposive sampling method in order to get properties that are in line with the study's objectives. The researcher chose Shanghai City as the study area for the following reasons: 1) Shanghai City has been designated one of the first batches of national wisdom city pilots listed since 2012, 2) Shanghai City is economically important and the center of finance, trade and water transport in the Yangtze River Delta Economic Region of China, and 3) in 2018, Shanghai City was ranked second in the "TOP 100 China's smart cities", second to Beijing. This survey was organized by the Chinese Society for Urban Studies, which is a research institute under the Ministry of Housing and Urban-Rural Development of the People's Republic of China. The assessment was based on four smart areas, namely smart transportation, smart living, smart governance and smart healthcare (CSUS, 2018).

The scope of the content involves development of the concepts, processes and models of smart cities used for managing Shanghai City, including the factors affecting Shanghai Smart City in China between 2012 and 2019.

3.3 Population and Sampling

Concerning qualitative research, the researcher identified the population and samples to be used in the research by selecting experts, academics and people related to city management resulting in smart cities. The sample selection process used purposive sampling, whereby samples were selected by the researcher from representatives of the public and private sectors, as well as other agencies concerned. The following rules concerning the number and qualifications of key informants were established:

1) Eleven key informants were comprised of officials from the public sector and research institutes relating to the project operation of smart cities.

2) Eighteen administrators of business operators involved in the smart city project's operations.

3.4 Data Collection and Research Tools

To collect research information, the researcher collected data from various sources, e.g. comments of relevant officials in the public sector and personnel from the private sector who promote Shanghai City management. The researcher applied questionnaires as a major tool for collecting data. The conceptual framework and questions for this research were based on a review of concepts from books, academic articles and meeting documents explaining the operation of project plans. The following key issues were specified – 1) the origin of the smart city concept, 2) definition of a smart city, 3) major components of a smart city, 4) smart city standards or smart city framework, 5) critical success factors, and 6) challenges of smart cities.

These questions were used to interview people relating to the smart city development process. Prior to using these questions, the researcher asked the experts to verify the reliability of these questions, which came to 60%. The field data collection for this research comprises:

3.4.1 Tools and Primary Data Collection

3.4.1.1 Observation:

The researcher visited the area to observe and find out relevant factors promoting Shanghai Smart City. Activities and projects surveyed are from public and private agencies. Because of the survey, the researcher has come to understand and realize the actual readiness of Shanghai City, which has to apply the city concept for use.

3.4.1.2 Structured-questionnaires

Structured-questionnaires were used in the in-depth interviews and focus groups. Data collection using structured questionnaires made the researcher understand in-depth conditions affecting the project's plan of operation. Structured questionnaires were used to interview key informants. Questions involved factors that affect the project's operation in accordance with smart city guidelines. The researcher applied a structured interview form, whereby questions were designed to be used in a semi-structured interview, which is a flexible and open research process. Keywords and concepts could also be used in the interview. Open-ended questions were

designed with keywords along with flexible and adjustable questions to suit each interviewee in each situation. This is expected to lead to complete and diverse information in different dimensions in accordance with the research objectives.

Thirty key informants from agencies relating to Shanghai Smart City will inspect the findings from secondary information, and study additional issues about current conditions, problems and solutions, as well as opportunities, constraints and challenges related to Shanghai Smart City development in China between 2011 and the present.

1) Research Tool Construction

The tool used to collect data consisted of questionnaires which were developed by the researcher to be consistent with the research objectives, and consisting of the four following parts:

Part 1 General information on the interviewees, namely gender, status, age and occupation.

Part 2 Factors affecting the development of Shanghai Smart City, comprised of internal environmental factors, both supports and threats, and external environmental factors, which are both supports and challenges.

Part 3 Additional recommendations.

Tool construction steps:

(1) Study the concepts, theories and relevant research, and use them to determine the research concept based on the research objectives.

(2) Select suitable methods of data analysis by specifying information necessary for the analysis based on the selected method to meet the research objectives.

(3) Draft questionnaires for collecting information and submit to the advisor for review and editing until they are complete.

(4) Submit the revised questionnaires to two experts: Assoc. Prof. Dr. Danuvasin Charoen, Professor at NIDA Business School, National Institute of Development Administration (NIDA) and Assoc. Prof. Dr. Achakorn Wongpreedee, Professor at Graduate School of Public Administration, NIDA for consideration and judgment as to if these tools are accurate. This is the method to check the accuracy of relevant tools, based on the discretion of experts in their field.

The researcher's practice of research tool construction to insure accuracy are as follows: 1) Define the definition of factors to cover and be consistent with the required topics by using concepts and theories, as well as consulting experts, 2) Set questions and construct research tools by taking into account relevant theories to serve as a framework, and 3) Let experts have a preliminary review on appropriateness and coverage.

(5) Check the content validity based on clarity and appropriateness of questions and variables. If they are consistent, +1 score will be provided. In case of inconsistency, -1 score will be provided. If uncertain, 0 score is provided. Then, the experts' review is checked with the Index of Item-Objective Congruence (IOC) by selecting statements with congruence ranging from 0.67 to 1.00. Afterwards, the advisor's recommendations will be used to improve on them in order to correspond to the content, as well as to revise questionnaires and insure completeness. The sum of the overall IOC amounted to 0.85.

2) Acquisition of Key Informants' Data

To acquire the key informants' data, the researcher selected key informants using the three following steps:

Step 1 The researcher studied academic documents, articles, journals, theses, research reports, data from the internet, as well as laws relating to smart cities in China in order to acquire key informants, organizations or agencies related to Shanghai Smart City in order to cover the research questions.

Step 2 After receiving the list of key informants, organizations or agencies involving Shanghai Smart City in Step 1, select one agency concerning Shanghai Smart City by the researcher, which was the Shanghai Municipal Commission of Economy and Informatization. Then, after an in-depth interview with the key informants, the key informants were requested to suggest experts or organizations related to Shanghai Smart City.

Step 3 Use the list of experts or organizations suggested by the key informants in the first interview, and the list of experts or organizations from the analysis of documents collected by the researcher, to analyze which agencies are related to and have expertise in each field in accordance with the research objectives as much as possible. After that, select the key informants using purposive sampling

and snowball sampling. There were 14 agencies selected for the in-depth interview, classified into each type, as follows:

Table 3.2 Key Informants from Agencies Related to Shanghai City Development

Type	**Agency**	**Number of people**
Public Sector	- Shanghai Municipal Commission of Economy and Informatization	5 people
Research Institutes	- Shanghai Pudong Smart City Research Institute	2 people
	- Shanghai Industrial Internet Center	3 people
	- Shanghai Economy and Informatization Research Center	1 person
Entrepreneurs	- Shanghai Data Exchange (SDE) Co., Ltd.	1 person
	- Shanghai Cloud Data Co., Ltd.	3 people
	- Transwarp Technology (Shanghai) Co., Ltd.	5 people
	- Shanghai Shibei Hi-Tech Enterprise AI Experience Pavilion	1 person
	- Xiao-I Co., Ltd.	1 person
	- DeepBlue Technology (Shanghai) Co. Ltd	2 people
	- Shanghai PartnerX Co., Ltd.	1 person
	- Goldpalm Data Technology	1 person
	- Global Tone Communication Technology (Shanghai) Co., Ltd.	1 person
	- Huawei (Thailand) Co., Ltd.	3 people
	Total	**30 people**

Note: * The names of administrators of each agency cannot be disclosed by the researcher because of the researcher's ethics, in that the details of key informants must not be revealed as they may have a detrimental effect on the key informants.

There is only type of questionnaire used to interview key informants related to the development of Shanghai Smart City, consisting of the following questions:

Issue 1 Question about the current conditions and guidelines for developing Shanghai City

Issue 2 Question about Shanghai City's competitiveness and constraints concerning development of smart cities

Issue 3 Question about Shanghai City's opportunities and challenges concerning development of smart cities

3) Questionnaire-based data collection

Questionnaire-based data collection was applied to a total of 30 key informants. Questions related to support factors and challenges affecting smart cities included: policy-based policies that have an effect on the application of the smart city concept to Shanghai City, etc. Information from questionnaires, e.g. percentages were used for analysis in accordance with the specified research objectives and questions.

(1) Data collection period

During this research, the researcher collected information based on study of the data and interviews from July to October 2019, detailed as follows:

Table 3.3 Key Informants

Period	**Key informant**
July 22, 2019	- Shanghai Data Exchange (SDE) Co., Ltd. - Shanghai Cloud Data Co., Ltd.
July 23, 2019	- Shanghai Industrial Internet Center - Shanghai Municipal Commission of Economy and Informatization - Xiao-I Co., Ltd.
July 24, 2019	- DeepBlue Technology (Shanghai) Co. Ltd - Transwarp Technology (Shanghai) Co., Ltd.

Period	Key informant
August 28, 2019	- Transwarp Technology (Shanghai) Co., Ltd.
August 29, 2019	- Joined the World AI Conference 2019
	- Shanghai Pudong Smart City Research Institute
August 30, 2019	- Shanghai Economic and Information Development Research Center
August 31, 2019	- Joined the International Smart City Summit 2019
October 16, 2019	- GovInsider Conference by the United Nations, Thailand
October 17, 2019	- Special lecture on “China Smart Government” by Mr. Lu Yong, Deputy Managing Director, Shanghai Data Exchange
October 21, 2019	- Shanghai Data Exchange (SDE) Co., Ltd.
	- Shanghai Shibei Hi-Tech Enterprise AI Experience Pavilion
October 22, 2019	- Goldpalm Data Technology
	- Global Tone Communication Technology (Shanghai) Co., Ltd.
October 23, 2019	- DeepBlue Technology (Shanghai) Co. Ltd

(2) Secondary data collection

Documentary research refers to collection of data from academic documents, articles, journals, theses, research reports, data from the internet, as well as legal regulations relating to smart cities in China. This data involves secondary information to analyze current conditions, problems and solutions, as well as opportunities, constraints and challenges related to Shanghai Smart City development in China between 2011 and the present.

3.5 Data Analysis

Data from the study of official and relevant documents, the in-depth interviews and focus group interviews, including information from the survey and observation of actual facts related to management of Shanghai City, were used based on the following analysis techniques: verifying the reliability of data from various sources based on the study, preliminary survey, interviews, observations and

triangular discussions, as well as classification of data from various sources to put them in the same category in order to compare common or different characteristics in a context that is definitely different.

As for the data analysis process based on the in-depth interview, the researcher applied information from the in-depth interview to the data analysis and data processing process based on a content analysis process and method, as well as data analysis using descriptive statistics. This process is in accordance with a qualitative research approach, such as data analysis by considering major themes or major patterns in accordance with the specified objectives. Then, the major themes were divided into sub-themes and linked to the organized data according to the specified conceptual framework. This is an analysis process that starts from image analysis using a descriptive method, which is an analysis of issues in the analysis process based on qualitative research.

In addition, the researcher used an analytic induction technique acquired from the interpretation of concrete data or phenomena perceived from the collection of up to two sets of data, such as the operations of officials concerned and smart city technology that have been used for Shanghai City, and summarized as facts concerning the research. After that, the researcher used a data triangulation technique that verified data to prove that the data obtained by the researcher from various sources was accurate by verifying the sources of data in terms of time, place and personnel. The researcher also used Methodology Triangulation by applying data in the form of documents, observations and recorded interviews from different sources in order to compare their consistency, and then add key issues so that the content is complete and covers the issues as specified. This could lead to lessons learned for visualizing the operation of Shanghai Smart City in China.

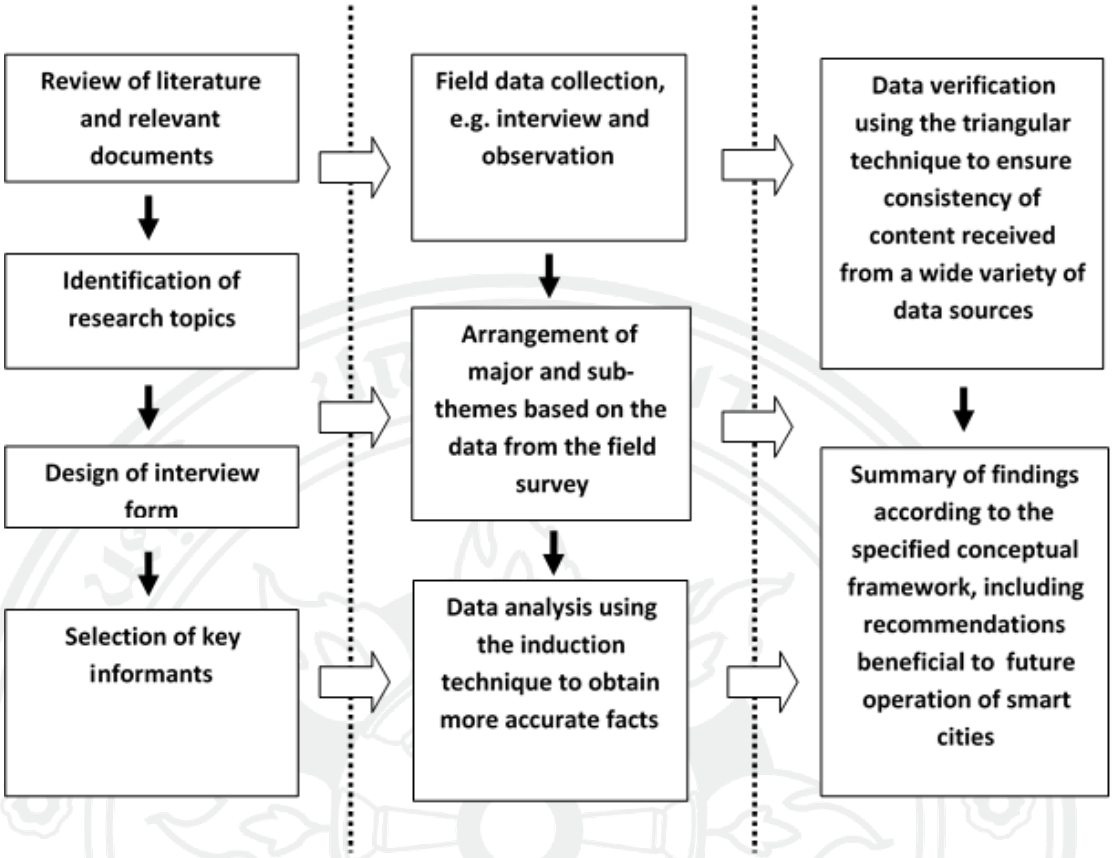

Figure 3.1 Research Procedures

CHAPTER 4

DEVELOPMENT OF SHANGHAI SMART CITY IN CHINA

4.1 Background of Shanghai Smart City Development in China

Shanghai is the largest city in China. It is a special administrative area as one of the province-level municipalities. It is situated in Zhejiang Province, not under the province but under the central government. It is the world's busiest port. Currently, Shanghai is China's most populous city full of shops, structures, roads, vehicles, bicycles and people. The population in Shanghai City is about 27 million people.

During the previous decades, China has changed its economic structure from an industrial sector for export to a digital economy. A large number of information technology companies have been formed, especially Huawei and Alibaba companies, two business leaders in e-commerce who changed the global attitude towards China from a developing country that focuses on production, to a developed country or leader of information technology, outpacing Japan and Korea, who previously occupied the market shares of technology products in the Asian region.

4.1.1 Shanghai Tech Ecosystem

There are a large number of tech ecosystems in China, which have specific characteristics according to the economic type of each city, e.g. Shanghai, Beijing, the capital city, Shenzhen and other cities. As for the tech ecosystem in Shanghai, an outstanding feature that makes Shanghai one of the world economies, from a port emphasizing logistics business, is that of becoming a center of Tech Talent Hub, particularly FinTech.

The Shanghai Tech Ecosystem started from the "Mass Entrepreneurship and Innovation Project Policy" that Chinese Premier Li Keqiang announced for the first time in mid-2014, which was a policy that stimulated development of the Chinese economy which was declining at that time. It also helped new graduates get employed by helping small-scale businesses to grow quickly. The Chinese government

supported tech startup companies and many tech entrepreneurs. In addition, there are other agencies that bear the risks as co-investors with venture capital for startup companies in Shanghai by securing investment of the maximum allowable venture capital, up to 60 percent.

The Chinese government has put an effort in pushing Shanghai to become the Asian economic center by providing more financial facilities. The government has planned to make Shanghai the International Financial Center by 2020, resulting in supporting a wide variety of businesses, including tech and startup companies.

Additionally, Shanghai is a very successful city for creating unicorns, as there are now up to 21 unicorns. Including unicorns from other cities, China has the most unicorn startup companies in the world. The startup businesses in Shanghai that serve foreign customers amounts to 32 percent, which is higher than Beijing, which offers 7 percent of its services abroad.

Apart from the economic center, Shanghai is a leading production source of personnel, as it is the foundation of intensive education at all levels, particularly, science personnel at universities. It is also the city where people have the most English proficiency, according to the EF English Proficiency Index 2017.

4.1.1.1 Technology institutes in Shanghai

Educational institutions are another factor that drives Shanghai to switch from a port to the nourishing source of a Tech Startup Ecosystem. In 2015, the Chinese government promulgated a policy to push national innovation, and as a result, universities in China now have to develop a curriculum for entrepreneurs. Currently, most students at educational institutions initiate their own startup projects by being provided resources by their universities. Innovation technology projects can be submitted instead of credits to complete their studies. The universities in Shanghai which are famous for developing innovation technology are as follows:

1) Fudan University is one of the oldest universities in Shanghai, in which the Science Park Project has been operating since 2000. It is outstanding in technology, e.g. cloud data, education technology and mobile technology. It is also a production source of more than 800 technology companies. In addition, the Student Entrepreneur Center has allocated area and technology resources, as well as joint ventures in the students' startup projects. In 2016 this center

invested in up to 152 startup projects with a capital value of more than 2.7 million dollars.

2) Shanghai Jiao Tong University supports entrepreneurs by cooperating with the Shanghai Human Resource and Social Security Bureau and the Bank of China with the objective of nurturing qualitative innovation in Shanghai's ecosystem.

3) East China University of Science and Technology also established a Science Park by stressing game development and entertainment media industries. Additionally, interesting R&D Deep Technologies are assisted, such as BioTech and materials.

4.1.1.2 Shanghai GDP

Shanghai is the city with the highest economic growth in China. Shanghai's GDP accounts for 41 percent of the GDP and has been ranked first for decades. Shanghai's key economic structure now consists of finance, trade, water transport and service innovation, whereas the city's traditional industries, namely agriculture, automobiles and textiles, are decreasing and moving to rural areas.

Since the Chinese economic reform in 1978, Shanghai has been changing its economic structure from the original heavy industry, producing automobiles, ships and machines, which have a low value chain and relies on a large amount of labor, to innovation industry, with a high value chain, e.g. new industries, new technology, new businesses and new models. Advanced innovation technology has been adopted to assist in the business operations. This business accounts for 30% of Shanghai's GDP, especially major service industries: information services, business services, research services and cultural & creative services, as well as innovation industries, namely Big Data, Cloud, AI and Driverless Vehicles, which were defined by the Shanghai government as strategic industries to drive its economic systems in the future.

One interesting issue is that the Shanghai government has emphasized the development of innovation technology since 2018 by allocating 4 percent of its budget, or 14.786 billion US dollars of Shanghai's GDP for R&D innovation. This confirms that Shanghai has defined the technological innovation industry as one of its major strategies for developing the city's economy.

Table 4.1 Shanghai GDP (2011-2019)

Year	GDP (billion US dollars)	Country rank
2011	297.202	1
2012	318.437	1
2013	337.531	1
2014	368.141	1
2015	390.078	1
2016	429.156	1
2017	470.843	1
2018	369.640	1
2019	596.177	1

Source: National Bureau of Statistics of China, 2019.

4.1.1.3 Distinguished technology industries in Shanghai

The most outstanding and remarkable industries in Shanghai include FinTech, gaming, AI and Big Data.

FinTech – As Shanghai is the economic and financial center, plenty of Fintech Startups have emerged in this city. From 2012 to 2017, the investment in Fintech Startups has amounted to 26.5 percent. As for quality, it meets the standard. According to the KPMG's China Leading Fintech's selection, 50 companies were on the list, 30 percent of which came from Shanghai, especially Peer-to-Peer Lending, such as PaiPaiDai, Lufax and Dianrong.

Table 4.2 Outstanding Fintech Startup Companies in Shanghai

Type of Fintech Startup	Company	Type of business
Peer-to-Peer Lending	PaiPaiDai	A service provider to Consumer Financial Marketplace linking between lenders and borrowers. It is the top major Peer-to-Peer service provider in China. It is only one company raising funds in the New York Stock Exchange in 2017.
	Lufax	A developer of a Peer-to-Peer Lending Platform in partnership with borrowers and lenders. At present, Ping An Insurance Group, a leading insurance company in China, holds the largest share and is expanding its financial services to be more diverse.
	Dianrong	A developer of Online Marketplace connecting between borrowers and investors. One of the founders of the Lending Club is Soul Htite, a leading Peer-to-Peer Lending website in the United States. It is, therefore, called Lending Club of China.

Source: SHEITC, 2018.

Gaming – China has the most game players in the world, or around 600 million people. Game players on smartphone platforms amount to up to 49 percent. Shanghai is the center of Chinese game producers, which generates income of up to 7.3 billion US dollars per year. Leading gaming startup companies in Shanghai include Shanda Interactive Games and Giant Interactive companies, including Zhouhua Entertainment, the Motion Capture developer for video games.

It is remarkable that Shanghai has become the economic center in China through development of digital technology, especially FinTech. It is also a source of innovation technology personnel development in China, in order to drive the city in the direction of the China 5.0 age in accordance with the Chinese government's digital economy development policy. The public and private sectors have cooperated in developing Chinese innovation technology. Tech Startup was encouraged by the public sector to create an attractive investment atmosphere to emerging entrepreneurs, including other policies promoting industrial demands, and as a result, Shanghai has become one of the model cities for digital economic development in China.

Artificial Intelligence (AI) – Shanghai is planning to be the center of AI in China and wishes to expand the size of its industry to be higher than 100 billion yuan (around 500 billion baht) by 2020, according to a new municipality plan. The national government website cites 21 measures to stimulate industry as well as create global AI industrial groups, support ten AI innovation organizations, and construct six additional areas for developing demonstration applications, as well as launching more than 100 applications.

Mr. Chen Ming Bo, Director of the Shanghai Municipal Commission, stated "a large-scale source of information with fertile resources in Shanghai, the application of smart technology and ready industry, including research potential is a steady foundation of AI industrial development".

As AI industry has grown rapidly, it is a new tool for Shanghai's growth. Shanghai, as a city with large sized information and large-scale factories, has many advantages helping it be consistent with the national plan, called Made in China 2025, which was announced by the central government in 2017.

Shanghai will become the main source of AI Unicorn Companies. The city government has promoted a combination of AI and other industries, including hi-technology equipment, circuit boards, and medical and automobile technology to construct an innovation center for smart production and internet industries. The AI industry in Shanghai has been produced across the city with various emphases, e.g. smart driving, smart robots, smart software and smart hardware. Famous AI business operators include Deep Blue, Xiao I, PartnerX, etc.

In addition, due to a public sector policy that attracts both local and international technology, plans will be prepared. The Strategic Advisory Committee was set up to provide advice to business operators who are interested in investment or wish to apply information technology to improve their businesses, such as the Shanghai Pudong Smart City Research Institute, The Shanghai Industrial Technology Research Institute, etc. Shanghai also builds on alliances to develop AI with almost 30 major organizations, including investment and financial institutions, as well as educational institutions.

Big Data – To develop smart cities successfully, large-scale data management is the first priority. Management of information from different areas across the city relies on information technology's potential. Shanghai Data Exchange (SDE) is the most modern center of digital data exchange in China, and a Chinese state enterprise with joint venture established in 2016 by various IT companies with a registered capital of 200 million yuan or 1000 million baht. It has been approved by the Shanghai City Government. The Economic and ICT Commission is an organization established by the government to support strategies, e.g Big Data Development 5 Plus: Exchange Org.+, Innovation base+, Industry fund+, Development partnership+, and a Research Center, with numerous tasks, namely promotion of the business data flow, cooperation between regional organizations, data network connections, as well as application and integration of public and private sector information, and establishment of the National Data Portability Project Lab, the only one in China.

In addition to state enterprises in China, there are other private business operators in Shanghai, such as Transwarp Company, the first company to develop Hadoop platform technology to manage Big Data, GTCOM Company who

provides cross-language Big Data services and Goldpalm Data Technology Company, the top list of Chinese companies who built the S2b2c platform concerning tourist information.

