

LESSONS LEARNED FROM THE PREPARATION FOR THE 13TH FIVE YEAR PLAN FOR LARGE AND COMPLEX SMART CITIES IN CHINA

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ABSTRACT

Despite its tremendous success, the Chinese Economy is still characterized and controlled by a recurring process of 5 year planning. This comprehensive National planning program occurs at all levels of the Chinese government, educational system and state owned companies. This paper reports on a study that was made in preparation for the 13th 5 year Plan for the Smart City component of the upcoming city of Tianjin. The objective of this study was to identify problems in informatization, automation and centralization of command and control, so that these could be solved as part of the 5 year plan. The study followed a three-stage mixed-method approach. First, questionnaires were used to assess the state of development of the smart city features in the different departments of the city government. Second, the study organized thematic joint development groups consisting of expert representatives from different city's departments and units. Third, results of questionnaires and thematic joint development discussions were analyzed in departmental focus groups to clarify and specify the problems and assess proposed solutions and viability of those solutions. This paper analyses the findings of this three-stage process and offers a classification of the identified problems, an integrative conceptual representation of these and a discussion of the importance of this identification in the overall planning process. The results and discussion are of particular importance in China for the next round of 5 year planning that will take place in 2020. However the meaning of the findings of this applied research process are transferable to any smart city planning process all over the world as the majority of the issues discussed are generic.

KEYWORDS

Smart Cities, Smart City Planning, Planned Economy, Thematic Analysis, Mixed-Methods

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1. INTRODUCTION

Smart city as a concept centers on Information and Communication Technologies (ICT) as the core tools to collect, record, analyze and integrate key information captured by core sensors and systems in all of the city's activities. Therefore, smart cities are essentially built by utilizing a set of advanced ICT, including smart hardware devices (e.g. wireless sensors, smart meters, smart vehicles, and smart phones), mobile networks (e.g. Wi-Fi, 3G/4G/5G networks), data storage technologies (e.g. data warehouse, cloud platform), and software applications (e.g. back-office control systems, mobile apps, big data analytical tools) (Peng et al., 2017).

From a conceptual perspective, Hall (2000) defined a smart city as a city that monitors and integrates information of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings. This monitoring aims to optimize city's resources, plan its preventive and maintenance activities, monitor security aspects and maximize services to its citizens.

In China, this concept of smart city is seen as the product of the Digital City combined with the both Internet of Things and the Internet+ (Su et al., 2011). A digital city is seen as an open, complex and adaptive system based on digital networks and urban information resources, which forms a virtual digital space for a city (Li and Lin, 2001). Couclelis (2004) further elaborated on this concept by defining the digital city as a comprehensive, networked representation, or reproduction, of several aspects or functions of a specific real city, open to non-experts. The concept of Internet +, is a specifically Chinese concept put forward by Premier Li Keqiang for the first time in a government work report presented in March 2015 (Ning, 2015). This concept focus on the use of the Internet as a platform for the provision of online services and integrate advanced information technologies, such as big data, cloud computing and Internet of Things. In this way, it promotes the transformation and upgrading of traditional industries and improves quality and efficiency of services. The smart city concept in China is therefore a combination and integration of the Internet + and the digital city and is perceived to include several dimensions: social, cultural, political, ideological and theoretical. These dimensions make planning of smart cities very complex as the understanding and integration of these different aspects is multifaceted, difficult and subjective.

Furthermore, Chinese city management is characterized by the five yearly centrally planned economy that has been put in place since the inception of the People's Republic. This planned economy practice adopted from the Soviet Union tradition has since then evolved and become dynamic and one of the reasons the Chinese economy has become so stable and progressive. The Chinese government updates its targets and directions for the nation's economic development based on this Five Year planning cycle (Zheng *et al.*, 2012). All main organisms of the Chinese society then produce their own 5 year plan adapted to local objectives and their specific nature and mission. All cities in china are required to produce a number of different 5 years plans, which in the case of the more developed cities includes a smart city plan since the last two 5 year periods.

In terms of smart city, planning is seen as the development of a roadmap to provide a first comprehensive and unified view of current and future social and technological solutions for the development of the smart city based on explicit National, Regional and City policies and the identification of specific local aims, requirements and problems. As proposed by Lee et al., (2013), each city develops their own services based on current technologies using coherent strategic planning following National and Provincial level guidelines as the coordinating view.

Ultimately, a smart city plan should offer a developed and customized roadmap that serves as a guiding strategic resource and communication tool to support the city's R&D initiatives and allow the city to take advantage of opportunities offered by emerging technological trajectories. Therefore, the first requirement in drawing up such a roadmap is the crafting of an identification process of the various problems that need to be resolved and services that should be implemented (Rinne, 2004) according to the cities characteristics, vision and aims.

The study reported in this paper aimed to produce this the first requirement in drawing up such roadmap for smart city development for the city of Tianjin, which is the fifth more developed city in China, after Shanghai, Beijing, Guangzhou and Shenzhen. Tianjin is directly under jurisdiction of the Central Government and is located in the Northeast coast of China. It is the closest seaport to Beijing and one of the biggest industrial and port cities in China. Tianjin covers an area of 11,000 square kilometers and has a population in excess of 10 million people. Specifically, the study aimed to craft a method to enable the identification of problems that can be resolved by smart city development as well as those that may become barriers to its implementation. The results of this study are now particularly important with the exponential expansion of the smart city initiatives in China as well as worldwide.

2. SUMMARY OF THE LITERATURE REVIEW ON SMART CITY PLANNING

For the policy makers, the value of the smart city concept is directly related to the resolution of increasingly complex large city problems, such as rising population, limited water and energy resources, polluted air, limited geographical space, traffic congestion, safety and security issues, etc. Progressively more important in smart city development are also issues related to environment, cultural and social aspects (Sabella et.al, 2018).

Investment by city government in smart technologies, such as cloud computing, big data analytics and internet of things, is expected to bring vast benefits to modern cities. These use of these smart technologies associated with adequate city policies and leadership has the potential of allowing very large cities to be better governed, run more efficiently and allow citizens to be happier. Consequently, urban planners and city leaders are developing comprehensive smart city plans that covers all aspects of city life and governance (Sidhu, 2015), such as public safety and security services, e-government, smart industries, smart energies, smart buildings, smart transportation services (Biron and Follett, 2018).

