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GLOBAL SMART CITIES 2022
Digital Rights & Inclusion

全球智慧之都报告 (2022版)
数字权利和包容性

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The report is available at：
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━ OUTLINE ━

EXECUTIVE SUMMARY

The "Global Smart City" (2022 Edition) was completed by the Smart City Research Group of Shanghai Academy of Social Sciences in cooperation with the Smart City Research Center of Fudan University's School of Management, with continuous support from the UN Public Administration Network (UNPAN). It was the sixth release of the research outcome of the Smart City Think Tank.

Based on the "5+1" assessment model of smart cities, this report compares the five quantitative indicators of the 20 "smart cities" in the world: smart infrastructure, smart economy, smart services, smart governance, and smart innovation; and with a qualitative indicator which is "smart reputation", in a total of six dimensions, trying to set a benchmark for global smart cities and provide diversified solutions for all regions to achieve the sustainable development goal 2030(SDG 2030) proposed by the United Nations in 2015.

This year's report highlights the theme of "digital inclusion" in Smart Cities. Digital inclusion refers to the fact that cities take care of the survival and development of different groups in the process of digital and smart transformation, especially to those vulnerable groups. Digital inclusion embodies the human-oriented spirit and sustainable development spirit of smart cities, which needs the support of digital technology.

The first part of this report is the overall ranking, which classifies the world's smart cities into 3 types as "leading cities", "advanced cities" and "following cities" . This year's leading and following cities are the same as last year, and their ranking positions are quite established. But the rankings of the top three leading cities are different from last year: now London is the first, New York is the second and Singapore is the third.

Table. Global Smart Cities 2022 Ranking

Level	City	Smart Infrastructure	Smart economy	Smart service	Smart governance	Smart innovation	Score	Ranking	Relative to 2021
Leading	London	85.3	81.7	87.7	84.9	94.3	100.0	1	▲2
Leading	New York	82.0	89.6	85.8	80.3	87.1	97.9	2	▼1
Leading	Singapore	89.5	72.3	91.3	80.6	85.0	96.5	3	▼1
Advanced	Hong Kong	95.8	65.0	87.8	70.7	85.5	93.3	4	▲3
Advanced	Los Angeles	82.3	69.5	83.5	85.2	81.8	92.7	5	▲1
Advanced	Shanghai	63.9	79.1	99.7	73.5	77.9	90.8	6	▼1
Advanced	Paris	74.1	72.6	81.3	81.9	82.4	90.4	7	▲5
Advanced	Beijing	64.8	79.9	97.4	69.4	79.0	90.0	8	▼4
Advanced	Sydney	77.5	60.4	84.8	81.9	85.8	90.0	8	▲2
Advanced	Tokyo	77.7	66.6	75.0	79.0	88.9	89.3	10	▲3
Advanced	Seoul	75.5	58.9	84.5	76.5	88.7	88.5	11	=
Advanced	Chicago	81.1	69.9	77.0	73.2	81.1	88.1	12	▼3
Advanced	Dubai	83.5	59.7	91.5	81.8	65.5	88.1	13	▼5
Advanced	Toronto	78.2	64.9	80.7	74.4	75.4	86.1	14	▲1
Advanced	Berlin	78.0	58.7	77.9	82.1	76.0	85.9	15	▲1
Advanced	Moscow	75.6	56.7	87.6	70.2	76.1	84.4	16	▼2
Following	Buenos Aires	71.0	40.0	72.0	63.5	58.9	70.4	17	▲1
Following	Bombay	56.8	46.8	88.5	57.8	51.6	69.5	18	▼1
Following	Rio de Janeiro	65.5	36.5	66.5	62.8	61.0	67.4	19	=
Following	Cairo	50.2	29.4	80.0	53.0	54.0	61.5	20	=

Note: The symbols of the last column show the rising, falling and unchanging, and the following numbers indicate moving rankings.

The second part of this report is the analysis of sub-index ranking.

Hong Kong and Singapore rank second in terms of smart infrastructure sub-indicators. Some cities in Europe and the United States followed behind. Among the cities in developing countries, Dubai has performed relatively well.

In the sub-index of smart economy, New York and London are ranked in the top two; Beijing and Shanghai have performed well in this area, entering the first camp.

The smart services sub-index reflects the degree of wisdom in providing services to people. Shanghai and Beijing have performed very well, indicating that China's major cities have already taken the lead in the world in the application of digital technology. Dubai and Singapore came in second.

Los Angeles and London rank second in the smart governance sub-index. Paris and Sydney tied for third place.

In terms of smart innovation sub-indicators, London, Tokyo and Seoul rank in the top three. They have outstanding performance in science and technology, education and innovation, and have abundant human capital.

The smart reputation reflects the attention paid to each big smart city in the academic circle. The results show that Singapore, Beijing and New York rank in the top three. They each have advantages in different aspects of smart city construction and are most favored by academic circles.

Preface

It is a great honor to present Global Smart Cities 2022, the third edition based on the revised evaluation model, and the sixth edition of the Global Smart Cities series.

As a continuous research project, we continue to track and review the development of smart cities in global major cities from the perspective of "technology + management" and respond to global concerns through our annual reports.

The pace of global digitalization has been significantly accelerated in response to the worldwide challenge posed by the COVID-19 pandemic. However, in tandem with the acceleration of digitalization, there is a threat of increased marginalization of those who were already "digitally disadvantaged". This has brought "digital divide" to the forefront on a global scale as never before, related issues like digital exclusion and digital outcast are triggering urgent and globally shared social tensions. This also makes "digital inclusion" one of the most pressing and important concerns in the current development of global smart cities.

The insurance of digital rights and inclusion is highly valued by international organizations and governments. A series of UN publications and agendas highlight inclusion as the key element of urban development, especially the development of smart cities, including the UN New Urban Agenda (2019), UN-Habitat's Centering People in Smart Cities: A playbook for local and regional governments (2021), etc. Meanwhile, initiatives such as London's Charter for Emerging Technologies and Shanghai's Digital Partnership Program also provide examples of how to promote digital inclusion and bridge the digital divide in cities. In this report, we include benchmark cases like London and Shanghai, hoping that their efforts of enhancing digital inclusion through smart cities can provide lessons for other cities around the world.

We believe that an ideal smart city is one in which all citizens can benefit from the digital rights and welfare brought about by the development of smart cities. It's people who benefit from smartness in cities that come first, followed by smart cities. This series of reports investigates what a smarter city can provide for all of its citizens.

Based on this perspective, we have seen numerous cities prosper over the past ten years through the development of smart cities and digitalization. At the same time, we have also witnessed cases of "inappropriate" smart cities, resulting in wasted public resources, missed development opportunities, and even negative growth. Undoubtedly, the lack of digital rights and inclusion has a significant impact on these unsuccessful cases. The absence may further escalate social tensions and even accelerate social fragmentation. One such example is the Malaysian Multimedia Super Corridor project, which is now controversial in academia.

With the above in mind, we select the theme of "Digital Rights and Inclusion" for this year's annual report in an effort to promote a more people-centered approach to smart cities.

Last but not least, we appreciate United Nations Public Administration Network (UNPAN) in support of the Global Smart Cities 2022. We also appreciate the media who report on and interpret the Global Smart Cities 2022. 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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1. Overall ranking

1.1 Overview

Smart city is not only the goal of city digital transformation, but also the means of digital transformation. The emergence of various digital technologies has improved the lives of citizens, promoted the growth of urban economy and made cities more intelligent.

Globally, the human-centered governance model is increasingly favored. The city, should be people's city, the city should put its people as the center. However, each person is different from each other in various aspects. In this case, how to achieve inclusive growth in cities is particularly important. Without good governance, social polarization, information security and invasion of privacy, all kinds of unpredictable risks will inevitably arise. The equal rights of people in the digital environment, namely "digital inclusion", are becoming increasingly important (United Nations, 2020).

"Digital rights" is the sum of a set of rights related to digital technology and has multiple meanings. The earliest digital rights only involved the protection of digital intellectual property rights. With the increasing popularity of the Internet, more and more people are online, and the global network world has gradually formed. While it allows people in all countries to enjoy the digital benefits, various kinds of violations of people's rights also emerge in endlessly. Digital rights have received unprecedented attention from the international community, and various major cities have successively issued Digital Rights Protection Acts.

For the understanding of digital rights, Gill et al.(2015) found that among the 30 digital charters studied, freedom of speech, privacy and the right to access the internet were the three topics most emphasized (27, 26 and 24 times respectively).

Dheere(2017) proposed that "digital rights" refers to the introduction of human rights established in the Universal Declaration of Human Rights, United Nations resolutions, international conventions, regional charters, domestic laws and human rights case law into the digital cyberspace.

Tan(2019) believes that digital rights do not only refer to "online". All scenarios that use digital technology and are affected by digital technology can be classified into the category of digital rights. This can be summed up into four meanings: "(1) digital rights are regarded as the transformation from traditional rights to digital space by considering numbers as one or more spaces; (2) Focus digital rights on data security and privacy by treating numbers as data representations of physical entities; (3) Access to digital space and meaningful participation; And (4) participating in digital or internet governance. " The former two are related to digital rights and the latter two are related to rights in digital development.

In the construction of smart cities, there are many potential violations of digital rights. For example, in smart homes, smart facilities are equipped with monitoring function, which will continuously transmit the collected data collection back to the manufacturer's data center. Although this might provide better services for users, but also contains a large amount of personal privacy data. The ubiquitous digital facilities in cities also raise huge concerns about over-surveillance. Moreover, residents of some cities have low trust in the public sector, various reasons including lack of transparency, insecure digital infrastructure and limited opportunities for community representation and participation.