1) Case Study

(1) The Shanghai Caohejing Finance Tech Ecosystem

Within the Shanghai Tech Ecosystem, there are numerous Tech Ecosystems, e.g. Lujiazui Fintech ecosystem, Shibei High-tech ecosystem, etc. One interesting example is the "Caohejing Finance Tech Ecosystem". Caohejing is a key business, financial and banking district in Shanghai and a district with advanced technology business operators and more than 3,000 diverse research institutions in Caohejing Hi-Tech Park.

Creation of the Caohejing Finance Tech Ecosystem is aimed at solving the fund raising problems of small- and medium-scale startup entrepreneurs, because a startup business has high risks. It is, therefore, difficult for them to seek funds from general financial institutions, e.g. banks. Thus, when Caohejing wished to push for the Caohejing Hi-Tech Ecosystem, it collaborated with the Shanghai Sci-Tech Institute of Shanghai University to formulate a strategy to create Caohejing Finance Tech Ecosystem, which is an ecosystem whereby startup enterprises collaborate with financial institutions based on dependent cooperation.

Caohejing Finance Tech Ecosystem has the three following characteristics:

(1.1) The ecosystem is a system where Technology Innovation and Financial Innovation relies on each other, using the Innovation Life Cycle as a criterion in each phase of the cycle. The types of financial services and different financial policies are specified in accordance with the demands of the entrepreneurs.

(1.2) The ecosystem is linked by all parties – the government, investors, financial institutions, insurance institutions and securities traders. Its resources are exchanged with external agencies.

(1.3) Concerning the ecosystem, relevant industries are grouped into clusters to create an industry chain and a unique industrial ecosystem, whereby Caohejing Hi-Tech Park is the hub of this clustering.

(1.4) During the event of the gradient transfer of industry, important components were transferred into the Caohejing Hi-Tech Park to create a specific industry cluster.

However, a Tech Ecosystem can be caused by the following significant success factors: 1) an incubation of startup enterprises, as the more entrepreneurs there are, the more efficiency exists in driving the operation, 2) strong financial and fiscal policies for guiding and supporting the clustering and development of startup enterprises, 3) inclusive fund raising systems to support funding, so as to be consistent with startup enterprises in each phase of the cycle, 4) highly efficient and diverse financial management systems to serve as an important base for enterprises in the ecosystem, and 5) a complete enterprise credit system to monitor, inspect and prevent risks that may occur in startup enterprises.

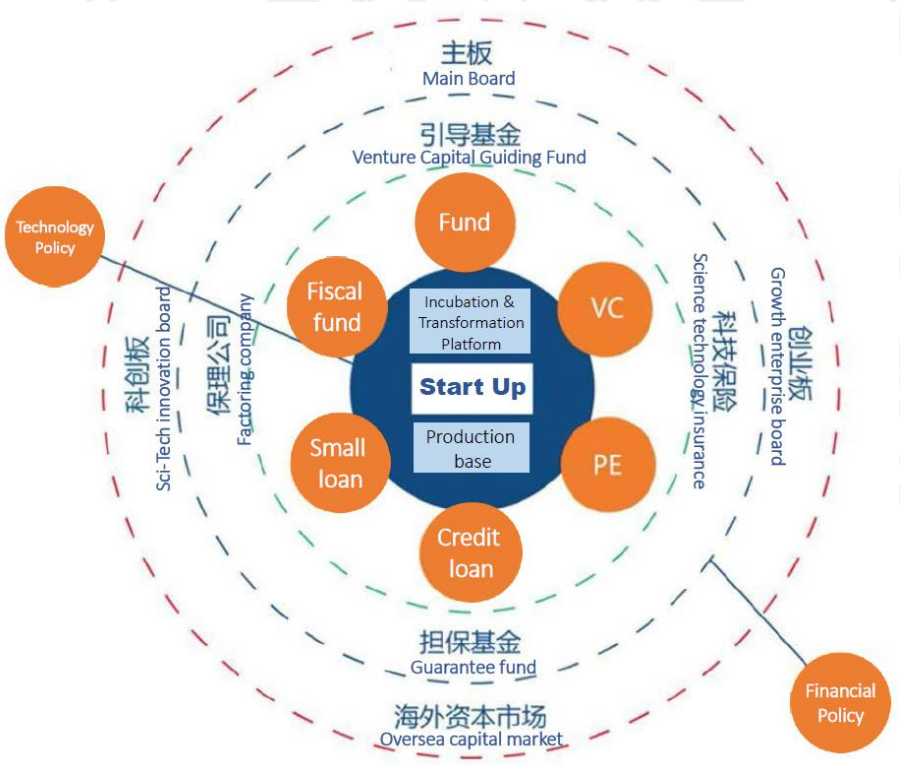

Figure 4.1 Caohejing Tech & Finance Ecosystem Framework

Source: Shanghai Sci-Tech Institute of Shanghai University, 2019.

The establishment of many tech Ecosystems, each of which has a unique identity enables each unit to connect to each other as a strong network of Shanghai Tech Ecosystem Cluster, which is a key base of rich technology resources of expert personnel and knowledge of innovation technology that is the most important force driving Shanghai Smart City.

(2) Shanghai Smart City Development Evolution

Since the 1990s Shanghai has been using information technology as a strategic method to modernize the city. Pushing for the construction of smart cities is a major tool for accelerating Shanghai's change because of its innovation drive. The evolution of Shanghai Smart City development has been divided into five periods, as follows:

2) 2010 - Expo 2010 Shanghai China: "Better City, Better Life"

Expo 2010 was an international exhibition held from May 1 to October 31, 2010 (183 days) in Shanghai, China with participants from more than 240 countries. The objectives were to transfer key statements: the civic sector shall focus more on various problems arising in the Urban Age and brainstorm ideas to seek solutions, as well as promote the concept of city sustainable development in order to create models suitable for developing countries on the basis of understanding, sympathy and mutual respect among human beings.

Major themes for the world exhibition were "Better City, Better Life" based on the concept of a harmonious city under the United Nations Human Settlement Programme (UN-HABITAT) that promotes a balance between humans and the environment, human, human and spirit, and materials by reflecting through multicultural harmony, urban economy harmony, technology age harmony and urban & township interaction harmony. New challenges will be applied to city management and better town planning.

Apart from main topics on the concept of a happy town, interesting topics were presented, e.g. cultural identification (Ennaji, 2005), circular economy, urban innovation, urban re-structuring and urban & township interactions.

Some new technology innovations were exhibited at Expo 2010 for the first time to showcase the potential for the foundation of Shanghai Smart City to the world.

3) 2011 – Shanghai Action Plan for Promoting Smart City Construction 2011-2013 (Shanghai 1.0 Age: Four Firsts, Four Centers)

This Three-year Action Plan (2011-2013) consisted of the following missions: to construct an international metropolis of Chinese socialist modernization and to adjust strategies to stimulate Shanghai's economic growth, including the frontline soldiers of the great economic reform in China (Hu, 2006).

The central government under Chinese President, Mr. Hu Jintao's administration (2006), assigned major missions to Shanghai entitled "Four Firsts", namely 1) changing development models, 2) upgrading capability of innovation invention, 3) pushing for reform to open new economies, and 4) creating a harmonious socialist society.

To support and promote the importance of Shanghai, the State Council of the People's Republic of China formulated development strategies (Four Centers) pertaining to four industries, namely the economic center, the financial center, the commercial center and the water transport center. This reflects the strategic significance of Shanghai, which is one of three of China's strategic economic zones.

4) 2013 – Shanghai Pilot Free Trade Zone: Shanghai Hi – Tech Caster

The Shanghai Pilot Free-Trade Zone (Shanghai FTZ) was the first pilot free trade zone in China and the first testing ground for new economic reform. It is situated in New Pudong district and was established in August 2013 under the instruction of the State Council of the People's Republic of China supported by President Xi Jinping and H.E. Mr. Li Keqiang, Premier of the State Council of the People's Republic of China.

The area of Shanghai FTZ is 240 km2 or equivalent to that of the Macao Special Administrative Region. The area is divided into eight zones – in the beginning, Waigaoqiao Free Trade Zone, Waigaoqiao Free Trade Logistics Park, Yangshan Free Trade Port Area, and Pudong Airport Comprehensive Free Trade Zone. Later, Lujiazui Financial and Trade Zone, Shanghai Jinqiao Economic

&Technological Development Zone, and Zhangjiang Hi-Tech Park were also incorporated.

The importance of the Shanghai FTZ is that the central government uses this area as a testing ground for new-style economic and social reform, particularly economic reform measures, such as changes in the public sector's function, financial systems, trade services, foreign investment, tax collection policies, etc. It is also vital to the intermediary trade changes and off-shore banking businesses in Shanghai.

The key policies related to the Shanghai FTZ have two sides: open and restricted policies. As for open policies, they include approval of the establishment of banks invested by foreign countries or private banks invested by China and foreign countries. Banks invested in by China will provide off-shore banking business services. International health insurance institutions were allowed to be established and the minimum registered capital of subsidiary financial leasing institutions was cancelled. Foreigners were allowed to operate value-added telecommunications and to sell video game console products.

Restricted policies or prohibited businesses for foreign companies to operate in the Shanghai FTZ include information transmission, computer services and software, scientific research and technical services, mining, manufacturing, construction and retail trade. Strictly prohibited businesses include gambling and internet cafés.

Special industries in the Shanghai FTZ include e-commerce, legal services, logistics, marine insurance and telecom.

5) 2014 – Shanghai Action Plan for Promoting Smart City Construction 2014-2016 in the 2.0 Age

The Three-Year Action Plan (2014-2016) comprises two key missions, 1) to upgrade the basic information structure potential, promote the integration of information and complete city development, and 2) to push Shanghai to become a pioneer in developing innovation, be a leader of leading smart cities in China to be equivalent to other international smart cities, and to build an international metropolis of Chinese socialist modernization.

The goal of the Three-Year Action Plan (2014-2016) is for Shanghai to focus on smart, convenient and efficient information and application systems within three years.

6) 2018 – Shanghai new generation of information infrastructure construction, improve the urban energy level and core competitiveness Three-Year Action Plan (2018-2020)

The “Three-Year Action Plan” (2018-2020) is aimed at promoting technological transformation and upgrading the city’s economic level by launching new plans to transform technology and push for the development of economic quality, as well as create the Made in Shanghai brand.

Shanghai will start its plan to transform technology. The targets at the end of 2020 are to increase the ability of innovation and technology of the manufacturing industry in Shanghai to a higher level, and to enhance industrial competitiveness and share labor in global value chains. All industrial chains will be developed at an exponential rate and modern manufacturing industry at the global level will be created. As a result, Shanghai will become a major manufacturing base and a source of modern technology, as well as the center of knowledgeable and innovative personnel development.

Figure 4.2 Shanghai Smart City Development Evolution

4.2 Policies and Agencies Related to Smart City Development

4.2.1 Key Policies for Developing Shanghai Smart City

4.2.1.1 Shanghai Action Plan for Promoting Smart City Construction 2011-2013, Shanghai Smart City in the 1.0 Age: Four Firsts, Four Centers

The Three-Year Action Plan (2011-2013) consists of the following missions: to construct an International metropolis of Chinese socialist modernization and adjust strategies to stimulate Shanghai's economic growth, including the frontline soldiers in the great economic reform in China (Hu, 2006).

The central government under Chinese President, Mr. Hu Jintao's administration (2006), assigned major missions to Shanghai entitled "Four Firsts", namely 1) changing development models, 2) upgrading capability for innovation invention, 3) pushing for reform to open new economies, and 4) creating a harmonious socialist society.

To support and promote the importance of Shanghai, the State Council of the People's Republic of China formulated development strategies (Four Centers) pertaining to four industries, namely the economic center, the financial center, the commercial center and the water transport center. This reflects the strategic significance of Shanghai, which is a key economic city in the Yangtze River Economic Zone, one of China's three strategic economic zones.

Promotion principles:

1) Upgrade the infrastructure and information technology, and develop them step by step to enhance the efficiency of infrastructure and the application of smart applications, promote overall planning and standards management, and separate development into phases to gradually push for smart city development plans.

2) Develop innovation and provide a good quality of life to focus on the transformation of existing economic development, improve the quality of people's lives, promote innovation development in terms of technique and application, management and promotion of new style industries leading to upgrading the efficiency and quality of city administration and public services.

3) Build a distinctive identity of projects with an emphasis – Projects pertaining to city key components, e.g. city administration, social management and public services, were determined to stress specificity, efficiency, usability, basis and project innovative demonstration, as well as prioritize the achievement of goals according to the timeframe, and follow up the project's construction progress to accelerate the use of information technology to develop cities in all sectors.

4) Initiate pilot projects by cities and districts – The government at the city and district levels shall cooperate in pushing for development, encourage the district level to start operating, accelerate development of pilot projects at the industrial, district and project levels in order to promote readiness in infrastructure and promote extensive application in the development of smart city industries.

5) Guided by the public sector and implemented by the private sector – Promote public private partnerships by letting the public sector formulate relevant policies, regulations and standards, regulate and supervise the market order and let the private sector apply existing resources to drive industrial markets by emphasizing market demand and encourage the social sector to take part in joint smart city development.

Strategies and goals:

Four goals and strategies must be achieved within 2013:

1) A city of broadband and construction of wireless city networks completed: For example, the average bandwidth will be accessible to households at 20 Mbps, internet bandwidth can be internationally and domestically exported at 1 Tbps and 5 Tbps, respectively, and a wireless broadband network covering multi levels and signal points will be created to provide broadband services at anytime and anywhere.

2) Primary efficiency of information sensing and intelligence applications appear: All people have their own e-health profiles and follow up of food safety. The network management should cover the entire city, dynamic traffic data should be accessed through many channels, information technology will be applied to the management and manufacturing process, the index

of information and industrial integration will amount to 80%, and the annual e-commerce transaction will be valued at up to 850 billion yuan (3.4 trillion baht).

3) Modern information technology industry is a strong pillar for smart city development. By 2013 the value of the information industry shall reach 1.28 trillion yuan (5.12 trillion baht). The value added of the information service industry will maintain the production share of the city at 6.2 percent. It will be a global leader of integrated circuits, telecommunication, network equipment and cloud computers, as well as become a convergence of new information technology industrial clusters in China.

4) Highly reliable and controllable information security: To upgrade the city information security prevention and the public awareness level of information security, as well as to be able to supervise cyberspace and respond to emergency events rapidly.

Strategies:

1) Construction of information infrastructure systems to be equivalent to international standards

Strategy: Urban Information Infrastructure Specific Project consists of five parts: broadband city, wireless city, communication hub, network convergence and functional facilities.

Strategy: Standardization System Setting up comprises three systems as follows:

(1) Improve planning systems: Prepare and implement plans for the layout of information infrastructure in Shanghai only, as well as plan wireless WLAN points, and formulate strategies for specific plans.

(2) Draft and collect technical standards for telecommunication construction projects: Collect and determine regulations and measures concerned with the construction projects in practice.

(3) Strengthen monitoring using an institute mechanism: The co-working meeting is comprised of fiber optic network agencies, 3G system structures and network convergence.

2) Creation of convenient and efficient information recognition and smart application systems

Strategy: Promotion of the use of information technology to improve the quality of versatile city management, focusing on:

(1) Urban construction management involves management of strong points and weaknesses for urban construction using modern information technology and innovation to improve the quality of urban management, e.g. maintaining city facilities, managing construction projects, as well as integrating information from the public and private sectors to upgrade the accuracy and intelligence of urban construction management.

(2) Urban safety operation is based on data sharing and business coordination as a foundation to link all steps of seamless management, reduce loopholes from redundant problems concerning inspection and management, improve government monitoring and the ability of public services, such as establishing a food safety information service platform, intelligent digital fire-fighting platform, and safety video resource sharing systems, etc.

(3) Smart transportation: Strengthen data sharing and exchange among industries for transport, support the use of transport data covering both organizational operation and management, create smart transport network systems based on land transport and public transport as the core mode and external transport as an extension in order to provide transport data that covers the public, transport business operators and public agencies, e.g. road traffic information service application platforms, public transport data service systems, highway toll collection systems without stopping the vehicles, etc.

(4) Smart public services: Study people's demands in education, public health, community services, etc, which receive much attention from the people sector, encourage the easy and wide application of information technology to social activities and public services so that people have a good experience when using public services, e.g. smart public health service projects from public health data center digital study projects, electronic cash collection platforms, information inquiry via virtual meteorological stations, etc.

(5) E- Government to facilitate people, improve the public sector's potential for city administration, promote data sharing among government agencies, adjust service methods and channels in order to improve the

convenience of public services, such as online government services, personnel recruitment service, electronic document management, online government approval services and public service hotline platforms, as well as online juristic person identification systems, etc.

(6) Information resource development and utilization to promote the collection of varied information, open data sharing, step-by-step development, and encourage the public sector to share information resources seriously, improve information resource systems continuously and upgrade development levels and the continuous application of information resources, e.g. company information application systems, geographic information applications, SME loan service platforms, etc.

Strategy: Four Strategic Centers Establishment

The Four Strategic Centers Strategy is aimed at promoting integration between e-commerce businesses and traditional industrial development, and at expanding the use of e-commerce applications by integrating and discovering strengths of resources from all relevant sectors. The following four strategic centers are:

(1) International economic center

(2) Financial center

(3) Trade center

(4) Shipping center

Strategy: Transition of traditional industries and development of hi-tech industries

(1) Integrate the application of industrial chain information to drive the overall improvement of industrial information.

(2) Increase construction and the use of third-party information platforms in order to enhance the overall efficiency of information technology of SMEs.

(3) Speed up the construction of digital industry parks to enhance the overall quality of organizations in industrial estates to form informatization, e.g. Zhangjiang AI-land Park.

3) Information Technology Industry as a Strong Pillar for Smart City Development

Strategy: Encourage business operators to develop eight information technologies, namely: cloud processing, Internet of Things, TD-LTE, advanced software, integrated circuits, NGN, car internet and information services.

Strategy: Promote information technology research and development, as well as application demonstration, and accelerate industrial development

4) Highly reliable and controllable information security

Strategy: Promote three safety projects: information security, monitoring services and support industries.

Strategy: Formulate three major measures – integrated monitoring of data security, improvement of cyberspace mechanism monitoring and public awareness raising on data security.

4.2.1.2 Shanghai Action Plan for Promoting Smart City Construction 2014-2016 “Shanghai Vitality” 2.0

The Three-Year Action Plan (2014-2016) consists of two main missions: 1) upgrade the basic information structure potential and promote the integration of information and complete city development, and 2) push Shanghai to become a pioneer in innovation development and a leader in leading smart cities in China to be compared to other international countries, and construct an international metropolis of Chinese socialist modernization.

Shanghai Municipal Commission of Economy and Informatization was established under the advisory group comprising educational institutes, e.g. Fudan University, Tongji University and business operators related to industries such as Alibaba, Huawei, etc, led by the Shanghai government and brainstormed by all sectors. The Three-Year Action Plan (2014-2016) was mapped out in accordance with Shanghai’s situation and its information technology developmental direction.

Promoting principles:

1) Adhering to public needs and benefits: Use public needs as a compass to change economic development and increase the ability of public society management to be consistent with the actual needs of the civic, manufacturing

and public service sectors. High technology should be used to support the efficient allocation of resources to increase convenience and efficiency for smart city residents.

2) Application innovation as a driving mechanism: Promote all types of business technology and strengthen the application of information technology to industries to initiate new types of information industries.

3) Extra security and more coverage: Network security and information technology should be united, planned and implemented simultaneously to be consistent, including strengthening network security and increasing the technical potential and improving safe information management systems.

4) Guided by the public sector but implemented by the private sector: Promote public private partnerships whereby policies, regulations and relevant measures are formulated by the public sector, including supervising and controlling market order. The public sector shall apply the available resources to drive industrial markets by focusing on market demand and encouraging the social sector to take part in developing smart cities together.

Strategies and goals:

By 2016, the following four key strategies must be achieved:

1) Increasing use and efficiency levels of information applications: Information applications are efficient to promote information applications and smart public services, e.g. medicine, education, transport and elderly care covering people from all sectors. Information technology leads to the development of four major aspects, namely new technology, new industry, new patterns and new models. Indicators of information and industrial integration amount to 86.5 and e-commerce transactions are valued up to 2 trillion yuan (around 8 trillion baht) per year.

2) Upgrading new urban information infrastructure services: Create a broadband city with fiber optic broadband networks throughout the city. Fiber optic rate at the household level accounts for up to 60%. The average internet access bandwidth of fiber users in the household reaches 40 megabits per second and the Next Generation Broadcast Network (NGB) covers 6 million households.

Wireless cities cover the entire urban area. The number of 3G and 4G mobile communication technology users reaches up to 70%. The wireless

network in public areas (WLAN) has more than 200,000 wireless access points and the city internet data center has more than 50,000 rack servers.

3) Enhancing development of information technology innovation in the new age: Create entrepreneurs concerned in new patterns to cover technologies, e.g. Big Data, cloud computing, Internet of Things and mobile internet; push Shanghai to become a new production base of information technology in the new age in China by aiming to value the new-age information technology industry to reach 1 trillion yuan (around 4.5 trillion baht), or more than 70% of industry. More than 800,000 people will be employed and an income of 680 billion yuan (around 3,060) from information industry services will be generated. The value added will exceed 7% of the city's GDP.

4) Highly reliable and controllable information security systems: Raise the city information security systems, including the awareness level of public information security as well as the supervision ability of cyberspace and rapid response to emergency.

Strategies:

1) Enhance the use and efficiency in information applications

Strategy: "Shanghai LIVED" contains the five major actions, as follows:

(1) Livable cities and smart living: The principle of "citizens shall receive maximum benefits" will be used to push informatization in all sectors of public services that are closely related to people's livelihoods. Resources from all parties will be mobilized to change service types, including public access channels by encouraging to build a comprehensive public service system of the public, business and people sectors (meta-governance). Significant public services include smart traffic, smart health, smart education, smart pension, smart culture, smart tourism, smart employment and smart weather.

(2) Innovative industry will develop a smart economy using high technology: Information technology will be applied to drive the establishment of the Four Centers with the objectives of developing advanced technology industries, as well as the integration of informatization and industries to

promote Shanghai's policies of "Shanghai Service" and "Made in Shanghai". The relevant scope includes internet banking, smart business, smart manufacturing and smart enterprise.

(3) Viable operation based on increasing accuracy of smart administration: All types of information technologies will be used to collect, store, analyze and display data to promote the application of information to construct and administer cities, as well as support and upgrade functional urban areas and safety pertaining to Shanghai City administration. The relevant scope includes informatization comprising urban integrated management, food safety management, environmental protection, public safety and urban public infrastructure management.

(4) Transparency and efficiency by providing smart government services: to develop the benefits of government information through data sharing, system collection, business operation and public service channel integration based on information technologies, such as Cloud computing, Big Data, Mobile internet, etc. to improve quality and efficiency in public sector administration and public services. The scopes concerned consist of: E-government, Government public data, a public service channel and public credit information service platform.

(5) Create experimental zones at the district level: including urban communities, rural areas, business zones and industrial estates serving as a smart city model. The relevant scopes are smart community, smart village, smart commercial zone, smart park and smart new city.

2) Upgrade the new generation information infrastructure services

Strategy: Strengthen three main support systems in smart cities

(1) New generation city information infrastructure emphasizes 4G mobile communication and network convergence. Scopes concerned include "Shanghai Broadband", Next Generation Broadcast Network (NGB), "i-Shanghai" and a city internet data center.

(2) New generation information technology industry involves new-style economic development and the support of leading business operators to be leaders of industrial development, as well as the promotion of new

generation information technology industry in terms of mobility, networking, intelligence, green, technical support and industrial security for smart city development. The relevant scopes comprise: integrated circuit, display device, high-end software, cloud computing, Big Data, Internet of Things, network audiovisual and network security technology.

(3) Network security: To strengthen basic network security, industry control system security and internet content security, enhance the potential for the support of basic platforms, e.g. emergency management, assessment, network confidence, etc, including managing cyberspace and creating public awareness in cyber security, etc. The scopes concerned are comprised of basic network security, internet content security management, network security supervision, cyberspace governance, etc.

4.2.1.3 2018 – Shanghai new generation of information infrastructure construction to improve the urban energy level and core competitiveness Three-Year Action Plan (2018-2020)

"Three-Year Action Plan" (2018-2020) is aimed at promoting technological transformation and lifting the city's economic level by starting new plans for technological changes and pushing for the development of economic quality, as well as striving to create the brand of 'Made in Shanghai'.

The goals are set to develop the innovation and technology of Shanghai's production industry to be apparently higher by the end of 2020. Labor will be shared with the production of Global Value Chains and all industrial chains will be developed at an exponential rate, as well as global modern production clusters. As a result, Shanghai will become a base of high-level production, a source of advanced and up-to-date technologies and a source of skillful experts in innovation.

Key strategies in the "Three-year Action Plan" (2018-2020) include "Connection, Hub and Computing & Sensing" to support economic development and provide services to people.

