

# TRANSFORMING THE SUPPLY CHAIN OF THE ELECTRONIC INDUSTRY FOR URBAN SUSTAINABILITY: AN ANALYSIS OF THE INNOVATION SYSTEM OF SMART CITIES IN THE GREATER BAY AREA IN CHINA

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## ABSTRACT

In addressing the challenge of climate change, smart cities are expected to play an important role in introducing renewable energy sources and improving energy efficiency while maintaining resilience against natural disasters as well as socio-economic disruptions. In this paper, we examine the innovation system of smart cities in the Greater Bay Area, with a particular attention to knowledge and technological domains, actors and their networks, and institutions surrounding the actors. The innovation system of smart cities in GBA in China mainly concerns health and medical care, transportation, logistics, agriculture, surveillance, and public safety and shows a disintegrated structure of functions provided by companies in the electric and electronic industry.

**Keywords:** innovation system, smart city, urban sustainability, electronic industry, Greater Bay Area, China

## NONMENCLATURE

### *Abbreviations*

GBA	Greater Bay Area
ICT	Information and Communication Technology
IoT	Internet of Things
LDA	Latent Dirichlet Allocation
PPP	Public-Private Partnership
SIPO	State Intellectual Property Office

## 1. INTRODUCTION

In addressing the challenge of climate change, smart cities are expected to play an important role in introducing renewable energy sources and improving energy efficiency while maintaining resilience against natural disasters as well as socio-economic disruptions. Widely seen as a future trajectory of technological change, smart cities utilize advanced information and communication technologies in augmenting various functions provided in cities, including energy, environment, buildings, and transportation [1]. Smart cities have been evolving into sophisticated systems of assembling and processing an increasing amount of information on multifaceted dimensions of cities, providing various types of high-quality products and services. As a diverse mixture of hardware as well as software are involved in a complex way, however, a variety of approaches would be possible to implementing the concept of smart cities in practice. Therefore, the innovation system of smart cities exhibits a significant degree of diversity in terms of the knowledge, actors, and institutions involved, depending on the specificities of the local conditions [2, 3]. For example, in the Japanese innovation system of smart cities, knowledge and technological domains basically concern renewable energy, energy storage, community energy management, and electric vehicles, and the network of the actors shows a concentrated structure dominated by large, well-established organizations in the energy and electric industries and the public sector [4]. On the other hand, the U.S. innovation system of smart

cities shows knowledge and technological domains centering around energy transmission and distribution based on sophisticated information and communication technologies, and the main actors are utilities, system integrators, and smart meter manufacturers, including many small- and medium-sized enterprises and start-up companies. Basically speaking, the innovation system of smart cities in Japan is emerging from the innovation system of the energy and electric sectors, whereas the innovation system of smart cities in the U.S. is strongly driven by the information and communication technology (ICT) sector. There have been very few previous studies, however, that have tried to examine the innovation system of smart cities in the context of the rapid development in China.

## 2. INNOVATION SYSTEM OF SMART CITIES IN GREATER BAY AREA IN CHINA

China's Greater Bay Area (GBA), which includes Shenzhen, Guangzhou, Dongguan, Macau and Hong Kong, is one of the most vibrant regions in the world with remarkable economic development in recent years. Shenzhen, in particular, initially benefited from the relocation of manufacturing from Hong Kong and the establishment of manufacturing facilities by multinational firms for a vast pool of relatively unskilled but inexpensive labor, which facilitated a rapid growth as a center for export [5]. As labor and infrastructure costs inexorably rose, the municipal government devised a strategy to encourage innovative activities in the region. In pursuit of building an innovation city, technology parks have been established to attract multinational corporate R&D and to encourage the entry of local high-technology companies in the manufacturing sector. In particular, many entrepreneurial firms have started to provide various kinds of support for bringing initial ideas up to final products and to supply a variety of modules and services particularly in areas related to manufacturing sectors including the Internet of Things (IoT) technologies [6, 7]. With large technological companies established and new start-up firms popping up, the region has been transforming itself into a world-leading innovation cluster.