This report believes that in the field of smart city construction, digital rights are a set of basic rights -- individuals should obtain to enjoy digital infrastructure, access digital products and services, and be able to participate in urban data governance, including the right to access services at an affordable price, the right to control personal data, the right to protect personal privacy and the right to participate in urban governance. It is inherently universal and inclusive.

1.2 International Organizations and Cities' Advocacy for Digital Inclusion

The UN's "New Urban Agenda" (2019) points out that smart cities must prioritize people and communities in their strategies, use information and communication technologies in a more inclusive way, and make societies more inclusive, safe, resilient and sustainable, supported by sustainable development goal 11.

At the city level, many governments have issued basic laws that define digital rights and obligations. For example, London's Charter on Emerging Technologies contains four principles of technology implementation: openness, respect for diversity, trust in people's data and sustainable development. The city of Los Angeles has enacted a digital rights bill to promote trust and innovative solutions that must be ethical, setting out eight rules for the development of digital services.

In its report "People-Centered Smart Cities: A Manual for Local and Regional Governments" released in 2021, UN-Habitat emphasizes the equal use of digital facilities and enjoyment of cities and human settlements, and seeks to promote inclusiveness. Ensure that all residents, without discrimination from generation to generation, are able to live and build safe, healthy, accessible, affordable, resilient and sustainable urban settlements. By creating a people-centered smart city development framework, policy and planning delivery can be more inclusive and responsive to diverse needs. Based on international best practices, UN-Habitat has summarized the five pillars of a smart city: community, digital assets, infrastructure, security and capabilities. Each pillar contains core values and recommended actions that, taken together, can help local government to provide appropriate solutions. Specifically, the community pillar discusses how local governments strive to place people and their needs at the center of the smart city development. The digital assets pillar addresses how to establish fair access to ICT with a focus on internet connectivity, digital skills and digital devices. The infrastructure pillar addresses how to develop systems to manage data and digital services to promote inclusive digital transformation. The security pillar addresses how to drive an inclusive digital transformation by developing systems, processes, and policies to manage data and digital services. The competency pillar addresses how to develop multi-stakeholder partnerships and build organizational capacity to better promote people-centered smart cities.

Globally, similar initiatives are being launched everywhere. The European Union Agency for Fundamental Rights (FRA) strongly advocated the concept of "human rights city" in 2021 and defined it as: "In a human rights city, the local government, local actors and city residents work together and commit themselves to uphold international human rights standards and legal obligations in the declaration. To this end, developing rights-based policies for urban problems, which contributes to the protection, respect, realization and promotion of human rights." The human rights framework for European cities issued by the EU Agency for Fundamental Rights includes "foundation", "structure" and "tools". The city formalizes its commitment to all human fundamental rights. The structure includes mechanisms and institutions that integrate commitments into urban work. These include the official declaration of a human rights city, the establishment of human rights offices and advisory committees, and the provision of remedies. Tools include support for the application of human rights-based approaches and resources to integrate human rights into all aspects of urban work and to raise awareness of human rights, including a rights-based planning approach that measures progress through action plans, baselines, monitoring and evaluation.

Table 1-1 The human rights framework for European cities

level	meaning	Key issues
Tools	Methods and resources to support structural and human rights work	A human rights-based approach Mainstreaming human rights Planning, monitoring and evaluation Right to awareness-raising and communication
Structures	Mechanisms and procedures for integrating human rights into practice	Official commitment An office or unit responsible for human rights Participating agencies Complaint mechanism annual report
Foundations	Commitment to rights and principles	International human rights instruments, sustainable development goals, etc. The EU Charter of Fundamental Rights and other EU instruments or initiatives

Source: FRA(2021)

Founded in November 2018 by the cities of Amsterdam, Barcelona and New York, the Digital Rights Cities Alliance now has members in more than 50 cities around the world. Its goals are: to unite in collective and local action to meet challenges through the application of expertise in real urban Settings; Gathering local experiences and practices to influence international policy; Development of policy and technical toolkits; And set up working groups to focus on digital rights topics and make cities flexible test beds for new policies and rules. And actively promote, promote and defend digital rights through legislation and management of public Spaces. For digital rights, they put forward five initiatives:

1. Universal and equal access to the Internet to enhance digital literacy;

2. Privacy, data protection and security;

3. Transparency, accountability and non-discrimination of data, content and algorithms;

4. Participatory democracy, diversity and inclusion;

5. Open and ethical standards for digital services.

Some organizations emphasize digital rights for specific topics. Data sharing and privacy protection are a pair of persistent contradictions in this regard. In this regard, the "MyData" declaration believes that it is necessary to build on the relationship of trust and confidence among people and between people and organizations. At the same time, data needs self-determination. It is not only guaranteed by legislation, but also realized by the power of sharing data with individuals through initiatives. Finally, it is possible to maximize the collective benefits of personal data through fair sharing among organizations, individuals and society.

In addition, there are also initiatives to focus on the digital rights of specific groups such as children and ethnic minorities, which have converged into a new trend of building an inclusive and smart city.

Adhering to this guiding ideology, this report focuses on the issue of inclusive urban development this year.

1.3 Ranking framework and measurement method

This report adopts the "5+1" assessment framework and pays special attention to the development of smart infrastructure, smart services and smart governance in major cities from the perspective of inclusive growth.

SMART REPUTATION

SMART GOVERNANCE

1. Provide people with decent jobs
2. Provide convenience for people's life and travel
3. Provide people with quality public services
4. Involve people in urban public affairs
5. Promote sustainable urban development

SMART INNOVATION — Combined with Sci. & Tech. attracting high quality talents

SMART ECONOMY — ICT industry development and enabling major industries

SMART SERVICE — ICT Industry Development and enabling the public to serve

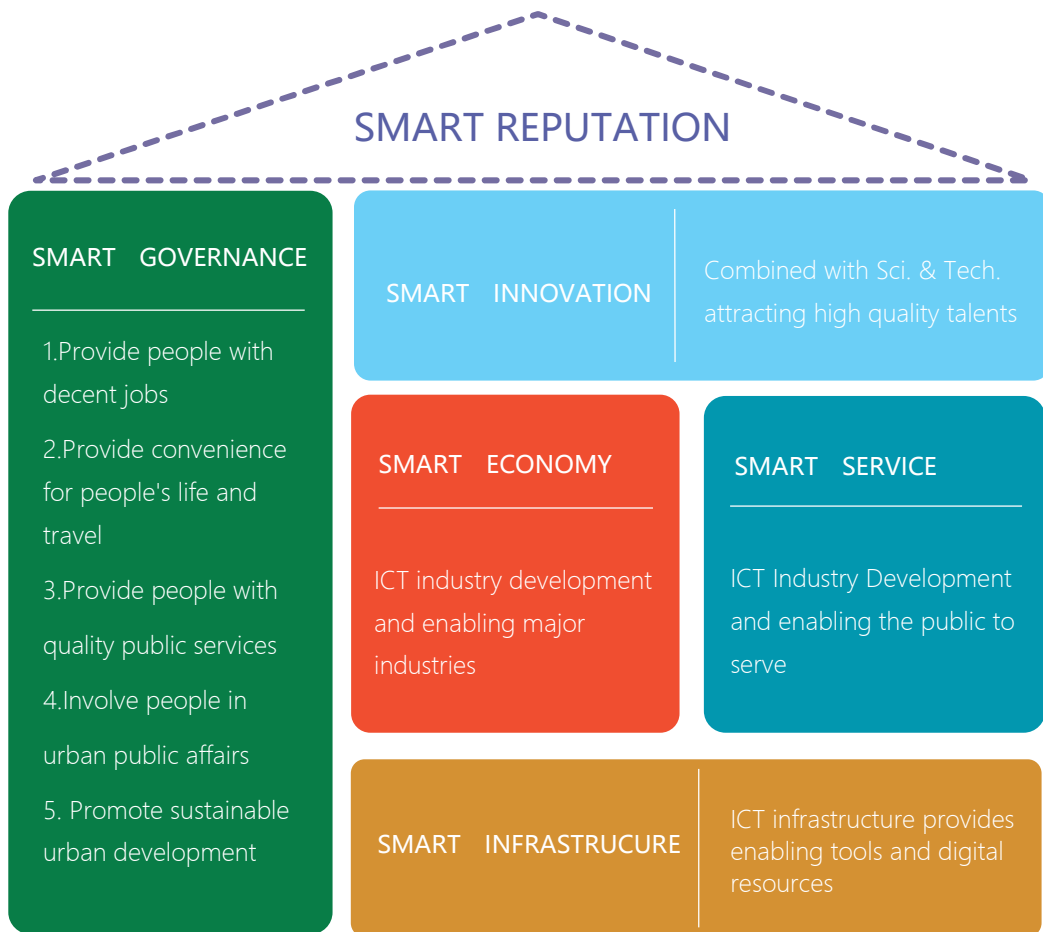**SMART INFRASTRUCURE** — ICT infrastructure provides enabling tools and digital resources

Figure 1-1 "5+1" Framework for Global Smart City Construction

The composition of the "5+1" indicator is shown in Figure 1-1 and 1-2:

University strength 25%
Scientific research and development 25%
Innovative entrepreneurship 25%
Human skills 25%

Smart Innovation

Mobile phone 25%
Next generation network 25%
Export bandwidth 25%
Data center 25%

Smart Infrastructure

Smart Reputation

Theoretical Framework of Global Smart Cities

Interactive design 25%
Software development 25%
Digital applications 25%
Credit rating 25%