Therefore, smart cities encompass a wide variety of different aspects including people, technology, environment, process, economy, innovation, sustainability and much more (Sabella et al., 2018). All of these aspects can be synthesized into three key elements of smart cities (Pereira et al., 2017):

- 1) Human factors - citizens, knowledge, privacy rights, etc;
- 2) Institutional factors - government, public transparency policies, legislation, citizen empowerment, open data; and
- 3) Technological factors - ICT infrastructure, digital inclusion, internet of things, etc.

Smart city planning requires the harmonization of these three key elements according to different stances and results in different strategic approaches (Bolívar, 2016):

- Techno-centered - This approach take infrastructures (especially ICTs) as the key driver of smart city, gives priority to solving technical issues and the deployment of ICT

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infrastructures (Greco & Cresta, 2015). It usually comprises automating a number of cities functions and services in selected application contexts (Pacaux-Lemoine et al., 2017). Its explicit objective is techno-centric and aims at improving and transforming life and work in the city with support of ICTs (Cocchia, 2014).

- Human-centered approach – This is a human centered approach that puts citizen users at the heart of the smart city design and decision making (Mitchell et al., 2016). It is characterized with a concern with social and human aspects, rather than just technological issues (Greco & Cresta, 2015). Therefore, people are the key drivers of the smart city planning and the planning criteria focus on livability, education, ecology and quality of living (Cocchia, 2014).
- Integrated approach – In this case the information infrastructure deployment and information system design and implementation is seen to be closely connected with humans’ needs and requirements (Shin, 2014). The smart city planning process is seen as an integration of the two previous approaches. This integration is expected to enables the creation of better condition for the continuous growth and innovation of a livable city (Campbell, 2013).

Policy and planning of smart cities has seen a worldwide increase in quantity, quality and attention to detail. This policy making and planning can be divided into multi-state regional, national and city planning. In addition to comprehensive planning, these different plans include detailed aspects such as information infrastructure, information economy, city management and citizen services as shown in Table 1.

Table 1. Examples of Smart City Planning Worldwide

Examples	Comprehensive Plan	Information Infrastructure	Information Economy	City Management	Citizen Service
Multi-State Regional Plan	A Digital Agenda for Europe (EU, released in 2014) European Innovation Partnership on Smart Cities and Communities Strategic Implementation Plan (EU, released in 2013)	The Connecting Europe Facility (EU, released in 2014) Unleashing the Potential of Cloud Computing in Europe (EU, released in 2012)	A renewed electronics strategy for Europe (EU, released in 2018) EUROPE 2020:A European strategy for smart, sustainable and inclusive growth (EU, released in 2010)	EU eGovernment Action Plan 2016-2020 (EU, released in 2016) Smart Grids Strategic Research Agenda 2035 (EU, released in 2012)	eHealth Action Plan 2012-2020: Innovative healthcare for the 21st century (EU, released in 2012)
National Plan	Smart Nation 2025 (Singapore, released in 2014) Digital Canada 150 (Canada, released in 2014)	Government ICT Strategy (UK, released in 2011) Jordan National Information and Communications Technology Strategy (Jordan, released in 2012) Government ICT Strategy and Action Plan to 2017 (New Zealand, released in 2013)	A National Strategic Plan for Advanced Manufacturing (USA, released in 2012) Made in China 2025(China, released in 2015) AU20 National Digital Economy Strategy (Australia, released in 2011)	Digital Government: Building a 21st Century Platform to Better Serve the American People (USA, released in 2012) Open Government Directive (USA, released in 2009) 13th Five Year Plan for Modern Comprehensive Transportation System (China, released in 2017)	The Malaysian Public Sector ICT Strategic Plan (2016-2020) (released in 2016) The Republic of Macedonia Education Strategy For 2018-2025 and Action Plan (released in 2018) Australia's National Digital Health Strategy (released in 2018)
City Plan	Smart Seoul 2015 (Korea, Seoul, released in 2011) Amsterdam Smart City (Holland, Amsterdam, released in 2009)	ICT Strategy 2018 - 2023 (Hertsmere Borough, UK, released in 2018) ICT Strategic Plan 2016 – 2021 (Shire of Broome, Australia, released in 2016)	City of Vancouver Digital Strategy (Vancouver, Canada, released in 2013)	Open Data law (USA, New York City, released in 2012) Future Transport Strategy 2056 (Australia, New South Wales, released in 2018)	Florida Digital Learning Summary (USA, Florida, released in 2015)

Despite the existence of all these plans at the different levels, the problems and challenges of smart city projects are related to the complex governance of cities, multiple areas of management and often difficulties of uniform strategy. This complexity is reflected in problems of coordination, different infrastructures and difficulties in data sharing between different departments and city organizations. In fact, it is not uncommon that in the same city there are multiple specific smart city development plans. The cost and complexity of data sharing has become the fundamental barrier for smart city efficiency and success (Sabella et al., 2018). These problems show that the smart city depends on good governance and inter-city departmental partnership, which requires all the tiers of government and non-government to collaborate. This is only possible with inclusive and integrated city level planning.

3. CHINESE SMART CITIES POLICIES AND PLANS

In China like in the rest of the world, smart city thinking planning and development has gained prominence in government policies and legislation, business strategy and academia research (Argyriou, 2016). Specifically in China, smart city development is seen both politically and socially significant to progress urbanization, informatization, industrialization, city government and the sustainable development capacity of cities. Chinese centralized government plays a more important role than social and market demand. City urbanization and development follows national, provincial and city policies. In this sense urban and smart city planning in China is rather different from the West. Since the year of 2010, these national policies have given priority to very specific smart city themes such as city service, public security, environment, and citizen life.

In order to promote the healthy and the quality of the smart city development and lead the new urbanization with Chinese features, in November 2012 the Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD) released a smart city related guiding policy entitled "Work Notification of Lanching National Smart City Pilots". This establishment of National pilot projects aimed at exploring an evidence basis approach for the development, operation, management and service development for smart cities (MOHURD, 2012). There were a total of 290 cities that were awarded the status of "National Smart City Pilot" after three different call for tender, namely 90 pilots in the first call in January of 2013, 103 pilots in August of 2013 and 97 pilots in the April of 2015 (MOHURD, 2013a; MOHURD,2013b; MOHURD 2015). The centralized approach to policy making does not mean that there is a monolithical and unified strategy for smart city planning all over the country nor that there are very rigid development standards.

The central government does release leading national policies (recent chronology shown in Table 2), which followed by provincial interpretations according to their specific characteristics, needs and strategic plans. These National policies are seen as general guidance, general strategic directions and set both general targets and evaluation standards. They are in nature open, inclusive and very general.