Promoting principles:

1) Develop in accordance with plans and improve from previous experience: Development of Shanghai Smart City in order to be consistent with the 13th five-year development plan on China's national information and the

Shanghai City Development Master Plan (2017-2035), and drive Shanghai development using the “Five Centers” strategy promoting Shanghai to become a leading global smart city and a model of the new generation information infrastructure.

2) Planned by the central and local governments and developed by the public and private sectors, who are the leaders to follow these national development plans of China, especially as the city to initiate development of the Yangtze River Delta Economic Region by prioritizing the leading roles of the public sector and resource allocation based on market mechanisms in order to create a new model for a new generation information infrastructure industry.

3) Encourage cross-organizational cooperation in joint creation and sharing: Coordination between the public city and district agencies will be promoted to provide cross-organizational cooperation, as well as cooperation between urban and rural communities to lead to integrated development on resource use and application to industries, and an industrial ecosystem of the new generation information infrastructure.

4) Increase investment through the government’s support policy: Good policies will be formulated to support the public sector, increase investment in permanent assets, as well as attract private business operators to join the PPP to push for efficient information infrastructure reform.

Strategies and goals:

By the end of 2020, the following four strategies and goals must be met:

1) Connection: Create smart and high-speed information networks, namely creating a broadband city of “Dual Gigabit” to cover the entirety of mobile communications and steady broadband networks throughout the city, as well as initiate 5G mobile communication technology commercially in order to transform it into smart networks.

2) Hub: Build a network for an efficient information exchange center, establish a world center of information by creating “a data port of the Yangtze River Delta Economic Region” to become one of the cities with the most

links to information to exchange data among countries in the region, as well as be a leader of local content distribution network coverage.

(1) Capacity of international submarine communications cable amounts to 35 Tbps.

(2) International bandwidth and inter-provincial bandwidth amounts of 5 Tbps and 50 Tbps, respectively.

3) Computing: Establish a center of information exchange that can store and analyze data in order to create a center of super computers with calculation ability at the E-level. The city information center has more than 160,000 rack servers. The indicators for power usage effectiveness (PUE) at the information center are determined to not exceed 1.3.

4) Sensing: Standardize high performance data recognition applications for new-style smart cities focuses on three key components: public services, public governance and public safety pertaining to creation of "city sensing network systems", which are sensitive, connected and in real-time. More than 100 locations of IoT network applications will be installed in the city in order to promote city administration and smart social monitoring.

Strategies:

1) Speed up creation of the "Shanghai Connection"

Strategy "Broadband city of Dual Gigabit": Commercial trial use of 5G mobile communication technology network, install about 10,000 5G signal stations across the city, designate 5G signal experimental areas at mega exhibitions, e.g. WAIC to push Shanghai to be one of the bases for developing technology in China. Other goals include high speed networks of Gigabit Ethernet covering 9 million households. The MB capacity network covers 8,000 office buildings. The ability to access mobile communication networks and broadband access accounts for 1,000 Mbps. The average perception rate of users is 50 Mbps, etc.

Strategy: Build a network of smart information communication to encourage the use of internet protocol version 6 (IPv6) with the objective of IPv6 users of more than 50% of internet users in order to drive application networks and terminals to serve the IPv6 operation completely and change to virtual network functions (SDN, NFV).

Strategy: Build an industrial internet network architectural system in order to promote the transformation and upgrade of internal and external industrial networks, stressing the development of key industrial estates in Shanghai, e.g. Shanghai Lingang Industrial Area, Shanghai Songjiang Economic & Technological Development Zone, Shanghai Jinshan Chemical Industry Park, Shanghai Baoshan Industrial Park, etc.

(1) Promote the use of passive optical networks (PON), narrow band Internet of Things, time-sensitive networking (TSN), whereby many machines can work on the same real time internet systems.

(2) Encourage key industrial estates to operate from internet industrial networks and industrial wireless networks.

Strategy: Set up combined line standards and underground standards for overhead lines to push for transmitting information lines on the road to 470 km, with 62% underground in order to improve city landscape and security in Shanghai City.

2) Construct the “Shanghai Hub” to strengthen the city

Strategy: Establish a global information communication center comprised of:

(1) Constructing a Cable Landing Station “Lingang Cable Landing Station for NCP” owned by China Mobile.

(2) Expand the capacity of cable systems, namely Trans-Pacific Express Cable Network (TPE), Asia Pacific Cable Network-2 (APCN-2), New Cross Pacific (NCP) and Asia Pacific Gateway (APG).

(3) Accelerate construction of a cable station “South-East-Asia Japan Cable 2 (SJC2)” owned by China Mobile.

The following targets are: 1) the capacity of cables linking Shanghai’s sea of 35 Tbps is 50% of the country, 2) the internet bandwidth for export of 5 Tbps accounts for 35% of the country.

Strategy “Yangtze River Delta Economic Region Data & Information Port”: To improve communication network architecture and the quality of network connectivity of the Yangtze River Delta Region, as well as expand the

capacity of export internet bandwidth by more than 50 Tbps at international and inter-provincial levels.

Strategy: Establish a center of content exchange, promote the expansion of CDN capacity to 1.5 million people per node, a CDN export bandwidth of 800 Gbps, a capacity of streaming media processing of 480 Gbps, as well as storage space of up to 1,600 TB playing music, videos and animation data via the real time internet.

3) "Shanghai Computing" enhances efficiency

Strategy: Establish a center for high performance computers at the E-level, to provide a high performance computer system and a large-scale data processing platform to emphasize the center of computer science in collaboration with leading research centers to develop mechanisms of high performance computer systems.

Strategy: Promote the establishment of an advanced and environmentally friendly data center and accelerator systems with a limited number of 60,000 rack servers and a total of 160,000 rack servers.

(1) Promoting the use of technology and restructuring the data center by stressing energy savings with revised PUE indicators not exceeding 1.4 and PUE of the new data center not exceeding 1.3.

(2) Establishing a computer center with a central processing unit and a graphic processing unit in accordance with the data center.

(3) Resources accelerating the speed calculation of AI shall occupy 50% of the total rack servers of the increasing data centers.

4) Build genius by "Shanghai Sensing", create a new-style IoT network comprised of a city awareness network leading to the City Brain.

Strategy: Push "the city awareness network" into an IoT network that covers the IoT, install more than 30 million nodes of awareness throughout Shanghai, both in urban and rural communities, collect data on the city, transform it into statistical data, and increase the data to at least 20 P per year.

Strategy: Create an integrated awareness network service platform that is ready to connect to the City Brain with a structure called "1+16+X", which means 1 city platform per 16 district platforms and X platforms at the road

level in sub-districts, communities or industries. The data processing capacity is at P level.

Strategy: Application innovation providing awareness networks to improve city public services, create cross-industry innovation applications driven by big data and AI, including a blockchain application to at least 100 items in the vertical industry.

4.2.2 Agencies Relating to Shanghai Smart City Development

4.2.2.1 Shanghai Municipal Commission of Economy and Informatization

The Shanghai Municipal Commission of Economy and Informatization was founded in 1999 under the Shanghai government and under the supervision of the Ministry of Industry and Information Technology. Its function is to promote the transformation of information in the industrial and social sectors of Shanghai, and to formulate regulations, directions and policies of Shanghai information development. Currently, there are 300 administrators and staff.

Major responsibilities pertaining to information monitoring and management:

1) Apply laws, regulations and relevant policies on industrial and information operations to study and draft local laws and regulations about industry and information, as well as cooperate with parties involved in complying with these regulations.

2) Formulate special and annual plans for developing the information industry and producers' services in line with the overall planning of Shanghai Municipality's social and economic development to study policy measures for planning structures and improving industrial and information structures. Determine policies and standards in accordance with the national industrial policy, and prepare development plans of Shanghai Municipality to serve as a direction and support industrial development and the information industry.

3) Audit and analyze the operation of the industrial and information sectors. Carry out statistical operations and publicize relevant information, forecast and disseminate information, as well as provide advice and

coordinate solving problems related to industrial operations and development, including responsibility for missions pertaining to industry and information emergency management and industrial security. Raise funds for national defense and industrial administration, take part in management, cooperate with agencies concerned in the production, reservation and transport of disaster mitigation materials to fight against natural disasters, coordinate with agencies involving anti-monopoly, manage research and development in military and production, and manage marine industry.

4) Provide recommendations about the industrial direction of Shanghai Municipality and information investment, prepare and plan key industry projects and information construction projects in accordance with rights approved by the Shanghai Municipality. Cooperate with related agencies to order organization and promotion of industrial operations and information projects related to public sector investment. Be responsible for basic inspection and approval of the public sector's information projects under the Shanghai budget, provide suggestions as a monitoring agency on trade for significant information projects and financial information projects in Shanghai Municipality, cooperate with agencies concerned to provide balance and management of special expense benefits for information investment, as well as cooperate with agencies concerned in coordination and exchange of industry and information.

5) Establish guidelines for technological innovation and progress, promote technological reform, enhance efficiency of the original industrial sector, reform and upgrade advanced technology, coordinate and organize significant projects that are national industries and study and develop scientific and technological industries in order to drive the management of quality and branding strategies in the industry. Coordinate and organize the use of technical standards by the government and local agencies, cooperate with agencies concerned to study and propose technical standards of information as a guideline for managing the quality of products, create innovation and develop software, as well as provide information and industrial services.

6) Utilize resources completely and implement clean production in the industrial sectors of information and innovation. Manage the

industrial sector and information in order to enhance quality and industrial competitiveness, as well as introduce relevant industries to increase safe production management.

7) Improve the original industrial zone and upgrade the industrial level in accordance with national social and economic development plans, including the criteria and policies for industrial development to increase development of industry and innovation responsible for preparing medium-scale industrial development plans and industrial development zones. Promote gatherings of park industrial projects and adjust the project types properly, with responsibility for coordinating integrated construction and development of industrial development zones.

8) Set up an operating system to serve medium- and small-scale enterprises to improve services of medium-scale organizations in Shanghai as a guideline for promoting, developing and establishing medium- and small-scale enterprises, as well as managing and supervising the operation of industrial associations.

9) Add development services to producers and coordinate with agencies related to modern logistics development and promote integrated development of services and production.

10) Oversee and coordinate the production of coal, electricity and fuel as well as participate in providing suggestions for management, coordination and efficient enhancement of energy.

11) Coordinate the development and use of information resources related to e-government development, e-commerce publication and data application in the economic and social sectors. Be responsible for coordination and managing of public information resource sharing in order to organize and cooperate in the application of data in various agencies in the industrial sector.

12) Maintain responsibility for planning, coordinating and managing construction of municipal information infrastructure. Organize and give recommendations to agencies pertaining to communication planning in public communication and information networks for special purposes and relevant management, coordinate major activities related to public interest in the

telecommunication market, and be responsible for connecting between trade businesses, agencies and social service networks.

13) Organize order and coordinate the establishment of information security systems responsible for giving advice and coordinating data security, coordinating and managing key events on information network security, cooperate with agencies concerned with strengthening the regulating and managing of technical data on security, equipment networks and products for the network operations of Shanghai Municipality. Coordinate information security, organize, coordinate and suggest training, publicize education information, including information prediction and planning.

14) Coordinate and promote development of the smart card industry, organize and give advice on significant smart card project operations and smart card applications. Organize, coordinate and develop the credit card industry to be more popular in order to increase popularity among industries and apply technologies, e.g. radio frequency identification, etc. to cover all socio-economic and livelihood aspects for individuals and organizations, and introduce the loan service industry and credit information (Shanghai Municipal Commission of Economy and Informatization, 2019).

4.3 Models for Smart City Development on Shanghai City Management in China

In 2018, the index of Shanghai Smart City stood at 105.13, an increase of 5.6 points from 2017. The network readiness, applied application use and environmental development levels continuously increased, while disparities between urban and rural communities decreased. In particular, the network readiness index increased by 18.67 points from the previous year. This reflects the growth of information technology development of Shanghai City, including smart city development models using more innovation. As a result, the quality of information infrastructure and public services have improved. At the same time, the index of applied application use increased by 4.2 points from the previous year. This indicates that Shanghai has applied more

applications to urban administration in terms of smart living, smart economy, smart governance, e-government and green environment (SHEITC, 2018).

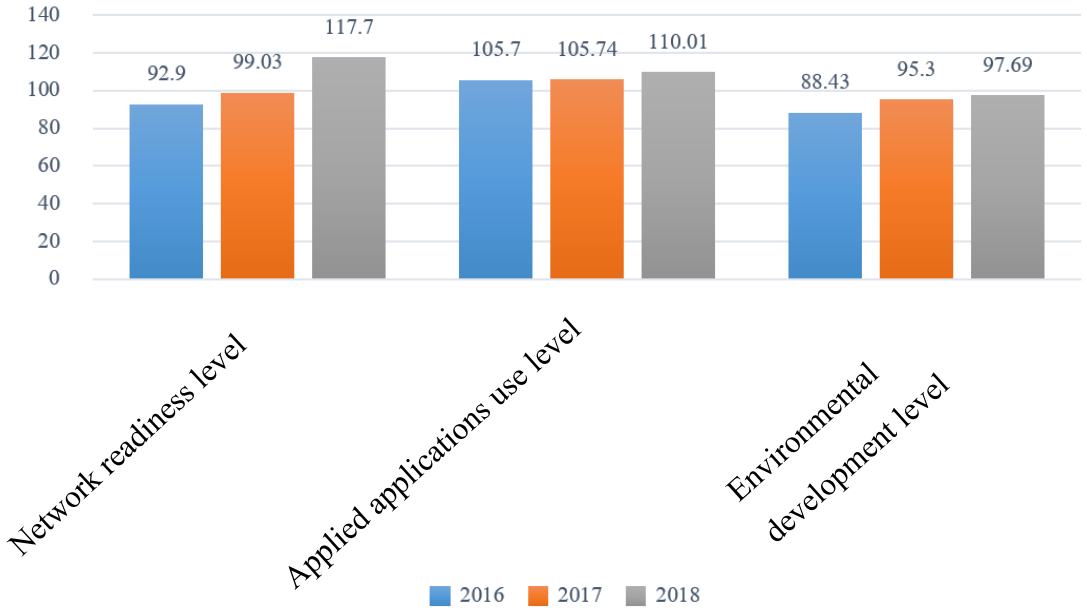

Figure 4.3 Shanghai Smart City Development Index, 2018
Source: SHEITC, 2018.

The researcher applied Rudolf Giffinger et al's conceptual framework (2014b) of smart city components to describe smart city development in each aspect of Shanghai City.

4.3.1 Components of Shanghai Smart City

Figure 4.4 Shanghai Smart City Components
Source: Modified from Giffinger et al., 2014b.

The components include 1) smart governance, 2) smart people, 3) smart mobility, 4) smart living, 5) smart economy, and 6) smart environment, with the following details:

1) Smart Governance – comprised of the application of ICTs to public sector management at local and central levels, and promotion of interactions between the public sector (service providers) and the people sector (service users), including support of public sector services to increase the efficiency and effectiveness of ICTs.

Figure 4.5 One Net E-Service Project

Shanghai's "One Net E-Service" Platform was started on November 1, 2018. It serves as a channel for receiving public services. It is a platform that provides complete online services based on the structure of "one beam and four pillars", comprising one beam which refers to the platform of public service channels, and four pillars meaning identity confirmation, customer service, service payment and service delivery. As a result, the type off public service has been changed from "meet the department" to "meet the government", from "people search for services" to "services search for people" and from "people arrange services to "data arranges services".

At present, 100% of platform services are accessed. There are on average 72,000 transactions received and operated per day. The regulations on public information management and One Net E-Service will be issued to provide further services on electronic certification, electronic data files and electronic stamps.

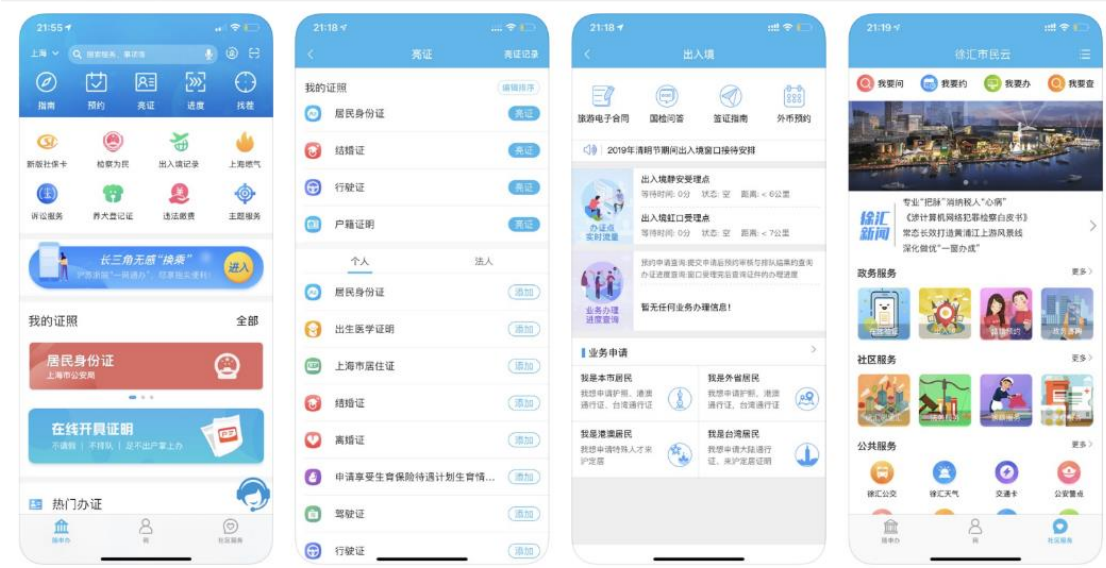

Figure 4.6 Shanghai Citizen Cloud, the First Public Application in China

"Shanghai Citizen Cloud" is a key component in the general portal. Shanghai's public services have been upgraded to increase a new channel of "One Net E-Service" leading to five functions: a personal inquiry guide and online juristic person; online appointments; ID car scanning; progress inquiry; and complaints.

"Shanghai Citizen Cloud" provides information on public services covering eight major categories, e.g. births, deaths, retirements, company registration, company cancellations, etc., related to more than 40 public agencies. At present, a total of 235 items of public sector management services, personal services and public services have been gathered covering urban and rural community services. Smart customer services are also provided so that users can pose urgent questions through the Quick Q & A in order to access the required service quickly.

2) Smart People – The application of ICTs is to develop human resource capability in terms of educational development, training and the country's human resource management, which helps to bring about an environment that promotes creativity and innovation.

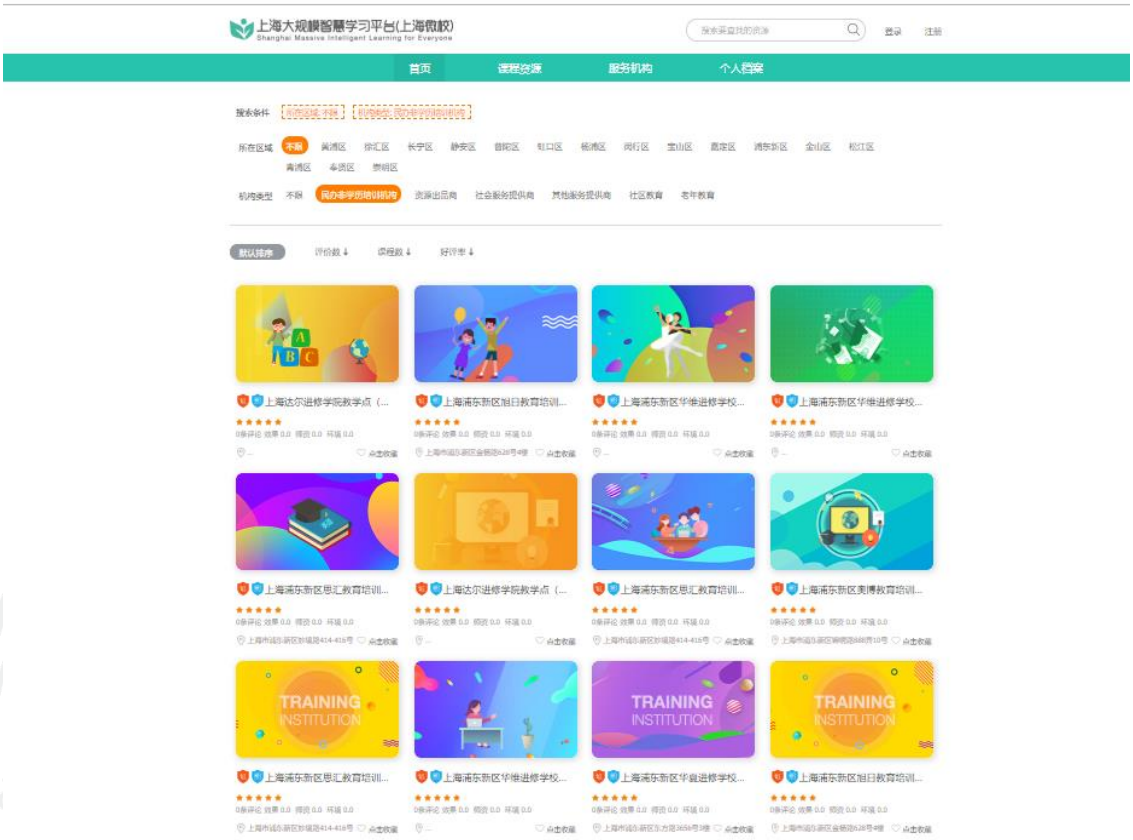

Figure 4.7 Shanghai Massive Intelligent Learning Platform

"Shanghai Massive Intelligent Learning for Everyone" was launched on December 7, 2018. It is one of the key projects under the 13th Five-year Development Plan and "Education 2.0" to create smart cities, with such platform functions as the integration of education and information technology in Shanghai and connection of data from the learners' studies in each period. Teachers can also search for teaching tools and applications so that students can use advice services on educational institutions, online classrooms (wxiao.net) and lifelong personal data files.

Currently, more than 200 primary and secondary schools use this platform and more than 90,000 people have registered, while about 8,000 items of learning resource sites have been collected.

3) Smart Mobility – This consists of the application of ICTs to link data, such as passenger, transport, traffic, etc, including Big Data, which becomes key

information used for analysis to search for problems and suggestions to solve traffic problems.

Figure 4.8 Road Traffic Data Application Service Platform

Because of the communication network platforms connected to real-time traffic information between cities and districts, and improvements in collection and preparation of traffic situation parameter indicators, people can track information through real-time road traffic via channels, e.g. the internet, radio, television and mobile communications.

(1) Public transport data service systems

Information will be collected from railway transport networks, including real-time operation and passenger flow data. Pilot tests of bus information service notification systems will be carried out and the collection of data on public

parking areas will be improved. Electronic parking fees and online parking reservation services will be promoted.

(2) Electronic Toll Collection (ETC)

Electronic toll collection will be improved and all toll collection systems will be changed to the Electronic Toll Collection (ETC).

4) Smart Living – Smart living comprises the application of ICTs to daily lives, such as the environment in residential areas and all communication devices, which will be managed automatically by smart networks with high-performance, convenience, reliability and benefits.

Figure 4.9 Shanghai Health Cloud linking residencies and people

Source: Shanghai Municipal Health Commission, 2019.

"Shanghai Health Cloud" links city health services with more than 2.77 million registered users, including 10,688 expert physicians covering more than 240 public health service centers in Shanghai.

"Shanghai Health Cloud" offers new forms of health services to people who can check their health profiles on line, it gives online doctor consultations, provides care for chronic diseases, as well as makes appointments for vaccines and doctor visits via such applications. This platform connects to mobile applications between patients and physicians, making health services online and more efficient.

(1) "Smart Police" Security covers all parts of the city

High technology, such as Big Data and AI are used to support Shanghai public security by enhancing the perception of smart city components and smart information processing.

Currently, Shanghai is capable of storing data at the PB level and processing real-time data per millisecond. There are around 500,000 sensing nodes on roads, in communities and buildings, etc, including research and development of smart security applications, such as facial recognition systems and smart security procedures.

5) Smart Economy – Smart economy consists of the application of ICTs in the form of e-business and e-commerce to increase manufacturing efficiency, deliver products and services, as well as create new economic innovations and build smart clusters and eco-systems.

(1) Smart Business

"E-commerce transaction service platform" supports innovation platform development in order to meet SME business demands, promotes the application of technology, e.g. cloud computing, Big Data and mobile internet, to accelerate the emergence of service chains of the e-commerce industry.

(1.1) "Online Shopping and Online Shopping Mall" promotes new-style e-commerce services, O2O business model (Online to Offline) and C2B (Consumer to Business).

