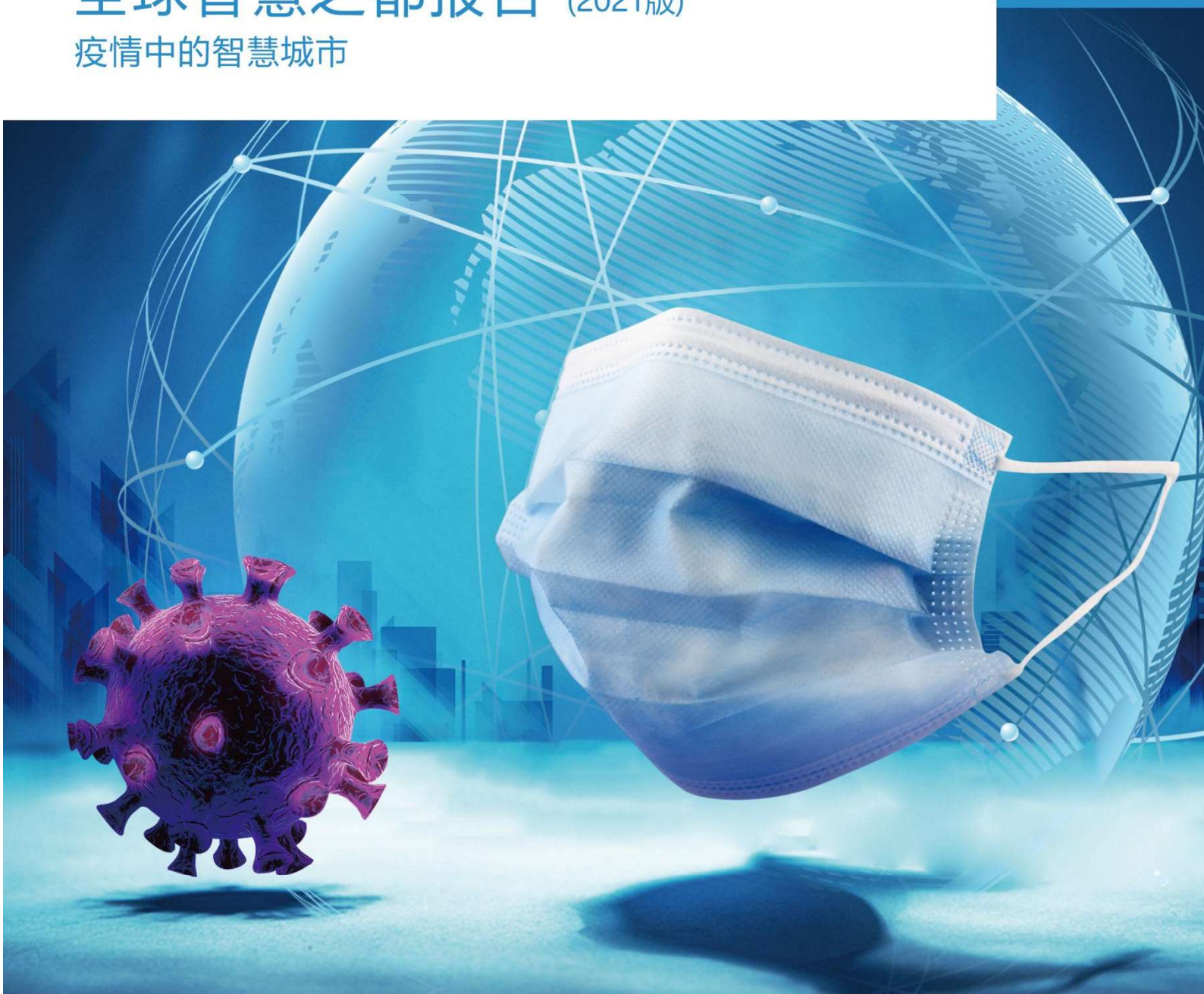


GLOBAL SMART CITIES 2021

Smart cities at the epicenter of the pandemic

全球智慧之都报告 (2021版)

疫情中的智慧城市



INSTITUTE OF INFORMATION, SHANGHAI ACADEMY OF SOCIAL SCIENCES
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PREFACE

We are delighted to announce that *Global Smart Cities 2021: Smart cities at the epicenter of the pandemic* is released on time in October 2021. This report is the second edition based on the new evaluation model adopted in 2020, and the fifth edition of the *Global Smart Cities* series.

It is our pleasure to see that the 2020 report has gained massive media coverage and inspired many smart cities practitioners. Moreover, during this year, we have witnessed the industry reaching a consensus on humanity-centered, technology-empowered, and sustainability-targeted concepts and pathways towards smart cities, which live up to our expectations.

The 2021 report maintained the “5+1” evaluation model for global smart cities in the 2020 report, providing five quantitative indicators, namely smart infrastructure, smart economy, smart services, smart governance, and smart innovation, plus one qualitative indicator “smart reputation”.

Meanwhile, the COVID-19 pandemic has been continuously spreading across the globe for over one year. We realize that the pandemic crisis is a critical turning point on smart cities in terms of development focus and citizens’ demands, rather than a temporary public health issue. Under this circumstance, it is worthy of questioning and reflecting that how might we build a better smart city through digital technologies and approaches.

Being the first country that detected and controlled the COVID-19 pandemic outbreak, China’s “Digital Fights for COVID-19” has achieved excellent performance, and supported China coordinating epidemic control with economic and social development. For instance, under the unified decision-making and deployment at the national level, the “One-code Pass” took effect in a very short time, and provided nearly 50 billion times of personal authentication services in 2020 in China.

It is also noticeable that many cities around the world have made equally outstanding achievements in combating the COVID-19 pandemic by deploying digital technology. Unlike previous smart cities development which was often composed of piecemeal informatization projects for different city public sectors, these successful “Digital Fights for COVID-19” are information technology services based on the needs of all citizens. Considering that this would be the future trend of smart cities development, we selected these practices in this report, hoping to provide useful references for future smart cities.

Last but not least, we appreciate United Nations Economic and Social Council (ECOSOC) and United Nations Public Administration Network (UNPAN) in support of the Global Smart Cities 2021. We also appreciate media who report and interpret the Global Smart Cities 2021. This report is a joint fruit of the Institute of Information, Shanghai Academy of Social Sciences, and Smart Cities Research Center, Fudan University.

We sincerely invite anyone who is dedicated to smart cities development from all countries to join our debate and discussion on smart cities.



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EXECUTIVE SUMMARY

Global Smart Cities 2021 is a collaborative result by Institute of Information, Shanghai Academy of Social Sciences partnered with Smart City Research Center, Fudan University, with consistent support from the United Nations Public Administration Network. This report is the fifth edition of annual review of global smart cities.

This report based on a “5+1” evaluation model for global smart cities, and provides five quantitative indicators, namely smart infrastructure, smart economy, smart services, smart governance, and smart innovation, plus one qualitative indicator “smart reputation”, a total of six dimensions of comparison, attempts to set a benchmark for global smart cities, and provides diversified solutions for the realization of the Sustainable Development Goals 2030 (SDG 2030) proposed by the United Nations in 2015 as well.

During the past year, Smart Cities have given an impressive performance in epidemic control. Practices show that when basic healthcare conditions are similar, countries and cities attaching greater importance to smart cities development are more resilient in the face of pandemic crisis. Meanwhile, “Smart” not only means a quick response from the government, but also the trust between citizens and government officers, and more bottom-up technology solutions provided by the private sector. A city will never become a “Smart City” if there are only top-down commands.

This report highlights the themes of “Smart Cities at The Epicenter of The Pandemic”. It not only focuses on performance of global smart cities in the face of the COVID-19 pandemic crisis, but also adheres to the “Humanity, Technology and Sustainability” principle.

The first part of this report is the comprehensive ranking. The results show that global smart cities can be divided into three levels: “leading”, “advanced” and “following”. Cities ranked at leading and following levels in 2020 have maintained their levels this year. However, the ranking of the three leading cities has changed: New York ranks first, Singapore and London rank second and third respectively.

The second part analyses the sub-index rankings:

With regard to **smart infrastructure**, Hong Kong and Singapore rank in the top two. Some cities in Europe and America followed closely behind. Among developing cities, Dubai has a relatively outstanding performance.

In terms of **smart economy** sub-index, New York and London ranked the top two. Beijing and Shanghai have performed well in this field and entered the first camp.

The **Smart Service** sub-index reflects the smartness of city citizens' livelihood services. Shanghai and Beijing have performed very well, indicating that the China's leading cities have already been at the forefront of the world in terms of digital technology applications. Dubai and Singapore ranked third and fourth respectively.

In terms of **Smart Governance** sub-index, Dubai and Singapore rank the top two. They excel in the dimensions of data openness and sustainability. Seoul and Sydney ranked third and fourth respectively.

In terms of **Smart Innovation** sub-index, traditional global cities such as London, New York, and Tokyo rank top three. They have outstanding performance in science and technology, education, innovation, and have stronger human capital as well.

"**Smart Reputation**" reflects the degree of attention in academic research of major smart cities. The results show that Singapore, Beijing, and New York rank in the top three, and their efforts on smart city construction attract more eyeballs by academic circles.

Table. Global Smart Cities 2021 Ranking

Level	City	Smart Infrastructure	Smart Economy	Smart Service	Smart Governance	Smart Innovation	Score	Rank	2020 Rank	Smart Reputation	
Leading	New York	83.0	89.7	81.3	78.9	93.4	100.0	1	▲1	3	
	Singapore	90.7	72.3	90.8	84.3	83.0	98.8	2	▲1	1	
	London	82.7	81.7	80.8	71.9	97.4	97.3	3	▼2	4	
Advanced	Beijing	68.2	79.9	97.1	80.6	73.4	93.6	4	▲1	2	
	Shanghai	67.5	79.1	99.2	81.5	71.7	93.6	5	▼1	6	
	Los Angeles	83.0	69.5	77.8	77.8	88.1	93.0	6	▲2	18	
	Hong Kong	97.7	65.0	81.9	68.8	82.6	92.9	7	=	7	
	Dubai	81.7	59.7	90.7	94.7	65.0	91.9	8	▲3	11	
	Chicago	83.0	69.9	75.4	74.7	85.0	91.0	9	=	12	
	Sydney	77.4	60.4	79.1	81.6	84.0	89.7	10	▲3	17	
	Seoul	73.8	58.9	81.1	82.5	84.6	89.4	11	▼1	5	
	Paris	74.9	72.6	78.1	68.2	82.7	88.3	12	▼6	12	
	Tokyo	75.6	66.6	68.8	72.1	90.7	87.7	13	▼1	10	
	Moscow	75.5	56.7	85.4	77.0	72.1	86.0	14	▲2	12	
	Toronto	74.4	64.9	73.4	74.6	77.5	85.6	15	▼1	9	
	Berlin	77.0	58.7	70.8	68.2	79.5	83.1	16	▼1	15	
	Following	Mumbai	59.9	46.8	86.2	63.9	49.2	71.8	17	=	16
		Buenos Aires	69.9	40.0	66.8	61.9	63.5	70.9	18	=	20
Rio de Janeiro		67.8	36.5	52.9	49.6	60.4	62.7	19	=	8	
Carol		55.6	29.4	72.5	56.2	50.7	62.0	20	=	19	

1. Overall Rankings

1.1 Overview

Cities have become the home of most people in the world and the center of economic growth and innovation. The highly concentrated urban population and economic activities not only improve the economic efficiency, but also reduce the cost of social interaction. However, it also leads to unprecedented vulnerability of cities. Compared with scattered villages, cities are more susceptible to various natural disasters, pandemics and epidemics. The arrival of the era of globalization has undoubtedly greatly intensified this situation. Most epidemics spread from cities, the epicenter, to the whole world. According to the briefing of United Nations (UN) in July 2020, it is estimated that urban areas account for 90% of all reported cases of COVID-19, and the virus has affected nearly 1,500 cities.