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Table 2. A Chronology of Chinese National Smart City Policies

Released Date	Policy Title	Targets	Web Address (URL)
2012.11	Interim Measures for the Administration of the National Smart City Pilot	To guide the smart city pilot application and management	http://www.mohurd.gov.cn/wjfb/201212/t20121204_212182.html
2012.11	The Indicator System of National Smart City Pilots	To list the index of smart city pilot	http://www.mohurd.gov.cn/wjfb/201212/t20121204_212182.html
2014.03	National New Urbanization Plan (2014-2020)	To actively promote the smart city development in China, and point out the directions for smart city development.	http://www.gov.cn/gongbao/content/2014/content_2644805.htm
2014.08	Guidance on Promoting Healthy Development of the Smart City	To create a set of featured smart cities that by the 2020 show significant progress and can serve as exemplary models for growth and development. The areas of priority for expected development are ensuring and improving citizen service, city management innovation, livable environment and network security.	https://www.ndrc.gov.cn/fzggw/jgsj/gjss/sjdt/201408/t20140829_1154517.html
2015.01	Guidance on the Promotion of Smart Tourism	To improve the capacity of the smart tourism service by 2020. Specifically significantly enhance smart management ability, improve big data analysis and smart marketing ability.	https://www.mct.gov.cn/whzx/bnsj/zcfgs_bnsj/201501/t20150114_821909.htm
2015.05	Guidance on Promoting the Digital Transformation and the Upgrading of Cities to Smart Cities	To emphasize the significance of smart city development, to launch the pilot projects of digital transformation and upgrade to smart city, focusing on spatio-temporal information and cloud platform. To emphasize promoting the application and development of geospatial frameworks of digital cities. To explore a long-term mechanism to strengthen the supervision and the management of smart cities.	http://d.oldg.wanfangdata.com.cn/Claw_G000940061.aspx
2015.10	Guidance on the Development, Application and Implementation of the Smart City Standard System and Evaluation Index System	To create the standard system of smart cities, speed up in development of core standards for smart cities; ensure the basic infrastructures such as required technology and platform, infrastructure, livable environment, city management, local government services, industrial development and improvement of city economy.	http://www.sac.gov.cn/sgybzeb/xwxc/201511/t20151103_196295.htm
2016.11	Notification on Organizing and Carrying out the Practical Evaluation of New Smart Cities to Promote the Healthy and Rapid Development of New Smart Cities	To ensure correct work directions for the new smart city development based on evaluation; to improve the level of citizen services and benefits through evaluation. To ensure that the evaluation work is taken as enhancer to promote experience sharing and promotion of new smart cities principles.	https://www.ndrc.gov.cn/xxgk/zcfb/tz/201611/t20161128_962791.html
2017.01	Action Plan for Smart Transport Development (2017-2020)	To achieve 5 targets by 2020 in the aspects of smart infrastructure, smart production and organization, smart transportation services, and smart decision and supervision in transportation.	http://xxgk.mot.gov.cn/jigou/zhghs/201702/t20170213_2976478.html
2017.12	Notification on the Launch of the National E-Government Comprehensive Pilot Project	By the end of 2019, the overall capacity of e-government in the pilot areas have been significantly enhanced. The key aspect includes of development are infrastructure, government information resources, government services, a set of e-government development models.	http://www.cac.gov.cn/2017-12/27/c_1122173899.htm

Provincial government and city government set their own smart city policies according to National policies described in Table 2, but specifically aimed at their development state, strategic aims and visions for the future. In the case of smart city policies and development, city government has a significant degree of autonomy and base their own smart city policies and planning on these more general policies, but in turn interpret them in terms of their relative state of development; business and industrial characteristics; social and cultural features; and specific economic and social needs as shown in Table 3 (Hu and Wang, 2016). Therefore despite the centralization, there is no uniform model or plan that is followed by all cities, but a rather heterogeneous scenario in which Chinese city government explores and develops their own smart city models by flexibly interpreting and customizing national policies and at times studying other cities' models (Wang et al., 2017).

Table 3. Representative Chinese cities in smart city plans

City	Policy title	Targets	Web Address (URL)
Shanghai	13th Five year plan of Shanghai smart city development promotion (2016-2020)	To develop featured and leading smart living projects, build new information infrastructure based on high speed mobile, safe and ubiquitous features. To create sharing and open data resource utilization systems. To develop innovation driven industrial and service structures. To promote green ICT industries. To establish reliable information security systems.	http://www.shanghai.gov.cn/nw2/nw2314/nw2319/nw12344/u26aw50147.html
Beijing	Smart Beijing Action Plan (2012-2015)	To implement ubiquitous information infrastructure, create integrated smart information systems and create an innovative sustainable development environment. To leap from Digital Beijing to Smart Beijing.	http://www.beijing.gov.cn/zfxz/gk/110001/szfwj/2012-07/24/content_eclbd2af99a54ed3af9f6ffafd1de52.shtml
Guangzhou	13 th Five Year Plan of Guangzhou Informatization (2016-2020)	By 2020, the Guangzhou city targets to develop well equipped ICT infrastructure. To lead the ICT industry development in both market size and quality level in entire China. To largely improve the big data related development and application. To apply ICTs in all social and economy aspects. To reach new stages of smart city development. To achieve new milestones in cyber and internet security.	http://zwgk.gd.gov.cn/007482532/201702/t20170215_692934.html?from=singlemessage&isappinstalled=0
Shenzhen	Overall Plan for the Development of a New Smart City in Shenzhen (2018-2020)	Shenzhen smart city development focus on 10 key aspects: to construct high speed broadband networks project, sensors deployment projects, big data project, smart city managements project, smart public services project, smart public security project, smart city governance project, smart industry development project, network security monitoring project, new smart city standardization development project.	http://www.sz.gov.cn/zfgb/2018/gb1062/201807/t20180730_13798766.htm
Tianjin	13 th Five Year Plan for the Tianjin Smart City Development (2016-2020)	To develop Tianjin as a representative city in smart city management, a featured city with convenient citizen services, a pioneer city with smart industry integration and innovation, equipped with ubiquitous and interconnected information networks and sensors, a secure city with efficient monitoring system.	http://gyxxh.tj.gov.cn/fzgh/59538.htm

The study reported in this paper aimed to produce the first requirements in drawing up the “13th Five Year Plan for the Tianjin Smart City Development (2016-2020)” for the development of Tianjin as a smart city. Tianjin is the fourth largest city in China, after Shanghai, Beijing, and Guangzhou. Tianjin is one of the few cities in China that is directly under the jurisdiction of the Central Government (i.e. not administratively part of a province) and is located in the Northeast of China. It is the closest seaport to Beijing and one of the biggest industrial and port cities in China. Tianjin covers an area of 11,000 square kilometers and has a population in excess of 10 million people. Specifically, this study describes and explains the method crafted to enable the identification of informatization problems that can be resolved by smart city development as well as those that may become barriers to its implementation. The presentation and description of this method is particularly topical now that the 14th Five Year Planning process is underway all over China.