(1.2) "E-commerce Industrial Estate" encourages development among e-commerce, transport and express logistics industries to push for e-electronic payment services and loan services, including electronic invoices and electronic contracts.

(1.3) "Security assessment and express logistic service tracking platform" creates a service method innovation and industrial monitoring

model, and promotes large-scale business operators to consistently develop applications in order to increase the quality of the express logistics industry.

(2) Smart Enterprise

(2.1) Promotes the application of advanced manufacturing technology, e.g. industrial robots, additive manufacturing, digital laboratories and smart factories.

(2.2) Encourages business operators to use information, such as Big Data, IoT, mobile internet, etc. to develop new business models that increase service efficiency and organizational decision-making.

(2.3) Create “Information and public service platforms for small and medium enterprises (SMEs)”

(3) YRD Urban Agglomeration

The State Council of the People's Republic of China has a policy to establish “YRD Urban Agglomeration” in accordance with China’s 13th Five-year Development Plan. Shanghai is a core city for pushing such policies. Significant cooperation includes:

(3.1) “White paper on the development of 5G network cooperation in the Yangtze River Development Zones” which drives the trial use of 5G networks in various cities within the Yangtze River Development Zones. It is a first-time cooperation in China, with video call services linking 5G networks across Shanghai, Suzhou, Hangzhou and Hefei provinces.

(3.2) “Health insurance payment linking systems of the Yangtze River Development Zones”

(3.3) “Air quality forecast data and warning platform in the Yangtze River Development Zones”

(3.4) “White paper on the development of Big Data industry cooperation in the Yangtze River Development Zones” cooperates in organizing open data competition at the regional level with more than 100 items of open data.

(3.5) “National top-level Industrial Internet Addresses and Identifier Resolution System”

6) Smart Environment consists of preservation of the environment, forests, plants, ecology, agricultural promotion, city food sources, public parks green areas, water management, water pollution, air pollution and urban heat islands.

(1) “Shanghai Environmental Quality Monitoring Network”

(1.1) “Environmental quality monitoring network systems” include air, water and noise pollution, radioactivity, soils and ecology in Shanghai.

(1.2) “Air quality forecast and warning systems in the Yangtze River Data”

Sharing regional real-time data on air pollution monitoring to prepare a list of pollution emission sources to be applied to regional weather forecasts and warnings.

Strengthening the management of environmental pollution sources and utilizing information systems in the production, transport, disposal and control process of hazardous waste from the point sources.

Enhancing the development and utilization of environmental protection data sources and guiding business operators to provide convenient and quick environmental information to public and joint venture groups.

Figure 4.10 Food safety monitoring and information service platform

A food safety monitoring and information service platform is to create a food safety control and monitoring system based on information systems.

The food safety monitoring platform covers tracking of nine major types of food and agricultural products. At present, 57,553 business operators have joined the platform with data on 355 million items on average through the platform.

4.4 Shanghai Smart City Development Indicators

In Chapter 2 the Chinese smart city development indicators were designed into two indicators: 1) capability indicators and 2) performance indicators (SMCSTD, 2016a). In summary, the evaluation is comprised of three aspects, namely indicators on infrastructure readiness, industrial applications and development environment levels (including government support and the urban development level) related to smart city development prioritization in China (SMCSTD, 2019a).

Table 4.3 Smart City Development Evaluation Indicator System in China

Evaluation list	Level 1 indicator	Level 2 indicator	Method of indicator evaluation
Public policies (30%)	- Smart city strategies - Goal achievement	- Coverage - Effort level - Action plans and timetable - Operation efficiency	- Number and level of covered areas - Budget amount in the project - Number of projects - Achievement of goals in due time
Infrastructure and service levels (20%)	- IT infrastructure - Basic services	- Network connectivity - Technology potential - Convenience and quick public services	- Average city internet speed and telecommunication income - Number of technology innovation business operators and number of information personnel - Number of opened online services

Evaluation list	Level 1 indicator	Level 2 indicator	Method of indicator evaluation
Progress of application use to city management (50%)	- Smart transportation - Smart security - Smart community	- Transport smartness - Security smartness - Community smartness	- Number and level of smart transport coverage areas - Number of city monitoring devices and number of monitoring system productions - Number of smart communities and level of smart uses

Source: SMCSTD, 2019a.

The survey results of China smart city development evaluation indicators in 2019 (SMCSTD, 2019a) revealed that the top ten smart cities in China are: Shanghai, Hangzhou, Beijing, Shenzhen, Guangzhou, Chengdu, Dalian, Chongqing, Suzhou and Ningbo, respectively. Shanghai ranked first with 85.7 scores, Hangzhou second (85.6 scores), Beijing third (85.1 scores), Shenzhen fourth (78.4 scores) and Guangzhou fifth (76.4 scores), respectively.

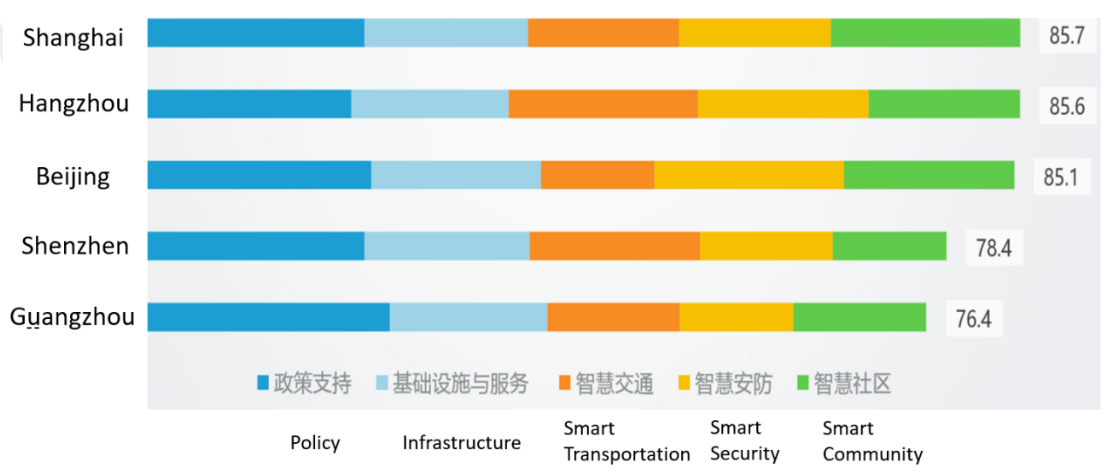

Figure 4.11 China Smart City Development Evaluation Indicators in 2019
Source: SMCSTD, 2019a.

Table 4.4 TOP 5 China Smart City Development Evaluations from 2015-2019

2015	Wuxi (80.2),Shanghai (80.05),Beijing (79.72), Hangzhou (76.97),Ningbo (76.67)
2016	Shenzhen (80.57), Shanghai (80.13), Hangzhou (79.06), Beijing (78.68), Wuxi (76.71)
2017	Hangzhou (76.59), Shenzhen (75.1), Shanghai (74.97), Guangzhou (68.62), Xiamen (62.55)
2018	Shenzhen(76.3),Hangzhou(75.4), Wuxi (74), Ningbo(73.6), Shanghai (73.2)
2019	Shanghai (85.7), Hangzhou (85.6), Beijing (85.1), Shenzhen (78.4), Guangzhou (76.4)

Source: Guomai Smart City Research Institute, 2019.

With respect to the analysis according to each category, it is notable that 1) support of public policies: smart city planning to cover all aspects includes Guangzhou, Shanghai and Beijing. The governments of these three cities spent high budgets for their projects and prepared clear action plans resulting in a high ability of goal achievement, 2) infrastructure and service readiness, the cities with IT infrastructure readiness include Beijing, Shenzhen and Shanghai. However, infrastructure services, especially online public services, includes Hangzhou, Shanghai and Beijing, and 3) progress of city management application use, e.g. smart transportation, smart security and smart communities includes Hangzhou, Shanghai and Beijing.

However, Shanghai has prepared its first annual report on Shanghai Smart City Development Evaluation since 2015. The latest report was prepared by the Economic and Information Technology Commission of Shanghai Municipal People's Government in 2018. There are three indicators for Shanghai smart city development evaluation, namely infrastructure readiness; industrial application; and development environment. It is remarkable that Shanghai Smart City development has expanded consistently every year and has had continuous growth in all three aspects, namely infrastructure readiness, industrial applications and development of the environment.

Table 4.5 Comparison of Shanghai Smart City Development Evaluation Indicators from 2015-2018

List of evaluation	2015	2016	2017	2018
Mean	88.77	97.65	99.53	105.13
Public policies 30%	80.40	88.43	95.30	97.69
Infrastructure and service levels 20%	84.45	92.90	99.03	117.70
Application use progress of smart city management 50%	96.10	105.70	105.76	110.01

Source: Guomai Smart City Research Institute, 2018.

CHAPTER 5

DATA ANLAYSIS: QUALITATIVE ANALYSIS

The review of literature, articles and relevant documents, as well as the application of in-depth interview tools used to interview 30 key informants, are comprised of 1) key informants, consisting of 11 public officials and research institutions related to project operations leading to smart cities, and 2) 18 administrators or business operators related to project operations resulting in smart cities.

The researcher adopted PEST analysis tools to analyze the constraints, opportunities and challenges of Shanghai Smart City, as well as uncontrollable factors affecting the development of Shanghai Smart City.

The researcher applied Chourabi et al.'s "smart city integrative framework" (2012) to analyze factors affecting key success elements in the development of Shanghai Smart City. Each factor may have an influence depending on the situation. Chourabi classified the factors into two main categories: internal factors and external factors. Internal factors comprise technology, management and policy; while external factors consist of governance, people and communities, the natural environment, infrastructure and the economy.

Table 5.1 Key Informants from Agencies Related to Shanghai City Development

Type	Agency	Number of people
Public Sector	- Shanghai Municipal Commission of Economy and Informatization includes the Vice Chairman, Deputy Division Director of Technical Progress Division, Director of Informationization Promotion Division, Director of Software and Information Services Division, and Director of Information Technology Applications.	5 people
Research Institutes	- Shanghai Pudong Smart City Research Institute comprises the Executive President and Assistant of Executive President.	2 people
	- Shanghai Industrial Internet Center comprises the Executive President, Director of Big Data Division and Director of Information Services.	3 people
	- Shanghai Economy and Informatization Research Center includes a Vice President.	1 person
Entrepreneurs	- Shanghai Data Exchange (SDE) Co., Ltd. includes Vice President of Sales.	1 person
	- Shanghai Cloud Data Co., Ltd. consists of the General Manager, Deputy General Manager and Director of Sales Department.	3 people
	- Transwarp Technology (Shanghai) Co., Ltd. comprises the Vice President, General Manager, Industry Solutions Director, General Manager of Ecosystem and Partnership Department and a Big Data Architect.	5 people

Type	Agency	Number of people
	- Shanghai Shibei Hi-Tech Enterprise AI Experience Pavilion includes a Data Intelligence Industry Manager.	1 person
	- Xiao-I Co., Ltd. consists of a Deputy General Manager.	1 person
	- DeepBlue Technology (Shanghai) Co. Ltd. comprises the Vice President and General Manager of the AI Innovation Centre.	2 people
	- Shanghai PartnerX Co., Ltd. Comprises the Deputy General Manager.	1 person
	- Goldpalm Data Technology consists of a Deputy General Manager.	1 person
	- Global Tone Communication Technology (Shanghai) Co., Ltd. comprises a Deputy General Manager.	1 person
	- Huawei (Thailand) Co., Ltd. Comprises a Managing Director, Product Development Manager and Senior Marketing Manager	3 people
	Total	**30 people**

Note: * The names of executives cannot be disclosed by the researcher because of the researcher's ethics not to reveal the details of the informants, as it may damage them.

5.1 Analysis Results

5.1.1 Constraints of Shanghai Smart City Development

5.1.1.1 Politics and Policy

1) Insufficient cooperation in cross-organization and cross-agency public agencies

Based on statistics over the past few years, the percent of smart city projects operated by only one single agency was higher than that of those

relying on collaboration of various agencies. As a result, those projects made slow progress and some projects had to stop. Mrs. Choen, a senior official of Shanghai Municipal Commission of Economy and Informatization stated that projects that require cooperation during construction and post-construction from all agencies concerned usually need much cooperation from various relevant agencies. However, cross-organizational coordination can be difficult, for example each agency trying to evade its duties or having its own different goals. Even territorial conflicts (Gil-García & Pardo, 2005) delay joint decision making in smart city projects. For example, to install smart electricity poles, the following agencies must be contacted: the Shanghai government, the Department of Security, transport agencies, telecommunication agencies, environmental agencies, electricity agencies, pipeline agencies, etc. Thus, the Shanghai Smart Electric Pole Project is a trial installation in limited areas. It is remarkable that cross-sectorial cooperation and inter-departmental coordination are vital to the development of smart cities (Ebrahim & Irani, 2005).

2) Lack of public sector coordination with absolute power

Currently, the Shanghai Smart City Project has switched from focusing on management to services. The Shanghai government's efforts in the earlier period for this "type of electronic government management" could not meet the increasing variety of demands in the Smart City Construction Project and could not contribute to an atmosphere of innovation.

Internal governmental authority is insufficient. All processes of information projects, from planning, design, project approval, project tendering and purchasing, to operations, maintenance and coordination led by the public sector must be strengthened more, as stated by Mrs. Wang, Deputy Managing Director of Deep Blue Company Limited.

Mrs. Wang, Deputy Managing Director of Deep Blue Company Limited also added that Shanghai still lacks "a mechanism for social gathering". As a result, forced integration and participation in smart city development from other sectors, such as business operators, research institutions and the public sector are not at the highest level possible. It is notable that collaboration is a key mechanism for developing smart cities by letting people and stakeholders from all sectors take part in all steps of the process (British Standards Institution, 2014).

3) Unprofessional management of the public-sector team

The public-sector team's potential for managing the project must be strengthened, especially the management team's skills and expertise (Gil-García & Pardo, 2005) to push for project planning and construction. Mr. Foeng, Director of the Shanghai Pudong Smart City Research Institute stated that after considering city public agencies it was notable that city information promotion and power distribution were not strong enough. Additionally, the Shanghai Municipal Commission of Economy and Informatization, as a regulating agency, still lacks the leadership to instruct and guide other relevant agencies to cooperate. This operation depends on coordination and negotiation only. As a result, the impetus for pushing a Shanghai Smart City is difficult. Mr. Foeng also added that Shanghai agencies still do not have strong and decisive agencies to regulate information and guide agencies concerning information establishment and information management projects. Thus, this cannot solve the individual operations among agencies. It is remarkable that successful smart city development must be based on a connection of public sector culture which must create an open atmosphere and collaboration (British Standards Institution, 2014).

5.1.1.2 Economy

1) Inadequate force from economic benefits

British Standards Institution (2014) wrote that benefit realization strategies are initiated to encourage the private sector to be ready to cope with smart city policies. That way the private sector realizes the benefits that organizations receive, and also realize the country's overall development as a key component for developing smart cities.

Smart city development plays a large role in changing China's economic growth models and bringing about economic growth of good quality, efficiency and sustainability. Currently, Shanghai Smart City construction is unclear concerning economic benefits. Mr. Lu, Deputy Managing Director of the Shanghai Data Exchange Center, stated that budgetary investment in the Shanghai Construction Project has not driven relevant social capital, such as health, education, housing, environment, security, transport, communication, participation, etc., to be efficient. Mrs. Liu, a researcher of Shanghai Pudong Smart City Research Institute,

added that as the business profit model of social capital for smart city projects is not clear, it is difficult to promote business operators to take part in social capital. It is evident that clear benefit mapping will make the private sector wish to join the business willingly and completely (British Standards Institution, 2014).

2) Difficult fund raising leading to business operators' policy-based risk insurance at a low level

The Shanghai government has funded the Smart City Project (smart up), especially for research to encourage the private sector to invest in public projects and develop them to become ecosystems. It has also cooperated with higher educational institutions, such as Jiaotong University and Fudan University, which encourages students to propose smart up projects through their universities to responsible agencies. The public sector has the criteria to select excellent projects for the smart up fund, said Mr. Fang, Director of the 3IN Research Center.

Additionally, Mr. Fang mentioned that the Shanghai government has issued policies to promote startup businesses using business promotion policies, such as incorporating an income tax deduction and import tariff reduction, establishment of an industrial zone of information technology clusters designated as the FTA, e.g. Lingang Advanced Technology Industrial Estate. It is notable that public sector support for investment promotion provides business operators with sufficient innovation funds. At the same time, the public sector insures their risk. This can attract entrepreneurs to take more part in developing smart cities (Gil-García & Pardo, 2005).

5.1.1.3 Social

1) Ignorance of the people's actual needs

The citizen-centric concept for city development and citizen-centric service management are international principles of modern public service (British Standards Institution, 2014). In the past, development of significant projects in Shanghai, e.g. Smart Living, Smart Governance, Smart Security, etc. was guided and invested in mainly by the Shanghai government. Project approval procedures took a long time. This affected the progress of city development. Mrs. Lee, Manager of the Public Relations Department of Transwap Company, stated that most projects initiated by the public sector usually start with the perspective of "services focusing

on city services and management". This has caused a discrepancy between the projects and the public's actual needs, and affected the perception of public smart experiences towards the project. Thus, people's needs and the response to the needs of city residents in terms of convenience and quick access to public services, must be taken into account (Makoto Yusui, 2012) in order to create social sector participation to drive Shanghai Smart City, resulting in sustainable development.

2) Insufficient personnel development mechanism

In relation to driving the smart development of grassroots governance and rural areas in Shanghai, it is notable that the technical professional skills of operators at the district and rural levels are relatively low. This causes restrictions in the development of grassroots information. Mr. Wang, Senior Researcher of the Shanghai Pudong Research Institute, said that the Shanghai government has to provide adequate training in order to provide a grassroots team with more skills and expertise (Gil-García & Pardo, 2005).

5.1.1.4 Technology

1) Undetailed specific technical standardization systems

A mechanism for special technical standardization still lacks prudence and completeness. Mr. Wang, Senior Researcher of the Shanghai Pudong Research Institute, cited an example of the project called "food security regulating and data service platform", of which the regulating standard and classification contain no details. As a result, the follow up of data from some business operators is not of good quality. Another example relates to announcement of the standard BIM application, which was later than application promotion measures, as well as inconsistencies between Shanghai local standards and national standards, which affects the project's progress and efficiency in data analysis. It is remarkable that clear and measurable planning, as well as continuous business process improvements are necessary for upgrading the quality of public services.

(1) Design of increasing citizen-centric applications to the public sector

The Shanghai Pudong Research Institute conducted an opinion analysis of Shanghai people, revealing that they are not very satisfied with projects involving people's smartness perceptions. Most people were of the opinion

that information technology services that are received currently are not consistent with their demands. Public services are also not convenient, fast or efficient. In particular, target-oriented smart and personalization services are still limited; as a result, people feel that smartness in their daily lives is low.

It is therefore necessary to manage disparities between public expectations and projects. It is notable that stakeholders of all sectors play a large role in driving the development of smart cities. Citizens not only suggest recommendations to the public sector, but also take part in pushing for the community's smart city projects (Harms, 2016).

5.1.2 Opportunities for Shanghai Smart City Development

5.1.2.1 Politics & Policy

1) Supported by the central government's policies

As the central government focused on new-style economic change strategies through the development of smart large-scale cities in China, the number of initiated smart city projects ranked first among the global total of 542 projects, with the highest investment cost of 65.04 billion yuan (or around 2.731 trillion baht) in the world.

Shanghai, in particular, maintains the growth center in the Yangtze River Delta in the east of China. Shanghai has been listed in the first series of smart city trial projects since 2012. China also pushed Shanghai to be one of the world's leading economic cities as a Tech Talent Hub, especially FinTech.

2) Country leaders with vision

According to the vision of President Xi Jinping of China, China must change its digital-based economic development strategy, particularly China's construction of new-type smart cities. He stated that China is entering the Internet Age. With China's new-style smart city development strategy, the essence of Chinese leaders' visions includes a proposal to accelerate construction of network infrastructure and push for innovation of the internet economy, as well as prioritize network system security.

3) Supporting central policies

The country leaders' vision has led to the formulation of strategies and practical policies. The central government has instructed agencies concerned, e.g. National Development and Reform Commission, Ministry of Industry and Information Technology, the Ministry of 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 have all cooperated in issuing strategies related to China's smart city development, such as an "Internet Plus" Strategy, a Big Data Strategy, etc.

The 13th Five-Year Plan for Economic and Social Development of the People's Republic of China highlighted major goals to enable China to respond to challenges and change economic types according to new global situations by applying innovation to upgrade new industrial value chains focusing on modern infrastructure, e.g. Chinese Prime Minister Li Keqiang's innovation and entrepreneurship policies.

5.1.2.2 Economy

1) New Chinese economic policies

New economic development guidelines for the Chinese government on "innovation-balance-green-open-inclusive" drive development of the innovation of an internet economy according to the green economic policy, in order to create a sustainable green ecology and bring about joint economic development, especially concerning environmental protection and energy management. Information and innovation provide a key impetus for blending new information technology and economic modernity development.

2) Digital economy

The economic structure in China has changed from that of an industrial sector for export to a digital economy. A large number of information technology companies have emerged, particularly Huawei Company, Alibaba Company and e-commerce business leaders who have changed the global attitude towards China from a developing country that focuses on production to a developed country or an IT innovation leader surpassing Japan and Korea, who used to occupy the market shares of technological products in the ASEAN Region.

The Chinese government has supported the establishment of many Tech Startup companies and Tech Entrepreneurs. Additionally, there are other agencies supporting risks of venture capital companies investing in startup companies. Shanghai is a very successful city for producing unicorns as it is a source of 21 unicorn cases. As a result, China has the most unicorn startup companies in the world.

3) One Belt One Road Strategy

Following the concept of economic belt cooperation on a silk road of high-tech information technology, the internet silk road and the digital silk road have been proposed for construction.

“Intelligent belt” on the silk road refers to the application of new information technologies, e.g. mobile networks, Internet of Things, Big Data and cloud computing for the development of smart cities along new economic silk roads in order to push for smart city clusters, which brings about all types of development, namely transport, energy, environment, public services and industry. This leads to regional economic integration and the Great Western Development Strategy.

4) Integrated Development of the Yangtze River Delta

The Yangtze River Economic Belt consists of Shanghai City, Jiangsu Province and Zhejiang Province. In 2018, the GDP of the Yangtze River Delta accounted for about 2.2 trillion US dollars, which is equivalent to that of Italy.

The combination of three cities in that area has created one of the world’s most intensive inter-city economic cooperation zones, covering an area of 99,600 km2 with a population of more than 115 million. In 2013, its urban population was about 84 million people. Its portion of the Chinese population amounted to one out of 10, and its GDP accounted for 20% of all of China. It is regarded as the fastest growing region in East Asia.

Shanghai is a strategic city, which initiates collective development in the Yangtze River Delta Economic Region.

5.1.2.3 Social

1) Awareness in sustainable city development

Urbanization has led to problems that affect the quality of life and people’s well-being in China. In 2011, the urbanization rate in China accounted for 50% (Ying CUI, 2017). As a result, problems were more severe, such as a

shortage of water resources, land and energy; deteriorated quality of life; and incomplete public services. China has had to speed up developing its country by creating smart cities.

2) Geographic diversity and unique city identity

The topography varies greatly in China. Each city varies according to its topography and industry. Each smart city development is, therefore, different and unique.

For instance, Wuhan and Tianjin cities prioritize smart living, while Shanghai and Chongqing aim to strengthen their information infrastructure and cyber security. Some cities focus on the application of IoT for various projects, e.g. Shenzhen or Guangzhou, and Chengdu which emphasizes smart transportation, etc.

5.1.2.4 Technology

1) China has a large number of technology business operators related to smart city projects.

Technology entrepreneurs from overseas and Chinese companies provide services of relevant technologies, e.g. Big Data, IoT, AI, etc.

Thanks to the Ministry of Industry and Information Technology support, numerous Chinese companies providing information technology have stepped up in the first row and expanded their businesses to abroad, namely China Telecom (CTCC), Digital China (DC), China Mobile (CMCC), China Unicom (CUCC), and Huawei, respectively. They provide relevant solutions and help to plan the systems for smart city development projects.

2) Outstanding strengths of China’s large-scale information technology service providers

Projects undertaken by China’s service companies have strengths and support points, which are an impetus for information industries in China. The companies are classified according to topography, location, equipment and major interests.

Table 5.2 Large-scale Information Technology Service Companies in China

Company	Type	Business strength	Significance
China Telecom (CTCC), China Mobile (CMCC), China Unicom (CUCC)	Telecommunication service providers	5G mobile networking	1. Build a business platform covering smart city development areas 2. Construct and develop infrastructure for urban informatization cities
Digital China (DC), Chinasoft International (CSI)	System integrators	Overall integrated planning and information system services	Connect external industrial chains and internal resources through smart city projects
Huawei	Information and solution products	Internet of Things Communication network Internet convergence technology	3. Create digital cities to have diverse interactions and monitoring methods 4. Develop a comprehensive ecological city system

Source: Adapted from China Electronics Standardization Institute, 2013b.