Smart Economy

Smart Governance

Open data 20%
Public safety 20%
Public participation 20%
Social inclusion 20%
Sustainability 20%

Smart Services

Medical and health services 25%
Public transport services 25%
Intelligent education service 25%
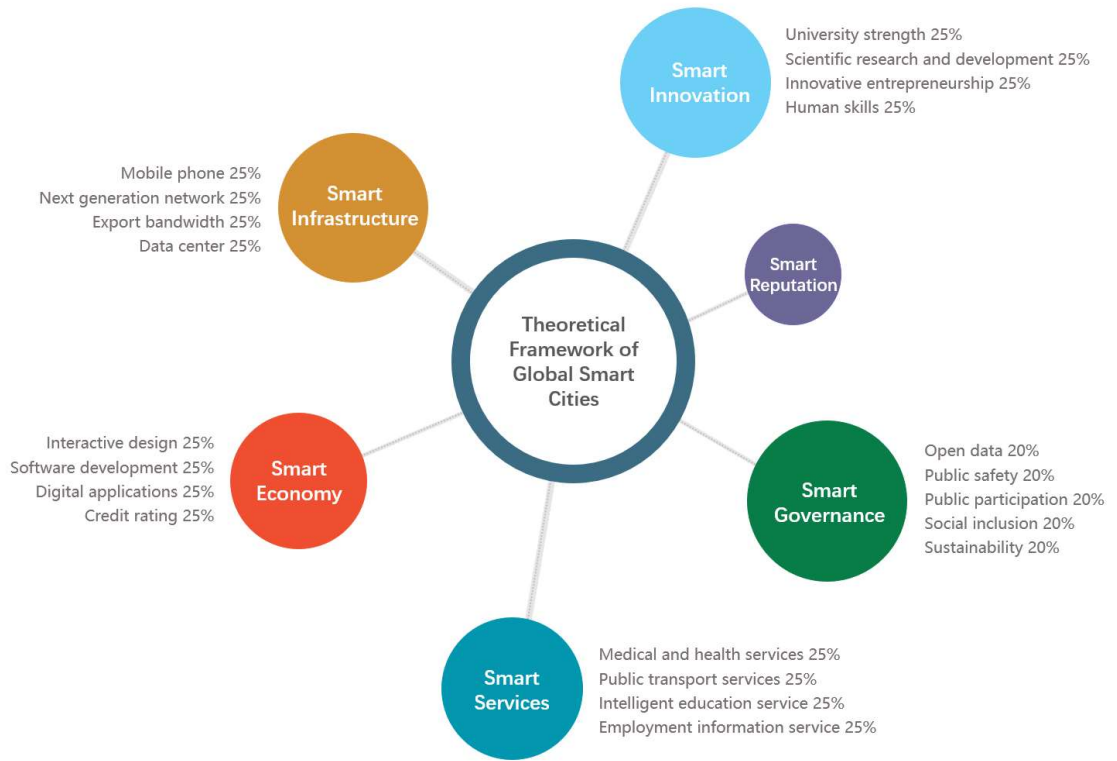Employment information service 25%

Figure 1-2 Theoretical Measurement Index System of Global Smart Cities

Our research group selected the data of 20 major cities in the world to rank. Through dimensionless data and conversion to percentile, the method is as follows:

$$F_{i,j} = \frac{X_{i,j}}{X_{max,j}} \times 100 (\text{i=1,2,3,}\cdots\text{,20; j=1,2,}\cdots\text{,5})$$

Where I represents a city, j represents a specific indicator, Xi,j represents the actual value of the j indicator for city I, and Xmax,j represents the maximum of all city values on the j indicator. Through this transformation, the city with the best performance scores 100 points, and other cities use it as a benchmark to score within 100 points respectively.

After calculating the score of each item, the average score is taken to obtain the total score. The final summary is then translated using this section as described above.

1.4 Overall Ranking

Table 1-2 Global Smart Cities 2022 Ranking

Level	City	Smart Infrastructure	Smart Economy	Smart Service	Smart Governance	Smart Innovation	Score	Ranking	Relative to 2021
Leading	London	85.3	81.7	87.7	84.9	94.3	100.0	1	▲2
Leading	New York	82.0	89.6	85.8	80.3	87.1	97.9	2	▼1
Leading	Singapore	89.5	72.3	91.3	80.6	85.0	96.5	3	▼1
Advanced	Hong Kong	95.8	65.0	87.8	70.7	85.5	93.3	4	▲3
Advanced	Los Angeles	82.3	69.5	83.5	85.2	81.8	92.7	5	▲1
Advanced	Shanghai	63.9	79.1	99.7	73.5	77.9	90.8	6	▼1
Advanced	Paris	74.1	72.6	81.3	81.9	82.4	90.4	7	▲5
Advanced	Beijing	64.8	79.9	97.4	69.4	79.0	90.0	8	▼4
Advanced	Sydney	77.5	60.4	84.8	81.9	85.8	90.0	8	▲2
Advanced	Tokyo	77.7	66.6	75.0	79.0	88.9	89.3	10	▲3
Advanced	Seoul	75.5	58.9	84.5	76.5	88.7	88.5	11	=
Advanced	Chicago	81.1	69.9	77.0	73.2	81.1	88.1	12	▼3
Advanced	Dubai	83.5	59.7	91.5	81.8	65.5	88.1	13	▼5
Advanced	Toronto	78.2	64.9	80.7	74.4	75.4	86.1	14	▲1
Advanced	Berlin	78.0	58.7	77.9	82.1	76.0	85.9	15	▲1
Advanced	Moscow	75.6	56.7	87.6	70.2	76.1	84.4	16	▼2
Following	Buenos Aires	71.0	40.0	72.0	63.5	58.9	70.4	17	▲1
Following	Bombay	56.8	46.8	88.5	57.8	51.6	69.5	18	▼1
Following	Rio de Janeiro	65.5	36.5	66.5	62.8	61.0	67.4	19	=
Following	Cairo	50.2	29.4	80.0	53.0	54.0	61.5	20	=

Note: The symbols of the last column show the rising, falling and unchanging, and the following numbers indicate moving rankings.

According to the score, the intelligence degree of 20 cities is divided into three levels based on plus or minus 1 standard deviation of the average value.

The first level (above 96.3 points), called "leading" smart cities, includes the top three: London, New York and Singapore. They maintain a leading position in almost every aspect of smart cities and become role models for other cities in the world. It is worth noting that these three cities have been in the top for three consecutive years.

The second level (75.8-96.3), which is called "advanced" smart city, includes 13 cities, which remain advanced in various indicators and outstanding in individual indicators. At this level, only one city (Seoul) remained unchanged, with seven cities rising and five cities falling. Paris, Hong Kong and Tokyo made faster progress, while Chicago, Beijing and Dubai dropped by more than three places.

The third level (below 75.8 points) is called the "follow-up" smart city, with a total of four cities. Compared with the first two groups of global smart cities, each of these cities is not particularly outstanding, with a few exceptions, such as Mumbai, where the smart services score higher, but are basically in the position of followers.

2. Sub-item ranking

2.1 Smart Infrastructure

The "smartness" of the smart infrastructure is embodied in a combination of three aspects: digital, connectivity and intelligence. Smart infrastructure is the foundation of digital twin cities. Human beings and machines cooperate with each other, and the material world and the digital world are integrated, which is the development direction of the future smart city.

The content of smart infrastructure mainly includes the growth and popularity of broadband (fixed and mobile), new generation of mobile communication services, computers and various intelligent terminals, and sometimes the number of various applications. The "Smart Infrastructure" in this report is limited to the hardware component and focuses on software aspects such as applications in various services and industry development.

Interpretation of sub-indicators

Table 2-1 Smart Infrastructure Ranking

City	Mobile phone	New generation network	Export bandwidth	Data center	Smart infrastructure	Ranking
Hong Kong	92.4	90.9	100.0	100.0	95.8	1
Singapore	81.8	92.1	95.0	89.2	89.5	2
London	93	84.6	83.7	79.7	85.3	3
Dubai	100.0	100.0	79.1	55.0	83.5	4
Los Angeles	80.7	91.7	66.9	90.0	82.3	5
New York	79.4	91.7	66.9	90.0	82.0	6
Chicago	75.9	91.7	66.9	90.0	81.1	7
Toronto	92.2	80.6	59.5	80.4	78.2	8
Berlin	88.0	81.4	55.3	87.2	78.0	9
Tokyo	93.2	97.0	44.6	76.2	77.7	10
Sydney	82.3	88.8	58.3	80.4	77.5	11
Moscow	88.0	83.6	58.6	72.1	75.6	12
Seoul	90.5	86.6	58.8	66.0	75.5	13
Paris	77.8	83.5	55.4	79.7	74.1	14
Buenos Aires	90.3	80.1	51.5	62.3	71.0	15
Rio de Janeiro	72.5	81.7	46.6	61.0	65.5	16
Beijing	77.8	83.4	46.1	52.1	64.8	17
Shanghai	74.1	83.4	46.1	52.1	63.9	18
Bombay	65.0	70.3	45.1	46.8	56.8	19
Cairo	59.0	74.5	38.4	28.7	50.2	20

Mobile phone

refers to the penetration rate of mobile phones. The mobile phone is a basic configuration in the current mobile internet era. For the global smart cities, the gap is not too big.

According to the comprehensive permeability data, there are certain differences in the popularity of the new generation of mobile communication networks among major cities. Dubai's performance on this indicator is outstanding.