4. RESEARCH QUESTIONS AND METHODOLOGY

This study was conducted within as a part of a much larger project entitled “13th Five Year Plan of Tianjin Smart City Development” that was led by the Tianjin Municipal Commission of Industry and Information Technology (TMCIT) (<http://gyxxh.tj.gov.cn/>). This project was conducted in partnership with the National Industry Information Security Development Research Center (NIISDRC) (<http://www.etiri.com.cn/index.html>) and Tianjin Smart City Research Institute (TSCRI) (<http://www.tscri.org/Default.aspx?MenuCurrentID=1>). The general aim of this larger project was informed by a city vision of the “Smart Tianjin” as proposed in the 2015 city guidance policy document entitled “Suggestions on formulating the 13th Five Year Plan for Tianjin's Economic and Social development” (<http://leaders.people.com.cn/n/2015/1209/c58278-27903742.html>) by the Tianjin’s Municipal Committee of the Communist Party of China. The explicit and specific objective of this research

project targeted the identification of informatization problems and establishing of the requirements specification for the 13th Five Year Smart City Plan of Tianjin. The point of departure to the project was the analysis of achievement in informatization, automation and urban development of the previous 12th Five Year plan. Although there was an expectation of continuity from the previous plan, the 13th Five Year Plan faced more developed and demanding national and city guiding principles, more tight basic rules and more technological driven city services, operation and missions. The study addressed by this paper occurred at the first part of the planning process and aimed at identification of technological, infrastructure, resource, contextual and geographically localized problems in Smart Tianjin.

4.1 Research Questions

The general aims of this research aimed not only to identify problems in the development of smart cities but also to devise a process that would enable the identification of these problems in the context of an extremely large and complex city like Tianjin. Therefore, two main research questions were set as follows:

- R1 – How to identify problems to the development of a very large and complex smart city?
- R2 – What are the problems that can be resolve by efficient smart city planning?
 - R2.1 – How can these problems be categorized and classified?
 - R2.2 – Which of these problems are Chinese in nature and which ones are general to smart cities?

4.2 Methodology

The study followed a mixed-method research design composed of five sequential stages as shown in Figure 1:

1. The first stage consisted of a review of both academic and gray literature. This included National, provincial and city reports and policies as well as a number of Chinese smart cities reports. These cities were chosen according to their similar circumstances with Tianjin, i.e. because they are port cities, large cities or are specialized in the same industry and business sectors. Tianjin is the cradle of China's modern mechanic industry and textile industry, but has recently witnessed a rapid development of the services sectors. Therefore, cities selected had at least one of these characteristics, such Beijing which is a services city, Ningbo a port city and Nanjing a city characterized by well-designed and effective industry parks.
2. This literature review enabled a preliminary identification of problems encountered by other cities. This preliminary identification was used as the base for the design of the questionnaire survey that constituted the second stage of the study. The aims of the questionnaire survey were twofold. First, to assess the comparative state of development of the Smart Tianjin in relation to other cities. Second, to compare problems identified in other cities with those encountered by Smart Tianjin. The questionnaire was sent to all the relevant committees, units and departments of the city municipal government. The questionnaire used mostly open questions to allow rich expressions of problems and situational descriptions. Questionnaires were designed

according to the following thematic topic division: Infrastructure; Information security; e-government; urban management; information economy; citizen services; key districts and counties; and key zone. Questionnaires were sent to 53 units as shown in Table 4 and, since this research was done under the auspices of the city government, got a response rate of 100%. No response was not an option.

Table 4. Participating units and departments in thematic joint development group discussions

Emerging Themes	Participating Units	Participating Departments
Infrastructure and Information Security	Municipal Communications Administration, Public Security Bureau, Network Information Office, Maritime Administration, Unicom, Mobile, Telecom, Radio And Television, National Supercomputing Tianjin center, Tianjin Unicom Huayuan Data Port (10 units)	Planning Office, Research Office, Information Infrastructure Management Office, Information Security Office
E-government and Urban Management	Market Supervision Committee, City Appearance and Garden Committee, Construction Committee, Transportation Committee, Planning Bureau, Guotufanguan Bureau, Water Affairs Bureau, Environmental Protection Bureau, Public Security Traffic Management Bureau, Safety Supervision Bureau and Emergency Office (11 units)	Planning Department, Research Department, Information Promotion Department, e-Government Center
Information Economy	Municipal Science And Technology Commission Business Committee, SASAC, Port Office, Oceanic Administration, SME Bureau, Financial Bureau, Tianjin Customs, Tianjin Branch of the People's Bank of China, Banking Regulatory Bureau, Tianjin port (10 units)	Planning Department, Research Department, Integration Department, Electronic Information Industry Department, Software And Information Service Department
Citizen Services	Municipal Development And Reform Commission, Health and Family Planning Commission, Agricultural Commission, Education Commission, People's Social Council, Civil Affairs Bureau, Cultural Radio, Film and Television Bureau, Tourism Bureau, Post Office, Electric Power Company, Municipal Tap Water Group And Municipal Public Transportation Group (12 units)	Planning Office, Research Office and Integration Office
Key Districts and Counties, Key zone	Binhai New District, Heping District, Hexi District, Nankai District, Wuqing District, Jinnan District, Sino-Singapore Ecological City, Development Zone, Bonded District, High-Tech Park (10 units)	Planning Office, Research Office and Integration Office

3. The questionnaire analysis enabled the creation of thematic areas of problems and lists of specific problems as well as the identification of areas where Smart Tianjin seemed to be behind in relation to other cities. However, these were very generic and anecdotal in nature. In order to specify these problems in detail and acquire in depth understandings, the researchers organized a series of thematic joint development groups consisting of expert representatives from different city departments and units. These group discussions were organized in conjunction with and supervised by the Tianjin city government. The basic method used was a process cognitive walkthrough as proposed by Aleixo et al., (2012) and Wharton et al. (1994). The different experts were asked to elaborate on particular problems, their causes and consequences. Often intense discussion ensued between related departmental experts and problems across departmental borders. The walkthrough process enabled clarification of processes and connections between governmental units as well negotiated agreement over contested issues. The sessions were recorded both by stenographic transcription and audio recording.
4. Nevertheless, the thematic joint development groups met with strong time limitations and were only attended by selected group of experts from each unit. Therefore, although informative and extremely useful, these discussions often lacked in detail and information that was with other experts not in the room. Therefore, in order to further specify the problems and acquire a full and fine detail understanding of the problems being analyzed, the researchers undertook a series of focus groups with a carefully selected group of governmental units.

