

Beijing
Shanghai
Guangzhou
Shenzhen
Chengdu
Nanjing

Hangzhou
Wuhan
Hong Kong
Zhengzhou
Changsha
Suzhou

Xi'an
Xiamen
Chongqing
Tianjin
Qingdao
Ningbo

Kunming
Jinan
Hefei
Macao
Foshan
Zhuhai

Wuxi
Taiyuan
Guiyang
Shenyang
Fuzhou
Dalian

Nanchang
Zhongshan
Urumqi
Shijiazhuang
Changchun
Nanning

Harbin
Haikou
Lanzhou
Baoding
Tangshan
Hohhot



Chinese Cities of Opportunity 2020



中国发展研究基金会
China Development Research
Foundation



Seizing the new opportunities of China's urbanisation

While China has entered the mid to late stages of its urbanisation process, urbanisation maintains a strong driving force for China's economic and social development, yielding tremendous opportunities and potential for growth. In 2019, for the first time, the urbanisation rate of China's permanent population exceeded 60 percent, which is expected to approach the average level of developed countries in the next 20 years. However, the urbanisation rate of the registered population is currently below 45 percent. Continuous promotion of a new type of "people-centric urbanisation" will help narrow the gap between the economic and social development of urban and rural areas, extensively improve public services and social welfare, and provide internal impetus for robust economic growth. Moreover, since the start of the 21st century, a number of super-large urban clusters have emerged in the process of China's rapid urbanisation. Industrial agglomeration has proven to be a robust driver for economic growth, and urban clusters have become the most important centres for bolstering economic growth.

At present, the world is undergoing a period of great change unseen in a hundred years, and the development of cities plays a crucial role in addressing these challenges and seizing historic opportunities. Research by the China Development Research Foundation (CDRF) indicates that both the global and Chinese economy are being severely tested by the rise of competition among the major powers as well as anti-globalisation and economic nationalist sentiment. Yet China's large urban centres have continued to witness higher-than-average growth throughout this process. The unexpected COVID-19 outbreak of 2020 has posed a monumental challenge to urban development and governance, with large cities serving as the main battlefield in this crisis. But under the strong leadership of the Chinese government and the joint efforts of society as a whole, China has managed to control the epidemic relatively well, with the solid infrastructure of major cities, widespread application of information technologies, precise and efficient community management, extensive participation from social organisations, as well as an elevated sense of civic duty playing a crucial role in responding to the epidemic-driven crisis. All this has shown that cities, particularly large cities and urban clusters, possess strong resilience and excellent restorative capabilities in responding to crises.

As President Xi Jinping, who is also general secretary of the Communist Party of China Central Committee,

stressed, China must gradually form a "dual circulation" development pattern, in which the domestic economic cycle plays a leading role while the domestic and international dual circulations complement each other. This "dual circulation" not only demonstrates a logic of ensuring bottom-line security by improving economic resilience, but also a logic of expanding opening-up and integrated development with an enterprising spirit. In the process of developing a "dual circulation" pattern, cities—especially central cities—will play a leading role as platforms for growth and opening-up as well as pillars of resilience—veritable places of opportunity.

The China Development Research Foundation and PwC have paid close attention to China's urbanisation, with the *Cities of Opportunity* series of reports representing the key results of research. Since 2014, *Chinese Cities of Opportunity* has published seven consecutive issues. The report draws on the research perspective and analytical framework of PwC's *Cities of Opportunity*, while closely tracking the country's overall development strategy and creating an urban development evaluation index that's suited for the Chinese context in terms of the economy, society and people's livelihoods. Since its publication, the *Cities of Opportunity* series of reports have had wide-ranging social impact while receiving widespread attention from business and academic circles, and city governments of all levels.

The number of cities in this year's report has risen to 42, encompassing most provincial capital cities as well as key cities of comparable size and scale. In the selection of variables, we've placed more emphasis on the substance of high-quality urban development such as urban resilience, sustainable development, regional integrated development and refined urban management to reflect the core concerns of cities under the current new normal.

I would like to take this opportunity to express my appreciation and admiration for PwC's strong sense of social responsibility and the contribution of their insights to the development of China. I would also like to express my thanks to the PwC and CDRF teams for their efforts. Both sides are expected to continue this in-depth cooperation going forward and jointly contribute valuable insights to society.

Fang Jin

Fang Jin
Secretary General of the China Development
Research Foundation

Responding to challenges: Elevating urban resilience and digital transformation



The COVID-19 pandemic has brought unprecedented uncertainty to cities all around the world, causing a profound effect on the business operations and livelihoods of the residents of those cities. Irrespective of when a region or city can bring the epidemic under control, one thing is for certain: the world has changed, and with that change comes new challenges for society. Businesses are faced with an increasingly volatile external environment and more difficult business decisions, while many city dwellers are faced with immense changes to their everyday lives and risks to their job security.