From the penetration rate of 5G, by the end of 2021, China had 1.643 billion mobile phone users, among which 355 million were 5G users, accounting for 21.61% of the mobile phone users.[1] This is the world's largest 5G network. According to OOKLA, south Korea has the world's fastest 5G network, with the U.S. ranking first with a penetration rate of 49.2%[2].

The new generation of mobile communication network

mainly refers to the mobile broadband Internet quality represented by 4G, which is represented by download speed. Mobile communication is the fundamental guarantee for the quality of data transmission and internet services, and is also the basic guarantee for collecting big data and promoting various economic and social innovations.

From the data point of view, there are certain differences in the popularity of the new generation of mobile communication networks in major cities. Dubai's performance on this indicator is very outstanding, ranking first with a penetration rate of 100.0%. But Canada's Toronto and India's Mumbai are less than 90%, ranking much lower.

Export bandwidth

Compared with the new generation of mobile communication network indicators, export bandwidth mainly reflects the global connectivity of cities. The global smart city has much higher level of global connectivity than other cities. For a country, the global smart city is the most important communication hub and the main channel for the import and export of internet data. In terms of internet data flow, the export bandwidth indicator fully reflects the development level of data communication in cities.

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① The number of 5G users reached 384 million -- Analysis of China's 5G construction and application status in 2022
https://www.qianzhan.com/analyst/detail/220/220406-e1aed59e.html
② Growing and Slowing: The State of 5G Worldwide in 2021. https://www.ookla.com/articles/state-of-worldwide-5g-2021

Data center

Data is the most important strategic resource of a city. Many cities have set up data operation centers, developing various citizen service applications, and at the same time, they will serve as the basis for the operation of digital city. Due to the lack of city-level data, here we use the country-level data from the World Bank as an alternative.

2.2 Smart Economy

With the emergence of big data, data has increasingly become the most basic factor of production, and has received extensive 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. Industry digitalization includes the increasing adoption of digital technology in various traditional industries and the transformation of the original operation mode; Digital industrialization refers to new industries formed by various new technologies, such as artificial intelligence industry, block chain industry, etc. Industry convergence and innovation is driven by digital technologies such as mobile internet. The boundaries of traditional industries are increasingly blurred, whereas new industries and formats emerge.

This section uses four indicators to interpret the smart economy, namely, interactive design, software development, digital application and credit rating. These indicators comprehensively examine a city's smart economy level from the applications in creative design, the level of development in software development, dynamism of the digital economy, and the energy level of urban information service industry. This paper comprehensively investigates the level of smart economy of a city and constructs a three-dimensional smart economy system.

Interpretation of sub-indicators

Interactive design

The interaction between virtual and entity 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 to represent the development level of graphic design and modeling design industry respectively. In this regard, Beijing's performance is the most outstanding, reflecting its status as a national cultural center and a visual arts center. In addition, the concentration of large state-owned engineering enterprises has placed its design capability at the top of the global cities. The next outstanding cities are London, New York and Shanghai, which are either the centers of global advertising, the gathering places of top architectural design firms, or design schools with many outstanding spillover effects. Today, these cities have become the industry hubs of the world as information technology fully interacts with traditional design methods.

Software development

Software development capability represents the capability of a city's software products and the level of factor market development. This indicator comprehensively examines several key indicators of the software development capability industry, which is the core department of the digital content industry, including business environment, legal environment, market conditions, talent pool, degree of specialization, infrastructure and connectivity, and living environment. The most outstanding performance in this field is in London, New York, Paris, Berlin, Singapore and Chicago. These cities have a stable legal environment and sufficient talent reserves. They are able to provide very full facilities in terms of the global connectivity of software and hardware. Tokyo, Los Angeles, Beijing, Shanghai, Mumbai, etc., are not so different from the cities mentioned above. Some have long been global multimedia hubs, such as Tokyo and Los Angeles; Some are emerging global software hubs in recent years, with prominent software clusters, such as Beijing, Shanghai and Mumbai.

Digital applications

This indicator comprehensively reflects a city's ICT application capability, as well as the quality and cost of relevant talents. Including availability of ICT software, availability of ICT professional scientists and engineers, availability of venture capital; Software research and development capability and export; Specialization of software development capability; The size of the leisure and entertainment sectors; Degree of specialization and track record; Information technology facilities; Quality of life and skill availability. The most outstanding performance in this respect is in Paris and London, which are famous university cities. The number of engineers is growing on a large scale. The urban environment can provide a better work-life balance. Then there are Seoul, Tokyo, New York, Singapore, Los Angeles and Hong Kong. These cities, for example, Seoul, Tokyo and Singapore, take the digital economy industry as their top priority in economic development; Or other industries that are closely related to the digital economy and have outstanding capabilities, such as Hollywood in Los Angeles, finance and business in New York and Hong Kong.

Development Level of Information Industry

The energy level of information service industry is a landmark indicator of a smart city. Considering that this data is difficult to obtain, and even if there is a city with this data, its connotation is also quite different, we selected the distribution of major information industry consulting companies and information industry operating companies in the world to evaluate the development level of urban information service industry. The most outstanding performances in this respect are New York and Shanghai, which embody the status of urban economic hubs of the two largest economies in the world. The cities ranked behind have a large gap with them. The cities with higher energy levels include Tokyo, Singapore, Mumbai, Beijing, Paris, Dubai and Hong Kong. These cities are either regional economic centers of information service industry or emerging clusters of information industry cities, which have performed well in the new information society.

Table 2-2 Smart economy ranking

City	Interactive design	Software development	Digital applications	Development level of info. ind.	Smart economy	Ranking
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

As can be seen from the table, New York, London and Beijing are in the top three respectively. Compared with the previous ranking, Chinese cities have consolidated their position in this category, which shows that the overall development level of China's smart economy has become very competitive internationally. Singapore, Chicago, Los Angeles, Tokyo and Hong Kong, which rank second, are all global cities that take the smart economy as their core strategy for 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 node cities in various regions, with a level of smart economy that matches the energy level of the nodes. Although Mumbai has performed well in software development and production level, which reflects its potential as a base of emerging smart economy, its application in the social and economic fields and the inadequacy of working and living environment restrict it from making further progress in the ranking. Buenos Aires, Rio, Cairo and other cities lag behind the above-mentioned cities in every index and are subject to the influence of their economic and political environment to a considerable extent

2.3 Smart Services

With the wide application of IOT, big data, artificial intelligence and other technologies, the digital and intelligent transformation of public services in smart cities is accelerating. The emergence of smart communities, smart medical care, smart campuses, smart transportation, smart government and other scenarios provides citizens with more personalized, diversified and intelligent services.

This section mainly interpreted from four aspects: medical and health service, public transportation service, intelligent education service and employment information service; and discuss how can smart services improve citizens' sense of happiness in urban life

Interpretation of sub-indicators

Medical and health services

The medical and health system is the main aspect of smart city construction. Since 2020, 90% of the COVID-19 cases in the world have occurred in cities. Although cities have responded by means of vaccination, physical isolation and epidemiological investigation, but the growing outbreak of the virus has caused urban health services to collapse and the health system is almost paralyzed. The popularity of COVID-19 has strengthened the city's demand for smart medical and health services. Different from the traditional medical model, smart medicine has obvious characteristics of numerology. Through "user-friendly" interaction, big data analysis and artificial intelligence, it can assist doctors in disease detection, improve diagnostic accuracy and efficiency, and play a role in improving the level of medical services and relieving the shortage of medical resources. The high degree of digitalization and intellectualization of medical services not only shortens the time and physical distance for medical treatment, but also promotes the openness and transparency of the medical treatment process, reduces the conflicts between doctors and patients, effectively protects the rights and interests of both doctors and patients, improves the efficiency and quality of medical treatment, and realizes the high degree of sharing of medical and health services.

With the help of "internet plus", online medicine can realize the optimal allocation of medical resources across time and space. Intelligent medical services, such as remote diagnosis, remote operation, remote first aid, remote monitoring, remote teaching and mobile medical care, have effectively solved the contradictions of unbalanced medical resources and asymmetric information

between doctors and patients. In order to meet the huge demand of users for medical treatment during the epidemic prevention period, online medical treatment has developed rapidly and is constantly penetrating potential users. This indicator mainly examines the improvement of online medical services to improve the level of medical and health system in smart cities.

Public transport services

Congestion is the most common problem of urban traffic, causing a series of economic, social and environmental problems, such as air pollution, energy waste, casualties and economic losses. In recent years, the technological revolution of "new four modernizations", a travel tool with the trend of motorization, intelligence, networking and sharing, is changing the development direction of global urban transportation services.

Intelligent transportation is based on the traditional transportation system and integrates high-tech IT technologies such as the IOT, cloud computing, big data, mobile internet, etc. It collects transportation information through high-tech and provides transportation information services under real-time transportation data. A large number of data processing technologies such as data model and data mining are used to realize the systematization, real-time, interactive information exchange and extensive service of intelligent transportation. Intelligent transportation service mainly provides application requirements in four aspects: first, monitoring real-time traffic and quickly feeding back traffic congestion, traffic accidents and other conditions to drivers and traffic management personnel in relevant sections; Second, to achieve mutual communication among drivers, dispatching management center and passengers, and improve the operation efficiency of shared vehicles, public rail transit and taxis; Thirdly, various kinds of comprehensive traffic information are provided to travelers in a timely manner through multi-media and multi-terminals; Fourthly, real-time data are used to assist drivers to drive cars, or replace drivers to drive cars automatically. The choice of "convenient transportation" in this section reflects the timeliness, reliability and safety of the public transportation network. This indicator mainly includes the residents' dependence on intelligent technology.