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- Focus group interviews were employed to generate data and as a source of data for analysis (McPherson and Nunes, 2006). Group forces or dynamics become an integral part of the procedure with participants engaged in discussion with each other rather than directing their comments solely to the moderator (Catterall and Maclaran, 1997). Thus, a focus group is, in essence, a semi-structured interview in which a moderator keeps the direction of discussions under control by utilizing a list of questions set by one or more researcher or facilitator (McPherson and Nunes, 2006). In this case, closely related groups of experts were asked questions on problems associated with their daily working processes. The research group visited the following specific units where lack in detail or absence of data prevented full understanding of the situation: Tianjin Administration of Work Safety, Cityscape and Landscape Management Committee of the Tianjin Municipality, Tianjin Garrison Command, Tianjin Market and Quality Supervision Administration, Tianjin Planning Bureau, Heping District and Jingnan District. Government staff in these focus groups, illustrated their problems and difficulties in their specific socio-technical infrastructure. The sessions were also recorded both by stenographic transcription and by audio recording.

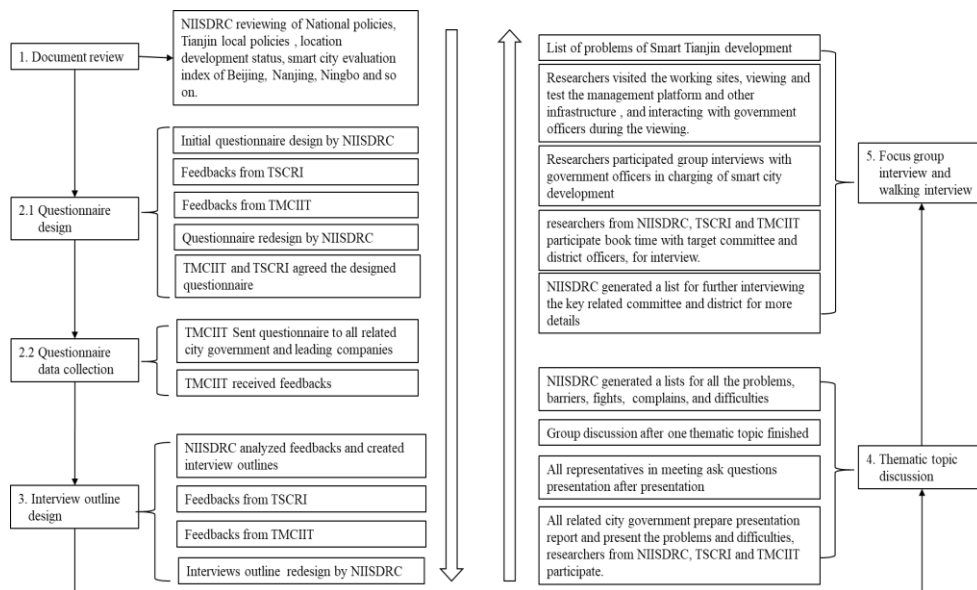


Figure 1. A framework to identify development problems of a very large and complex smart city (FIIDP)

The method of data analysis used was an integrative and evolutionary thematic analysis, that started with the analysis of the open questions in the questionnaire and was then continued, fine-tuned and expanded throughout the following two phases. The research findings presented in the next section are the final result of this evolutionary analysis. Finally, the framework to identify development problems (FIIDP) of a very large and complex smart city presented in Figure 1 aims to be a first contribution as an integrative and evolutionary thematic analysis framework to identify problems to the development of a very large and complex smart city. FIIDP was developed to respond to the research question R1 set for this project.

5. FINDINGS

In this study, data collection and data analysis were not separate and sequential processes. After each of the components of the mixed-design framework explained above, data was analyzed and the results operationalized for the next phase. This process enabled a gradual understanding, definition classification of problems to the development of a very large and complex smart city such as Tianjin. The resulting thematic list of problems is illustrated in Figure 2.