5.1.3 Shanghai Smart City Development Challenges

5.1.3.1 Politics & Policy

1) Too low level of agencies responsible for informatization and digitization

Due to a sharp division of responsibilities among agencies, it is difficult to coordinate with each other in collecting and exchanging information. The Chinese government has assigned and appointed high-ranking government officials, e.g. secretary-general of political parties, governors or deputy governors, to oversee smart city projects or information agency administrators in order to use political power or positions to build cooperation or coordination with other public agencies in order to break down the wall of functional division between agencies and create mutual cooperation. By this, the application of smart technologies can access the people sector rapidly. As a result, people realize the importance of “intelligence”

and “well-being” resulting in public participation when operating development of their smart cities.

2) Lack of clear operation mechanism in all government agencies

Various ministries have taken part in smart city development projects, such as formulation of regulations and standards, promotion and acceleration of development at the regional level, despite the joint operating mechanism created by China, e.g. China National Information Technology Standardization Network (NITS). However, it is still in the phase of learning and experience. As for such problems, a clear framework has to be developed, including relevant goals and strategies. In particular, in cases where conditions of cooperation are still disputed or unclear (Yang, Clery, & Di Liello, 2015).

5.1.3.2 Economy

1) Too much importance on GDP placed by the government and business sectors

As GDP growth and maximum profiting become the most important goals for developing smart cities in the public and business sectors, environmental impacts may be neglected, e.g. air pollution and water pollution. The public sector should raise awareness in conserving the environment in order to mitigate impacts on the environment (Yang et al., 2015).

Currently, air pollution has become a major issue in large cities such as Beijing and Shanghai. Thus, environmental pollution control policies should be drawn up and modern technologies should be adopted to improve the utilization of resources.

2) Unclear PPP models

PPP models have been promoted as innovation-based businesses in order to develop smart cities. All stakeholders can share their views about their methods, including efficient project implementation methods and helping residents know how to benefit from project construction.

However, the formulation of regulations and standards has not been confirmed by the Chinese public sector. There are still disputes about the

efficiency of PPP and its appropriateness to be used for infrastructure projects in China (Yang et al., 2015).

5.1.3.3 Social

1) Development disparities between large and small or rural cities

It is necessary to integrate the development of urban and rural communities to the overall country development. A reduction of development disparity between different sizes of cities, as well as access to information and knowledge are important (Chourabi et al., 2012). Information technology is expected to become a basic mechanism to create equality of development between urban and rural communities (Zhang, Zhang, Xiang, & Liu, 2018).

2) Enhancing the atmosphere of working together and sharing

Coordination is aimed to be generated among agencies to build an atmosphere whereby all parties realize the importance of business cooperation and resource sharing (Zhang et al., 2018).

The creation of smart cities involves various tasks, e.g. management of information and communication industries, city transport systems, public health services, education, community management services and others. A cooperative mechanism with open atmosphere and data sharing is vital to the development of smart cities.

3) Lack of expert personnel

The creation of expert personnel is essential for smart city development. Agencies must provide adequate IT training programs and deal with the shortage of experts in ICTs (Chourabi et al., 2012).

4) China entering an aging society

China's population is experiencing an aging society. Based on the statistics, people aged more than 60 or 65 accounted for 10% or 7% of the total population, respectively. In 2017, people aged more than 60 in China amounted to 17.3 %, or about 241 million people. It is expected that the population aged more than 65 in 2050 will increase to 487 million people, or 35% (Zhao, Yang, & Ju, 2017). This phenomenon is a consequence of China's "One-child policy" issued in 1979 to

decelerate the Chinese fertility rate. However, the Chinese government has since issued the “Two-child policy” to solve this problem.

Elderly people in China tend to affect society, politics and the economy. The growing rate of China’s aging population has increased the dependency rate. The labor shortage has also affected China’s economic development (Banister, Bloom, & Rosenberg, 2012).

5.1.3.4 Technology

1) No experience in initiating smart city projects and most of them at the learning stage

The government has continuously learned from experience and encourages local governments to organize meetings to share their experience openly. Chinese smart cities that are successful in each aspect, e.g. Beijing, Shanghai, Hangzhou, etc. Have transferred their experience via successful pilot projects to other cities. As a result, this can save time for similarly featured projects.

The promotion of research and information technology study at the university level has led these educational institutions to cooperate with business operators in creating new innovative knowledge and in producing specific personnel to serve the country’s smart city development.

The establishment of a smart city research center at the local level has been promoted to support personnel and academic knowledge, leading to strengths in the Chinese information technology industry, such as at the Shanghai Pudong Research Institute, the Beijing Smart City Research Center, Shanghai Industrial Internet Innovation Center (3IN), etc. In addition to the government’s role as a high-level think tank, these research institutions play a role as advisors to small-scale companies in promoting the transition of SME companies, who have insufficient funds for setting up their own information departments.

2) China’s lack of criteria for the control and inspection of local information system projects

China has attempted to set standards for the information technology industry and established agencies to formulate industrial standards, e.g. 5G, Sensor Network, IoT, Smart grid, RFID, IEC Smart Cities System, including indicators so that the local governments, entrepreneurs and agencies concerned have

clear evaluation guidelines, practices and criteria for further improvement. Agencies responsible for setting standards include the Ministry of Industry and Information Technology, the Chinese National Committee for Standardization and China National Information Technology Standardization Network (NITS).

In the beginning of smart city development, although nearly 200 cities countrywide have presented their concept of their own smart city development, because of inequalities in accessing knowledge, the digital transformation potential and investment budget for initiative projects, “the genius level” of each city, is definitely different. Without clear directions and standards, some cities have faced duplicating investments and an unnecessary waste of resources. Each city develops its own city without sharing information among each other. This has led to a situation called by the Chinese government, a “deserted island”, which cannot connect to intercity network systems. Thus, as for previous smart city development routes in China, the most important and difficult problem is the sharing and integration of data among all sectors, including cooperation among cross-organizations in developing smart cities together.

3) Data network security problems

In the process of smart city development, there are many applications working with information technology, such as the Internet of Things (IoT), cloud computing and other technologies. However, information network security problems are unclear and their harm must be realized.

Concerning data network security problems, laws should be formulated and be followed strictly. An intrusion detection system should be produced and improved to ensure that data networks are safe. The creation and improvement of a security surveillance system and emergency response can lower risks related to public and organizational networks.

5.2 Success Factors

5.2.1 Internal factors

5.2.1.1 Management and organization

The context of management and organization involves success in initiating E-government and IT projects (Gil-García & Pardo, 2005). Most pilot smart city projects rely on government support and ICT project benefits to upgrade the quality of public services (Chourabi et al., 2012). However, the following issues for the success of the Pilot Shanghai Smart City Project related to management and organizational factors are:

1) Clear and possible goals, and definite and measurable plans: The Shanghai government has planned smart city development systematically, clearly and measurably. This can be seen from Shanghai's three-year operating plans, e.g. "Shanghai Master Plan 2017-2035", 3-year plans (2011-2013), "3-year plans (2014-2016)", and "3-year plans" (2018-2020), whereby the principles of promotion, targets, strategies, action plans and evaluation have been clearly identified. It is notable that smart city strategies must include clear missions, visions and strategy frameworks (Harms, 2016).

2) Regular review of current practices or best practices: The Shanghai government has continuously monitored and evaluated the implementation of smart city projects in all aspects. This reflects in "the Annual Report of Shanghai Smart City Development Evaluation", which has been prepared every year from 2015 to 2018. The Shanghai government adopted the standard evaluation criteria determined by the China National Information Technology Standardization Network (SMCSTD) and mixed with specific characteristics of Shanghai. Clear evaluation criteria covering all aspects have been determined with indicators. Problems and suggestions have been summarized to be used for further improvement planning. Not only the city annual report, but also the "Annual Report of District Smart City Evaluation" has been prepared. When more detailed evaluation is observed, the Shanghai government's evaluation and monitoring is more inclusive and more efficient. This consistent improvement of work processes results in better efficiency (Gil-García & Pardo, 2005).

5.2.1.2 Technology

1) A production source of leading technology personnel in China is, in particular, science personnel at universities. Shanghai is the city in which people have the most proficiency in English in China, according to the EF English Proficiency Index 2017. In 2015, the Chinese government announced the national innovation driving policy, as a result, universities in Shanghai had to develop more entrepreneur development curricula. So far, most students at universities have initiated their own startup projects with the university's support of resources. They can also use technology and innovation projects to submit for completing their courses instead of credits.

2) A breeding source of a multiple of disciplines of advance information technology: Universities in Shanghai are renowned for their development of innovation technology. For example, Fudan University is outstanding in technologies, e.g. Cloud Data, Education Technology and Mobile Technology. Other educational institutions nurture technological industries such as FinTech, Gaming, AI, Big Data, BioTech and materials.

5.2.1.3 Policy

1) The Shanghai local government has prepared plans and guided development directions: The Shanghai local government's planning and guidance for smart city development is a vital factor in pushing for the Shanghai Smart City. One interesting observed issue is that local administrators who are driving smart city projects to top management commitment have more opportunity to achieve success in transforming cities to smart cities. Additionally, the formulation of relevant standards to serve as a guideline and clear indicators, as well as cooperation between agencies concerned in sharing and exchanging information to be gathered as a city large-scale database and the provision of knowledge about relevant information technologies, such as Big Data, Cloud, AI, 5G and IoT, are also crucial to smart city projects.

Smart city development is very vital to regional competitiveness. All models of Shanghai's economic and industrial system transition have been supported by the central Chinese and Shanghai governments, as well as the district government. However, smart city development still requires a large amount of

budget and collaboration among the agencies concerned. Coordination is a tough issue and often leads to duplicated projects, resulting in unnecessary loss of budget. Thus, to develop Shanghai Smart City, all levels of the public sector have to confront many obstacles that must be managed wisely. It is remarkable that all levels of the public sector, e.g. city municipality, state agencies and provincial agencies or local policies or local politics have been adversely affected by IT pilot projects (Rocheleau, 2003).

2) Creating an understanding in an appropriate model of information system use: The original city management model cannot be changed to a smart city model if there are no changes at the policy level and regulations are formulated as a city policy (Eger & Maggipinto, 2009). Annual action plans for smart city development have been drafted consistently and announced via the government's public relations channel. The Shanghai government organizes a meeting every year so that all relevant parties are informed of policies and share their views. As a result, the district government can understand policies to be properly applied at the district level.

5.2.2 External factors

5.2.2.1 Governance

1) ICT-based governance covers technology, people, policies, practices, resources, social norms and information, which affect each other in supporting city governance activities (Belissent, 2011). Shanghai adopted ICT-based governance to manage the city in various aspects, e.g. the projects entitled "One Net E-Service" and "Shanghai Citizen Cloud", which have helped enhance the quality of public services to be more efficient.

2) Citizen participation (Giffinger, Fertner, et al., 2007): Shanghai promotes public participation in developing smart cities. There is a channel for online complaints at the communication network platform linking information relating to public services. A survey of public comments has been consistently conducted to use these views to formulate policies in accordance with the actual needs of Shanghai people.

3) Private/public partnerships (Odendaal, 2003): The public sector guides and the private sector applies the operations. Public Private Partnerships have been promoted to let the public sector map out policies, regulations and relevant

standards, as well as supervise and monitor market orders, while the private sector shall apply available resources to drive the industrial market, focusing on market demand and encouraging the social sector to participate in development of smart cities. From the perspective of industrial cluster development, smart cities must be developed by mutual cooperation between different types of business operators to ensure safe, reliable and sustainable services. In addition, these services can be widely distributed to various users (China Electronics Standardization Institute, 2013b).

The Chinese government will plan the overall public private partnership between the public and private sectors and guide the direction through a marketing mechanism to attract business operators and other agencies who wish to participate in smart city projects. Mr. Choen, Deputy Director of the 3IN Research Center stated that the PPP models which are commonly used are BT, or BOT, in order to accelerate the development of information technology. For instance, as for Beijing Smart City, the public sector guides the scope of public services, city management, market monitoring and E-government systems. The private sector guides business digitization, digital live, smart community and information infrastructure.

5.2.2.2 People and communities

1) Disparity in accessing the digital divide: Shanghai is committed to bridging the gap between city and rural communities using the power of advanced information technology, such as “the city perception network”, more than 30 million perception nodes were installed across Shanghai in urban and rural communities, or a structure called “1+16+X” referring to one city platform per 16 district platforms to connect the “City Brain”.

2) Communication is crucial to a wide use of smart applications. As a result, people understand the benefits of smart cities. As for Shanghai, there are many public relations, evaluations and contests related to smart cities. Major activities promoting people’s understanding include “Smart City Experience Week”, “Smart City into All Families”, “Intelligent Craftsman Contest” and WAIC.

3) Educational institutions are another key factor to switch Shanghai City from a port to a source of the Tech Startup Ecosystem. In 2015, the Chinese government announced a national innovation policy. Consequently, various

universities in China have had to develop entrepreneur courses. At present, most students at universities start their Startup Project, which is funded with university resources. They can also use their technology and innovation projects to submit, instead of credits, to request for the completion of their study. An example of famous universities in Shanghai City on innovation technology development is Fudan University, which has a Science Park Project that is outstanding in Cloud Data, Education Technology and Mobile Technology, and has produced up to 800 technology companies. There are also the Student Entrepreneur Center and a joint investment in the student startups project. In addition, Shanghai Jiao Tong University has supported business operators under the cooperation of Shanghai Human Resource and Social Security Bureau and Bank of China, with the objective of creating qualitative innovation in the Ecosystem, and East China University of Science and Technology. Apart from public universities, there are other educational institutions established by entrepreneurs in order to nurture personnel for Shanghai information technology, such as Deep Blue University, Transwap University, etc.

Mr. Lin, Deputy Rector of Transwap University mentioned that, due to information technology growth, there is a shortage of specific personnel. Shanghai has experienced this problem over the past few year. However, the Shanghai government has formulated policies to transit the innovation economy along with a personnel incubation policy. As a result, in the past few years a certain group of personnel from leading public and private educational institutions have been produced to serve the ICT industry's growth. Such personnel can also be dispatched to help develop smart city projects in other cities where personnel are in short supply. Shanghai is regarded as one of the most important cities for training ICT in China.

5.2.2.3 Natural environment

1) Use of technology to create sustainability: Shanghai has established an "environmental quality monitoring network system" covering air, water, noise pollution, radioactivity, soil and its ecology, "an air quality forecast and warning system in the Yangtze River Delta", which shares regional real-time monitoring data on air pollution, strengthened environmental pollution sources management, and undertaken the development and utilization of environmental protection data sources for the public.

5.2.2.4 Infrastructure

1) Readiness and quality of ICT infrastructure: Shanghai has consistently upgraded its infrastructure potential, promoted the integration of information, developed a comprehensive city and pushed Shanghai to become a pioneer in developing innovation and a leader in bringing China's smart cities into an intelligent city equivalent with other international smart cities. Shanghai also created an international metropolis of Chinese socialist modernization, e.g. "Shanghai LIVED Strategy".

2) Wireless infrastructure: Shanghai had a trial use of 5G mobile communication technology network for commercial use and installed 10,000 5G signal stations across the city covering 9 million households with a megabyte capacity covering 8,000 office buildings. The capacity of an access to mobile communication and broadband networks amounts to 1,000 Mbps, such as "Shanghai Broadband Strategy", Next Generation Broadcast Network (NGB) and wireless city, or "i-Shanghai".

3) Service-oriented information systems: Shanghai has enhanced the service level of a new-style city information infrastructure and created a network of efficient data exchange centers to become one of the cities with the most international links and information exchanges in the region. It is also a domestic leader capable of covering the content distribution network (CDN).

4) Security and privacy: Shanghai has increased security to ensure protection and security of networks and information technology in order to be unified. Both must be planned, determined and conducted simultaneously and consistently. Network security must also be strengthened based on legal management. Technical potential must be increased and safe information management systems must be improved.

5.2.2.5 Economy

1) Application innovation is a driving mechanism that promotes all types of business technology innovation and enhances the application of information to industries. New information industries were initiated in Shanghai, such as the establishment of "the Four Centers", aimed at developing an advanced

technology industry and pushing for the integration of informatization and industries in order to support the policies of “Shanghai Service” and “Made in Shanghai”.

2) Entrepreneurs: A Public Private Partnership has been promoted. The public sector shall act as the one to formulate policies, regulations and relevant standards and oversee monitoring and supervision of the market order. The private sector shall apply available resources to drive the industrial market by emphasizing market demand and encouraging the social sector to take part in developing smart cities.

CHAPTER 6

QUANTITATIVE ANALYSIS RESULTS

This study of quantitative information used questionnaires as a tool to collect data and support the qualitative analysis by using documentary research and in-depth interviews.

Data collection through the questionnaires will be applied to key informants based on questions pertaining to support factors and the challenges affecting smart cities, e.g. policy-based factors that have an impact on the application of the smart city concept to Shanghai City, etc. Information acquired from questionnaires, such as percentages, will be analyzed in order to be consistent with the objectives and specified research questions.

6.1 Characteristics of the Respondents

The following 30 key informants from personnel in agencies related to Shanghai Smart City development were asked to check the findings from secondary data and study additional issues related to the current condition, problems, solutions, opportunities, threats and challenges concerning Shanghai Smart City development from 2011 to the present time, they include:

Table 6.1 Key Informants from Agencies Related to Shanghai City Development

Type	Agency	Number of people
Public Sector	- Shanghai Municipal Commission of Economy and Informatization, includes the Vice Chairman, Deputy Division Director of Technical Progress Division, Director of Informationization Promotion Division, Director of Software and Information Services Division and Director of Information Technology Application.	5 people
Research Institutes	- Shanghai Pudong Smart City Research Institute comprises the Executive President and Assistant to the Executive President.	2 people
	- Shanghai Industrial Internet Center comprises the Executive President, Director of Big Data Division and Director of Information Services.	3 people
	- Shanghai Economy and Informatization Research Center consists of a Vice President.	1 person
Entrepreneurs	- Shanghai Data Exchange (SDE) Co., Ltd., consists of the Vice President of Sales.	1 person
	- Shanghai Cloud Data Co., Ltd. consists of a General Manager, Deputy General Manager and Director of Sales Department.	3 people
	- Transwarp Technology (Shanghai) Co., Ltd. comprises the Vice President, General Manager, Industry Solutions Director, General Manager of Ecosystem and Partnership Department and Big Data Architect.	5 people

Type	Agency	Number of people
	- Shanghai Shibei Hi-Tech Enterprise AI Experience Pavilion includes a Data Intelligence Industry Manager.	1 person
	- Xiao-I Co., Ltd. consists of a Deputy General Manager.	1 person
	- DeepBlue Technology (Shanghai) Co. Ltd. comprises the Vice President and General Manager of the AI Innovation Centre.	2 people
	- Shanghai PartnerX Co., Ltd. Comprises a Deputy General Manager.	1 person
	- Goldpalm Data Technology consists of a Deputy General Manager.	1 person
	- Global Tone Communication Technology (Shanghai) Co., Ltd. comprises a Deputy General Manager.	1 person
	- Huawei (Thailand) Co., Ltd. Comprises the Managing Director, Product Development Manager and Senior Marketing Manager.	3 people
	Total	30 people

Note: * The names of executives cannot be disclosed by the researcher because of researcher's ethics not to reveal the details of the informants as they may damage them.

6.1.1 Percentages of Responsible Agencies of Key Informants

Table 6.2 Percentages of Responsible Agencies of Key Informants

Type	Number of people	Percentage
Public sector	5	16.60
Research institutes	6	20.00
Entrepreneurs	19	63.40
Total	**30**	**100.00**

Percentages of responsible agencies of 30 key informants indicate that five of them were representatives of the public sector, or 16.6%, six were representatives of research institutes, or 20%, and 19 were representatives from entrepreneurs, or 63.4%.

6.1.2 Percentages of Position Levels of Key Informants

Table 6.3 Percentages of Position Levels of Key Informants

Type	Number of people	Percentage
Top management	18	60.00
Middle management	7	23.40
Operators	5	16.60
Total	**30**	**100.00**

Percentages of key informant positions reveal that the 30 key informants were comprised of top management (18 people or 60%), middle management (seven people or 23.40%) and five operators (16.6%).

6.1.3 Percentages of Key Informants' Education

Table 6.4 Percentages of Key Informants' Education

Type	Number of people	Percentage
Doctoral degree	7	23.40
Master's degree	20	66.60
Bachelor's degree	3	10.00
Total	**30**	**100.00**

Percentages of key informant positions reveal that the 30 key informants were comprised of master's degree (20 people or 66.60%), doctoral degree (7 people or 23.40%) and bachelor's degree (10.00%).

6.2 Attitudes to Working with the Public Sector to Drive Development of Smart Cities

6.2.1 Threats in Driving Shanghai Smart City Development

6.2.1.1 Politics & Policy

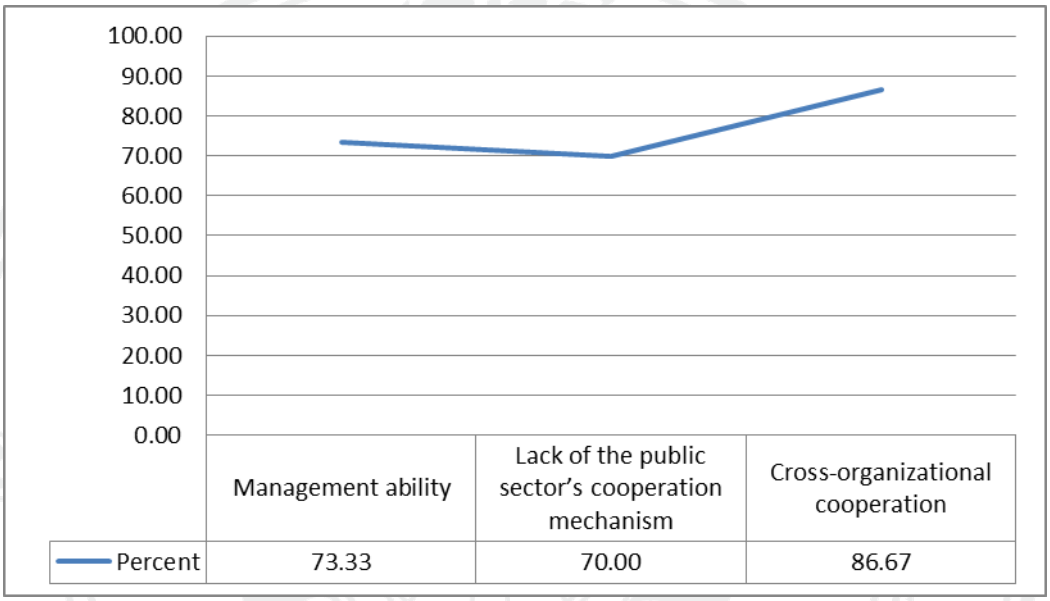

Figure 6.1 Political and Policy Factors

As for political and policy factors, the first threat was due to lack of cross-organizational cooperation. Twenty-six of the total 30 key informants (86.67%) agreed with this, followed by threats concerning the public sector's team management ability (73.33%), and lack of good cooperation mechanisms in the public sector (70%), respectively.

6.2.1.2 Economy

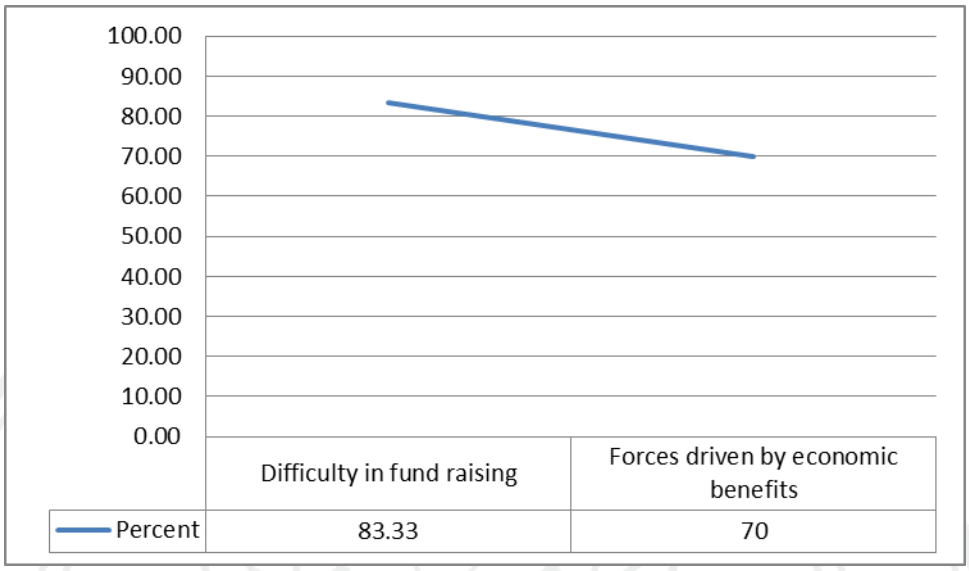

Figure 6.2 Economic Factors

Concerning economic factors, the first threat came from difficulty in startups regarding entrepreneurs' fund raising. Twenty-five (83.33%) out of 30 key informants agreed with this factor, followed by threats concerning unattractive forces driven by economic benefits (73.33%).