Intelligent education service

As one of the major livelihood issues, with the rapid development of urbanization, the problems of shortage of educational resources, uneven distribution, inadequate personnel support system, and imperfect social training system are beginning to emerge.

Intelligent education services mainly solve the problems of education informatization, equalization and fairness through the co-construction and sharing of high-quality education resources. By introducing a new generation of information technology and creating a platform for intelligent education, education can be digitized, networked, intelligent and multimedia. Through the education portal, intelligent education learning platform and education resources trading platform, we can realize the co-construction and sharing of high-quality education resources, promote the deep-level reform of education, teaching and management, to a certain extent, ease the hot issues of public concern such as school selection and family education, and help realize the balance of education resources. The co-construction and sharing of educational resources are beneficial to the introduction of social capital, exploration of corporate operation, cultivation of intelligent education industry, construction of a lifelong education system with universal participation, and provision of convenient, high-quality, safe and efficient educational services for students and citizens. This indicator mainly reflects the utilization, convenience and richness of online education.

Online employment

Affected by the COVID-19 epidemic, jobs and wages in the global job market have both declined in recent years. The report "World Employment and Social Outlook Trends 2022" released by the International Labor Organization points out that as the COVID-19 pandemic continues to have a significant impact on the global labor market, the number of unemployed people in the world will reach 207 million in 2022, significantly exceeding the level of 186 million in 2019. The global labor market recovery is slow and uncertain. Due to the existence of information barriers and data islands, it is difficult to solve practical problems such as the interaction between supply and demand of employment, accurate matching of people and posts, career planning, information resource sharing, etc. by relying solely on traditional information means, which results in the coexistence of "difficult employment, difficult recruitment" and "jobs, posts, etc." At this stage, providing multi-channel, more matching and more convenient employment services to solve the employment problem, promote economic development and maintain social stability has become an important part of smart city construction.

Employment information service is mainly to enhance 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. The employment information service is mainly provided through online processing of employment services, accurate push of employment information and online visualization of interview and double selection meetings. The improvement of the informatization level of online employment service not only improves the matching degree of the demands of the employing units and the employees, but also provides effective and equal employment opportunities. This indicator mainly reflects the degree of informatization, convenience and supply-demand matching of online job hunting, online interview and other employment services.

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

Table 2-3 Smart Services Ranking

City	Online medical care	Convenient transportation	Online education	Online employment	Intelligent service	Ranking
Shanghai	99.9	100.0	100.0	99.1	99.7	1
Beijing	100.0	91.8	97.6	100.0	97.4	2
Dubai	99.6	94.3	87.8	84.2	91.5	3
Singapore	92.0	94.5	86.3	92.4	91.3	4
Bombay	96.4	81.5	85.2	90.9	88.5	5
Hong Kong	99.6	92.8	74.2	84.6	87.8	6
London	99.7	97.3	74.6	79.3	87.7	7
Moscow	92.4	90.9	75.1	91.9	87.6	8
New York	98.0	96.3	66.7	82.2	85.8	9
Sydney	99.7	88.1	67.1	84.5	84.8	10
Seoul	97.8	93.3	72.4	74.6	84.5	11
Los Angeles	96.0	89.5	67.5	80.9	83.5	12
Paris	99.3	97.3	65.3	63.4	81.3	13
Toronto	94.7	91.2	60.6	76.3	80.7	14
Cairo	98.3	84.4	57.4	80.1	80.0	15
Berlin	96.3	90.5	53.8	71.1	77.9	16
Chicago	78.7	94.0	58.1	77.1	77.0	17
Tokyo	92.4	96.8	41.9	69.0	75.0	18
Buenos Aires	96.4	82.1	47.6	61.7	72.0	19
Rio de Janeiro	94.2	83.1	29.2	59.6	66.5	20

The ranking results show that Shanghai, Beijing, Singapore and Dubai have the highest level of smart services, which is similar to the evaluation results of last year. Relying on the huge market demand, Shanghai and Beijing, as emerging global cities, have always been at the forefront of the world in the application of the new generation of technology market. Smart services such as First Network Office, Shared Travel, National 24365 Employment Service Platform for College Students, Health Code and Digital Sentinel have been effective in promoting online work, transportation and providing digital services, surpassing most cities in developed countries. Mumbai, Hong Kong, London, Moscow and other cities ranked next, either with convenient transportation or online employment. Although Sydney, Berlin, Chicago and other cities are developed cities, the level of intelligent service is relatively backward, especially in online education. Tokyo's level of smart services has been at the bottom. Compared with previous years, online medical services have improved significantly, but online education and employment services still score poorly. In the cities of Buenos Aires and Rio de Janeiro, many indicators lag behind other cities and are affected by their economic and political environment to a great extent.

Under the continuous impact of the COVID-19 epidemic, online medical care, online education, convenient transportation and online employment services will be further deepened. Among them, unmanned intelligent driving in the field of convenient transportation service will be the main race track for smart city construction competition. In Japan, the Road Traffic Law, which allows the use of Level L3 autonomous driving on expressways, came into force in April 2020. In the UK, from early 2022 onwards, vehicles with automatic lane keeping system (ALKS) technology will be the first batch of self-driving vehicles that meet the relevant requirements of the UK Automatic and Electric Vehicles Act (AEV Act). In February 2021, Germany passed amendments to the "Road Traffic Law" and "Compulsory Insurance Law"-the Autopilot Law. In March 2022, NHTSA of the United States issued the first standard rules for the protection and safety of automatic driving passengers. In April 2022, Beijing took the lead in carrying out pilot commercial operation of automatic driving nationwide, and the Implementation Rules for the Administration of Unmanned Road Testing and Demonstration Application of Passenger Cars in Beijing Intelligent Network Alliance Automotive Policy Leading Zone was officially released. From this point of view, the social and environmental conditions for the commercial landing of autonomous driving have been paid attention by governments of various countries, and the relevant legislative work is accelerating. Intelligent transportation service represented by autonomous driving will become the focus of future cities to improve the level of intelligence.

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" and is one of the internal driving forces and main objectives of smart city construction and continuous deepening development.

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

Interpretation of sub-indicators

Open data

Data openness can eliminate the phenomenon of "information isolated island" caused by poor information exchange among various departments within the city, and can protect the ordinary people's right to know about public affairs in the city. It is an important foundation to realize intelligent governance in the city.

This paper discusses the legal policy and organizational guarantee of data openness. Depth and breadth of data openness, freedom of access and data activity; User data usage and platform interaction; As well as the economic, political and social values brought by open data.

U.S. cities such as New York, Los Angeles and Chicago performed well in this score. Among the domestic cities, Hong Kong has achieved better results than Beijing and Shanghai, but the overall situation is not optimistic, and there is still room for greater progress.

Public safety

Safeguarding the personal and property safety of urban residents is one of the important functions of the local government, and is also an important prerequisite for a city to attract talents and settle down and work in peace and contentment. This year, the public safety score is adjusted to the digital safety index adopted by the Economist Intelligence Unit. It consists of data input and output. The input includes five aspects: privacy policy, citizen's awareness of digital threat, safe smart city, readiness for network arrangement and public-private partnership. Outputs include the proportion of Internet access, secure Internet servers, risk of attacks, IT infrastructure risks, and the proportion of computers affected by network attacks. Compared with the number of surveillance video installations in previous years, this new data can better reflect the situation of digital security.

Sydney, Singapore and New York rank in the top three in this index. Mumbai, Beijing and Rio scored relatively low in this regard.

Public participation

Public participation in smart governance refers to residents being able to communicate with government departments online end-to-end through mobile phones, tablets, computers and other terminals, instead of using the traditional offline one-way communication model. Through the online government platform, residents can put forward suggestions for government departments to further improve the appearance of the city, enhance the level of government services and improve the quality of life of urban residents.

As can be seen from the ranking, Beijing and Shanghai have achieved remarkable results in terms of public participation, with scores far higher than those of other cities, thanks to the in-depth implementation of China's government reform in recent years. The "one-netcom-run" model implemented in Beijing, Shanghai and other places has really realized the original intention of "letting data run more and letting the masses run fewer errands" and has greatly improved the sense of achievement and satisfaction of citizens and enterprises.

Social inclusion

A normal society must be diverse and colorful, and should not be single and monotonous. The so-called pluralism refers to the existence of not only a kind of values but also a way of life. It is precisely because there are different ways of life that society will become more colorful and people will have more choices. While 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, people's values are similar, and everyone lives the same way every day, the society will surely lack vitality and vitality, and lack innovation spirit and motivation.

Judging from the ranking score, Dubai is far ahead in social inclusion. Singapore and Sydney are close behind. China's cities such as Beijing, Shanghai and Hong Kong have performed generally in this respect, and 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: ecological sustainability, economic sustainability and social sustainability. The relationship between environmental protection and sustainable development is very close. Therefore, in the governance of each city, attention should be paid not only to the development of the city, but also to the environmental protection of the city. Therefore, in intelligent governance, the government should raise the people's awareness of environmental protection, solve the environmental crisis, change the traditional mode of production and consumption, develop science and technology, and speed up the research and development of new technologies for environmental protection.

Judging from the rankings and scores, Dubai has performed well in terms of sustainable development with full marks. Shanghai, Hong Kong and Beijing in China have low scores in this respect, hovering at the edge of the pass line, which indicates that China should change its development model as soon as possible and realize sustainable development as soon as possible.

According to the above indicators, the smart governance of the selected 20 cities are ranked as shown in Table 2-4.