As for the vulnerability of cities, scholars have been making extensive researches since the Black Death spread in Europe in the Middle Ages. Facing the emerging and spreading of the Covid-19 virus today, city administrators at all levels should deeply reflect on the inherent shortcomings of previous urban construction and how smart cities could facilitate to cope with such incidents, so as to bridge this gap.

Covid-19 makes us deeply realize that smart city must be a concept that adapts to the dynamic changes of the environment, and its dynamic nature is one of its basic attributes. Compared with the traditional way of coping with crisis, smart city gives us more and more intelligent technological choices.

Also, it makes us noticed that smart cities should not be just a top-down deployment, but need marketization and spontaneous actions of civil society to jointly build a levee to fight against the epidemic. Relying only on various bans issued by public sectors, the epidemic could be just curbed in a short time. Facing with such intractable virus as Covid-19, we need to prepare for the long-term struggle, mobilizing the bottom-up forces from all walks of life to cope with it together.

Therefore, we boldly assert that pandemics have refreshed people's previous understanding of smart cities, and we need to inject richer connotations into them.

We have noticed that smart cities around the world have demonstrated their positive and coordinated response to the pandemic, and have produced immediate results in curbing the virus and providing long-term and sustainable development for cities. The advantages of smart cities lie in the following aspects:

First of all, the construction of smart city equips it with good digital infrastructure and a large number of digital technology solutions, and the city operation is less dependent on physical space, thus making the economic and social operation more resilient. Singapore, for example, has long recognized the importance of speeding up the national digitalization process. Intelligent facilities management, Internet of Things and monitoring have become the main contents of building a smart country. These infrastructures have created an advanced, safe and livable urban environment for Singaporeans during the pandemic, and have a preventive effect on curbing virus infection.

Secondly, smart cities have become effective channels and platforms for the implementation of economic and social assistance programs. Accurate data and information are needed to design and implement large-scale social assistance programs in cities. Cities with better digital infrastructure are more effective in providing targeted relief to prospective beneficiaries. For instance, many urban centers in India are equipped with citizen's digital identity, aerial surveillance and global positioning system, which can use smart city network platform to transport basic commodities and make early warning response.

Thirdly, the wide adoption of digital technology in smart cities allows government and enterprise to cooperate better. Social and public affairs, such as the Covid-19, must be closely coordinated by the public and private sectors. Taking New York City as an example, the City launched the "NYC Recovery Data Partnership" (RDP) in July 2020, in which partner organizations shared data with the City free of charge to aid in Covid-19 response and recovery efforts. Among those organizations, Live XYZ is a provider based on storefront data and neighborhood map in New York City. This team has conducted more than 1,000,000 ground surveys in all administrative districts of New York City. Each location is personally drawn, photographed and classified at its front door, and is constantly updated as time goes by. Live XYZ has the turnover, job vacancy and data change of enterprises in each location of the City of New York, making it a new dynamic tool for New York City to understand the impact of Covid-19 on retail enterprises. The accurate data of every store in New York City has strongly promoted the City's recovery work.

Finally, the lockdown brought by Covid-19 means that the relationship between us is being broken and society is becoming fragmented, while smart cities could build more connections among people. The epidemic leads people to ponder about such a fundamental question: what does it mean to put people first in cities? There are a group of keywords appearing more and more frequently in government conference documents, mass media and academic forums and becoming consensus of all walks of life, namely, sustainability, livability, wisdom, toughness, flexibility……Smart cities should also embody these characteristics.

1.2 Ranking Framework

To rank the smart cities in Covid-19, we must make a comprehensive review of the original index system and consider whether the existing index is sufficient to reflect the ability to cope with the crisis. Through investigation, we found that all indicators in the existing "5+1" framework are closely related to the below:

Smart infrastructure. Facing epidemic, the first thing to solve is to know the whereabouts of infected people in time and disseminate information. Smart infrastructure is the foundation of all these.

Smart economy and smart service corresponding to the activities of public and private sectors. With the arrival of Covid-19, all activities are heavily dependent on the network, which challenges the digitalization level of all sectors: to what extent can it be carried out with the help of the network? The indicators selected in this index system can reflect the ability of different subjects in cities to resume production and service.

Smart innovation shows the scientific and technological strength of the cities. In the face of epidemic, the ability of relevant scientific research institutions to develop vaccines and the scientific literacy of citizens can contribute to the city's response. Obviously, cities with high scientific literacy level are not easily affected by rumors in dealing with epidemic, so they can be more orderly.

Smart governance shows the participation degree of different subjects in the city and the safety degree of the city. Cities with high participation are also more dynamic in resisting epidemic risk. The security mainly refers to the security of personal data. For the need of prevention and control, the personal data collected during the epidemic, in particular, needs security and needs to be controlled in a certain range. Therefore, it has a significant impact on blocking Covid-19.

All in all, this assessment framework can better reflect the ability of cities to cope with the epidemic from different aspects, and has good adaptability.

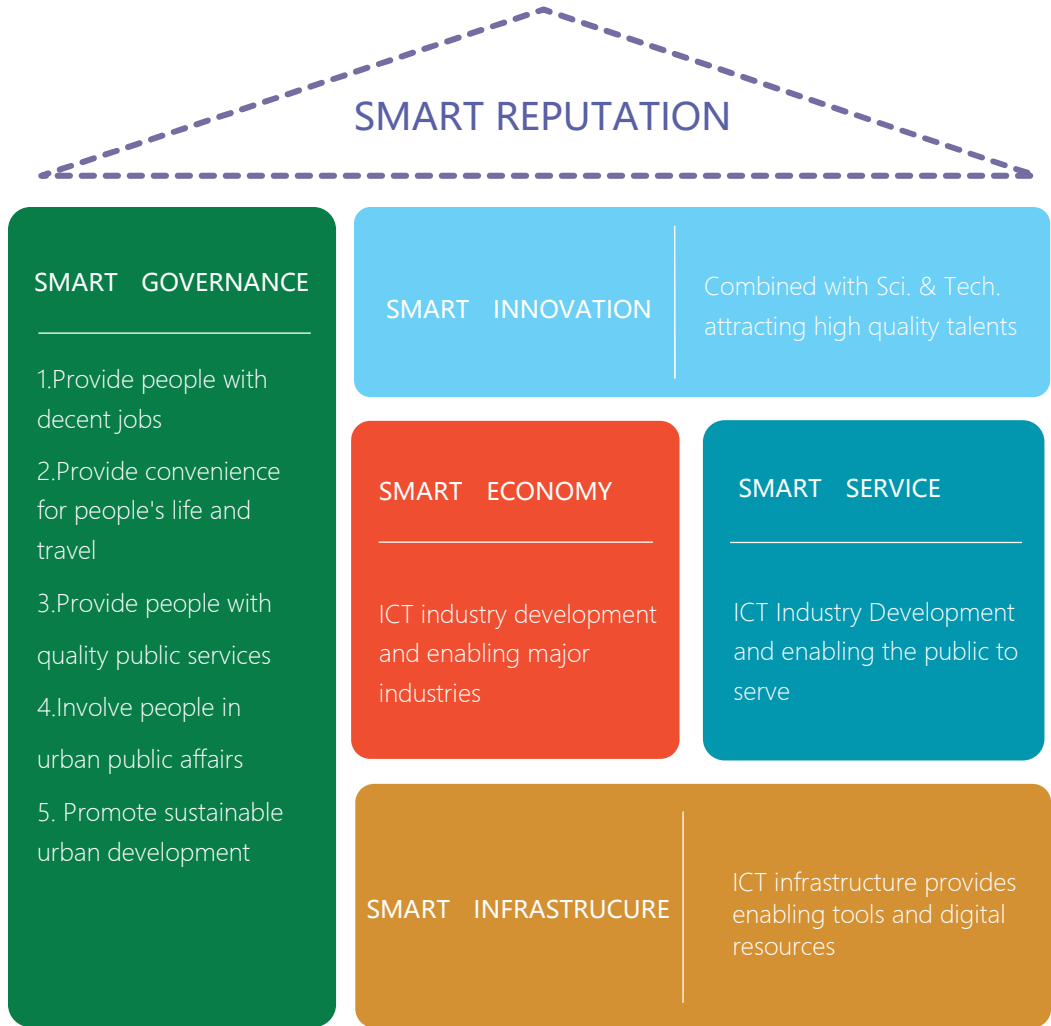


Figure 1-1 "5+1" Framework of Global Smart City Rankings

1.3 Measuring Method

This report maintains the measurement and evaluation method of last year, and still consists of "5+1" indicators, as follows:

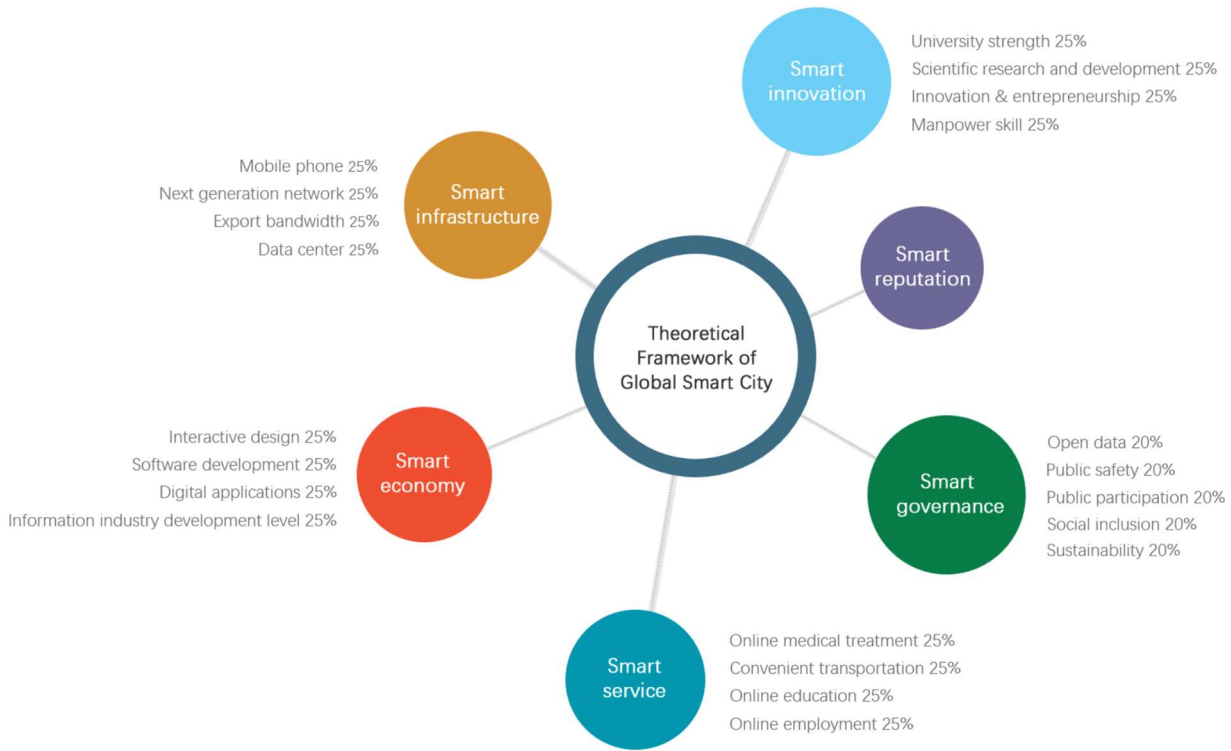


Figure 1-2 "5+1" Framework and weights of Global Smart Cities

1.4 Overall Ranking and Its Analysis

The research group selected the data of 20 cities in the world for ranking, and converted the data into a percentile system through dimensionless data. The method is as follows:

$$F_{i,j} = \frac{X_{i,j}}{X_{\max,j}} \times 100 \quad (i=1,2,3,\dots,30;j=1,2,3)$$

In this formula, i represents a city, j represents a specific index, $X_{i,j}$ represents the actual value of j index of i city, and $X_{\max,j}$ represents the maximum value of all city values on j index. Through this transformation, the city with the best performance gets a score of 100 points, while other cities take it as a benchmark and get scores within 100 points respectively.

Calculate the scores of each sub-item, and take the average to get the total score. The final general evaluation is converted with this part according to the above method.

Table 1-1 List of Global Smart Cities Ranking of Global Smart Cities 2021

Level	City	Smart Infrastructure.	Smart economy	Smart service	Smart governance	Smart innovation	Total score	Rank	Relative to 2020
Leading	New York	83.0	89.7	81.3	78.9	93.4	100.0	1	▲1*
Smart city	Singapore	90.7	72.3	90.8	84.3	83.0	98.8	2	▲1
	London	82.7	81.7	80.8	71.9	97.4	97.3	3	▼2
Advanced smart city	Beijing	68.2	79.9	97.1	80.6	73.4	93.6	4	▲1
	Shanghai	67.5	79.1	99.2	81.5	71.7	93.6	5	▼1
	Los Angeles	83.0	69.5	77.8	77.8	88.1	93.0	6	▲2
	Hong Kong	97.7	65.0	81.9	68.8	82.6	92.9	7	=
	Dubai	81.7	59.7	90.7	94.7	65.0	91.9	8	▲3
	Chicago	83.0	69.9	75.4	74.7	85.0	91.0	9	=
	Sydney	77.4	60.4	79.1	81.6	84.0	89.7	10	▲3
	Seoul	73.8	58.9	81.1	82.5	84.6	89.4	11	▼1
	Paris	74.9	72.6	78.1	68.2	82.7	88.3	12	▼6
	Tokyo	75.6	66.6	68.8	72.1	90.7	87.7	13	▼1
Follow-up smart city	Moscow	75.5	56.7	85.4	77.0	72.1	86.0	14	▲2
	Toronto	74.4	64.9	73.4	74.6	77.5	85.6	15	▼1
	Berlin	77.0	58.7	70.8	68.2	79.5	83.1	16	▼1
	Bombay	59.9	46.8	86.2	63.9	49.2	71.8	17	=
	Buenos Aires	69.9	40.0	66.8	61.9	63.5	70.9	18	=
	Rio de Janeiro	67.8	36.5	52.9	49.6	60.4	62.7	19	=
	Cairo	55.6	29.4	72.5	56.2	50.7	62.0	20	=

Note: The preceding symbols of * indicate the rising, falling and unchanging, and the following numbers indicate moving rankings.

According to the scores, the intelligence of 20 cities is divided into three levels with the plus or minus one standard deviation (10.8) of the average (86.5 points) as the boundary.

The first level (above 97.3 points) is called "leading" smart city, including the top three: New York, Singapore and London. They maintain a leading position in almost every aspect of smart cities and become models for other cities around the world. Compared with last year, New York and Singapore each advanced one ranking, while London dropped two rankings.

The second level (71.8-97.3), which is called "advanced" smart city, includes 13 cities, and keeps advanced in various indicators, while outstanding in individual indicators. At this level, the rankings of two cities (Hong Kong and Chicago) remain unchanged, while the rankings of five cities rise and six cities fall. Sydney and Dubai have made rapid progress, while Paris has the largest decline.

The third level (below 70.8 points), called "follow-up" smart city, includes four cities. Compared with the first two groups of global smart cities, these cities are not particularly prominent and are in the status of followers. Compared with last year, the ranking of cities at this level has not changed.

2. Sub-item Rankings

2.1 Smart Infrastructure

The "smart" of smart infrastructure is embodied in the combination of three aspects: digital, interconnection and intelligence. In other words, smart infrastructure has created a brand-new digital world, and then the physical world has been digitized, and all kinds of data have been collected. Everything can be interconnected, and instant communication and exchange can be realized; On this basis, the existence of intelligence is realized. With the cooperation of human beings and machines, the material world is integrated with the digital world.

Smart city is built on smart infrastructure, and its contents mainly include the growth and popularization of broadband (fixed and mobile), next generation mobile communication services, computers and various intelligent terminals, and sometimes the number of various applications. This report limits the smart infrastructure to the hardware part, while putting software part such as applications into various services and industrial development.

Table 2-1 Rankings of Smart Infrastructure

City	Mobile phone	Next generation network	Export bandwidth	Data center	Smart infrastructure	Subitem rank
Hong Kong	100.0	90.9	100.0	100.0	97.7	1
Singapore	86.7	92.1	95.0	89.2	90.7	2
New York	83.5	91.7	66.9	90.0	83.0	3
Los Angeles	83.5	91.7	66.9	90.0	83.0	4
Chicago	83.5	91.7	66.9	90.0	83.0	4
London	83.0	84.6	83.7	79.7	82.7	4
Dubai	92.8	100.0	79.1	55.0	81.7	7
Sydney	81.9	88.8	58.3	80.4	77.4	8
Berlin	84.3	81.4	55.3	87.2	77.0	9
Tokyo	84.9	97.0	44.6	76.2	75.6	10
Moscow	87.8	83.6	58.6	72.1	75.5	11
Paris	80.9	83.5	55.4	79.7	74.9	12
Toronto	77.2	80.6	59.5	80.4	74.4	13
Seoul	83.7	86.6	58.8	66.0	73.8	14
Buenos Aires	85.7	80.1	51.5	62.3	69.9	15
Beijing	91.1	83.4	46.1	52.1	68.2	16
Rio de Janeiro	82.0	81.7	46.6	61.0	67.8	17
Shanghai	88.5	83.4	46.1	52.1	67.5	18
Bombay	77.5	70.3	45.1	46.8	59.9	19
Cairo	80.8	74.5	38.4	28.7	55.6	20



Mobile phone

refers to the penetration rate of mobile phones. Mobile phones are a basic configuration in the current mobile Internet era, and most of them have exceeded 100% for smart cities around the world. Therefore, there is not much difference in scores in this index. The most prominent ones are Hong Kong and Singapore.



Next generation mobile communication network

mainly refers to the penetration rate of mobile broadband Internet represented by 4G. Mobile communication is the fundamental guarantee for data transmission and Internet service quality, and it is also the basic guarantee for gathering big data and promoting various economic and social innovations. With the development of 5G in recent years, this indicator will be dynamically updated. According to the data, there are some differences in the popularization of 4G in major cities. Compared with last year, Dubai has made significant progress in this respect, surpassing Singapore and ranking first. However, Mumbai in India is only 70%, indicating that India still has room for improvement in 4G.



Export bandwidth

Compared with the indicators of the new generation mobile communication network, the export bandwidth mainly reflects the global connectivity and level of cities. Global smart cities are much higher than other cities in China in terms of global connectivity, and they are the most important communication hub and the main channel for the import and export of Internet data. As far as Internet data flow is concerned, the export bandwidth index fully reflects the development level of data communication in cities.



Data center

Data is the most important strategic resource of a city. With the rapid development of 5G and Internet of Things, there has been an exponential growth in recent years. Due to the lack of city-level statistics, the department uses the national-level data from the World Bank as an alternative. For such populous countries as China and India, its major cities have been underestimated to some extent for this index.

2.2 Smart Economy

Smart city is supported by information industry. With the emergence of big data, data has increasingly become the most basic factor of production, which has attracted wide attention. According to the current practice in major cities, smart economy can be divided into three aspects: digital industrialization, industrial digitalization and industrial integration and innovation. Industrial digitalization refers to the increasing adoption of digital technology by various traditional industries to change the original operation mode; Digital industrialization refers to new industries formed by various new technologies, such as artificial intelligence, blockchain and so on. Industrial integration and innovation are driven by digital technologies such as Mobile Internet, and the boundaries of traditional industries are increasingly blurred, resulting in the emergence of new industries and formats.