6.2.1.3 Social

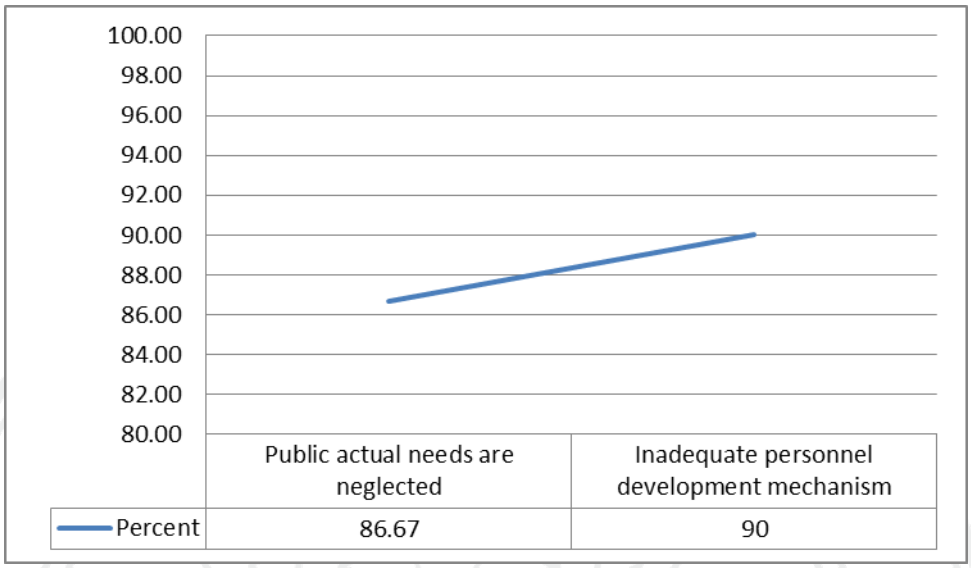

Figure 6.3 Social Factors

With respect to social factors, the first priority factor was related to inadequate personnel development mechanisms. Twenty-seven out of 30 agreed with this factor, or 90%, followed by people involved in planning the design of public service systems ignoring the public's actual needs and not satisfying people's needs (86.67%).

6.2.1.4 Technology

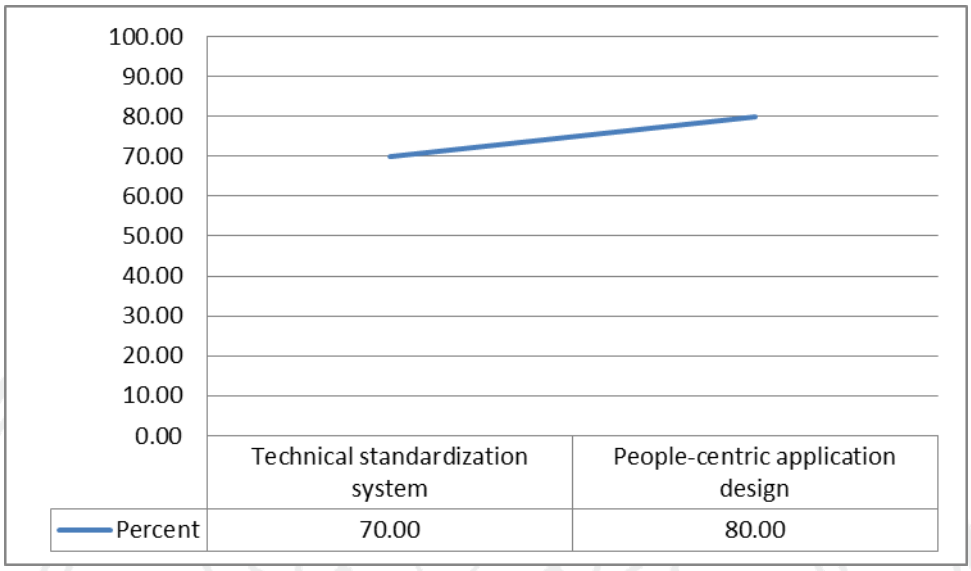

Figure 6.4 Technology Factors

Technology factors reveal that the first priority threat involved undetailed technical standardization systems. Twenty-four out of 30, or 80%, agreed with this, followed by a design of applications that was not people-centric, at 70%.

6.2.2 Opportunity for Driving Shanghai Smart City Development

6.2.2.1 Politics & Policy

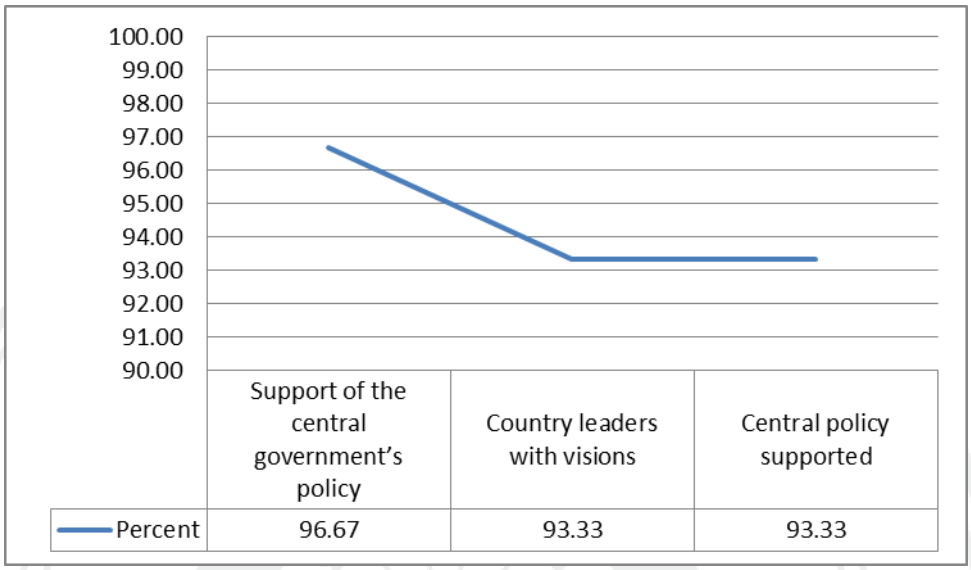

Figure 6.5 Political and Policy Factors

Political and policy factors indicate that the first priority threat came from the central government's support. Twenty-nine, or 96.67% of 30 key informants agreed with this, followed by the opportunity for China to have new leaders with a good vision and focus on new digital economic systems (93.33%), and a central policy that is well supported (93.33%).

6.2.2.2 Economy

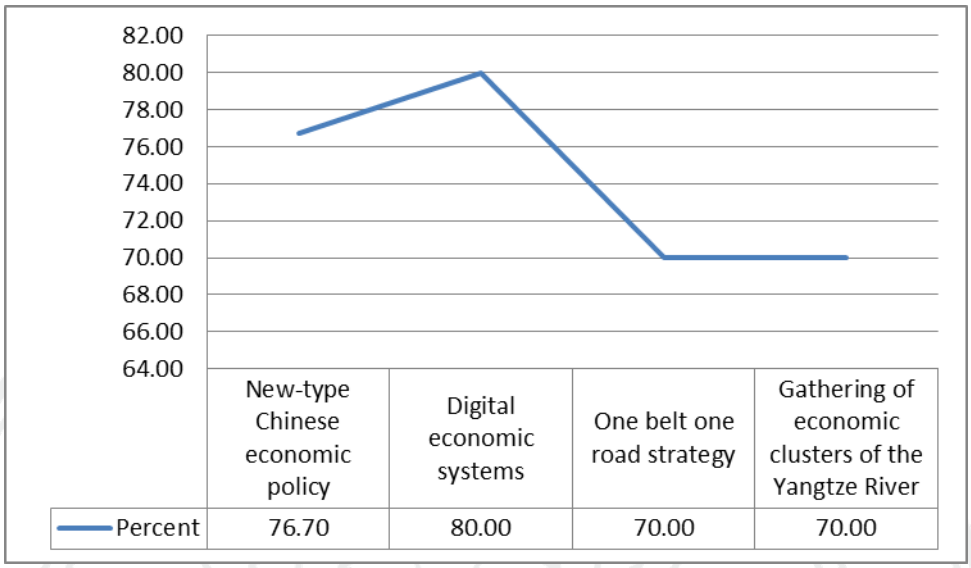

Figure 6.6 Economic Factors

As for economic factors, the first opportunity related to the support of digital economic systems. Twenty-four (80%) out of the total 30 informants agreed with this opportunity, followed by the opportunity for a new type of Chinese economic policy (76.67%), one belt one road strategy (70%) and gathering of economic clusters of the Yangtze River (70%), respectively.

6.2.2.3 Social

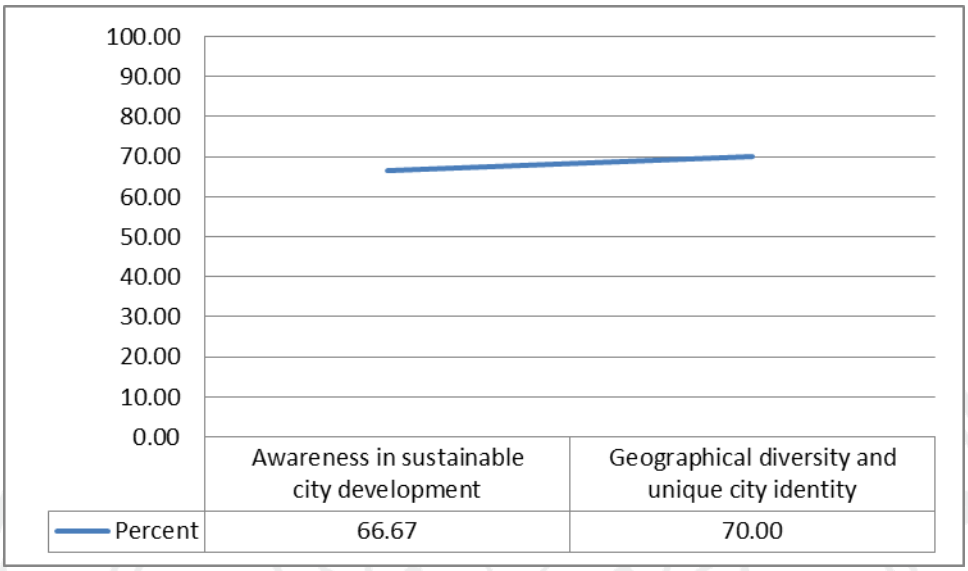

Figure 6.7 Social Factors

Social factors indicate that the first priority opportunity related to geographical diversity and a unique city identity. Twenty-one, or 70% of the total 30 key informants, agreed with this, followed by awareness in sustainable city development due to the many problems caused by urbanization in China (66.67%).

6.2.2.4 Technology

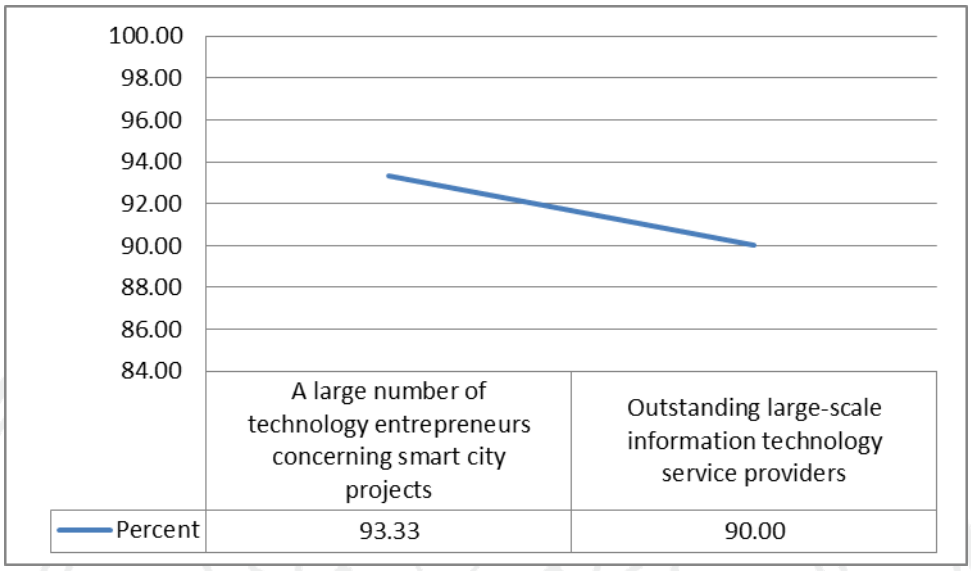

Figure 6.8 Technology Factor

Concerning the technology factor, the first priority involved a large number of technology entrepreneurs related to smart city projects. Twenty-eight of the total 30 informants, or 93.33%, agreed with this factor, followed by outstanding large-scale information technology service providers (90%).

6.2.3 Challenges in Driving Shanghai Smart City Development

6.2.3.1 Politics & Policy

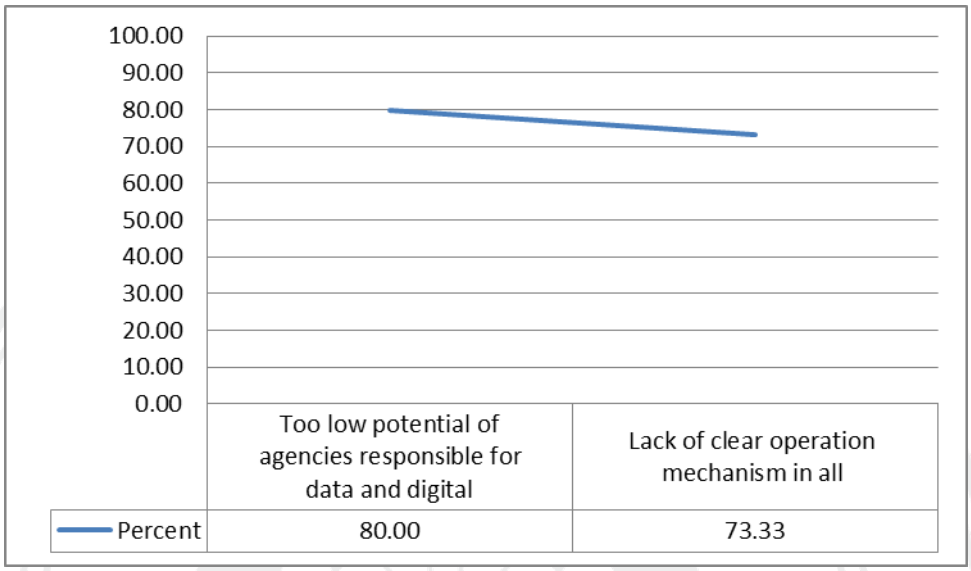

Figure 6.9 Political and Policy Factors

For political and policy factors, the first challenge was because of too low a potential of agencies responsible for data and digital. Twenty-four, or 80% of the 30 informants, agreed with this challenge, followed by a lack of clear operational mechanisms in all public agencies (73.33%).

6.2.3.2 Economy

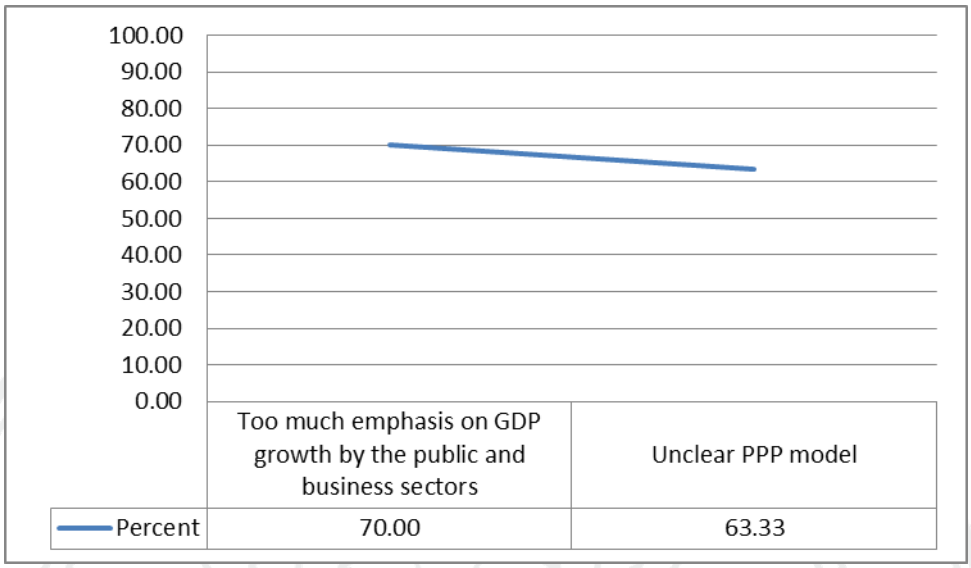

Figure 6.10 Economic factors

Economic factors indicate that the first priority challenge related to the fact that the public and business sectors placed too much importance on GDP growth. Twenty-one, or 70% out of 30 key informants, agreed with this, followed by an unclear PPP model (63.33%).

6.2.3.3 Social

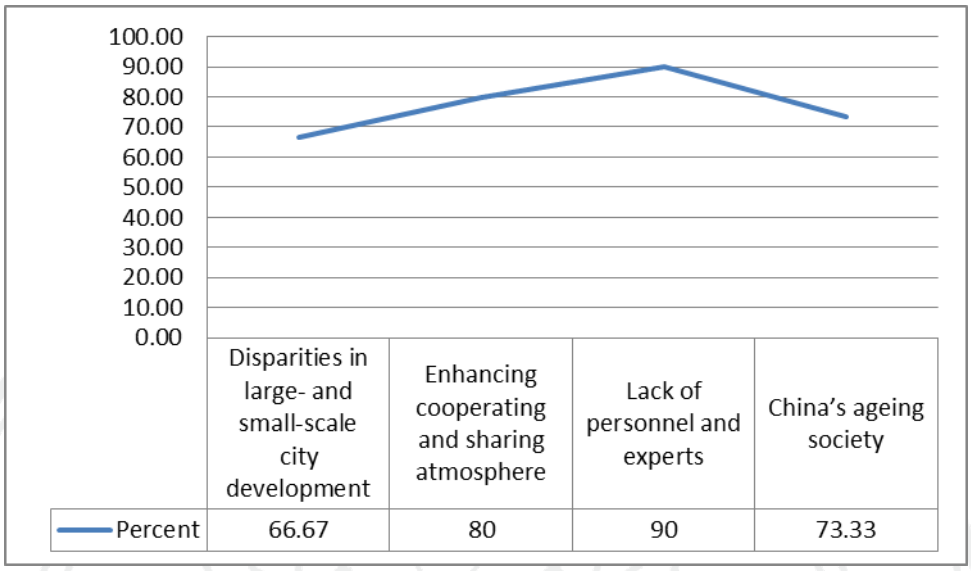

Figure 6.11 Social Factors

As for social factors, the first priority challenge involved lack of personnel and experts. Twenty-seven, or 90% out of the total 30 informants, agreed with this, followed by increasing an atmosphere of working and sharing (80%), China's ageing society (73.33%), and disparities in large-and small-scale city development (66.67%), respectively.

6.2.3.4 Technology

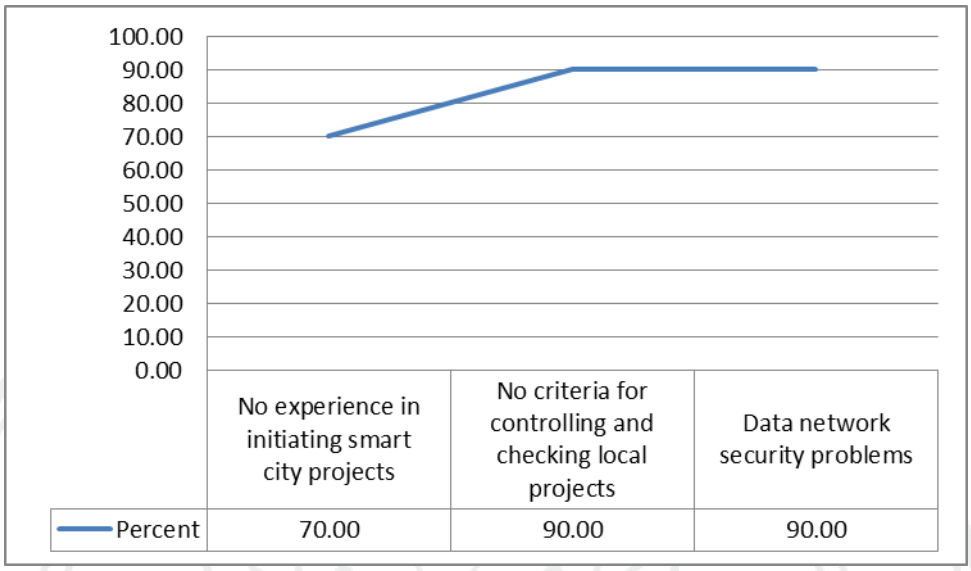

Figure 6.12 Technology Factor

For the technology factor, it is evident that the first challenges were because of lack of the criteria for controlling and checking local projects and data network security problems. Concerning these challenges, 27 of 30 informants, or 90%, agreed with them, followed by no experience in initiating smart city projects in China (70%).

6.3 Success Factors for Shanghai Smart City Development

The results of the survey opinions of 30 key informants are as follows:

6.3.1 Internal factors

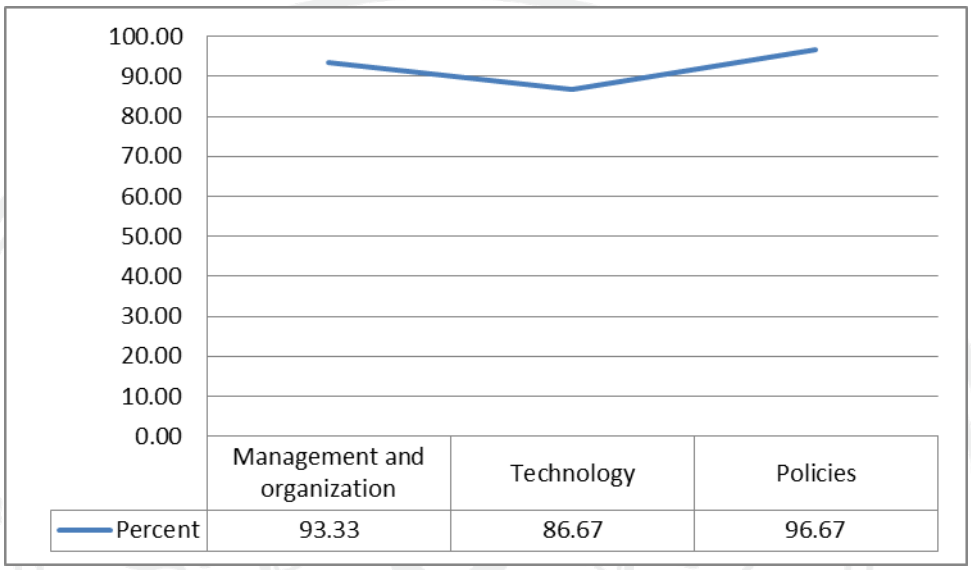

Figure 6.13 Internal Factor

The first priority internal factor that promoted the success of Shanghai Smart City development involved policies, comprising the local government who formulated the plans and guided the direction, and created an understanding in the application of information systems to the people concerned. Twenty-nine out of 30 informants agreed with this factor (96.67%), followed by expertise in management and organizations (93.33%) and modernity in technology (86.67%), respectively.