<p align="center">**Table 2-4 Smart governance rankings**</p>

City	Open data	Public safety	Public participation	Social inclusion	Sustaina bility	Smart governance	Ranking
Los Angeles	100.0	98.6	68.7	70.7	88.3	85.2	1
London	98.0	92.1	61.6	76.6	96.1	84.9	2
Berlin	92.8	92.2	54.1	74.6	96.9	82.1	3
Sydney	92.1	100.0	60.1	89.3	68.1	81.9	4
Paris	93.3	83.4	58.2	74.4	100.0	81.9	4
Dubai	88.5	80.3	83.9	100.0	56.4	81.8	6
Singapore	92.5	99.5	73.1	90.6	47.1	80.6	7
New York	100.0	98.1	65.8	64.9	72.8	80.3	8
Tokyo	94.2	85.3	40.2	80.2	95.3	79.0	9
Seoul	92.6	74.6	72.3	75.6	67.3	76.5	10
Toronto	91.8	90.1	55.8	77.8	56.4	74.4	11
Shanghai	84.3	68.8	97.0	74.8	42.4	73.5	12
Chicago	100.0	92.2	59.1	66.2	48.7	73.2	13
Hong Kong	84.3	84.3	58.8	68.7	57.2	70.7	14
Moscow	77.6	71.4	75.3	64.9	61.9	70.2	15
Beijing	84.3	62.7	100.0	70.0	30.0	69.4	16
Buenos Aires	69.7	72.1	57.4	65.9	52.6	63.5	17
Rio de Janeiro	80.0	64.7	42.0	63.9	63.4	62.8	18
Bombay	50.7	54.6	82.0	64.1	37.8	57.8	19

2.5 Smart Innovation

Innovation is the core element of a smart city. The construction of a smart city mainly acts on urban innovation through the interaction of technological progress, organizational management and policy innovation. The construction of a smart city provides a spatial environment and essential resources for innovation, which in turn reverses to make the city smarter. The construction of various information platforms in the smart city construction project, such as smart transportation, smart government affairs, smart medical care, smart ecology and other platforms, requires the elimination of the digital divide, breaking the information isolated island, and promoting informatization, which is an innovation in itself and directly enhances the innovation capability of the city; On the contrary, the construction of smart cities relies on the emergence and upgrading of new generation of Internet information technologies such as big data, cloud computing, 5G, the IOT, artificial intelligence, and other hardware and software facilities such as intelligent terminals, which are conducive to the optimal allocation of information resources, improve the breadth and depth of information sharing and knowledge diffusion, reduce information asymmetry in the innovation process, improve the efficiency of resource utilization, and reduce various costs of innovation activities.

This section examines the innovation capability of smart cities from four aspects, which are scientific research strength of universities, scientific and technological R&D, innovation and entrepreneurship capabilities, and human skills. Based on the triple helix-Industry & University-Research theory, it compares the innovation capability of smart cities.

Interpretation of sub-indicators

University strength

Universities, especially world-class universities, are important participants in the construction of smart cities because they can nurture new ideas, cultivate innovative talents, support innovative industries and build strategic scientific and technological strength. Universities with high mobility are an inexhaustible source of new ideas and innovative activities. World-class universities, like a huge reservoir of innovative resources, not only gather global talents and knowledge, but also promote local innovation and entrepreneurship based on knowledge spillover effect.

This section examines the strength of universities in smart cities based on the world's top 1000 universities list released by QS. As modern universities originated in western developed countries, their founding concepts and evaluation criteria are in the obvious western discourse system. There are many

universities in the big cities of developed countries, with a history of over a hundred years and profound innovation. However, with the attention paid by emerging countries to the construction of universities, such as China's launching of "985 Project", "211 Project" and "Double First-class Project" to build world-class universities, the strength of universities in emerging global cities is growing rapidly.

Judging from the QS University ranking in 2021, London has the strongest overall universities, with several top universities, including UCL, Imperial College London and King's College London. For many years, London has been the favorite destination for international students. Seoul and Hong Kong came in second, with Seoul University, Koryo University, Sung Kwan Kwan University, Yonsei University and many other world-renowned universities, ranking second in the list of the best cities to study abroad. Tokyo's university ranking dropped slightly, while Beijing and Shanghai's universities rank in the middle.

Scientific research and development

Scientific research and development are the organic unity of scientific innovation and technological innovation, and involves many related fields such as science and technology, economy, society, etc. Universities, research institutes, national laboratories, engineering and technological research centers, and enterprise research laboratories absorb a large number of researchers and produce patents and academic documents, which can reflect the city's scientific and technological research and development capabilities. Smart cities provide a smart solution for the sustainable development, which is strongly related to the strong scientific and technological research and development strength. Information technology needs to be combined with industrial application. Cities can become more digital developed with the help of external development, for example, multinational companies with strong scientific and technological strength are brought to the cities and settle down. However, if they lack corresponding scientific research institutions and personnel, they would lack the necessary "absorptive capacity", which leads to the lack of sustainability of the city's scientific and technological development and would fall behind in the competition of global cities.

Research and development of science and technology is a comprehensive index, which mainly inspects the innovation of smart cities from the aspects of urban investment and financing environment, talent resource pool, and scientific and technological output. From the ranking point of view, New York still tops the list after last year's performance. Although New York's world-class universities are not outstanding, its development in science and technology is far ahead of other cities. New York is at the top of the list of many innovative cities. Amazon, Apple,

Google and Facebook, the four tech giants, all set up offices in New York. New York has surpassed the San Francisco region as the location of Silicon Valley in the technology field and is widely recognized as the world's technology leader. London, Los Angeles and Tokyo are closely followed, with Beijing and Shanghai in the middle position. Although the investment intensity of research and development funds in Beijing remained at about 6% in 2021, surpassing internationally renowned innovation cities such as New York, the quality of innovation output lags slightly behind, with relatively few key and disruptive technology outputs. Buenos Aires, Cairo and Mumbai have been at the bottom of the list for many years. Technological innovation requires large capital investment. The relatively backward economic development restricts the level of technological research and development in these cities.

Innovative entrepreneurship

Social progress and economic development stem from the continuous emergence of new technologies, new enterprises and the upgrading and replacement of industries. The new round of scientific and technological and industrial revolution have provided a large number of opportunities for innovation and entrepreneurship. The sub-index uses 2thinknow and the global entrepreneurship index to rank the innovation and entrepreneurship capabilities of global cities as a comprehensive index to highlight the performance of smart cities in innovation and entrepreneurship.

In terms of ranking, Tokyo, New York, Sydney and Singapore are at the top, among which Singapore has been rated as one of the most suitable cities for entrepreneurship all the year round and is the fourth largest and most competitive financial center in the world. Singapore is also considered as a low-risk city for international business, one of the cities with the lowest degree of commercial corruption and the highest degree of economic freedom. Seoul, Chicago, London, Paris and other cities followed closely, with Shanghai and Beijing ranking 7th and 10th respectively. According to the "Global Uicorne List in the Middle of 2022" released by the Hurun Research Institute, nearly half of the world's unicorns are located in the United States, with China ranking second with 312 unicorns. Among them, San Francisco is still rank first with 176 unicorns, New York is second with 120, Beijing is third with 90, Shanghai is fourth with 69, and London is fifth with 39. It can be seen from this that the innovation and entrepreneurship environment in Beijing and Shanghai is continuously improving, and a large number of high-value start-ups are emerging. Cairo and Mumbai are still at the bottom of the ranking, among which Mumbai ranks only 22nd in the 2020 global entrepreneurship ecosystem ranking released by Startup Blink, a global entrepreneurship research institution. At present, India still faces huge infrastructure problems, which

affect entrepreneurs and start-up enterprises. Compared with most other countries, India's internet speed is slow, and frequent power outages. Improving infrastructure is Mumbai's top priority in improving its innovation and entrepreneurship capabilities.

Human skills

Highly skilled personnel is the core element of smart city innovation, and human capital determines the magnitude and development of the new generation of global smart innovation cities. Human capital is the carrier of knowledge and the core driving force for urban innovation. More human capital is associated with higher people's incomes and higher innovation output, but in the past two years, many economies are facing the risk of losing a large part of the human capital due to the COVID-19 (Coronavirus) pandemic. In the epidemic era, the cultivation, attraction and agglomeration of human capital will be the main factors affecting the sustainable innovative development of cities.

Judging from the ranking of human skills, Singapore ranks first. In the Human Capital Index (HCI) released by the World Bank, Singapore is also the country with the highest score of human capital index. Singapore has invested heavily in the next generation of human capital in areas such as education and health. Hong Kong, Tokyo, Seoul and London are among the cities with the highest scores of human skills, while Beijing and Shanghai have low scores of human skills. However, judging from the global talent flow in recent years, the scores of human skills in Beijing and Shanghai are expected to improve significantly in the future. For example, in the list of "highly cited scientists" in the world for 2021 released by Clarivate, the United States has the largest number of highly cited scientists in the world (2,622), followed by mainland China (935), among which the Chinese Academy of Sciences in Beijing has become the world's second-largest scientific research institution after Harvard University with 194 highly cited scientists. Cairo and Mumbai scored the lowest in terms of human skills. Because of their low scores in various sub-indicators, Cairo and Mumbai ranked 19th and 20th in terms of intelligence and innovation, with a big gap with London, Tokyo and Seoul in the top three.