This section uses four indicators to interpret smart economy, namely, interactive design, software development, digital application and development level of information industry. These indicators include the application of information technology in creative design, the development level of city in software development, the vitality of city in digital economy, and the development level of city information service industry. A comprehensive survey of the level of a city's smart economy has been made, and a three-dimensional smart economy system has been constructed.



Interactive design

The interaction between virtual and physical has become the main feature of the design industry, and the new design industry has also become a symbolic component of the content industry. We selected the world's top advertising design companies, and the distribution of engineering and construction companies in major cities, representing the development level of graphic design and modeling design industry respectively. In this respect, Beijing is the most outstanding, reflecting the status of national cultural and visual arts center, and the gathering of large state-owned engineering enterprises makes its design ability at the forefront of global cities. London, New York and Shanghai are closely followed. They are the centers of the global advertising industry, the gathering places of top architectural design firms, or those design colleges with many outstanding spillover effects. Currently, with the full interaction between information technology and traditional design methods, these cities have become the global industry centers.



Software development

Software development represent the level of market development of the capabilities and factors of a city's software product. This indicator comprehensively examines several key indicators of the software development capability industry, which is the core sector of the digital content industry, including business environment, legal environment, market conditions, talent reserve, degree of specialization, infrastructure and connectivity, and living environment. Cities with most outstanding performances in this field are London, New York, Paris, Berlin, Singapore and Chicago. These cities can provide very full convenience in terms of stable legal environment, sufficient talent reserve and global connectivity of software and hardware. Cities such as Tokyo, Los Angeles, Beijing, Shanghai and Mumbai are not much different from the first-level cities. Some of them have long been global multimedia centers, such as Tokyo and Los Angeles; Some are emerging global software industry center in recent years, with outstanding energy levels in software industry clusters, such as Beijing, Shanghai and Mumbai.



Digital application

This index comprehensively reflects a city's ICT application ability, as well as the quality and cost of related talents. It includes the availability of ICT software, ICT scientists and engineers, and the availability of venture capital; software R&D capability and export; specialization of software development ability; the scale of leisure and entertainment departments; degree of specialization and track record; information technology facilities; quality of life and availability of skills. In this respect, Paris and London are the most outstanding cities, which are two famous university towns. The number of engineers is developing in scale, and the urban environment can provide a better balance between work and life. Cities like Seoul, Tokyo, New York, Singapore, Los Angeles and Hong Kong are closely followed. These cities either regard the digital economy industry as the top priority of economic development, such as Seoul, Tokyo and Singapore, or other industries that are closely related to the digital economy and have outstanding energy levels, such as Hollywood in Los Angeles, finance and business in New York and Hong Kong.



Development level of information industry

The development level of information industry is the symbolic index of a smart city. Considering that this data is difficult to obtain and even cities with this data have different connotations, we have chosen the distribution of major information industry consulting companies and information industry operating companies in the world to express and evaluate the development level of urban information industry. In this respect, New York and Shanghai are the most outstanding ones, demonstrating the status of urban economic hubs as the two largest economies in the world. Those cities following next are far behind. Some cities with higher development levels includes Tokyo, Singapore, Mumbai, Beijing, Paris, Dubai and Hong Kong, among which some are either the regional economic centers of the information industry or the emerging city clusters of information industry, whose performances are eye-catching in the new information society.

Table 2-2 Ranking of Smart Economy

City	Interactive design	Software development	Digital application	development level of information industry	Smart economy	Sub-item rank
New York	75.0	99.0	84.6	100.0	89.7	1
London	85.0	100.0	92.0	49.8	81.7	2
Beijing	100.0	82.0	73.1	64.6	79.9	3
Shanghai	75.0	78.6	70.9	92.0	79.1	4
Paris	30.0	96.0	100.0	64.4	72.6	5
Singapore	42.5	94.5	84.6	67.6	72.3	6
Chicago	60.0	94.1	66.3	59.3	69.9	7
Los Angeles	62.5	85.3	82.9	47.4	69.5	8
Tokyo	12.5	87.8	88.0	78.2	66.6	9
Hong Kong	25.0	90.2	81.7	63.0	65.0	10
Toronto	45.0	93.3	73.1	48.2	64.9	11
Sydney	42.5	79.1	65.7	54.3	60.4	12
Dubai	62.5	65.0	48.0	63.4	59.7	13
Seoul	12.5	75.6	89.1	58.5	58.9	14
Berlin	15.0	95.3	76.0	48.6	58.7	15
Moscow	25.0	72.4	72.6	56.7	56.7	16
Bombay	22.5	78.6	21.1	65.0	46.8	17
Buenos Aires	12.5	57.8	32.0	57.8	40.0	18
Rio de Janeiro	12.5	55.3	30.3	47.7	36.5	19
Cairo	10.0	52.1	20.0	35.4	29.4	20

It can be seen from the table that New York, London, Beijing, Shanghai and Paris are ranked in the top five. Compared with the previous rankings, except for New York, London and Paris, the status of Chinese cities has been significantly improved, which shows that the overall development level of China's smart economy has already had very strong international competitiveness. Singapore, Chicago, Los Angeles, Tokyo and Hong Kong are all global cities that regard smart economy as the core strategy of urban development. All cities are located in Asia-Pacific or North America, which to some extent reflects the leading position of these two regions in the era of smart economy.

Sydney, Dubai, Berlin and Moscow are the node cities in various regions, which have the level of smart economy that is relatively matched with the energy level of the nodes. Some people are surprised by Seoul, and this is because the evaluation focuses on application, and Seoul's powerful information manufacturing capability is not taken into consideration, and the lack of its regional hinterland restricts Seoul from becoming a cutting-edge smart economy city. Although Mumbai has performed well in terms of software development and energy level of information industry, which shows its potential as a new smart economic base, its application in social and economic fields and the lack of working and living environment restrict it from making further progress in the rankings. Buenos Aires, Rio, Cairo and other cities all lag behind the above cities in terms of all those indicators, which, to certain extent, is influenced by their economic and political environment.

2.3 Smart Service

Smart service mainly reflects the digital service level for citizens. Smart cities must be people-oriented in the development process, so the first criterion to measure a city's smart level depends on whether citizens have a higher sense of happiness and gain. Therefore, the smart service emphasizes taking citizens as the center, and extends the digital application to all aspects of citizens' lives.

In this paper, four main parts of urban citizen service are selected as indicators for evaluating smart city service: the first part is medical and health service; the second is public transportation service; the third is the wisdom education service; and the fourth is employment information service. These four aspects focus on different aspects of smart city services, which can improve the construction efficiency of the whole city and the happiness of citizens.



Online medical treatment

With the rapid development of Internet information technology, the construction concept of smart medical care has been continuously promoted and developed. As an important part of smart city construction, smart medical care is also the key link and core content of smart service construction. Smart medical care can effectively promote the benign interaction among doctors, doctors and patients, doctors and equipment, using data analysis and resource integration to optimize and upgrade the resource allocation of medical activities. The information co-construction and sharing also reduces the information asymmetry between doctors and patients, promotes the openness and transparency of the medical process, reduces the conflicts between doctors and patients, and effectively protects the rights and interests of both doctors and patients, thus being more conducive to enhancing the stability and security of society.

Using ICT and remote assistance to prevent and diagnose diseases, and providing medical services and effective health care systems for all citizens. In a word, smart medical care reflects the application degree of Internet information technology in the medical industry, and is conducive to solving the contradictions such as imbalance of medical resources and asymmetry of doctor-patient information. This indicator mainly examines the improvement of online medical appointments on visits.



Convenient transportation

In recent years, with the increasing traffic flow, serious congestion and poor traffic environment are plaguing people's travel and health, and increasing the unstable factors in cities. In big cities, the annual loss caused by traffic congestion is calculated as one billion yuan. Therefore, in order to quickly adapt to the corresponding requirements of the development of the times for urban traffic, the construction of smart transportation is imminent.

Smart transportation is the application of digital technology in traffic management and technology application. By integrating communication and transmission technology, navigation and positioning technology and information technology, it can realize all-round and instant comprehensive transportation supervision and build a comprehensive transportation management system. This is particularly significant in the context of economic recession caused by Covid-19. On the one hand, the construction of smart transportation can guarantee the development of urban traffic operation and improve the efficiency of transportation; on the other hand, it can reduce the consumption of energy and resources, save the cost needed for the development of transportation industry, and realize the harmonious development of transportation and environmental protection. More importantly, on the basis of helping cities improve the efficiency of traffic supervision, relieve the pressure of transportation, improve the traffic safety factor, provide more intelligent and humanized transportation services for travelers, and create a green, safe and smooth traffic environment, thus improving the public's traffic satisfaction and creating a better life.

This paper chooses "convenient transportation" to reflect the effectiveness, reliability and safety of public transportation network. This index mainly includes the dependence of residents' travel on smart technology.



Online education

Smart education refers to deepening the reform of the education system based on modern information technology represented by the Internet of Things, cloud computing, big data processing and wireless broadband network, paving the way for the Internet and intelligent instruments and equipment, focusing on the construction of a large number of educational resources, and adopting various supporting measures. Implementing and constructing a networked, digital, personalized and smart modern education system in an all-round way is a modern education service system led by the government, with the joint participation of schools, enterprises and relevant institutions.

The application of information technology and Internet for content dissemination and rapid learning will create more opportunities for students and teachers to use information and communication technology tools. With the help of network, learning is no longer limited by time and space. This index mainly includes the utilization, convenience and richness of online education.



Online employment

In smart city service, employment is an important factor to promote economic development and maintain social stability. It is necessary to strengthen the integration between public employment and talent service information network, promote the sharing of employment information resources, provide an equal employment opportunity for the public, and consolidate and promote the stability of employment. In addition, we will improve the social security system and raise the level of security. To realize the networking and automation of social security services, people can handle related businesses through the network, such as registering unemployment and inquiring social security information, which is conducive to expanding the coverage of social insurance. Social security services are inseparable from economic and social development, and the gradual intelligent improvement of its system can effectively improve the service quality of smart cities, improve public satisfaction and further promote social stability and economic development.

Online employment reflects the informationization of employment services, promotes the matching between employers and employees, and provides effective and equal employment opportunities. This indicator mainly includes online job hunting, online interview, etc., which makes the whole recruitment work easier.

According to the above indicators, the ranking of smart services in the selected 20 global cities is shown in the table.