6.3.2 External factors

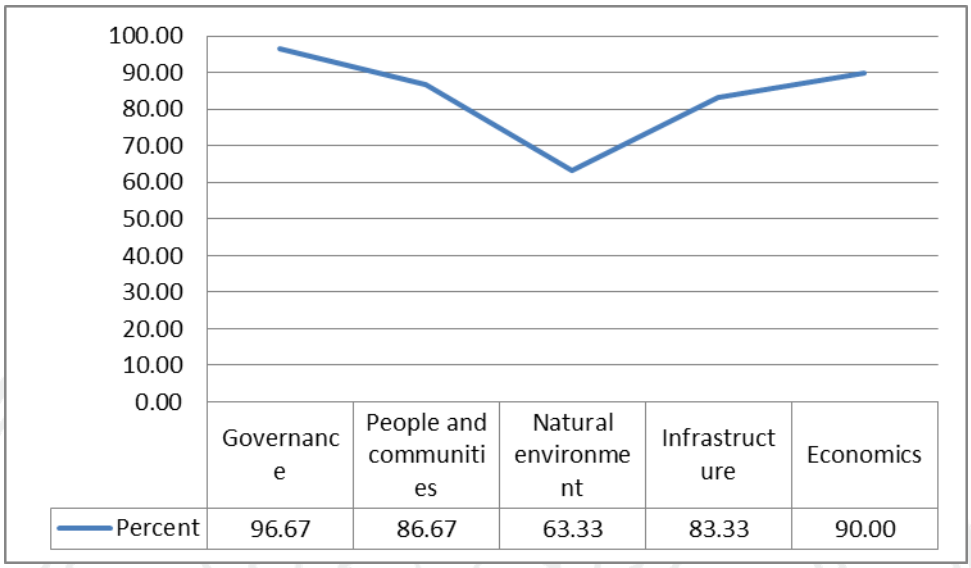

Figure 6.14 External Factor

The first external factor that promoted the success of developing Shanghai Smart City was good governance of the Shanghai government, comprised of the use of ICT for governance, citizen participation and PPP. Twenty-nine out of 30 informants agreed with this factor (96.67%), followed by economics (90%), people and communities (86.67%), infrastructure (83.33%), and the natural environment (63.33%), respectively.

The above survey results reflect that, concerning the opinions of the key informants, public officials as well as representatives of research units and entrepreneurs pertaining to Shanghai Smart City development, policy and governance factors are the most important factors to push for developing Shanghai Smart City. The public sector plays a big role in bringing about both factors, followed by the expertise in management and governance that leads to efficient smart city development.

The economic factor is one important factor to drive a new type of digital economy and vital to the development of information infrastructure in accordance with strategies. The technology factor is a major mechanism and a pillar in laying the

foundation for city smartness and upgrading the quality of public services to the public. In addition, people quality, inclusive infrastructure and natural environment are all factors that affect sustainable development of the Shanghai Smart City. Without one of them, this would not occur.

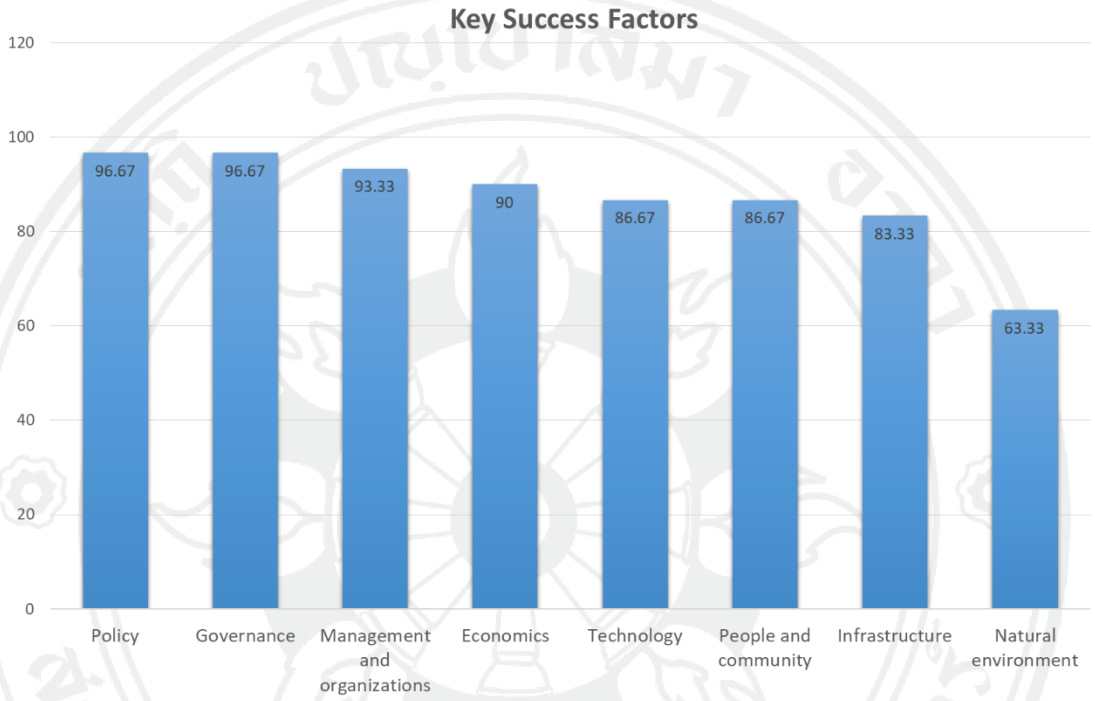

Figure 6.15 Success Factors for Shanghai Smart City Development

The results of the quantitative analysis correspond to the qualitative information. Key informants and samples had the same opinion - that Shanghai Smart City's development has the following relevant success factors. The internal factors for development of Shanghai Smart City were ranked as follows: 1) policies comprised of the local government's planning and direction, as well as an understanding of the application of information systems to people concerned, 2) expertise in management and organizations, namely clear, possible and measurable goals and plans, along with regular monitoring, review and evaluation, 3) technological modernization, including a production source of skilled personnel, and a nurturing source for a wide variety of advanced information technologies.

The external factors for development of Shanghai Smart City were ranked as follows: 1) good governance of the Shanghai government, comprised of the utilization of ICT to manage governance, public participation and public and private cooperation, 2) an economy consisting of the promotion of application innovation and entrepreneurs, 3) people and communities, e.g. reduction in the digital divide, with good communication and education, 4) infrastructure, e.g. readiness in ICT infrastructure use, wireless infrastructure, service-oriented information systems, as well as security and personal rights, and 5) natural environment, e.g. technological sustainability building.

CHAPTER 7

STRATEGIC ANALYSIS FOR PROMOTING INDUSTRIES

IN SHANGHAI SMART CITY

Following the analysis of threats, opportunities, challenges and success factors for driving the development of Shanghai Smart City, the researcher collected information from the literature review and interviews with people concerned to be used for analyzing strategies related to Shanghai Smart City business promotion.
The selected strategic analysis tools include a SWOT Analysis and a TOWS Matrix analysis. Additionally, Shanghai's competitive advantages were analyzed using the Diamond Model.

7.1 Shanghai Government Strategies and Methods Driving Smart City Business

As for the analysis of smart city development strategies, the following three-year action plan for (2011-2013), three-year action plan for (2014-2016) and the three-year action plan for (2018-2020) were used.

7.1.1 Comparison of the Promotion Principle (2011-2020)

Table 7.1 Comparison of the Promotion Principle (2011-2020)

Three-year action plan (2011-2013)	Three-year action plan (2014-2016)	Three-year action plan (2018-2020)
- Systematically upgrade and develop information infrastructure - Develop innovation and create a good quality of life for people - Create an outstanding identity with a focusing project - Initiate pilot projects by cities and districts - Guided by the public sector and implemented by the private sector	- Adhere mainly to public demands and benefits - Application innovation as a driving mechanism - Increase security and protection - Guided by the public sector and implemented by the private sector	- Develop according to the plan and improve on the operation from previous experience - Plan prepared by the central and local governments while developed by the public and private sectors - Encourage cross-organizational cooperation in production and sharing - Increase investment supported by public policies

With respect to the three-year action plan (2011-2020), it is evident that this three-year action plan (2011-2013) emphasized the foundation of all aspects concerning Shanghai Smart City development, e.g. information technology infrastructure, Shanghai outstanding identity, as well as city and district pilot projects.

The three-year action plan (2014-2016), Phase 2, switched to the importance of the people, or city residents, such as with application innovation and public services, whereby people were determined to be the heart of development. The three-year action plan (2018-2020), Phase 3, changed to a new type of economic policies

that focuses on an ecosystem that contributes to developing Shanghai's information industry up to the international level.

It is observable that the public sector has played a role in guiding these plans, while the private sector has implemented them in the three phases. In the latest plan, more cooperation between the central and local governments was stressed. The public and private sectors will be encouraged to join in the development to enable public services to meet more public demand.

7.1.2 Comparison of Strategies and Goals from 2011 to 2020

Table 7.2 Comparison of Strategies and Goals from 2011 to 2020

Strategies (2011-2013)	Strategies (2014-2016)	Strategies (2018-2020)
- A city of broadband and construction of wireless city networks. - Primary efficiency of information sensing and intelligence applications. - Modern information technology industry is a strong pillar for smart city development. - Highly reliable and controllable information security.	- Increasing use and efficiency levels of information applications. - Upgrading new urban information infrastructure services. - Enhancing development of information technology innovation in the new age. - Highly reliable and controllable information security systems.	- Connection: Create smart and high-speed information networks. - Hub: Build a network for an efficient information exchange center. - Computing: Establish an information resource exchange hub that can store and analyze data. - Sensing: Standardize high performance data recognition applications for new-style smart cities.

Goals	Goals	Goals
- Household average bandwidth access (20 Mbps) and international and domestic bandwidth internet export of 1 Tbps and 5 Tbps, respectively - Information and industrial integration index (80%) and annual e-commerce transaction value (850 billion yuan, or 3.4 trillion baht). - Information industry value (1.28 trillion yuan, or 5.12 trillion baht)/value added information service industry occupies a 6.2% share of the total city production.	- Information and industrial integration index (86.5) and annual e-commerce transaction value (2 trillion yuan, or 8 trillion baht) - Household fiber optic (60%) and average bandwidth internet access of household fiber users (40 megabits per second) and next generation broadcast network (NGB) covering 6 million households. - Value of modern information industry up to 1 trillion yuan (4.5 trillion baht) and employment of more than 800,000 people and income from information industry services (680 billion yuan, or 3.06 trillion baht).	- "Dual Gigabit" broadband city covering the entire city communication network/5G commercial mobile communication technology/application of the Internet Protocol version 6 (IPv6). - Yangtze River Delta Economic Region Information. Port/international submarine communications cable (35Tbps)/international and inter-provincial bandwidth of 5 Tbps and 50 Tbps, respectively. - Construction of supercomputing (level 6)/city information center with more than 160,000 rack servers/energy efficiency indicator of the PUE, not exceeding 1.3. - Creating an "urban sensing network" and installation of IoT network applications at more than 100 key locations in the city.

The goals for strategies in each phase still mainly focus on infrastructure and promotion of new generation information technology industry innovation, as well as

information security. However, the goals in the latest plans emphasize proactive strategies in order to become an information technology industry leader, especially a regional information center, e.g. Yangtze River Delta Economic Region information port and city brain.

7.2 Shanghai City SWOT Analysis

Albert Humphrey's SWOT Analysis (2005) was used to assess Shanghai City's situation. Strengths and weaknesses can be determined from the internal environment, while opportunities and threats can be determined from the external environment, including potential impacts from these factors on the development of Shanghai Smart City.

7.2.1 Internal Environmental Assessment

All aspects of resources and capabilities in Shanghai City were analyzed and considered in order to know their strengths and weaknesses. The primary source of information for internal environmental assessment includes data systems covering all aspects, e.g. system structure, regulations, practices, development atmosphere and management resources (people, money, materials and administration), including Shanghai's previous performance, in order to understand past situations and strategic plans.

7.2.1.1 Strengths

1) Clear and feasible goals with definite and measurable plans (S1)

2) Regular review of current or best practices (S2)

3) A production source of leading technology personnel in China (S3)

4) A nourishing source of advanced information technology in various fields (S4)

5) Shanghai local government planning and development guidance (S5)

6) Creating understanding of an appropriate information system model (S6)

7) ICT-based governance (S7)

8) Leading information technology educational institutions (S8)

9) ICT infrastructure readiness and quality (S9)

10) Inclusive wireless infrastructure (S10)

11) Upcountry areas of the Yangtze River Economic Zone (S11)

7.2.1.2 Weaknesses

1) Inadequate public cross-organizational cooperation (W1)

2) Lack of public coordination with decisive power (W2)

3) Unskillful management teams in the public sector (W3)

4) Insufficient forces driven by economic benefits (W4)

5) Difficulty in fund raising leading to low policy-based entrepreneur insurance (W5)

6) Ignorance of public actual needs (W6)

7) Inadequate personnel development mechanisms (W7)

8) Undetailed specific technical specifications (W8)

9) Lack of design of citizen-centric applications provided to the public sector (W9)

7.2.2 External Environmental Assessment

Shanghai's assessment of its external environment has led to the findings of its opportunities, threats and operations, affected by both local and international economic circumstances related to its operations, e.g. economic growth rate, policies, finance, budget and social environment, such as educational level, people settlements and evacuation, community characteristics, traditions, values, beliefs and culture, political environment, e.g. legal provisions and technological environment, which refers to new processes and technological development that increases production and service efficiency.

7.2.2.1 Opportunities

1) Support from the central government's policies (O1)

2) Visionary country leaders (O2)

3) Policies supported by the central government (O3)

4) New types of Chinese economic policies (O4)

5) Digital economic systems (O5)

6) One Belt One Road Strategy (O6)

7) Integrated Development of the Yangtze River Delta (O7)

8) Sustainable city development trends and awareness (O8)

9) Geographic diversity and unique city identity (O9)

10) Numerous smart city technology entrepreneurs (O10)

11) China's large-scale information service companies with eminent strengths (O11)

7.2.2.2 Threats

1) Too low levels of agencies responsible for informatization and digitization (T1)

2) Lack of clear operation mechanisms in all public agencies (T2)

3) Too much emphasis on GDP growth by the public and business sectors (T3)

4) Unclear PPP model in China (T4)

5) Development disparities between large-and small-scale or rural cities (T5)

6) Enhancing atmosphere of collaboration and sharing (T6)

7) Lack of expert personnel (T7)

8) China's aging society (T8)

9) No experience in initiating smart city projects, most of them are at the learning stage (T9)

10) Lack of clear criteria for control and inspection of local information system projects in China (T10)

11) Data network security problems (T11)

12) Data network security problems (T11)

7.3 TOWS Matrix Strategic Analysis

Following the analysis of Shanghai's strengths, weaknesses, opportunities and threats (SWOT Analysis) derived from the external and internal environmental analysis, the TOW matching has been divided into SO Strategy, WO Strategy, ST Strategy and WT Strategy.

The researcher selected the three-year action plan (2011-2013), the three-year action plan (2014-2016) and the three-year action plan (2018-2020) for the analysis, summarized as follows:

7.3.1 SO Strategy

SO1 Strategy: Urban Information Infrastructure Specific Project (S9)(O3)

SO2 Strategy: Standardization System Set up (S9)(O3)

SO3 Strategy: Information technology promotion to enhance the quality of versatile city management (S7)(O8)

SO4 Strategy: Four strategic center establishments (S7)(O9)

SO5 Strategy: Acceleration in entrepreneurs' development of information technology in eight areas (S4)(O5)

SO6 Strategy: Information technology research and development promotion (S3)(O4)

SO7 Strategy: "Shanghai LIVED" (S7)(O4)

SO8 Strategy: Promotion of three major support systems in smart cities (S9)(O5)

SO9 Strategy: "Dual Gigabit Broadband City" (S10)(O5)

7.3.2 WO Strategy

WO1 Strategy: Establishment of a global information communication center (W4) (O6)

WO2 Strategy: "A data port of the Yangtze River Delta Economic Region" (W4)(O7)

WO3 Strategy: Building of an industrial internet network architectural system (W4)(O10)

7.3.3 ST Strategy

ST1 Strategy: Promote three safety projects (S1)(T11)

ST2 Strategy: Formulate three major measures (S1)(T11)

ST3 Strategy: Create an integrated awareness network service platform (S10)(T5)

7.4 Diamond Model of Shanghai Advantages

Following the analysis of Shanghai's competitive advantages of its ICT industry, Porter's Diamond Model of National Advantage (1990) was used to explain the environmental factors in Shanghai's ICT industry using the following determinants: (1) Factor Conditions, (2) Demand Conditions, (3) Related and Supporting Industries and (4) Firm Strategy, Structure and Rivalry.

7.4.1 Factor Conditions

Shanghai's generalized factor conditions comprise city infrastructure, such as roads, transport systems and electrical systems, at a good level. Specialized factors refer to personnel in Shanghai with graduate degrees or specific training, who are usually those who've graduated with both a Bachelor's degree and higher degree, plus infrastructure for specialized purposes and advanced knowledge for specialized use in information technology, including many specialized educational institutions related to the technology industry.

Specialized factors usually bring about highly competitive advantages. As for development of the nation's and Shanghai's competitiveness, specialized factors lead to more innovation than generalized factors. Thus, Shanghai has upgraded and unceasingly increased the number of factor conditions, from generalized to specialized factors. In addition, the standard classification of generalized and specialized factors has continuously been increased along with Shanghai's growth. Due to pressure for innovation to solve urbanization problems, Shanghai has adopted technology to create sustainable competitive advantages.

7.4.2 Demand Conditions

Countries have competitive industrial advantage when local buyers pressure domestic entrepreneurs to create faster innovation so that their competitive advantages are higher than in other countries. Two demands in Shanghai are vital to creating the following national competitive advantages:

1) Mixture of local demands in the same industry: manufacturing entrepreneurs in Shanghai have international competitive advantages in the markets that are similar to the global demand, especially in innovation business, e.g. AI, Big Data and Cloud. This market is very important to domestic markets of the ICT industry and vital to the same market segment of that industry in the global market.

2) Buyers who really know products or ICT services: Local buyers in Shanghai know the products better than foreign buyers, e.g. consumers selling channels, or buyers who are companies, institutes, organizations and factories. The standards set by these groups for selecting products or services are high. This has pressured entrepreneurs in Shanghai to consistently develop competitive advantages.

3) Local demand size: As China is a large market, it is more likely to reduce costs per unit as a result of economies of scale than small markets, or decrease costs per unit caused by the accumulation of learning curves. Because of China's good domestic demand, competitive advantages in China have been promoted.

7.4.3 Related and Supporting Industries

Related and supporting industries in China have led to international competitive advantages. International competitive advantages in the related and supporting ICT industries pertaining to manufacturing are caused by the three following factors:

1) China's channels are faster, more efficient and more privileged than other countries in accessing the best raw materials or parts.

2) China always cooperates with users and producers of raw materials, parts or technological innovation.

3) China collaborates all the time in innovation, and upgrades and increases the processes of competitive advantage creation in the global value system of both entrepreneurs and suppliers. The cooperation of both parties in solving

problems or exchanging research and development results in more efficient and effective results more quickly.

7.4.4 Firm Strategy, Structure and Rivalry

China is internationally successful in the ICT industry. This is in line with management systems, e.g. selection of company strategies and structures that reflect the specific innovation characteristics of those countries. In the past 10 years China developed its basic information technologies at an exponential rate through the introduction of Alibaba, Tensent and Huawei companies using information technology. As a result, China has been successful in the complicated ICT industry, etc.

Concerning international competition, the competition among domestic industries in China is very fierce. As a result, those industries are internationally successful at a high level because there is pressure among them to develop innovation. Intensive competition usually leads to export pressure in order to seek additional markets, or results in decreasing cost advantages in cases of mass production.

In addition to the four determinants of the Diamond Model, other external factors play a role in factors affecting Shanghai's competitiveness. The government is an institution that simultaneously affects and is affected by the four determinants, which have both positive and negative effects. The Chinese central and Shanghai governments have issued public policies on the stock exchange, education and government fund that promotes and drives Shanghai's ICT industry, as well as policies on product standards and services related to the demands of buyers and consumers. The government is also a large buyer of many types of ICT services in pilot projects or public services, including tax policies to promote entrepreneurs in Shanghai's special economic zone of the ICT industry.

CHAPTER 8

CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

Following data analysis of the smart city development model study in China with a case study of urban management in Shanghai City, the following conclusions, discussion and recommendations were summarized.

8.1 Research Conclusions

The research results were summarized on three topics according to the study objectives with the following details:

8.1.1 Summary of Shanghai Smart City Development

The first study objective was to study previous developments of the Shanghai Smart City in China, namely the background, process, steps and models. The details are:

8.1.1.1 Summary of the Background, Process and Steps for Shanghai Smart City Development

The background, process and steps for development of Shanghai Smart City were summarized as follows:

1) Background: Based on a relevant literature review, Shanghai's ICT-based solution is a strategic method of city modernization and smart city promotion. Shanghai's tech ecosystem has a strength that makes it number one in the global economy. It was transformed from a port city that focused on logistics business into a tech talent hub because of rich technology resources in terms of technological knowledge and personnel. In the past, Shanghai's original economic structure included heavy industries, e.g. automobiles, shipbuilding and machinery. Later, when the central government wished to change the economic system to a digital economy in order to provide a competitive advantage in the global market, Shanghai

transformed its economic structure to innovation industries with high value chains, such as business information and research services.

There are leading technological and educational institutions in Shanghai, e.g. Fudan University, Jiao Tong University and information technology research institutions, e.g. Shanghai Industrial Internet Innovation Center (3IN), which is a nurturing source of key personnel, experts and tech startups. As a result, Shanghai has possessed the processes of innovation technological resource accumulation for a long time.

2) Process and steps: The Shanghai government formulated its smart city development strategy in three phases: Shanghai Smart City development promotion plans (2011-2013, 2014-2016 and 2018-2020). With respect to these three promotion plans, in the beginning period (2011-2013), the Shanghai government emphasized an "information technology infrastructure foundation" and outstanding city projects. Vasseur and Dunkels (2010) stated that the readiness and quality of information technology infrastructure is very vital to smart cities because it can transform smart cities from just theory into something livable that really exists. Later, in the second phase (2014-2016) the Shanghai government switched to stress "citizen centric service management" in compliance with a new international principle of citizen centric public services (British Standards Institution, 2014). In the third phase (2018-2020), the government aimed to develop Shanghai's information technology industry to meet the international market. However, during the previous development of Shanghai Smart City in three phases, the Shanghai government focused on a model in which "the public sector had a role in guiding and forming the rules for the private sector to implement them based on the market mechanism". The public sector also encouraged public-private partnerships for information technology infrastructure projects and smart city flagship projects in order to enhance public services to meet public demand. This issue is important because the private sector has more budget, personnel resources and agility for the operation and development of smart cities than the public sector.

Shanghai's strategic goals emphasize mainly infrastructure and the promotion of new-generation information technology industry innovation,

information security systems, and its leadership among global information technology industries.

As for the operation of Shanghai Smart City, the Shanghai government has applied numerous projects to develop the city, namely the use of ICTs for administering the public sector and promoting interactions between the public and people sectors, e.g. “Shanghai One Net E-Service”, which is a platform to serve on-line public services. The Shanghai government also stresses the application of ICTs to develop its human resource potential, especially education development for a new generation of youths, who will be a key force for future city development.

Platform building projects and communication networks linking real time intercity traffic information are aimed at reducing the number of accidents and saving energy for people’s travel. On-line programs are developed to facilitate people, such as on-line health services, artificial intelligence police, environmental monitoring network systems and air quality early warning and forecasting systems, etc. In addition, relevant agencies have adopted E-Business, E-Commerce and Smart Cluster to promote the city’s business sector.

In summary, the study of promotion plans and target goals for Shanghai Smart City development indicates that its plans emphasize management, clear public sector plans, cooperation between the agencies concerned and the services that meet the actual demand of the people sector and communities. However, when considering development goals, Shanghai City has still stressed the management of infrastructure necessary for city development in terms of upgrading a new generation of information infrastructure services, creation of new generation information technology innovation, high-speed information networks and efficient information exchange networks, as well as establishment of an information exchange center, etc. Therefore, the development of smart cities consists of two parts in parallel, 1) policy development and cooperation among relevant sectors, and 2) the construction of necessary infrastructure needed as a supporting factor to promote complete smart cities.

8.1.1.2 Summary of Shanghai Smart City Development Model Study

The results of the Shanghai Smart City development model study are summarized as follows:

Key types and components of Shanghai Smart City include: 1) smart governance through the application of ICTs to public sector management and promotion of interactions between the public sector (service providers) and the people sector (service users), e.g. Shanghai's "One Net E-Service", which is a platform that provides online public services, 2) smart people, by using ICTs to develop human resources for educational development, 3) smart mobility based on communication network platforms connected to real-time traffic information between cities, 4) smart living comprised of the application of ICTs to daily lives, e.g. online health services, AI police, 5) smart economy that supports the E-Business, E-Commerce and Smart Cluster, and 6) smart environment, such as environmental quality monitoring networks and air quality early warning and forecasting systems, etc.