Table 2-5 Smart Innovation Ranking

City	University strength	Scientific research and development	Innovative entrepreneurship	Human skills	Smart innovation	Ranking
London	100	97.2	91.1	89.1	94.3	1
Tokyo	70	93.9	10 0	91.5	88.9	2
Seoul	80	91.1	92.9	90.9	88.7	3
New York	72	10 0	96.4	79.8	87.1	4
Sydney	78	83.0	94.6	87.6	85.8	5
Hong Kong	80	85.7	83.9	92.5	85.5	6
Singapore	60	85.4	94.6	10 0	85.0	7
Paris	66	86.0	91.1	86.8	82.4	8
Los Angeles	64	94.2	89.3	79.8	81.8	9
Chicago	64	87.6	92.9	79.8	81.1	10
Beijing	68	84.3	89.3	74.3	79.0	11
Shanghai	64	82.2	91.1	74.3	77.9	12
Moscow	66	75.1	85.7	77.5	76.1	13
Berlin	52	81.0	85.7	85.4	76.0	14
Toronto	50	77.0	83.9	90.7	75.4	15
Dubai	40	59.9	85.7	76.6	65.5	16
Rio de Janeiro	42	60.7	78.6	62.7	61.0	17
Buenos Aires	50	42.2	75.0	68.5	58.9	18
Cairo	42	44.7	73.2	56.2	54.0	19
Bombay	44	36.7	69.6	56.1	51.6	20

2.6 Smart Reputation

The world's major cities have already achieved many results in the construction of "smart cities". At the same time, there are also many theoretical research results. These research results reflect the achievements of smart city construction from different aspects and the degree of attention paid to the city. This year, we continue to track the reputation of smart cities with the help of academic databases. We examine the reputation of global smart cities from an academic perspective by examining the frequency of academic literature in different cities.

Using "smart cities/smart city" as the key word, with English names of different cities, we searched in the article titles, key words and abstracts among academic literatures in the Web of Science database. The time span was selected from January 2012 to June 2022. 1100 English literatures were found and we built the original database based on these resources.

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

Table 2-6 Global Smart Reputation and Smart Cities Ranking

Cities	Total Num. of Papers	Repu. Ranking	Smart City Ranking	Ranking Change
Singapore	88	1	3	
New York	84	2	2	
Beijing	83	3	8	
London	68	4	1	Reputation Smart CitiesR.
Seoul	63	5	11	
Shanghai	47	6	6	
Hong Kong	24	7	4	
Toronto	21	8	14	
Rio de Janeiro	20	9	19	
Tokyo	19	10	10	
Chicago	17	11	12	
dubai	17	11	13	
Moscow	15	13	16	
In Paris,	14	14	7	
Berlin	13	15	15	
Sydney	12	16	8	
mumbai	10	17	18	
Los Angeles	8	18	5	
Cairo	5	19	20	
Buenos Aires	3	20	17	

As can be seen from Table 2-6, Singapore, New York and Beijing rank among the top three in terms of attention and reputation for smart city research. Beijing's reputation has fallen slightly.

Judging from the difference between the two rankings, the most significant is that the academic reputation of Seoul, Rio de Janeiro and Toronto is far higher than their intelligence ranking, while Sydney, Los Angeles and Paris are just the opposite. Relevant research literature is far less than their actual intelligence level.

According to the top-level design of smart city, i.e. macro-model of smart city, specific application or optimization of specific application of smart city, and based on the results and spillover effects of smart city application, we divide the topics of the existing literature into three sub-categories: macro-model, research and specific application; and arranged by city, year and category. We obtain the results shown in Figure 2-1.
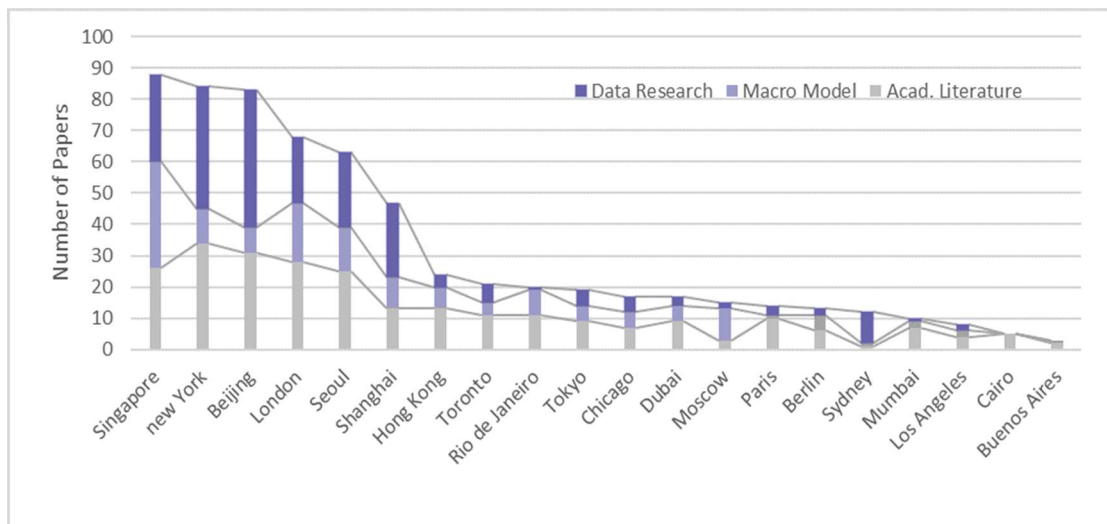
Figure 2-1 Number of Academic Articles on Smart Cities Worldwide (2012-2022)

From the perspective of sub-items, there is a situation of tripartite confrontation: Beijing ranks first in terms of data research; Singapore is most favored by the academic community in terms of model and is considered to be a model of smart cities. New York overtook Beijing to rank first in application.

3. Digital inclusion in smart cities

Inclusive cities generally refer to cities that allow everyone (regardless of gender, race, disability, age, sexual orientation, means of livelihood, immigration status or religion), to participate fully in the social, economic, cultural and political opportunities that cities must provide. In the capital of wisdom, everyone enjoys the same digital rights, which is the core of inclusiveness. This is illustrated by the case of New York and Tokyo, two major cities, in making digitalization inclusive.

3.1 Shanghai's Digital Inclusion Measures

Shanghai is one of the biggest cities in China with an aging population problem. By the end of 2020, Shanghai's elderly population aged 60+ had reached 5.3349 million, accounting for 21.4% of the total population.

In order to promote the development of the smart old-age care industry, Shanghai has launched a series of digital inclusion measures to enable the majority of the elderly to better adapt to the smart society, paying constant attention to the demands of the elderly and also other vulnerable groups (disabled groups, low-income groups etc). In 2021, starting from the application scenarios and based on the needs of the elderly, with assistant of pension service institutions and street communities, Shanghai sorted out and formed the first batch of 12 smart pension application scenarios, covering four categories: safety protection (6), care services (2), health services (2) and emotional care (2). Attract market forces through government procurement to contribute to Shanghai Digital Inclusion.

The following are some typical digital applications for the elderly.

(1) One-click taxi

The elderly in Beixinjing Street can place orders online using the community call terminal "One-touch Call Screen". They only need to enter the mobile phone number and the verification code, and wait for the taxi drivers to accept the order and come to pick them up at the designated boarding point. After a simple operation and 3 minutes of waiting, you can get on the taxi conveniently. Up to now, the streets have set 9 pick up points in 7 residential areas.

"One-touch Call Screen" also supports "Face swiping to Call a Car". After the system completes the face scanning recognition, it will automatically search for the vehicle to be transported that matches the closest distance. The license plate number, driver information and estimated arrival time will be displayed on the screen. The street has also built a white list with "Shencheng Travel" to create a green channel for the elderly and other vulnerable groups in the community, and to ensure that their taxi demand is given priority response.

(2) "Face wiping" payment

Community canteens in Cao Yang street Putuo District have smart dinner plates that can settle accounts by themselves. As long as the plates with chips are placed on the counter, the total price of the dishes can be displayed automatically. For the elderly over 60 years old, they can also bind their face information with their bank card, and pay for meals with "face scanning". The smart dinner plate not only greatly improves the efficiency and convenience for the elderly, but also scanning the orders so that the community canteens can better understand the tastes of the elderly and provide more considerate services.

(3) one-touch call

The "Cao Yang Spirit" in the streets of Cao Yang in Putuo District offers "whatever you want app"to the elderly: if you need help, you can press "call the community" to the "Cao Yang Spirit", you can make an instant call with the cadres of the neighborhood committee to learn about the latest developments in the community. Every morning you "punch the card" to the sound box, the neighborhood committee can simultaneously know the health status of the elderly and pay attention to it with precision.

The voice control operation is simple and easy to learn, the elderly punch in daily to report their safety, and the system background automatically counts these data. Once it is found that an elderly person has not punched in for several days in a row, the neighborhood committee cadres would carry out some visiting, in an appropriate way.

Putuo District has also installed a one-button calling device. There are emergency help, information inquiry and living services to the call center through the device. The call center is on duty for 7 ×24 hours. For the elderly who do not have telephone lines at home or are unwilling to install intelligent equipment, the call center will take care of them regularly, and pass the elderly information in the district-level database to the street and town communities. Through community intelligent audio and other equipment, the elderly information can be circulated efficiently between the town communities and the neighborhood committees. By the end of 2021, the "push-to-talk" emergency call is expected to cover the elderly service in the region.

(4) Policy personnel

Through digital means, Tianlin Street in Xuhui District "target" people who have not applied for various kinds of digital assistance, changing passive discovery into active service. The subdistrict office can find the residents who did the serious disease registration at the "One Network Communication Office". The big data platform automatically process data fusion and fill up the basic information of the family, residence information, assistance information, label information, etc. and upload these information to "Hui Governance app" (an online policy consultation and service software in Xuhui District) and send a tasks to social workers for on-site visits to meet the demand of elderly groups.