At the same time, the region faces a serious issue of achieving a well-balanced progress in environmental, economic, and social aspects of sustainability [8-11]. The challenge is that how the region can utilize the significant potential in making the best use of rich knowledge, human, and financial resources for creating innovation for sustainable smart cities. To address that, we need to understand the mechanisms and processes involved in

the innovation system of smart cities and to extract lessons and implications for policy making and institutional design in the context of the region. It is of particular importance to analyze what knowledge domains are emphasized with regard to smart cities, who are the key stakeholders in academia, industry, and the public sector and how they cooperate and collaborate with each other, and what institutional conditions and environments influence the stakeholders' interactions. Based on that analysis, we will be able to examine the drivers or obstacles in innovation by identifying the functions of the innovation system of smart cities in the region.

## 3. DATA AND METHODOLOGY

We examine the innovation system of smart cities with a particular attention to the three elements of innovation systems, that is, knowledge domains, actors and their networks, and institutions surrounding them. For identifying key actors involved in smart city projects, we analyzed the Public-Private Partnership (PPP) Projects Database provided by the Chinese Ministry of Finance. This database contains 11,260 projects in 19 industrial sectors. By using the keyword "smart city," we selected 204 projects that are related to smart cities. The descriptions of the projects were analyzed by using the methodology of Latent Dirichlet Allocation (LDA) [12]. LDA is an algorithm for text mining that is based on statistical (Bayesian) topic models and it is very widely used as a completely unsupervised technique for topic discovery in large document collections [13]. The patent applications for technologies related to smart cities were also analyzed by using the patent database maintained by the State Intellectual Property Office (SIPO) of China. A total of 860 patents were selected from the patent database by using the keyword "smart city."

## 4. RESULTS

Table 1 shows the result of the analysis of the descriptions of the projects on smart cities. It illustrates that the knowledge domains emphasized in the innovation system of smart cities include health and medical care, transportation, logistics, agriculture, surveillance, and public safety.

Table 1 Knowledge Domains in the Innovation System of Smart Cities

Topic	Key Concept
1. Data/information platform/system/management	Health and medical care, tourism, community

2. Construction of the city	Education, transportation, city management, infrastructure, tourism, agriculture, information safety, and civic life	Wuhan Hengyi Electronic Technology Development Co., Ltd.	Wuhan	40
3. City improvement engineering projects	Roads project, car park space, greening projects, and street lights	Zhongyuan Smart City Design and Research Institute Co., Ltd.	Henan	33
4. Big data/information platform/management/system	Access safety, operation surveillance, internet surveillance	Smart City Information Technology Co., Ltd.	Shanghai	28
5. Big data/information platform/management/system	Logistics system, agricultural technology, and surveillance and analysis on agriculture and logistics.	Chengdu Qinchuan Technology Development Co., Ltd.	Chengdu	25
6. Big data/information system/management	Video surveillance, public safety, and transportation.	Hangzhou Tianshi Intelligent System Co., Ltd.	Hangzhou	20
		Guangzhou Bochuang Information Technology Co., Ltd.	Guangzhou	19
		Guangzhou Zhongda Microelectronics Co., Ltd.	Guangzhou	19
		Wuhan University	Wuhan	18
		Dongguan Mengchuang Health Technology Co., Ltd.	Dongguan	18
		Wuhan Hengda Smart City Transportation R&D Co., Ltd.	Wuhan	17

Table 2 lists the major applicants of patents on smart cities. It shows that leading organizations related to the electric and electronic sector are active in working on innovation on smart cities.

Table 2 Major Applicants of Patents on Smart Cities

Organization	Location	Number of Patent Applications
Anke Smart City Technology (China) Co., Ltd.	Shenzhen	369
Dongguan Ronggong Automation Technology Co., Ltd.	Dongguan	78
Guangzhou Smart City Development Institute	Guangzhou	62
Dongguan Qiaoyan Industrial Design Service Co., Ltd.	Dongguan	60
Smart City System Services (China) Co., Ltd.	Shenzhen	52

A key characteristic of the innovation system of smart cities is the disintegrated structure of the companies that provide different functions in creating innovation on various technologies concerning smart cities.

## 5. RESULTS

The innovation system of smart cities in GBA in China mainly concerns health and medical care, transportation, logistics, agriculture, surveillance, and public safety and shows a disintegrated structure of functions provided by companies in the electric and electronic industry. The experience and expertise accumulated in the electronic supply chain can provide a critical potential for developing technologies that contribute to creating innovation on energy management, houses and buildings, and transportation systems in smart cities.

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