Table 2-3 Rankings of Smart Services

City	Online medical treatment	Convenient transportation	Online education	Online employment	Smart service	Sub-item rank
Shanghai	98.4	98.4	100.0	99.9	99.2	1
Beijing	100.0	94.5	93.9	100.0	97.1	2
Singapore	90.9	96.1	82.2	93.8	90.8	3
Dubai	93.5	96.9	86.5	85.9	90.7	4
Bombay	83.2	78.6	91.6	91.3	86.2	5
Moscow	82.0	94.8	72.3	92.6	85.4	6
Hong Kong	70.5	97.3	75.3	84.3	81.9	7
New York	75.2	98.4	68.3	83.2	81.3	8
Seoul	74.7	96.1	74.5	79.1	81.1	9
London	73.6	99.4	71.2	79.1	80.8	10
Sydney	74.4	89.6	66.4	86.0	79.1	11
Paris	80.3	100.0	66.1	66.0	78.1	12
Los Angeles	70.4	89.7	67.0	84.3	77.8	13
Chicago	71.4	94.5	55.6	80.1	75.4	14
Toronto	62.4	92.0	59.2	80.0	73.4	15
Cairo	73.4	85.6	52.2	78.8	72.5	16
Berlin	60.1	93.1	54.9	75.3	70.8	17
Tokyo	64.1	96.9	38.2	76.2	68.8	18
Buenos Aires	68.4	88.0	48.4	62.4	66.8	19
Rio de Janeiro	40.9	84.5	28.4	57.9	52.9	20

The ranking results show that Shanghai, Beijing, Singapore and Dubai are in the forefront. Although as cities in developing countries, Shanghai and Beijing have achieved fruitful results in promoting information transparency, doing business online and providing digital services, which exceeds most cities in developed countries. What follows are cities like Mumbai, Moscow, Hong Kong, New York, Seoul, London and other cities, which are with convenient transportation or with easy online employment, thus having obvious structural advantages. Although Sydney, Chicago, Berlin and other cities are developed cities, the level of smart services is not high, especially in online education. Buenos Aires, Rio de Janeiro and other cities lag behind other cities in terms of several indexes. To a certain extent, it is influenced by its economic and political environment. It is worth mentioning that Tokyo, despite its fair performance in transportation and employment, doesn't score high in medical care and employment.

2.4 Smart Governance

Smart city construction is the foundation and opportunity for the transformation from traditional city management to smart governance. Smart governance can meet the strategic demand of "modernization of national governance" put forward at the 19th National Congress of China, and it is one of the internal driving forces and main goals of building and deepening the development of smart cities. Smart city construction provides solid software and hardware foundation for smart governance. The openness and interactivity of the Internet and the awakening of public subjective consciousness provide the possibility of smart governance.

In the theoretical system of smart governance, efficiency is no longer the only scoring standard, and multiple values such as openness, participation and tolerance are increasingly concerned and valued. In the new era when emerging information technologies such as big data and artificial intelligence are leading the trend, data governance is attracting more and more attention. Therefore, this paper compares and analyzes the smart governance level of different cities from five aspects: data openness, public safety, public participation, social inclusion and sustainability.



Open data

Open data can eliminate the phenomenon of "isolated information island" caused by poor information exchange among various departments in cities, and guarantee the right of ordinary people to know about urban public affairs, which is an important basis for realizing smart urban governance.

Based on "Open Data Barometer" and "Open Data Index of Important Cities in the World" issued by Shanghai Academy of Social Sciences, this paper carries out evaluation for the data openness work of each city from the following aspects: legal policy and organizational guarantee of data opening; depth, breadth, freedom of access and data activity of data openness; user usage and platform interaction; and the economic, political and social values brought by open data.

Cities such as New York, Los Angeles, Chicago and Dubai performed well in this index. Among China's cities, Hong Kong scored higher than Beijing and Shanghai, but the overall situation is not optimistic, and there is still much room for improvement.



Public safety

Safeguarding the personal and property safety of urban residents is one of the important functions of the local government, and it is also an important prerequisite for a city to continuously attract talents to gather, take root here and live and work in peace and contentment. The public safety score in this paper is mainly based on the degree to which the installation of surveillance videos in cities making urban residents feel safe.

Dubai won the championship in public safety for two consecutive years. Apart from installing a large number of surveillance videos in public areas, it mainly benefited from the establishment and promotion of its integrated mobile police service platform and smart police station, which enabled residents to report to the police at any time, inquire and pay tickets and other activities through mobile APP and intelligent police station, which greatly facilitated residents' lives. It provides a guarantee for their personal safety. China's Beijing and Shanghai are also outstanding in public safety, mainly due to the rapid development of domestic network bandwidth, physical storage, cloud computing and other technologies in recent years, as well as a large number of surveillance cameras.



Public participation

Public participation in smart governance means that residents can communicate with government departments online end-to-end through mobile phones, tablets, computers and other terminals without leaving home, instead of using the traditional offline one-way communication mode. Residents can use the online government platform to put forward suggestions for government departments to further improve the city's appearance, enhance the level of government services and improve the quality of life of urban residents.

From the ranking, we can see that Beijing and Shanghai have made remarkable achievements in public participation, and their scores are much higher than those of other cities, which is due to the in-depth implementation of government affairs reform in recent years. The "Unified Online Government Service" mode implemented in Beijing, Shanghai and other cities has really realized the original intention of "making data run more and people run less errands". It greatly improved the sense of acquisition and satisfaction of citizens and enterprises.



Social inclusion

A normal society must be diversified and colorful, and should not be single and monotonous. The so-called pluralism means that there is not just a kind of values, or a way of life. It is because of different lifestyles that society will be more colorful and people will have more choices. Being open and tolerant of differences, people's inspiration for innovation and creation can be stimulated. If there is only one way of life in a society, and people's values are similar, and everyone lives in the same way every day, society will definitely lack vitality, and the spirit and motivation of innovation.

It can be seen from the ranking scores that Dubai is far ahead in terms of social inclusion. Singapore and Sydney follow closely. Compared with last year, Sydney's performance in this respect declined somewhat. China's Beijing, Shanghai, Hong Kong and other cities have performed moderately in this respect, and they still need to continue their efforts.



Sustainability

Sustainability refers to a process or state that can be maintained for a long time. The sustainability of human society can be divided into three parts, namely ecological sustainability, economic sustainability and social sustainability. The relationship between environmental protection and sustainable development is very close. Therefore, in the governance of cities, we should not only pay attention to the development of cities, but also pay attention to its environmental protection. So, in terms of smart governance, the government should raise people's awareness of environmental protection, solve environmental crisis, change traditional production and consumption methods, develop science and technology, and accelerate the development of new technologies for environmental protection.

In this paper, the sustainability of each city is evaluated according to the planet sub-index in the report of the Sustainable Cities Index 2018. This indicator measures the sustainable attributes of cities, such as green space and pollution, and it also emphasizes the United Nations' sustainable development goals related to clean water and sanitation, clean energy and climate action.

It can be inferred from the ranking and scoring of this indicator that Dubai has performed well in sustainable development and obtained full marks. China's three cities, Beijing, Shanghai and Hong Kong, obtain lower scores in this respect, lingering the passing mark, which indicates that China should change its development model and realize sustainable development as soon as possible.

According to the above indicators, the ranking of smart governance in the selected 20 cities is shown in Table 2-4.

Table 2-4 Rankings of Smart Governance

City	Open data	Public safety	Public participation	Social inclusion	Sustainability	Smart governance	Sub-item rank
Dubai	85.2	100.0	88.1	100.0	100.0	94.7	1
Singapore	97.7	94.7	74.2	90.6	64.1	84.3	2
Seoul	96.4	88.4	68.4	75.6	83.6	82.5	3
Sydney	96.5	73.5	56.4	89.3	92.4	81.6	4
Shanghai	76.9	94.5	97.7	74.8	63.6	81.5	5
Beijing	76.9	92.6	100.0	70.0	63.6	80.6	6
New York	100.0	71.8	66.1	64.9	91.8	78.9	7
Los Angeles	100.0	59.4	67.2	70.7	91.8	77.8	8
Moscow	82.7	80.2	76.7	64.9	80.4	77.0	9
Chicago	100.0	58.6	56.7	66.2	91.8	74.7	10
Toronto	91.1	60.7	53.9	77.8	89.2	74.6	11
Tokyo	94.1	71.1	42.9	80.2	72.2	72.1	12
London	98.1	68.3	60.4	76.6	56.3	71.9	13
Hong Kong	89.6	64.0	63.7	68.7	58.0	68.8	14
Berlin	86.2	55.8	52.4	74.6	72.2	68.2	15
Paris	86.8	62.7	63.2	74.4	53.9	68.2	16
Bombay	65.3	86.2	81.2	64.1	22.7	63.9	17
Buenos Aires	71.9	63.0	60.4	65.9	48.4	61.9	18
Cairo	57.7	74.2	57.2	63.5	28.6	56.2	19
Rio de Janeiro	72.5	46.1	40.0	63.9	25.8	49.6	20

2.5 Smart Innovation

Innovation is the core element of a smart city, and technological innovation and social innovation are the two major components of a smart city. In the current smart city practice, we usually pay attention to the technological innovation centered on ICT and realized by technicians, scientists, programmers and engineers. In contrast, social innovation has not attracted wide attention in academic community. But it may be a more important component in the construction of smart city. Of course, this dichotomy sometimes conceals the close interaction between the two. It is a part of social relations, and social decision-making guides the use and development of technology. The achievements of technological innovation can change the way people live, work, interact and enjoy. Online websites and smart devices have changed the way of business operation, customer communication, office space and information sharing. The promotion of autonomous vehicles is highly dependent on the consensus among citizens, and often has to rise to the legal level. A key to the construction of a smart city is to create a self-reinforcing environment for technological innovation through social innovation.

As a platform for innovation, the city needs an ecology, which involves different aspects of universities, scientific research, enterprise innovation and overall human skills. Smart cities can use science and technology to transform their core systems in an all-round way, and make maximum use of limited smart resources to create more employment opportunities.

At the level of global smart cities, this paper divides the innovation ability of cities into four aspects, namely, the strength of universities, scientific and technological research and development, innovation ability and human skills. The first three sub-indicators are closely related, reflecting the strength of city education, science and technology, innovation and entrepreneurship. The general idea is to try to analyze and compare the innovation strength of smart cities from different perspectives in Industry-University-Research.



University strength

For global smart cities, the existence of first-class universities may be the core driving force for the development of cities. The university pursues the spirit of "academic freedom", and the vigor and creativity generated by the gathering of youth can make a city more attractive. A good university is like a giant magnet, attracting outstanding students, scientists and other cutting-edge talents from all over the world, and it has become the cornerstone of skilled migration. At the same time, college graduates tend to work locally and become the base of talent inflow.

According to the distribution of university locations in QS University Rankings, this paper investigates the strengths of different cities in the construction of first-class universities. There are many universities in some big cities of developed countries, which have a history of hundreds of years and have obvious advantages in some disciplines. Recently, in some big cities in emerging countries, their university rankings have risen rapidly, showing a tendency to catch up.