3.2 Tokyo's Digital Inclusion Initiative

Tokyo is moving fast on the development of city intelligence level. The following is a brief introduction to Tokyo's efforts to better enable vulnerable groups to travel and participate in social activities.

(1) Popularize the application of barrier-free travel

Tokyo's barrier-free tourism promotion project has been working hard to improve the barrier-free environment in the city so that the disabled and the elderly can move around comfortably and easily. In terms of travel, local enterprises and citizens have jointly established an Accessible Japan portal for domestic and foreign tourists. This website provides information about transportation and how to find a barrier-free restaurant and a barrier-free toilet, and some other useful Japanese phrases. In addition, there are forums, blogs and accessible hotel databases on the website.

WheeLog! is the world's first mapping application that provides route information for wheelchair users. The routes taken by wheelchair users are recorded on the map, and other people can use the shared information to find the routes accessible by wheelchairs at a glance. In addition, wheelchair users can be helped to go out more actively through the barrier-free access information submitted by users, such as the locations of barrier-free toilets, elevators and ramps. WheeLog! applies not only to people in wheelchairs, but also to their families, friends and rehabilitation workers. About 30,000 people are using the application now, and people without disabilities account for 70% of the users. Wheelchair users said the app makes going out more fun, while those users without barriers are happy about their contributions helping others. Since autumn 2021, ANA's "Airport Access Navi" has started to provide information for the application to support wheelchair users to have a more enjoyable experience at the airport. Currently, WheeLog! It has cooperated with local governments such as Kobe City in Hyogo Prefecture and Jiutian City in Yamagata Prefecture.

(2) The "transparent panel" can communicate more vividly with the hearing-impaired people

The new application "See-Through Captions" makes the communication with deaf-mutes and hearing-impaired people more vivid. In the transparent caption panel, there is "see-through captions", which can display what the speaker said in real time. When the speaker speaks into the microphone, the tool automatically converts the speech into text and displays the spoken content on a transparent panel, such as subtitles. The prototype application was developed by Japan Display by combining the technology of displaying text on a PC display with Google's speech recognition technology. So far, two versions, fixed and hand-held, have been developed and piloted at the Tokyo Future Science Museum and the Tsukuba municipal government's comprehensive information desk. The team continuously validates and improves the tool by interviewing users to make it easier to use. People place great hopes on its potential as a next-generation communication tool to promote human-to-human interaction and information exchange.

3.3 New York's Digital Inclusion Initiative

In October 2021, Bill de Blasio, the mayor of New York, announced the "Master Plan for the Internet in New York". The master plan found that nearly one-third (29%) of households in New York lack broadband at home, while other households lack mobile connectivity. This means that nearly 3.4 million residents are partially or totally excluded from modern life. Based on this, the master plan has drawn up the first road map to narrow the digital divide and change the broadband market, which will motivate companies of all sizes, including those founded by ethnic minorities or women (M/WBE), to provide new high-performance and affordable broadband service options. Through this plan, New York will become the first city in the country to reverse the digital red line.

New York announced that it would use US$ 157 million to build a public-owned, open-access broadband infrastructure in the next 36 months, benefiting 1.6 million people in New York. New York has also established companies of various sizes, including multiple M/WBE, and another 70,000 New York Housing Authority (NYCHA) by early 2022[3]. Residents and 150,000 residents of surrounding communities provide fast, reliable and affordable connectivity options.

Differences between Internet infrastructure and Internet service providers (ISP) are particularly concentrated in specific geographical areas—the South Bronx, Upper Manhattan, southeastern Queens and central Brooklyn—where community poverty rates are among the highest in New York City. Due to the lack of competitive power of existing ISP, they have fewer service choices, which results in higher service prices. Since the launch of the Internet Master Plan in January 2020, the city has brought significant changes to the ISP market with the emergence of many new suppliers, approximately half of which are M/WBE or minority-dominated.

On May 27, 2022, Eric Adams, the new mayor of New York City, and the Commissioner of New York City's Department of Aging (DFTA) announced the distribution of 1,000 additional mobile tablets equipped with wireless networks to the elderly in New York to help them use city services. The goal is to remove the digital divide for the elderly in New York who do not have networked electronic devices. During the blockade due to the COVID-19 epidemic, services in the elderly centers turned to virtual programs and telephone services. The virtual program allows about 40,000 elderly people to safely use important services at home. In addition to maintaining participation and digital connectivity for the elderly, the distribution program also achieves one of the goals outlined in the DFTA Community Care Program to help the elderly spend their time at home and avoid entering the nursing home. Community care programs learned the lessons during the COVID-19 pandemic, such as expanding virtual services to keep many older people active so that they could willingly stay at home and avoid infection with COVID-19. Since Mayor Adams took office in January, about 3,700

③ The New York City Housing Authority (NYCHA), the largest public housing authority in North America, was established in 1935 to provide decent, affordable housing for low-income New Yorkers.

tablets have been distributed, and a total of 11,000 tablets have been distributed to the elderly in New York.

In addition to providing free Wi-Fi services by December 31, these tablets also have Zoom, Gmail and NYC COVID Safe apps installed to allow residents to access DFTA and other urban resources. The elderly will also receive free training on new tablets at the local elderly center and learn how to connect to the DFTA virtual program. During the distribution campaign, DFTA referred tablet recipients to the nearest elderly center that provides tablet use training.

On July 10, 2022, New York City Mayor, Chief Technology Officer (CTO) and LinkNYC Chief Executive Officer Nick Colvin unveiled the first Link5G kiosk located near Morris Heights in the Bronx. LinkNYC aims to provide free Wi-Fi, national telephone and other digital services to all New York residents. Link5G will provide mobile service providers with the necessary infrastructure to promote 5G wireless mobile phone services in the five districts.

New projects will give priority to those underserved communities. These communities were mainly lack of other broadband options, lack of existing Link NYC infrastructure , with low median annual income and high levels of pedestrian and street traffic. Once fully deployed, approximately 2,000 new Link5G kiosks will be located in five administrative districts, which will allow the entire LinkNYC network to cover at least 4,000 locations throughout the city. These wireless information kiosks will provide a wider range of free services to New York residents. The newly launched 5G spectrum radio will greatly improve the coverage and capacity of all New York residents, especially in areas previously underserved.

4. Conclusion

Based on the "5+1" theoretical framework, the report tracks and ranks the performance of 20 smart cities around the world. The results show that the group of leading, advanced and following cities remained stable overall. But the rankings of cities in the same group vary considerably. London, New York and Singapore continue to lead the world, making them the "big 3" in the world smart cities. In terms of smart reputation, Beijing replaces London as one of the cities with the best reputation.

With the development of the global digital economy and smart cities, people are increasingly aware of their digital rights. They hope that digitalization can benefit more groups, especially vulnerable groups, and avoid all kinds of discriminations. With the active advocacy of international organizations, such as the United Nations, the issue of digital rights and inclusion has received increasing attention. Major international cities and urban alliances have launched relevant policies and initiatives.

The Global Smart Cities Ranking has long focused heavily on inclusion and incorporated it into its indicators. In terms of digital infrastructure, for example, we look at mobile Internet penetration; In terms of digital services, we focus on digital applications such as citizens' travel, education and medical care. In the aspect of digital governance, we pay attention to the problem of digital security.

Finally, the report selects three cities that can be benchmarked in terms of inclusion, Shanghai, Tokyo and New York as examples of how they are using digital technology to drive inclusion. We've found that inclusion is not only about responsibility, it can also trigger a lot of innovation. The pursuit of perfection and testing in a special environment can promote innovation. We hope that in the future, more cities will continue to bring forth new ideas in this regard and build digital inclusive smart cities with their characteristics.

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Appendix：Indicator System

Secondary indicators	Level 3 indicators	Weight	Data source	Description
Smart infrastructure 20%	Mobile phone	25%	ITU	popularizing rate
	Next generation network	25%	ITU/Telecom Operators	4G penetration rate
	Exit bandwidth	25%	ITU	Bandwidth per capita
	Data center	25%	World bank	Millions of People Have Secure Internet Servers
Smart economy 20%	Interactive design	25%	Industry Ranking Plus Organization Distribution	
	Software development	25%	IBM	
	Digital applications	25%	PWC	
	Credit level	25%	Industry Ranking Plus Organization Distribution	
Smart governance 20%	Open data	20%	Government AI Readiness	Public data openness
	Public safety	20%	EIU Safe Cities Index 2021	Number of digital monitors
	Public participation	20%	Ranking of Smart Cities	The public reflects their opinions through the internet.
	Social inclusion	20%	Dynamic city ranking	The number gap between different population groups
	Sustainability	20%	Arcadis Sustainable Cities Index 2022	
Smart service 20%	Online medical care	25%	Ranking of Smart Cities	Make appointments through the internet
	Convenient transportation	25%	Global influence ranking	Travel reservation
	online education	25%	Ranking of Smart Cities	Carry out education and training through the network
	Online employment	25%	Ranking of Smart Cities	Looking for a job through the internet
Smart innovation 20%	University strength	25%	QS latest ranking	
	Scientific research and development	25%	Global Impact Cities Index	
	Innovative entrepreneurship	25%	2thinknow	
	Human skills	25%	Human Capital index	
Reputation for wisdom	Reflect the wisdom of the city reputation, equivalent to the brand image, as a reference index, not included in the total score			

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