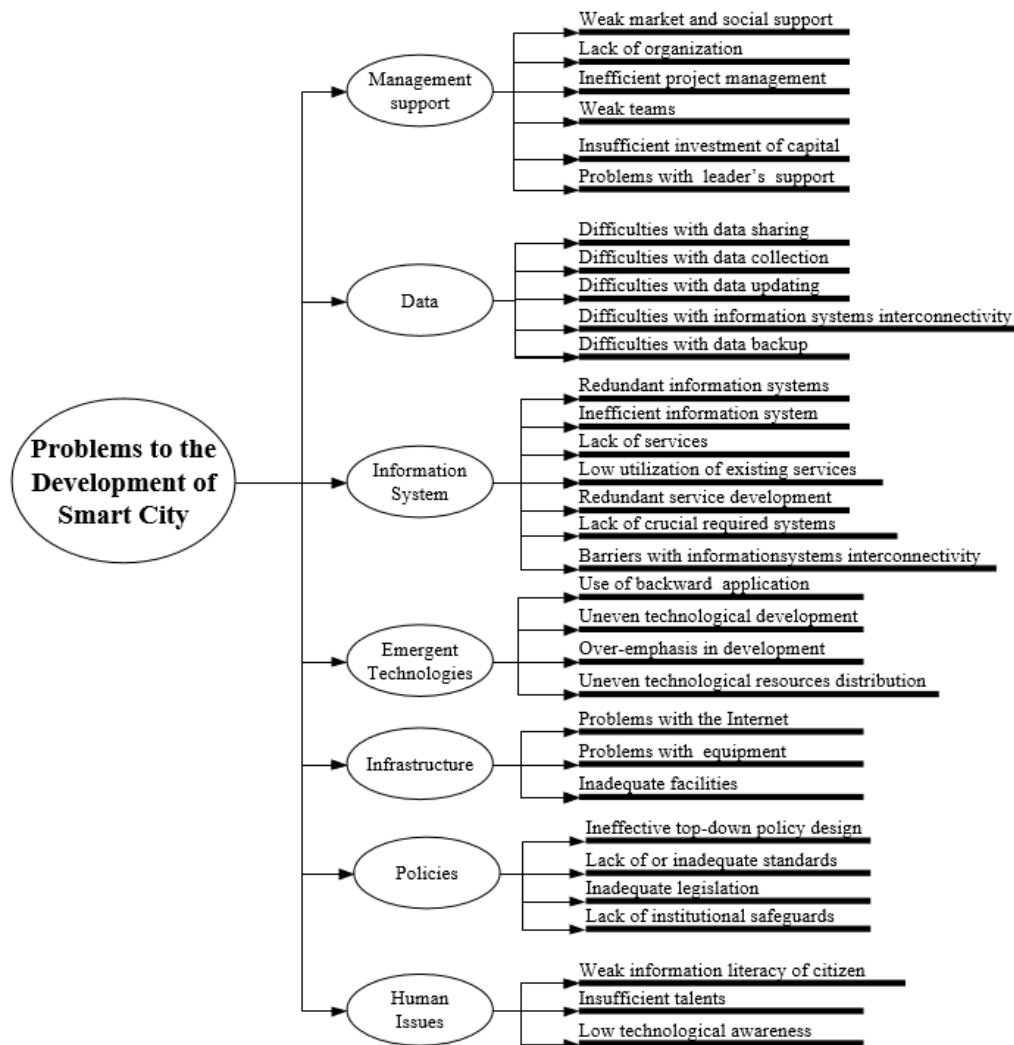


Figure 2. Thematic List of informatization problems to the development of smart cities

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The thematic list presented resulted from a thematic analysis as explained above and identified 7 main categories of problems and a total of 32 specific problems. All these problems are of high level and strategic nature. Many of them are very specific to the nature of the municipality of Nanjing that includes both urban and rural districts. Other are generic. Another aspect that emerged rather surprisingly is that the perceived problems for the development of Smart Tianjin were not necessarily linked with technological issues, but with resource, human, management and general infrastructure aspects. This is probably due to a more mature understanding of smart city planning by the participants who had to undergo a similar effort of planning 5 years before. The enthusiastic belief in and emphasis on technological solutions has been moderated by the reality of practice and the realization that technology by itself cannot resolve all the problems of an urban space.

One of the most often referred to problems was related to “Management Support”. This included lack of interest, engagement and support of management for the implementation of smart city projects that then resulted in obstacles with financial and resource investment. This category also includes problems with project management and support to projects that as a consequence resulted in failure. Finally, lack of management support resulted in weak project and development teams, often under-resourced, poor in influence and unable to take critical decisions. Finally, in China in particular, the lack of senior public manager’s involvement often creates both social and market disengagement, leading proposed solutions and applications to be underutilized by citizens and undersubscribed by the business and industrial sectors.

Problems with data and information systems were also often referred to as critical. Participants in the study were particularly worried with difficulties of data sharing across governmental departments as well with the urban environment. Problems of data collection from companies and citizens, consistency of data collected across the different departments on the same entity and data integrity across the different units were mentioned as a critical issue. These critical problems can be made worst with independent upgrading and updating of data collection and data processing systems. A good example of this type of issue happened when in 2016 the city’s Public Security Bureau’s Monitoring equipment was upgraded to high definition standards, but the digital city management system could not process these. This made it impossible to share the public security bureau’s data. Such updates, often decided autonomously by semi-independent city government units create sever problems of interconnectivity and data sharing. Finally, many units mentioned a problem of data backup and storing. Due to the massive quantity of data collected across the city by automatic sensors, many units were only keeping data for short periods of time before deleting it to make space. This may be surprising on our day and age, but the fact is that some of the operating HW is relatively old, partly due to strict National and Provincial regulations regarding the replacing of equipment (some HW can only be replaced after 5 years, some 8 years) , partly due to the disengagement of managers.

Information systems planning and development has also been highly problematic due to the lack integrated and systematic strategic planning and development. Information’s systems across the different municipal units and departments are developed autonomously with no guarantee of interoperability and interconnectivity. This results in redundancy for information procession, lack of integrity of data and information across the different government units, lack of consistency in reporting to and informing the citizen and ultimately lack of credible information to the citizen. Sometimes it is difficult outside of China to understand the dimension and responsibilities of municipal government. Tianjin is a city of 15.6 million legal inhabitants (approximately three times the population of Denmark) with a government structure that

oversees what amounts to a small country population. The size and responsibility of such a structure is therefore considerable as is the autonomy of different units that compose it. In terms of information systems design and development, this creates real and very significant problems. There is a large problem with redundant services, that causes some to be severely underused and others to be overloaded by users.

On the other hand, there is a general realization that some of the information systems in use are either outdated, obsolete or do not exist yet. Numerous cases were mentioned across disparate units ranging from the lack of an integrated regional health information platform to the need to create a GIS platform that can integrate video and other applications into one platform. Finally, there is also a great demand for public services that enhance the capability of e-government.

Closely related with information systems is another often mentioned category of problems: emergent technologies. There was an overwhelming opinion among participants that there an over-emphasis on technological development in detriment of socio-technical thinking. Emergent technologies and fashionable terminology seem to have influenced both strategic planning and development initiatives sometimes without clear understanding of user requirements or citizen needs. Developing applications for big data analysis, data visualization, cloud computing, Internet of Things, etc., seems to have become an end in itself without clear understanding of their actual role in the smart city systems. Moreover, since these technologies are relentlessly and continuously changing, the technological adoption and development across the different government units becomes unbalanced and uneven, depending on the timing for the development of the different information systems. This then results in uneven development, uneven capabilities, lack of consistency of services and applications and uneven technological resource distribution. Finally, a number of the more technologically sophisticated units point out that in the previous planning there was excessive focusing on technological solutions development and construction and too little thinking on application use and maintenance as well as insufficient integration between business processes and technology.

Additionally, participants stressed the importance of adequately installed infrastructures. The Rural Committee of Tianjin complained bitterly that the network infrastructure in their area was very poor. This idea was confirmed by the Health and Family Planning Commission that claimed that the network foundation was weak and that the network layout lacks in global planning and therefore affects the use and development of their smart city e-health applications. Furthermore, some of the already installed infrastructures resulted in very poor results. For instance the Heping District, is building a Wi-Fi wireless network with very poor effect. This network is a part of the iTianjin initiative that aims at providing free Wi-Fi internet for the whole of Tianjin. This initiative was built for the benefit of the people, but because its poor quality and slow connectivity the district is worried that it was all a waste of resources and has resulted lack of credibility and trust in smart city solutions. Participants also referred to problems with existing hardware and network infrastructures as well as with existing facilities. For instance, the Baodi District participants were rather focused with the construction of new facilities and their integration with older ones that are in urgent need of renovation. Their problem was on how to “form a working complementarity between new facilities and old facilities [... which has become] ‘old difficulty’ in informatization construction”.