In this year's QS university rankings, London's universities ranked first, Hong Kong kept second, and Tokyo, Sydney and Seoul ranked third. While the university ranking in Paris dropped from the first place last year to the sixth place.



Scientific research and development

The level of research and development (R&D) is closely related to the existence of first-class universities, which, to a large extent, are the foundation of R&D. In addition to universities, there are other kinds of R&D institutions, including national laboratories, engineering technology research centers and enterprise research laboratories, which can absorb a large number of scientific researchers for employment and produce patents and academic documents, etc. It can reflect the city's scientific and technological R&D capabilities. Therefore, this paper regards scientific and technological R&D as a comprehensive index.

Smart city provides a smart solution for the sustainable development of the city, which cannot be separated from strong scientific and technological R&D strength. Information technology needs to be generally combined with industrial application. Cities can become intelligent with the help of external forces, such as introducing multinational companies with strong scientific and technological strength to settle in or providing solutions. However, if they lack corresponding scientific research institutions and personnel, they will also lack the necessary "absorptive capacity", which leads to the lack of sustainability of urban science and technology development and falls into a disadvantage in the competition of global cities.

From the ranking scores, it can be seen that because R&D of science and technology is a more comprehensive index than the strength of universities, the gap between cities seems even larger. Take New York for example. Although the university ranking is not outstanding, its development in science and technology is far ahead of other cities. According to this year's data, the overall R&D strength of Beijing and Shanghai in China has made great progress.



Innovation and entrepreneurship

With the explosive emergence of new information technology, Internet infrastructure and data have become the most important strategic resources, providing a lot of opportunities for innovation and entrepreneurship. This sub-index adopts 2thinknow and Global Entrepreneurship Index as a comprehensive index to the ranking of innovation and entrepreneurship ability of global cities, highlighting the comprehensive performance of different cities in innovation and entrepreneurship.

Urban innovation ability is a comprehensive embodiment of technology and economy, and innovation is more settled in industry. Although some cities are not among the strongest in science and technology, a number of global enterprises will emerge because they are suitable for starting businesses, such as Los Angeles and Singapore, while others, such as Hong Kong, are on the contrary.

Urban entrepreneurship is the main driving force of urban industrial renewal and adaptability. In the tide of new scientific and technological revolution, many advantageous industries in traditional cities will gradually become obsolete and face elimination. Therefore, cities need a large number of entrepreneurs who are engaged in scientific and technological entrepreneurship, introduce new technologies into traditional industries, or create brand-new industries, and realize from 0 to 1 and then to 100, so that the industrial level of the city can be improved.

New York ranks first in this index, while London ranks second. London is a gathering place for European AI technology companies and industrial talents. Data show that there are 187,427 high-tech companies in London with a total turnover of 285 billion pounds, providing hundreds of thousands of "high-tech" jobs. In 2018 alone, employment opportunities in the financial technology industry increased by 61%, making it the fastest growing sector in London. According to incomplete statistics, there were 758 AI companies in London in 2019, of which 645 were based in London, twice as many as Paris and Berlin combined. The establishment speed of new AI enterprises in London is increasing by 42% every year, which is much higher than the global annual speed of 24%. Meanwhile, London has talent channels from Cambridge, Oxford and Imperial College London, which promotes the research on cloud computing and AI hardware. Imperial College London is recognized as the world leader in artificial intelligence research, and more than 600 employees in the college are dedicated to artificial intelligence projects. Semiconductor company ARM is a derivative company of Cambridge University.

London is a world-class financial center. In 2018, one third of European financial technology venture capital was invested in London companies. London technology start-ups raised 1.8 billion pounds, accounting for 39%, almost twice as much as Berlin, the second place. London is close to San Francisco in the number of financial technology unicorns. 25% of entrepreneurs in the world have important relationships with more than two people in London. Among the 29 financial technology unicorn companies in the world, 9 are located in the Bay Area of California and 7 are located in London, including several banking disruptors, such as Transferwise, Oaknorth and Revolut, as well as the initial public offering of Funding Circle, a P2P company. The artificial intelligence ecosystem has also received strong support from major American technology companies. For example, in 2016, Google acquired Deepmind, Microsoft acquired Swiftkey, Twitter acquired Magic Pony, Facebook acquired Bloomsbury AI, a startup focusing on natural language processing.

Considering only the total amount of venture capital, according to the statistics of American Entrepreneurship Center, from 2015 to 2017, the dominant position of the United States in venture capital has been challenged globally. Among several indicators, the United States is dominant in the current total amount of venture capital and per capita, but Beijing surpasses San Francisco in promoting global venture capital to take the first place. In terms of the growth rate of venture capital, such Asian cities as Bangkok, Hangzhou and Jakarta rank among the top three. Six of the top ten are from Asia, and two of them are from China.

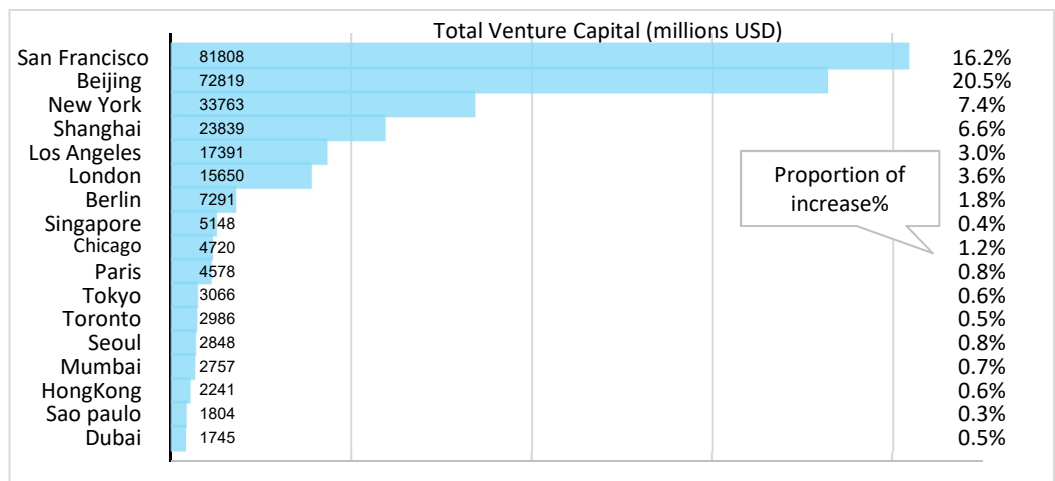


Figure: The total amount of venture capital in major cities in the world and its proportion in the increase

Note: "Increase" refers to the added value from the total amount in the three years 2010-2012 to the total amount in 2015-2017

Source: Center for American Entrepreneurship. Link:

<https://startupsusa.org/global-startup-cities/>

The epidemic has obviously had a subversive impact on venture capital. According to the "2021 American Venture Capital Outlook Report" released by Pitchbook in 2021, the share of Silicon Valley Bay Area in the total VC in the United States will be reduced to below 20% for the first time in history, while other cities in the country will seize more shares in the capital of their local innovators. According to PitchBook, in 2020, the United States has raised \$156.2 billion in venture capital. Among them, 22.7% of the transactions took place in the Bay Area, and 39.4% of the transaction value was invested in companies headquartered in the Bay Area. Since 2006, the share of Silicon Valley in American venture capital transactions has been declining every year.



Manpower skill

Manpower skill refers to the quantity and availability of technical engineers or workers in each city, which reflects the relationship between supply and demand of highly skilled talents. Senior skilled workers are the important wealth of various industries, which reflect the quality of a city's labor force, and they are a kind of personnel with serious imbalance between supply and demand in the labor market in various cities. Berry and Glaeser (2005) found that in 1940 or 1970, cities with higher skilled workers have improved their technical level in the following decades. Today, when the population of many countries is gradually entering an aging society, how to attract and cultivate excellent skilled workers in smart cities has become a top priority. The development of robot and other technologies is just to cope with this dilemma. According to the 2019 report of Hay's Global Skills, Singapore ranked the highest in robot application in 2016, reaching 488 robots per 10,000 employees, followed by Germany and Japan.

Attracting skilled workers is different from simply attracting talents. Generally speaking, the diversity and inclusiveness of cities have more advantages in attracting talents. Some global cities, such as New York, London and Berlin, are highly diversified and enjoy the unique advantage of attracting global talents, while other cities mainly attract domestic and regional talents, such as Moscow and Mumbai. Although the work of skilled workers has high technical content, it is closely related to the local industrial structure.

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Table 2-5 Rankings of smart innovation

City	University strength	Scientific research and development	Innovative entrepreneurship	Manpower skill	Smart innovation	Sub-item rank
London	100.0	97.6	93.5	98.4	97.4	1
New York	78.0	100.0	100.0	95.4	93.4	2
Tokyo	82.0	94.1	96.5	90.2	90.7	3
Los Angeles	72.0	93.9	90.9	95.4	88.1	4
Chicago	72.0	87.8	84.6	95.4	85.0	5
Seoul	80.0	91.1	75.5	91.7	84.6	6
Sydney	82.0	81.4	74.5	98.0	84.0	7
Singapore	68.0	85.9	88.5	89.5	83.0	8
Paris	72.0	85.7	86.5	86.6	82.7	9
Hong Kong	94.0	86.0	57.2	93.3	82.6	10
Berlin	60.0	80.6	77.6	100.0	79.5	11
Toronto	58.0	77.2	80.0	94.8	77.5	12
Beijing	72.0	84.9	66.9	69.7	73.4	13
Moscow	64.0	75.3	61.9	87.3	72.1	14
Shanghai	72.0	81.4	63.8	69.7	71.7	15
Dubai	50.0	60.4	64.6	85.0	65.0	16
Buenos Aires	52.0	56.6	54.9	90.7	63.5	17
Rio de Janeiro	50.0	68.2	49.7	73.6	60.4	18
Cairo	50.0	45.6	41.7	65.5	50.7	19
Bombay	48.0	37.4	52.7	58.9	49.2	20

2.6 Smart Reputation

Major cities around the world have achieved fruitful results in the construction of "smart cities". Also, there are many theoretical research results, reflecting the construction achievements of smart cities from different aspects, as well as the degree of attention to cities. Therefore, we track the reputation of smart cities with the help of academic databases. According to the frequency of academic literature in different cities, this paper investigates the reputation of global smart cities from an academic point of view.

Based on the title and keywords of the article like "smart cities/smart city" and English names of different cities, we searched the academic literature on the Web of Science database from January 2011 to May 2020. 1,100 English literatures were found and the original database was thus established.