As a society, it is vital we find ways to satisfactorily answer both questions: we need a stable urban environment for business that supports the health and prosperity of the people that lives there.

This raises important issues about the role of cities. In particular, global investors are increasingly thinking about the extent to which being physically together is important and the best ways to manage the risks of pandemics or other major emergencies.

On the risk side, cities need to be ready and responsive. How can adequate preparations be made? How can leaders respond swiftly and effectively? Learn, adjust and adapt? Repair, rebuild and restart? All these questions pose new challenges to urban resilience. Cities that are well prepared can expect more development opportunities, while cities with ageing structures may face more challenges.

Physical connection will always be important. However, the nature of that importance was changing before the pandemic, will change more quickly now, and will vary from place to place. Looking ahead, cities around the world may have to endure a certain period of uncertainty until new patterns of operations are established, and businesses and residents adapt to new business strategies and lifestyle habits. Optionality will be key – people will want both face-to-face connections as well as digitally-enabled ones. The more flexibility cities and businesses can offer, the better.

What's certain is that smart transformation strategies will play an indispensable role throughout this process. A reduction in cross-border travel and personal mobility paired with the rise of online meetings and working from home will have an impact on urban infrastructure and environment. There has been a trend of transitioning from

offline to online business and the increased use of smart devices and automated operations.

Technological advancements have provided modern cities with the means to respond with more flexibility than ever, making way for more agile recovery capabilities and greater resilience. In fact, during the pandemic, PwC China adopted WeFlex, a flexible work arrangement which utilises a variety of remote office tools to help our clients and employees smoothly navigate through these tough times.

However, these advances have also brought a new urgency for digitalisation, at scale, in business – no one can afford to be left behind.

Urbanisation in China is progressing rapidly, with urban infrastructure construction and modernisation advancing to higher levels while innovations such as mobile payments and e-commerce flourish amid the pandemic. By adopting digital transformation initiatives, many Chinese cities have developed effective response mechanisms for coping with the pandemic. In the coming years, urbanisation in China will continue to add momentum to regional economic growth. For the city, refined management, digital transformation, sustainability and resilience will all bring new development opportunities.

In keeping with our original intentions since entering the China market, PwC will continue to eagerly follow and engage in the progress of urbanisation in China, providing high-value products and services to Chinese cities and all types of businesses.

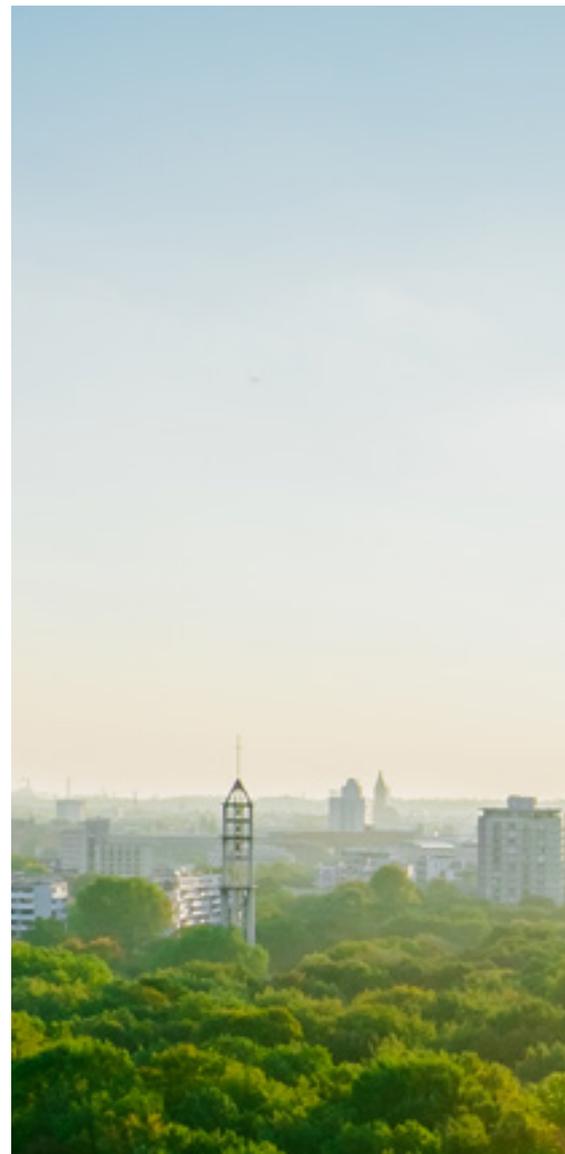
At the same time, we appreciate the continued generous support that the China Development Research Foundation (CDRF) has given to PwC China and the *Chinese Cities of Opportunity* study. We hope that our work will benefit the future development of Chinese cities.