The last two categories, in the ontology in Figure 2 are related to policies and human issues. The major concern expressed by participants is directly connected to the absence of detailed top-down policies by the top strategic thinkers on smart cities. Units receive holistic, aspirational and often vague guidelines that are difficult to put into practice. As very clearly put by the

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Tianjin Planning Bureau: “there are many perfect theories about smart city research, but few of them are implemented in smart city operation. We need detailed and practical policies and regulations”. This ineffective top-down policy design is compounded by lack of clear standards and institutional safeguards that can guarantee good quality outputs, adequate monitoring of development initiatives and proper evaluation of implemented applications, services and solutions. Policy inadequacies may some times be justified by weak awareness of the complexity of smart city technological needs and solutions. This lack of awareness is often caused by low information literacy levels and low ICT understanding, that often results in reductionist and limited solutions. Tianjin, despite its status as one of the most developed urban centers in China shares some problems associated with staff teams not being stable due to government salaries not being competitive in relation to the private sector. This led units such as the Public Transportation Group to claim that they have a lack of talent to support intelligent information systems construction for smart traffic management. The Finance Bureau reinforced this statement by complaining that their number of technical teams is low and the comprehensive ability of technical personnel is often not enough to fulfill their role.

6. DISCUSSION

The significance of this research is resides on two main aspects, both transferable to other cities in China and even worldwide:

- 1) Proposal of the FIdDP framework for the identification of informatization problems that can be resolved by smart city development;
- 2) An identification of specific and common problems that characterize large and complex cities and can be addressed by smart city development.

The FIdDP framework is transferable to the study of informatization development problems in very large and complex smart cities in China in particular. This is a useful tool that can be employed in 2020 for the coming 14th Five Year Planning process that will be happening all over China. As an integrative and evolutionary thematic analysis framework, it offers a systematic process for planners and policy makers in China to establish list of problems to be addressed in the planning and synthesized into requirement specifications. Although, developed for the specific context of Chinese cities, this framework is of potential interest to smart city developers elsewhere in the world, provided that hierarchical, administrative, cultural aspects of the framework are adapted to the different contexts.

On the other end the thematic list proposed is easily transferable to the realities of other cities, as it presents socio-technical problems that are commonly found in most cities. This research identifies 7 main areas of problems, namely: management support; data; information systems; emergent technologies; infrastructures; policies; and human issues. These main areas of problems are easily transferable to most types of smart city development initiatives, and flag areas of concern to planners and policy makers. These problem areas also pave the way for the understanding of social technical issues that require attention in smart city planning and can be a good basis for problem-based policymaking as well as prioritization and systematization of development efforts.

This research has some limitations that may be resolved by future work. Firstly, the study was only conducted in one case study in China. Validation through application in other cities would be beneficial in improving and fine-tuning the FIdDP framework. Furthermore,

application in cities outside China could help internationalize the framework and make it a generalizable tool. Secondly, the study adopted a top-design approach to the preparation work for the 13th Five Year Plan and therefore reflects problems that characterized Tianjin from the perspective of related commissions, bureaus, committees, senior city managers and policy, but does not really involved the opinions of the common citizen. Although adequate to the Chinese context, the problems identified make lack in representation of the citizen needs, aspirations and requirements. Future applications of the FIdDP framework may consider enlarging the stage 5. of the framework to include other all the actors in city life.

7. CONCLUSIONS

This paper resulted from a research project made in preparation for the elaboration for the 13th Five Year Plan for the Smart Tianjin. The paper offers two distinct and useful contributions to knowledge. The first contribution is an integrative and evolutionary thematic analysis framework to identify problems to the development of a very large and complex smart city: the FIdDP framework. FIdDP is based on a transferable and general mixed-method research design composed of four sequential stages. This framework represents a first proposal for a research design that can be used by other researchers if they undertake similar studies and should be tested and improved by other research projects in this area. The second contribution is an ontology of problems to the development of the very large and complex Smart Tianjin. This is an inductively generated ontology grounded on the context of the city of Tianjin. However, the ontology provides practice informed guidance to the main areas that should be considered in a smart city plan, namely: Policy Implementation and Planning; Management and Project Management Support; Information Systems Design, Development and Maintenance; Emergent Technologies Adoption Strategies; Data Integrity, Consistency and Continuity Safeguards; and Human Resource Issues. The researchers hope, that the paper will also be both timely and useful at a moment in time that China is preparing for a new round of Five Year planning in 2020 and many of the issues discussed in the paper will soon be revisited.