After reading the abstracts of these documents, we selected the research contents related to the smart city model, application and data generated by smart city construction, and finally got 519 articles. Their distribution is shown in the following table.

Table 2-6 Comparison of Rankings for Smart Reputation and Smart City

city	Total no. of documents	Reputation rank	Smart City Rank	Ranking changes
Singapore	81	1	2	
Beijing	79	2	4	
New York	78	3	1	
London	62	4	3	
Seoul	57	5	11	
Shanghai	44	6	5	
Hongkong	23	7	7	
Rio de Janeiro	20	8	19	
Toronto	19	9	15	
Tokyo	18	10	13	
Dubai	16	11	8	
Moscow	14	12	12	
Paris	14	12	14	
Chicago	13	12	9	
Berlin	12	15	16	
Mumbai	10	16	17	
Sydney	9	17	10	
Los Angeles	6	18	6	
Cairo	5	19	20	
Buenos Aires	3	20	18	

Table 2-6 shows that Singapore, Beijing and New York rank among the top three in smart city research, and their reputations are relatively close. As for English academic literature, Beijing, as a city located in a non-English-speaking country, receives even more attention than many English-speaking countries, which is quite surprising.

From the difference between the two rankings, the most remarkable thing is that the academic reputation of Seoul and Rio de Janeiro is much higher than their intelligence rankings, while Sydney and Los Angeles are just the opposite, and the relevant research literature is far less than their actual intelligence.

According to the top-level design of smart city, that is, the macro model of urban smart city, the specific application or optimization of specific application of smart city, and the results and spillover effects of smart city application, we divide the themes of existing literature into three subcategories: academic literature, data research, macro model and specific application, which are arranged according to city, year and classification. The result shown in figure 2-1 is obtained.

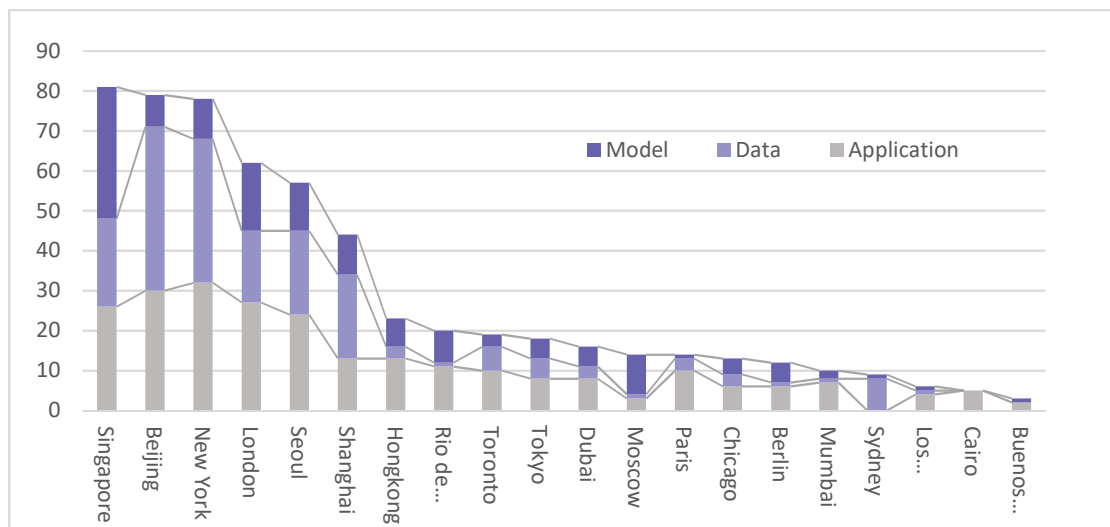


Figure 2-1 Distribution of academic articles related to smart cities

From the perspective of sub-items, it shows a situation of tripartite confrontation: Beijing ranks first in terms of data research; In terms of mode, Singapore is most favored by the academic community and is regarded as a model of smart city; New York ranked first in terms of applications.

3. Performance of smart city in Coronavirus Pandemic

3.1 The performance of fighting Covid-19 of global smart City

The achievements of smart city construction are reflected in many aspects, one of which is the impact resistance to black swan like accidents and the resilience of rapid recovery. During this epidemic, different cities showed great differences in terms of life security. This report collects data from various aspects, and the data, as of August 22, 2021, are summarized in the table below.

This report is not intended to rank or comprehensively summarize the achievements of cities during fighting epidemic, which requires data from longer period and more comprehensive indicators. Rather, we just try to examine the smart degree of the city from a short-term perspective based on several specific indicators.

From the table, it can be seen that several cities, such as Singapore, Shanghai, Dubai, Beijing, Tokyo and Seoul, all have their mortality rates below 1%. Taking Singapore, Shanghai and Dubai as examples, this paper briefly discusses the outstanding performance of their smart city construction in fighting against epidemic.

Table 2-7 some indexes of smart cities' fighting Covid-19 (until August 22, 2021)

City	Number of cases	Death toll	Mortality	Statistical range of data
Paris	6600000	113000	1.7%	France
Berlin	189000	3588	1.9%	this city
Beijing	1112	9	0.8%	this city
Buenos Aires	853000	15835	1.9%	this city
Dubai	707000	2014	0.3%	United Arab Emirates
Tokyo	303000	2365	0.8%	Bendu
Toronto	559000	9451	1.7%	this city
Cairo	286000	16654	5.8%	Egypt
Rio de Janeiro	4200000	144000	3.4%	Sao Paulo
London	5610000	115000	2.0%	England
Los Angeles	4300000	65020	1.5%	California
Bombay	6420000	136000	2.1%	Maharashtra
Moscow	412000	7624	1.9%	this city
New York	2220000	53564	2.4%	this city
Shanghai	2420	7	0.3%	this city
Seoul	235000	2202	0.9%	the republic of korea
Sydney	17173	122	0.7%	new south wales
Hong Kong	12049	212	1.8%	this city
Singapore	66406	47	0.1%	this city
Chicago	1490000	26223	1.8%	Illinois

sources: Wikipedia and JHU CSSE COVID-19 data

3.2 Singapore

Singapore recorded its first case on January 23, 2020, about the same time as the United States. Since then, as of June 2, 2020, Singapore has reported an average of 6126 cases per million people, higher than 5621, 3857 and 2492 cases per million reported by the United States, Italy and Brazil respectively. However, Singapore reported a very low average mortality rate of 4 per million people, while the United States, Italy and Brazil reported 323, 554 and 141 deaths per million, respectively. By June 2021, Singapore proposed that, due to the high vaccination coverage rate, the blockade and mass contact tracking would be lifted, and quarantine free travel and large-scale gatherings would be allowed to resume, and the next step would be to stop counting the daily epidemic cases.



What is the difference between Singapore and other countries?

From the perspective of objective conditions, Singapore is a city from developed country without hinterland. Its independent geographical space, relatively concentrated population (nearly 8000 people per square kilometer, one of the most densely populated countries on earth), a good society of mutual trust among its citizens and strict border control are conducive to epidemic control.

Singapore has learned many lessons from the outbreak of SARS-CoV in 2002. Although the incidence and mortality rate are low, it has revealed that the country is not well prepared for the epidemic. To bridge this gap, its government has continued to establish 900 rapid response Public Health Preparedness Clinics (PHPC) across the country dedicated to improving response to epidemic outbreaks. As an intermediary between community and hospital, PHPCs divided all patients with symptoms of influenza or pneumonia into low-risk and high-risk groups. High risk groups were transferred to infectious disease hospitals for further assessment and management.

Singapore's first line of defense is to reduce the import of diseases, that is, to conduct body temperature screening at the port of entry. At the beginning, screening and subsequent decision-making were poorly managed in most countries, with no serious follow-up of travelers with high temperatures. In addition, masks have been distributed to every family to protect people around them. Not just give limitations to ports of entry, Singapore carries out temperature checks at restaurants and store entrances, and screening measures are extended to the community level.

Close tracking of the population is the key to ensure that the spread of the epidemic is controlled. Singapore's physical infrastructure is one of the best in the world. The country has a high-quality fixed telephone network, with wireless broadband penetration rate of 200% and mobile phone penetration rate of 150%. Opensignal ranks first in the world in terms of 4G speed. The national broadband network provides Singaporeans with affordable ultra-high-speed broadband, laying the foundation for the future development of digital services.

Singapore's TraceTogether token is the latest effort to address Covid-19 with technology. This program requires people to use a smartphone app or a dedicated Bluetooth token to monitor personal social interaction, and if two people turn on the app, they will automatically exchange ID when they meet. Once a person is tested positive for the virus, these data will enable the tracker to quickly contact anyone who may have been infected, thus helping to track and control the epidemic. According to statistics, nearly 80% of Singapore's residents have registered for the TraceTogether program. For the elderly, the Singapore government provides them with this special equipment free of charge, which can last for 9 months without charging.

To encourage people to register this, Singaporean authorities promised never to use the data for any other purpose, saying that "we will never access those data unless users are tested positive for Covid-19 and are contacted by the contact tracking team".

WHO praised Singapore for this practice, believing that Singapore can quickly identify and manage cases, has the world-class monitoring level and successful experiences for others to go by.



Figure 3-1 The Use Process of Singapore's TraceTogether Token

3.3 Shanghai

As one of the cities with the closest international exchanges and connections in China, Shanghai smart city has experienced more severe challenges than other cities during the epidemic. With the help of good scientific and technological strength and smart city foundation, Shanghai has not carried out the whole city's nucleic acid detection and investigation like other cities in China since the beginning of the epidemic. Shanghai effectively controlled the epidemic, with operation of the city stable and orderly and the impact on people's life and work kept to a minimum. Zhang Wenhong, a Chinese infectious disease expert and head of the Covid-19 medical team in Shanghai, describes metaphorically the epidemic prevention work in Shanghai as "catching mice in porcelain shops", namely "wide, fast and early". That is to say, the screening scale should be wide, the response speed fast, the epidemic situation controlled in the early stage through the fever sentinel clinics and fever clinics, and the most critical problems should be solved with the lowest cost, so that the people will be less disturbed and live a normal life.



For example, a foreign airline cargo service staff at Pudong Airport was tested positive for the novel coronavirus on August 2, 2021. After the outbreak, Shanghai's emergency response procedures and pace in the following 36 hours were remarkable.