8.1.2 Summary of Success Factors, Constraints, Opportunities and Challenges for Shanghai Smart City Development

Concerning the second objective of the study: To study the success factors, constraints, opportunities, challenges and solutions concerning previous development of the Shanghai Smart City in China, the details of the study results are:

8.1.2.1 Summary of Success Factors for Shanghai Smart City Development

Success factors for smart city management were analyzed by academics and agencies in different contexts. Thirty key informants from the public sector, research institutions and executive directors in the private sector were interviewed about success factors for Shanghai Smart City development.

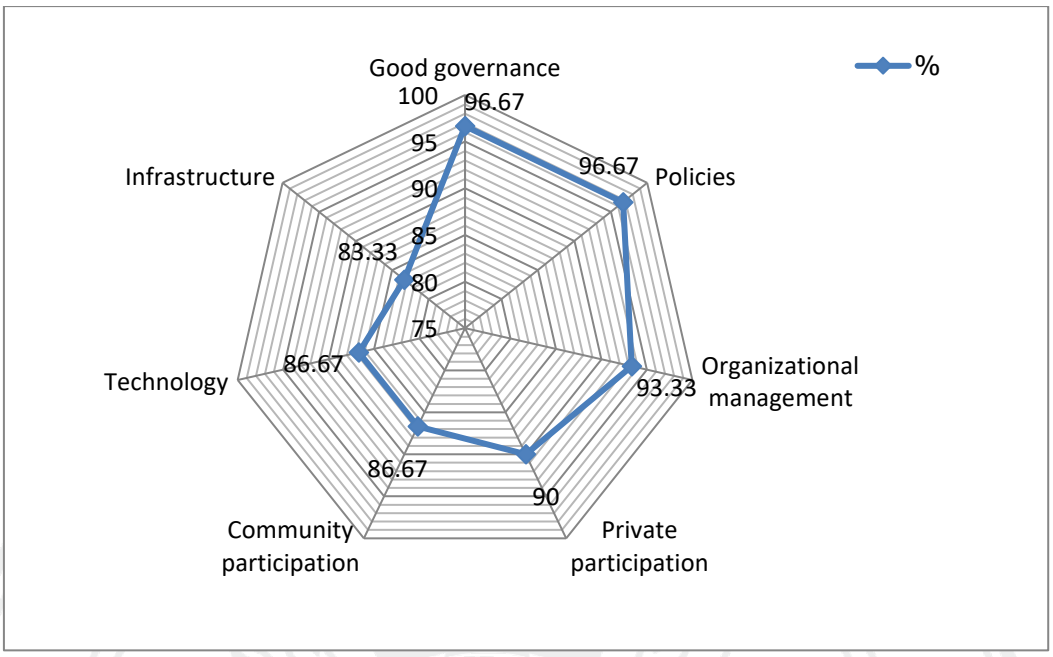

Figure 8.1 Significance of Factors Affecting Shanghai Smart City Development
Source: Key informant interview

According to the figure related to factors affecting smart city development, the factors were divided into three categories: Factor 1 involves public-sector management, comprised of good governance, relevant policies and organizational management. The interview revealed that 96.67% of key informants placed most importance on city development policies. The Shanghai local government formulated policies and plans for guiding development for the agencies concerned, including good governance (96.67%). The Shanghai local government adopted ICT-based governance to increase efficiency in providing pubic services to people and promoting private-public partnerships in order to provide public services to meet public demands, followed by management and organizations (93.33%). The government formulated clear and possible goals for measurements and monitoring, as well as regular reviews of its best practices, which is a factor that organizations have to seriously implement.

Factor 2 involves collaboration between the private sector and communities. The key informants emphasized public-sector cooperation (90%) in promoting and creating business application innovation, particularly by “supporting

the cooperation between the government and private sector". In the past, the Shanghai government encouraged the private sector, especially Tech Startups, to have a role in creating the tech ecosystem, which is a major mechanism for driving the development of smart cities. As for cooperation from the communities, the key informants placed its importance at 86.67%. The factor for the operation is to reduce the gap between access information and knowledge, to promote a tech startup training course and citizen participation. This issue is crucial for evaluating and improving public services in order to meet the demand of urban residents.

The last factor: technology is significant at 86.67%, while infrastructure is significant at 83.33%. This factor is less important than other factors because, although the readiness and quality of ICT infrastructure are vital to development, these factors may be the consequences of clear policies for developing technology and infrastructure. However, the scores are still higher than 80%. Thus, the development of technology and infrastructure services is still a significant factor that relevant agencies must take into consideration.

In brief, the key informants were comprised of high-ranking officials from the public sector. As representatives from research agencies and executives of relevant business operators, they were of the view that policies, good governance and expertise in management and public sector administration are the most important factors for driving smart city projects and expanding the cooperation to the people sector and communities, including infrastructure and information system services, as well as technological development to serve the development of smart cities in the long term.

8.1.2.2 Summary of Constraints, Opportunities and Challenges Study for Shanghai Smart City Development

Thirty key informants from the public sector, research institutions and executives from the private sector were interviewed about constraints, opportunities and challenges affecting the success of Shanghai Smart City development. The results of the study are summarized as follows:

1) Constraint Factor

Based on information from the key informants, constraints that affect smart city development were grouped into four categories: Factor 1:

political constraints. The key informants prioritized cross-sectorial cooperation at 86.67%, because most smart city projects rely on cooperation from various agencies. If cross-sectorial cooperation is difficult, some projects will be delayed or stop. Cross-sectorial cooperation is, therefore, very important to smart city development (Ebrahim & Irani, 2005). As for management of the public-sector team, the key informants placed its importance at 73.33%, especially for monitoring the team's skills and expertise, leadership of direction and guidance, followed by lack of public sector coordination with absolute power (70%). In cases where the public sector's internal coordination is insufficient, "a mechanism for social gathering is needed", leading to collaboration. Factor 2: the key informants put the first priority on difficulties in fund raising for entrepreneurs (83.33%) because smart city projects require high investment. The government should provide funds to support entrepreneurs and formulate policies contributing to business sector investment, such as tax reduction, FTA establishment and the information technology industry. Concerning inadequate force from attractive economic benefits (70%), the public sector must realize benefits in order to attract the private sector to invest and develop smart city projects. As for Factor 3, the key informants prioritized insufficient personnel development mechanism at 90%. In particular, development of personnel and expert ICTs in the public sector at the local level was considered very vital to efficiency in smart city management, followed by ignorance of the people's actual needs (86.67%) in order to enable projects to be consistent with the demand of urban residents. Citizen-centric service management is very important. As for Factor 4, the key informants prioritized the design of applications to meet people's demands (80%), followed by undetailed specific technical standardization systems (70%).

2) Opportunities

In relation to the information provided from the key informants, opportunities affecting smart city development were divided by the researcher into four factors: Factor 1 involves opportunities in a political context. The first priority topic involves support of the central government's policies (96.67%). The Chinese central government has focused on a digital economic strategy by determining innovation technology as a national strategy and developing large smart cities as pilot projects, resulting in China's smart nation. Central policies that promote

information technology are also important because they specify definite details of the information technology application to push for the achievement of this national strategy. Its importance is at 93.33%, and includes such strategies as the “Internet Plus” Strategy and Big Data Strategy, followed by visions of a new generation of Chinese leaders (93.33%). If country leaders like President Xi Jinping of China and Prime Minister Li Keqiang lacked the vision for information technology development, to help the country thrive as a “Strong Manufacturing Nation” and upgrade the manufacturing potential to a technology-intensive powerhouse, plus lacked absolute determination in eliminating obstacles to push for such strategies, China would not have been able to become the country with the most smart cities in the world. As for Factor 2, the key informants prioritized a digital economy (80%). As a result of Prime Minister Li Keqiang’s Mass Entrepreneurship and Innovation project policy (2014), there have been several start up operators leading up to the tech ecosystem, which is the key mechanism for driving smart cities and the digital economy in China, followed by new Chinese economic policies (76.67%). The Chinese government specified information and innovation technology as the key driving force for integrating a new generation of information technology and the strategy for developing an economic system as modern as in western countries. Concerning the one belt one road strategy and Yangtze River Delta Economic Region, its importance was at 70%. This is a strategy related to the promotion of economic belt cooperation using information technology to push for smart city clusters in cities and countries across the region. As for Factor 3, the key informants prioritized geographic diversity and unique city (70%), which leads to the different strengths of each smart city and ultimately strong smart city clusters. Concerning sustainable city development (66.67%), due to problems arising from urbanization, the Chinese government has had to speed up smart city development to bring about sustainability. Factor 4 involves technological context opportunities comprised of technological entrepreneurs related to a large number of smart cities (93.33%). Because of a policy promoting the Chinese ICT industry there are plenty of ICT leaders in China, e.g. Huawei and China Mobile, to reduce foreign dependence on smart city development. Additionally, large-scale information technology service users are outstanding and important at 90%. Each entrepreneur has supporting strengths, e.g. China Mobile (CMCC), a mobile

network service provider, 5G, Digital China (DC) to establish a system Integrator, and Huawei, a producer of the Internet of Things. As a result, Chinese ICTs are leaders and strong in the global market.

3) Challenges

Based on information from the key informants, the challenges affecting smart city development were divided by the researcher into four categories. Factor 1 – challenges in the political context and policy, consisting of too low a potential of agencies responsible for digital (80%). Digital agencies must have adequate power to break the barriers of individual operation at different agencies. This may lead to the holding of key positions in digital agencies by high ranking local government officials, e.g. governors or deputy governors, followed by a lack of clear operational mechanisms in all government agencies (73.33%) to establish a joint operational mechanism and let all parties concerned participate in formulating policies in the same direction. Factor 2 involves an economic context challenge, consisting of too much importance on GDP placed by the government and business sectors (70%). The public and private sectors have emphasized only economic indicators at a high level and might ignore other social issues that are also important to smart cities, such as disparities in accessing information, urban and rural news, education, environment, etc. As for unclear PPP models (63.33%), the public sector has to formulate clear cooperation regulations and standards so that the private sector actually realizes the benefits to be received, as well as the attractive policies that invite that private investment. Factor 3 involves social context challenges comprised of a lack of expert personnel (90%). The public sector must provide sufficient IT training programs and cope with a shortage of expert personnel for integrating ICTs at both the central and local levels in order to serve the demands of smart cities. Concerning the creation of an atmosphere of working together and sharing (80%), coordination, knowledge and resource sharing between the public, private and social sectors will cover smart city development in all dimensions. The Ageing society issue (73.33%) has had much effect on a shortage of labor for domestic economic development, followed by development disparities between large- and small-scale cities (66.67%). Reducing disparities in accessing information between rural and urban cities is necessary for overall smart nation development. Factor 4: technological context challenges consists

of the criteria for the control and inspection of local information system projects. The public sector has to formulate standards for industries with clear measurement criteria, including data network security with legal, protective and emergency response (90%), as well as experience in initiating smart city projects (70%). Continuous learning through the experience of local and foreign successful smart cities can save time for initiating projects.

8.1.3 Summary of Strategies and Tactics of the Shanghai Government for Promoting Smart City Industry

In relation to the third objective: To study strategies and methods of the government of Shanghai City for promoting and pushing smart city industries, the study results are summarized as follows:

The study of strategic policies for smart city development consists of Shanghai Smart City development promotion plans (2011-2013, 2014-2016 and 2018-2020), and government formulated strategies, goals and tactics in accordance with the mission in each phase of the smart city development process.

8.1.3.1 Summary of Strategy and Goal Study for the Shanghai Smart City development promotion plans (2011-2020)

With respect to the study, it is evident that the strategies and goals for Shanghai Smart City development must focus mainly on infrastructure, promotion of a new generation information technology industry and information security systems, as well as leadership in the global information technology industry. This is especially so with regards to the regional news center, which leads Shanghai to rich technology resources in terms of technological knowledge and technology personnel.

8.1.3.2 Summary of the Strategy and Tactic Study for Promoting Shanghai Smart City Industry (2011-2020)

Table 8.1 Comparison of Strategies for Promoting Shanghai Smart City Industry (2011-2020)

Three-year operating plans (2011-2013)	Three-year operating plans (2014-2016)	Three-year operating plans (2018-2020)
1. Construction of information infrastructure to meet the international standard **Strategy**: Urban Information Infrastructure Specific Project **Strategy**: Standardization System set-up **2. Creation of data sensing and smart and highly efficient application systems** **Strategy**: Information technology promotion to enhance the quality of versatile city management (urban construction management, urban safety operation, smart transportation, smart public services, E- Government, information resource development and utilization) **Strategy**: Four strategic center establishments (international economic center, financial center, trade center, shipping center) **3. Modern information technology industry is a strong pillar for smart city development** **Strategy**: Acceleration in entrepreneur development of information technology in eight areas **Strategy**: Information technology research and development promotion **4. Highly reliable and controllable information security** **Strategy**: Safety projects promotion **Strategy**: Major measure formulation	**1. Increasing use and efficiency levels of information applications** **Strategy**: "Shanghai LIVED"(smart living, smart economy, smart administration, smart government services, Smart community) **2. Upgrading of new urban information infrastructure services.** **Strategy**: Promotion of three major support systems in smart cities (new generation city information infrastructure, new generation information technology industry, and network security)	**1. Acceleration in building "Shanghai Connection"** **Strategy**: "Dual Gigabit Broadband City" **Strategy**: Creation of smart information communication networks **Strategy**: Building an industrial internet network architectural system **Strategy**: Standardization of underground and overhead lines **2. Creation of strong "Shanghai Hub"** **Strategy: Establishment of a global information communication center** **Strategy**: Yangtze River Delta Economic Region Data & Information Port **Strategy**: Building an efficient information exchange center. **3."Shanghai Computing" efficiency enhancement** **Strategy**: Building a highly efficient computer center at the E-level **Strategy**: Promotion of the data center and accelerators system **4. Creation of smartness by using "Shanghai Sensing"** **Strategy**: Creation of an "urban sensing network" **Strategy**: Creation of an integrated awareness network service platform (1+16+X) **Strategy**: Application innovation as a driving mechanism

8.2 Discussion

The concept of smart cities has been applied by many countries around the world, at both the national and local levels to city management during the current period. Following the study of smart city development in Shanghai City, researchers realized various success factors affecting the operation of smart cities. The concept of smart cities is not only the dimension or application of modern technology to development. However, major issues that are factors affecting success relate to the clear formulation of public policies. Concerning indicators improved in accordance with a city's potential and development supported by the public sector, Ingfah Singnoi and Rattachart Thasanai (n.d.) stated that public policies are one factor that has a direct impact on the public. The formulation of public policies relates directly to the budget and development resources. Thus, the formulation of clear policies regarding smart city development can lead to efficient city development.

In addition to the public sector's important role in managing smart cities, public participation in development is very vital because private agencies are more agile than public agencies. This is consistent with Pattaraporn Hiranyawong, Watcharapong Ratchatawetkul, Punyawit Setsomboon, and Phattira Nuanyai (n.d.), who studied the models and operation of smart city projects in Khon Kaen Province, and cited that projects that benefited from private sector investment were based on the concept that "the private sector has a major role in local development supported by the local government". This can efficiently lessen the public sector's budget constraints. However, public-private partnership models must be used carefully. For example, the selection committee and the supervision committee may contribute benefits to project owners in the private sector and there may be transparency and efficiency problems concerning project operations, as well as the quality of services provided, because private agencies may focus on maximum benefits rather than public services (Parliamentary Budget Office, 2016). Additionally, another key issue is privacy and confidentiality, whereby types of activities should be considered to be carried out by the private sector instead of public agencies.

As for the issue of cooperation among stakeholders from all sectors related to cities, Bătăgan (2011) mentioned that collaboration between agencies and

communities will promote economic growth and make smart city public services “a model of the citizen being the real center”. Kourtit, Nijkamp, and Arribas (2012) also viewed that smart city management is a city monitoring system with an active and open structure, as well as people concerned from various sectors in order to provide maximum efficiency to the social economy and city ecology. Caragliu, Del Bo, and Nijkamp (2011) thought that smart cities must invest in human and social capital, which builds cooperation between people and social groups.

Although technology and infrastructure in this study are not the first priority issues, based on the key informants’ perspectives, the study of Shanghai Smart City’s policies and development revealed that China is a country that has been accumulating technological knowledge for a long time. Since Deng Xiaoping’s unique socialist policies in 1978, the country has been opened up to foreigners to adopt their modern technology in order to produce products. The Chinese government has also been determined to develop scientific and technological knowledge for economic and industrial reform in China (The Communist Party of China Central Committee, 1995). The use of technology as a tool to transform normal to digital economic systems, as well as the “Made in China 2025” policy, is a target of superpower countries in innovation technology (The State Council of the People's Republic of China, 2015). Toffler (1987) described how each wave has pushed society and existing traditions away. China is one of the countries that are transforming its country development model from an industrial society, called the “Second Wave”, to the “Third Wave”, which is an information age society. This is an era of data connection and access from everywhere. Supported by basic technological components, it has become a network community where people from every corner of the world can access information and services linked together through the internet. It is a starting point of change and China’s new economy, which is a change of its economic structure to a value-based economy, or an “economy driven by innovation”. The basic concept is a switch from the production of “commodities” to “innovation-based products”, and from driving the country by its industrial sector to driving it by technology, creativity and innovation. Its emphasis has also changed, from product manufacturing to more service sectors.

According to Moore's law (1965), it is evident that the readiness of technology that has been rapidly developed requires the application of digital technology in order to drive the operation. Organizational digital transformation is more important, especially with the efficiency enhancement that uses digital technology and human resource development for more technological skills. As a result, China has a competitive advantage in the global market. In the beginning of smart city development in China, multinational companies such as IBM and Microsoft played a big role in developing Chinese smart cities. Supported by the Ministry of Industry and Information, various Chinese information technology companies, e.g. Huawei, China Telecom, China Mobile, Digital China, Tencent, ZTE and Alibaba, have replaced international companies to formulate plans and strategies for smart city pilot projects in collaboration with the public sector at both the central and local levels. For this reason, China only slightly relies on foreign technology, which is different from other developing countries across the world.

Based on Ministry of Industry and Information Technology information (2014), it is evident that economic values in the Software and Information services industry have increased, from 95.6 US dollars in 2000 to 493 US dollars in 2013. The number of internet users in China accounts for 61.2% of the population in China, which is the highest number of users in the world (World Bank, 2019). Classified by the types of users, on-line shopping amounted to 74.8%, network video was 74.8%, on-line government services 59.6% and on-line education 27.2%, to reduce the disparities in accessing public services and rural and urban education (China Internet Network Information Center, 2019). Roger's S-Curve of Technology (1995) was used to explain the phenomenon of the information technology industry in Chinese society, stating that China is in the take-off period of the S-Curve cycle. As information technology interacts with people in Chinese society widely, and people learn about information technology, which is popular in Chinese society, the information technology industry has grown very fast. The information technology industry has been adopted to consistently enhance efficiency when developing smart cities, along with an increasing number of users. This is a period when a large number of new information technology entrepreneurs wish to enter the information technology industry in China.

Study of China's experience indicates that it differs from the implementation of policies in Thailand, where their own technology has not been developed that much yet. It should be mentioned that Thailand's priority in technology development is necessary for Thailand's smart city development plans in the long term. Infrastructure service management is also a key issue, especially necessary infrastructure services, e.g. wireless communications, big data databases, etc. This topic must be emphasized in the beginning of smart city development in Thailand, particularly at the local level.

8.3 Recommendations

Following the study of success factors for developing Shanghai Smart City, the following recommendations from this study should be taken into consideration in order to enable this study to support smart city development in Thailand, to monitor smart city projects efficiently and to bring about utmost benefits to the people and the country.

The first recommendation is policy model development and collaboration with relevant sectors. The public sector has a large role in formulating policies and plans in order to guide development direction for various agencies. The formulation of plans and goals must be clear and possible for measurement and evaluation. To be efficient the best practices must be regularly reviewed in order to inspect and develop plans.

The significance of public-private partnership promotion is a driving factor for developing smart cities in Thailand. Private participation can range from the formulation of strategies, goals and plans, the establishment of the National Smart City Cooperation Advisory Council and the implementation of public service projects, including local pilot projects.

However, the people sector is very crucial to the success of smart cities, because the people sector is the direct user of public services. The providing of knowledge and understanding, as well as public participation, e.g. smart city demonstration activities, is needed so that they can gain experience in benefiting from smart cities. Smart Government, Smart Transportation and Smart Living, as well as people or residents with knowledge and ability, can continue carrying out the sustainable operation of smart cities.

The second recommendation is the creation of technology ecosystems and quality infrastructure to support smart city development. The creation of technology ecosystems is very essential for developing smart cities at the country and local levels. However, the process of technological ecology consists of readiness in information technology resources, e.g. knowledge, capital and experts, including policies supported by the public sector. The technological ecology, as well as relevant educational and research institutions, plays a significant role in pushing for the creation of a nourishing source of specific information technology to serve the demand in smart city development, to promote innovation-based creativity and the gathering of innovation business entrepreneurs and new businesses, which are foundations of smart city development. In addition, the support of necessary infrastructure to serve urban growth and apply the smart city concept to city development among several sectors is a significant supporting element that affects smart city projects in the long term.

8.4 Theoretical Contributions of this Research

According to the analysis of the study, researcher is able to find out some significant issues that are very important. These points of view are key success factors to help implement the smart city projects initiative in Thailand and other countries. They can also lead to assure the accuracy of some theories that will be valuable for academic community.

Firstly, following Moore's law (1965), the development of technologies can be positive factor to the growth of the country. Solow growth model (1956) is also confirmed that advanced technologies influenced economic growth. Without technologies development, it is hardly to expand the economy. These concepts can be proved by the case of China. The Chinese central government has adopted effective policies as instrument to stimulate technology development for several decades. In early stage of the development, international companies such as IBM and Microsoft Company are more important role. However, the government gives importance to the role of local companies such as Huawei, China Telecom, and Alibaba and adopts several policies to help promote them. In consequence of such policies, these local

companies become more influenced instead of such international companies. They are also play a major role among international market. One can say that China is one of the most successful in case of technological accumulation in the world.

As mentioned earlier, the researcher affirmed that the results of technologies development of China are relevant with the theoretical aspects of Moore's law and Solow growth model. If other countries like Thailand have desire to turn the concept of smart city into practical actions, they have to pay attention to long term policies and plans to support technology development and innovation.

According to a significant finding of the study, secondly, the cooperation between public sector and private sector as public private partnership method (PPP) affects the successful implementation of smart city projects of Shanghai. The potentials of private companies as we know it are higher more than public agencies in terms of human resources, technologies, and especially financial resources. The situation in Shanghai can assure that concept of PPP is an important mechanism to help public sector to operate public activities like smart city projects.

Thirdly, although advanced technology is a valuable factor for operating smart city projects as public activities, without citizen participation in public activities is barely successful. Due to public administration theory, citizen participation is a crucial component for the public policies implementation. If public agencies give opportunity to citizen to involve with public activities processes such as policy making process and implementing, this can lead to the successful and effective implementation of projects. Since, participation will create sense of belonging of citizen with those projects, so it is not difficult to obtain the goals of the projects. This is a theoretical point of view of the study.

Lastly, there is an opinion by the study about China polity. The central government of China is very strong powerful to govern the country. All public agencies in all level are enforced to follow strategies regulated by the central government (powerfully command and control approach). This condition can give either positive or negative effects when policies are implemented. However, in the study, it provides positive impacts to the operation of various activities related to smart city concept. In case of big data management, for example, it is very difficult to gather data from several government agencies and manage by a center as happened in

Thailand. This is because of set of regulations of each public agencies and also organizational culture that hinder the integration of different sources of data. Because of absolutely power of the Chinese central government, it is not difficult to gather and manage various kinds of sources of data. One can say that, in political aspect, strongly command and control mechanism can bring about to effective public administration. It can influence related agencies to respond rapidly and certainly. This is presented by the case of operation of Chinese's smart city development.

8.5 Delimitation and Limitation of the Study

8.5.1 Difficulty in data collection

Information study, and qualitative and quantitative data collection were difficult because the data collection venue is Shanghai City. The researcher travelled to Shanghai three times. Most of the key informants are high-ranking executives from public agencies and companies. Thus, it was difficult to arrange an appointment with them for the in-depth interview. The overseas trip is also costly, so data collection for this research was very difficult.

8.5.2 Content complexity or issues to be studied

As the topics and content of this research involve a wide range of information technology knowledge, it is difficult to understand and arrange the content and it is complicated to analyze the content. It took the researcher a long time to search for knowledge based on the relevant literature review and ask experts. In addition, smart city topics are concerned with a multi range of disciplines at various levels. The study is complicated and covers social, political, economic and technological aspects.

8.5.3 Duplication difficulty

Double data collection was difficult because all samples are in foreign countries. It would be, therefore, difficult to collect data again in case the researcher wishes to meet the key informants. Therefore, the researcher contacted them through their email addresses for more information.

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