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REFERENCES

- Aleixo, C.; Nunes, M. B. and Isaias, P., 2012. Usability and Digital Inclusion: Standards and Guidelines. *International Journal of Public Administration*, Vol. 35, No. 3, pp. 221–239.
- Argyriou, I., 2016. Planning the smart city in China: key policy issues and the case of dream town in the city of Hangzhou. In *Proceedings of the 25th International Conference Companion on World Wide Web*, International World Wide Web Conferences Steering Committee. Montreal, Canada, pp. 339-343.
- Biron, J., and Follett, J. 2018. *Foundational Elements of an IoT Solution. [Internet].Chapter of: Smart, Connected Operations*. O'Reilly Media, Inc. Available from <[https://connect.safaribooksonline.com/book/hardware/9781492042655/2dot-solution-patterns-for-the-internet-of-things/smartcomma_connected_operations_html?query=\(\(Smart+city+plan\)\)#snippet](https://connect.safaribooksonline.com/book/hardware/9781492042655/2dot-solution-patterns-for-the-internet-of-things/smartcomma_connected_operations_html?query=((Smart+city+plan))#snippet)> [Accessed 23 June 2019]
- Bolívar, M. 2016. Mapping dimensions of governance in smart cities: Practitioners versus prior research. In *Proceedings of the 17th International Digital Government Research Conference on Digital Government Research*, ACM. Shanghai, China, pp. 312-324.
- Campbell, T., 2013. *Beyond smart cities: how cities network, learn and innovate*. Routledge.
- Catterall, M., and Maclaran, P., 1997. Focus group data and qualitative analysis programs: Coding the moving picture as well as the snapshots. *Sociological research online*, Vol.2, No.1, pp. 1-9.
- Cocchia, A., 2014. Smart and digital city: A systematic literature review. In *Smart city*. Springer, Cham. pp. 13-43.
- Couclelis, H., 2004. The construction of the digital city. *Planning and Design*, Vol.31, No.1, pp. 5–19.
- Dameri, R., 2014. Comparing Smart and Digital City: initiatives and strategies in Amsterdam and Genoa. Are they Digital and/or Smart? In: Dameri, R., Rosenthal-Sabroux, C. (eds) *Smart City*, pp. 45-88. Springer, Cham.
- Greco, I., & Cresta, A., 2015. A smart planning for smart city: the concept of smart city as an opportunity to re-think the planning models of the contemporary city. In *International Conference on Computational Science and Its Applications*. Springer, Cham. pp. 563-576
- Hall, P., 2000. Creative cities and economic development. *Urban Studies*, Vol.37, No.4, pp. 633–649.
- Hu, Y., and Wang, J., 2016. Building smart government or developing industry?: Study on the designs of local smart city pilot projects in china. In *Proceedings of the 17th International Digital Government Research Conference on Digital Government Research*, ACM. Shanghai, China, pp. 532-533.
- Lee, J., et al. , 2013. An integrated service-device-technology roadmap for smart city development. *Technological Forecasting and Social Change*, Vol.80, No.2, pp. 286-306.
- Li, Q., and Lin, S., 2001. Research on digital city framework architecture. *IEEE International Conferences on Info-Tech and Info-Net*, New York, USA pp. 30–36.
- McPherson, M. and Nunes, M. B., 2006. Organisational issues for e-learning: Critical success factors as identified by HE practitioners. *International Journal of Educational Management*, Vol.20, No.7, pp.542-558.
- Mitchell, D., Claris, S., & Edge, D., 2016. Human-centered mobility: A new approach to designing and improving our urban transport infrastructure. *Engineering*, Vol.2, No.1, pp.33-36.
- MOHURD, 2012. Work Notification of Lunching National Smart City Pilot (住房和城乡建设部办公厅关于开展国家智慧城市试点工作的通知). Available at: http://www.mohurd.gov.cn/wjfb/201212/t20121204_212182.html (Accessed: 8 May 2019).
- MOHURD, 2013a. The first batch of the name list of national smart city pilot released by MOHURD (住房和城乡建设部公布首批国家智慧城市试点名单). Available at: http://www.mohurd.gov.cn/jsbflid/201301/t20130131_221676.html (Accessed: 12 May 2019).

- MOHURD, 2015. 97 cities are selected as national smart city pilot (97 个城市入选国家智慧城市试点名单). Available at: http://www.mohurd.gov.cn/zxydt/201504/t20150414_220664.html (Accessed: 8May 2019).
- MOHURD,2013b. The second batch of the name list of national smart city pilot released by MOHURD (住房城乡建设部办公厅关于公布 2013 年度国家智慧城市试点名单的通知). Available at:http://www.mohurd.gov.cn/wjfb/201308/t20130805_214634.html (Accessed: 10 May 2019).
- Ning, J.J. , 2015. The background, connotation and main contents of the implementation of the internet plus action plan (“互联网+”行动计划的实施背景、内涵及主要内容).*E-Government*. Vol.06.pp. 32-38
- Pacaux-Lemoine, M. P., Trentesaux, D., Rey, G. Z., & Millot, P., 2017. Designing intelligent manufacturing systems through Human-Machine Cooperation principles: A human-centered approach. *Computers & Industrial Engineering*, Vol.111, pp.581-595.
- Peng, G. C., et al. , 2017. Impacts of low citizen awareness and usage in smart city services: the case of London’s smart parking system. *Information Systems and e-Business Management* Vol.15, No.4, pp. 845-876.
- Pereira, G. V., et al.,2017. Building a Reference Model and an Evaluation Method for cities of the Brazilian Network of Smart and Human Cities. In *Proceedings of the 18th Annual International Conference on Digital Government Research*, ACM. New York, USA, pp. 580-581.
- Rinne, M.,2004. Technology roadmaps: Infrastructure for innovation. *Technological Forecasting and Social Change*, Vol.71, No. 1, pp. 67-80.
- Sabella, A., et al. 2018.*Orchestrating and Automating Security for the Internet of Things: Delivering Advanced Security Capabilities from Edge to Cloud for IoT.[Internet]. Chapter of Smart Cities. Cisco Press.* Available from <[https://connect.safaribooksonline.com/book/networking/security/9780134756936/chapter-14dot-smart-cities/ch14lev1sec4_html?query=\(\(sMART+city+plan\)\)#snippet](https://connect.safaribooksonline.com/book/networking/security/9780134756936/chapter-14dot-smart-cities/ch14lev1sec4_html?query=((sMART+city+plan))#snippet)> [Accessed 3June 2019]
- Shin, D., 2014. A socio-technical framework for Internet-of-Things design: A human-centered design for the Internet of Things. *Telematics and Informatics*, Vol.31, No.4, pp.519-531.
- Sidhu, I. 2015.*The Digital Revolution: How Connected Digital Innovations are Transforming Your Industry, Company & Career [Internet]. Chapter of Bright Lights, Big Cities.* FT Press, London, UK. Available from <[https://connect.safaribooksonline.com/book/business/9780134291321/5dot-smart-cities-bustling-with-activity-brimming-with-opportunity/ch05lev1sec4_html?query=\(\(Smart+city+plan\)\)#snippet](https://connect.safaribooksonline.com/book/business/9780134291321/5dot-smart-cities-bustling-with-activity-brimming-with-opportunity/ch05lev1sec4_html?query=((Smart+city+plan))#snippet)> [Accessed 1 July 2019]
- Su, K., et al., 2011. Smart city and the applications. *IEEE International Conference on Electronics, Communications and Control (ICECC)*. Ningbo, China, pp. 1028–1031.
- Wang, D.Q., et al., 2017. Research of top design issues of Chinese smart city (我国智慧城市建设中的顶层设计问题研究), *E-Government*, Vol.10, pp.70-78.
- Wharton, C., et al., 1994.*The Cognitive Walkthrough Method: A practitioner’s guide.* In Nielsen, J. and Mack, R. L. (eds.) *Usability inspections methods*. New York: John Wiley. pp. 105–140
- Zheng, J., et al., 2012. Strategic policies and demonstration program of electric vehicles in China, *Transport Policy*, Vol.19, No. 1, pp. 17-25.