On August 2, Pudong Hospital of traditional Chinese Medicine in Shanghai found a positive nucleic acid sample, which was announced to the media on the same day. Shanghai CDC quickly carried out screening, epidemiological investigation and sampling. Only one night, just before the news conference of epidemic prevention and control work was held at 9:00 a.m. on August 3, 52 people had been screened and 250 people had been closely contacted, and all of them were under centralized isolation. Nearly 65,000 people were sampled for nucleic acid, of which 27,000 people have already received testing results. The confirmed cases' history whereabouts were announced, including resident area, but personal privacy was not involved. The disinfection and other disposal were completed, and the medium risk area was determined. At the press conference on August 4, the screening and testing results were announced, and the virus gene sequencing results and the conclusion of the source of infection were announced.

The two press conferences were aimed at social concerns, answering questions and reminding citizens to do a good job of personal protection. Such system and practices have enabled Shanghai to forestall the virus again and again.

The reason why Shanghai can calmly deal with the Covid-19 epidemic crisis is inseparable from the precise prevention and control strategy of the whole city. This includes self-discipline of citizens, urban governance, anti-epidemic with science and technology, and public opinion guidance, etc., so as to quickly cut off the transmission route, block the transmission chain and nip the virus in the bud. Besides, Shanghai has enough medical resources and beds to cope with another possible Covid-19 epidemic, 122 fever clinics are equipped with more than 1100 observation beds, and another 8000 beds are reserved in hospitals for preparation.

Shanghai implements the grid-based management, in which neighborhood committees in various districts are responsible for promoting community cohesion and sense of belonging, and ensuring that citizens within the community comply with rules (such as garbage collection, safety and community hygiene). During the epidemic, the residents' committees were responsible for measuring the body temperature of the people at the entrance of each community, and paid more attention to the most vulnerable residents. This kind of management mode allows the government to closely monitor whether specific individuals have abnormal body temperature and health status, and enhance the government's quick response to new cases and prevent the spread of viruses.

The use of digital technology is an important tool for Shanghai to control the epidemic. Shanghai has installed security cameras at the entrance and exit of public transportation to measure the temperature of people, and integrated smart phone application (health QR code) to indicate the health level of public space and people's health status. You can know whether it is safe to visit a person or travel just through a simple QR code.



Figure 3-2 The Screenshot of Shanghai's "Shanghai QR Code"

3.4 Dubai

Compared with cities in developed countries, Dubai is particularly outstanding in this epidemic.

Dubai not only has the world's tallest building and the most important financial center in the Arab world, but also assembles the world's largest solar park, invests heavily in building the most advanced city through technologies such as the Internet of Things (IoT), big data and artificial intelligence, and has digitized all government services (transportation, communication, infrastructure, electricity, economy and urban planning). Citizens can access these services through the DubaiNow application. In addition, Dubai started the Artificial Intelligence (AI) Lab in 2017, aiming to use the power of machine learning to achieve the goal of becoming the smartest city in the world. The city has also established a partnership with IBM to provide the basic tools and support needed to integrate AI into all government services and city experiences.



On June 24th, 2020, Smart Dubai published COVID-19: Report on Elasticity and Impact of Urban Experience, which provided an overall view of the impact of COVID-19 outbreak, and summarized its impact on smart services, and proposed that the adoption of enabling technology is very important for flexible smart cities (such as UAE Pass and national digital identity).

Smart Dubai is led by Dubai International Relations and Partners Department, and the person in charge said: "When talking about epidemics like Covid-19 and protecting public health, one of the key words in the context of smart city is data. The more data you have, the stronger the resilience of the city. Before Covid-19 broke out, we had been investing in smart cities and technologies. Therefore, we can create a dashboard to monitor the different trends in the pandemic, and try to solve the crisis well".

Dubai's smart city infrastructure and large investment in artificial intelligence, data analysis and unmanned aerial vehicle (UAV) technology enable it to respond quickly to Covid-19. These technologies include digital applications for accessing public services and combining data sets to monitor residents' energy consumption and travel patterns. The government also uses networked devices to check whether residents comply with the "social distance" rule. This technology locates people by sending ping signals from people's mobile phones to nearby towers. The government regularly announced the research progress of COVID-19 disease and developed several applications to help manage the pandemic. One of these applications is Alhosn, and residents were encouraged to download. Alhosn is used to track people infected with viruses or who may have had close contact with confirmed cases.

The system was originally developed to monitor crowds during the New Year's Eve celebrations, and the Dubai Police Force just used it to slow down the spread of Covid-19. They can check the driver's license plate according to the database to see if the person who left home during the blockade has a permit. The police are also equipped with "smart" helmets with thermal sensors. To check whether residents show Covid-19 fever symptoms.

Dubai scientific research institutions and technology companies are active in the prevention and control of the epidemic.

Dubai's Covid-19 command and control center is a key component of its epidemic prevention and control. The center aims to coordinate the efforts of doctors, epidemiologists and other professionals in Dubai. It is located in the Mohammed bin Rashid University of Medicine and Health Sciences (MBRU) in Dubai Medical City, which is also home to the most advanced

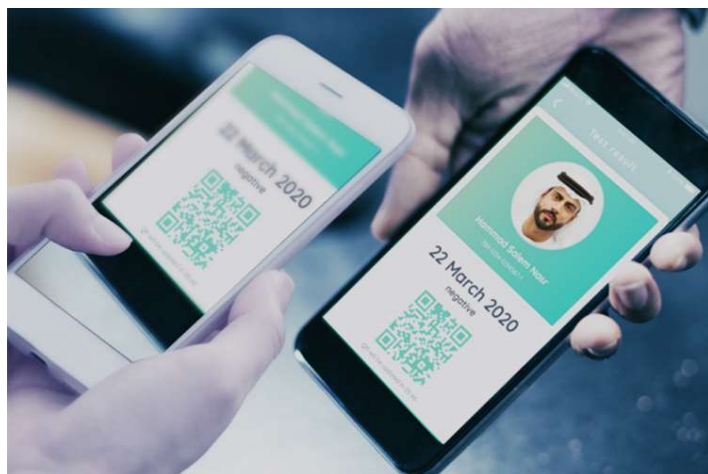


Figure 3-3 The Screenshot of Dubai's Alhosn

hospitals, laboratories and research centers.

Dubai health authorities use artificial intelligence and big data technology developed by technology startup NYBL to help manage hygiene products during Covid-19, so as to determine available products, which hospitals need it and when to order additional products.

CondoProtego, a Dubai-based technology consulting company, is a leader in smart cities. It advises UAE enterprises and national organizations on major projects, such as how to set up a "command and control" center to analyze the increasing data generated by urban networked sensors, closed-circuit television cameras and social media.

4. Conclusion

Although the official forecast of urban population growth has not changed due to the Covid-19, real estate agents and urban registration offices report that more and more people are considering moving to rural areas because they expect to stay at home more frequently in the future.

Dubai has an intelligent Dubai platform that provides access to urban services and data for all individuals and private and public sector entities.

Citizens' trust to data and cyber security threats are two factors closely related to the success of smart cities

This is driving the creation of smart cities, a market that will be worth \$833bn by 2030, by our estimates, up from \$441bn in 2018.

Lower carbonization, thus reducing the negative impact of COVID-19 pandemic. Jakarta has deployed a wide range of intelligent applications in traffic reduction during the blockade. Previously, the city developed a system that can track the cell phone signal to the cell phone signal tower to monitor the crowd during the festival celebration. With this innovation, it can help monitor the movement of polluted vehicles.

With the rapid rise of smart cities' high-tech solutions, it is necessary to think about data governance, especially when aggregating data from different sources in the new urban ecosystem.

In the face of epidemic, what is the difference between smart cities and ordinary cities?

Building a more sensitive and resilient smart city.

REFERENCE

- [1] The Report of Global Smart Cities 2017
- [2] The Report of Global Smart Cities 2020
- [3] Berry, C. R. and E. L. Glaeser. The divergence of human capital levels across cities[J]. Papers in Regional Science, 2005, 84(3), 407–444.
- [4] Mastercard. Smart Dubai and Expo 2020 Dubai. SEAMLESS, SECURE, HUMAN: Building the cities of the future. 2021.3
- [5] Smart Dubai. Covid-19: City Experience Resilience & Impact Report. 2020.6
- [6] United Nations. POLICY BRIEF: COVID-19 IN AN URBAN WORLD. 2020.7
- [7] Mayor of London. Smarter London Together. 2018.6
- [8] World Economic Forum. Governing Smart Cities: Policy Benchmarks for Ethical and Responsible Smart City Development. 2021.7
- [9] MSCI. Post-Pandemic Reflections: Smart Cities COVID-19 and its potential impact on the new ecosystem. 2020
- [10] Xiang Yu, Na Li, Yupeng Dong. Observation on China’s Strategies to Prevent the Resurgence of the COVID-19 Epidemic. Risk Management and Healthcare Policy, 2021, 14: 2011–2019
- [11] Z/Yen. Global Financial Centres Index 29 Report. March 2021
- [12] Cushman & Wakefield. Global Policy Responses TO COVID-19. 2021.4
- [13] Kevin Imboden. Data Center Global Market Comparison. Cushman & Wakefield'S Data Center Advisory Group, 2021

Appendix: Indicators

Pillars	Sub index	Weight	Data source	Description
Smart infrastructure 20%	Mobile phone	25%	ITU	penetration
	Next-generation network	25%	ITU/Telecom Operators	4G penetration
	Export bandwidth	25%	ITU	Bandwidth per capita
	Data center	25%	World bank	Secure Internet server for every million people
Smart economy 20%	Interactive design	25%	Industry ranking & agency distribution	
	Software development	25%	IBM	
	Digital applications	25%	PWC	
	ICT industry level	25%	Industry ranking & agency distribution	
Smart governance 20%	Open data	20%	Open Data Barometer/Shanghai Academy of Social Sciences Data Open Index	Public data openness
	Public safety	20%	Smart City index	Number of digital monitoring
	Public participation	20%	Smart City index	public reflects their opinions online
	Social inclusion	20%	Cities in motion	Digital gap between different groups
	Sustainability	20%	Sustainable City Ranking	
Smart Services 20%	Online medical treatment	25%	Smart City index	Make an appointment via the Internet
	Convenient transportation	25%	Global Power city index	Travel reservation online
	Online education	25%	Smart City index	Education and training via the Internet
	Online employment	25%	Smart City index	find a job online
Smart innovation 20%	University Strength	25%	QS university ranking	
	Scientific R & D	25%	Global Power City Index	
	Innovation and entrepreneurship	25%	2thinknow/ Global Entrepreneurship Index	
	Manpower skills	25%	Hay's skill index/ Global Competitiveness Index	
Smart reputation	Reflecting the city's smart reputation, or the city's brand image. Just as a reference index, not included in the total score			

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