A handwritten signature in black ink that reads "Bob Moritz". The signature is written in a cursive, flowing style.

Robert E. Moritz
PwC Global Chairman

Content

Overview	5
City selection	5
Research methodology	6
Observations	6
In-depth interviews	7
Comparison and analysis of ranking	8
1. Intellectual capital and innovation	10
(Interview) Liu Shijin: Two pillars of green urbanisation: accounting and technology	12
2. Technical maturity	14
3. Major regional cities	16
(Interview) Liu Zhibiao: Regional integration trends in the Yangtze River Delta	18
4. Urban resilience	20
(Interview) Yang Weimin: Three distinctions essential for refined urban governance	22
5. Transportation and urban planning	24
(Interview) Zhao Dan: A study of comprehensive risk assessment and urban resilience strategy for Beijing	26
6. Sustainable development	28
(Interview) Long Ying: Technology and the city: Enhancing urban resilience through smart city technology	30
7. Culture and quality of life	32
8. Economic clout	34
(Interview) Rao Xiang: Smart governance helps improve urban resilience	36
9. Cost	38
10. Ease of doing business	40
Variables	42
Supplement: PwC launches urban resilience Index	50
Acknowledgements	54
For further information	55



Overview

As hubs of social development, cities are faced with a myriad of diverse opportunities, bolstered by economic growth and scientific advances, as well as multiple obstacles and challenges. 2020 has brought challenges and uncertainty for a great number of cities, and has also presented us with a chance to slow down the pace of modern life and reconsider whether cities, in the midst of this rapid development, really possess the resilience to stave off risks and overcome challenges. Since 2014, the annual *Chinese Cities of Opportunity* report, jointly published by PwC and the China Development and Research Foundation has continued to monitor opportunities arising from China's urban development and track the progress of its urbanisation from different angles and perspectives. For each edition, we adjust our research priorities subject to the social and economic priorities of the year in China. This year, against the extraordinary backdrop of the COVID-19 outbreak, the 2020 edition pays attention to urban resilience and the sustainable development of cities, while incorporating some additional key elements and angles such as the refined management of cities and smart cities.

City selection

The range of cities we monitor has expanded over the years, from an original 15 in 2014 to 38 in 2019, including Beijing, Shanghai, Hong Kong and Macao. This year we have expanded the sample size to 42 cities, adding Changchun, Hohhot, Nanchang and Nanning to our list, with the aim of covering all the major cities in each region to provide more comprehensive observations. We have continued our efforts to monitor a relatively large number of cities in the following three major city clusters: the Beijing-Tianjin-Hebei Region, the Yangtze River Delta and the Guangdong-Hong Kong-Macao Greater Bay Area.

The 42 cities of the *Chinese Cities of Opportunity 2020* are as follows (roughly correlating from North to South, West to East): Harbin, Changchun, Shenyang, Dalian, Urumqi, Lanzhou, Xi'an, Hohhot, Taiyuan, Beijing, Tianjin, Shijiazhuang, Tangshan, Baoding, Jinan, Qingdao, Zhengzhou, Nanjing, Wuhan, Wuxi, Suzhou, Shanghai, Hangzhou, Ningbo, Hefei, Fuzhou, Xiamen, Changsha, Nanchang, Guangzhou, Shenzhen, Foshan, Zhongshan, Zhuhai, Chengdu, Chongqing, Kunming, Guiyang, Nanning, Haikou, as well as Hong Kong and Macao.





Research methodology

The *Chinese Cities of Opportunity* report uses PwC's city assessment tools to examine the selected cities. The tools provide targeted observations of the cities from ten dimensions, including economic growth, society and people's livelihood, urban infrastructure, the natural environment and influence. This year the scope has been enriched, with "health, safety and public security" being upgraded to "resilience", which is measured from multiple angles including the city's medical and healthcare services, production safety, natural disasters and public security. Urban resilience is not a brand-new concept, yet insufficient attention has been paid to this topic in previous years. Despite the limited supporting data and information, we tried as much as possible to choose appropriate variables applicable to this dimension. We set 55 variables under the ten dimensions, with some variables having two or three sub-indicators, and looked at both gross and per capita data to provide an overarching picture of each city's foundation for development and potential opportunities. We analyse all cities with consistent standards, while taking factors such as scale advantage into account. Our considerations for the design and data sources of these variables are detailed in the "Variables" section of this report.

The methodology is consistent with that of previous reports. Neither variables nor dimensions are weighted, every city has a ranking against each variable. One point is awarded for each position up the table, with the scores of the corresponding positions arranged in a descending order, i.e. the highest score, for the first place, is 42 points and the lowest score, for the last place, is one point, with tied rankings receiving equal points. However, for certain dimensions, such as cost, the scores are arranged in an ascending order, i.e. the scores reflect their corresponding positions in the table. The score awarded to each city constitutes its ranking for that dimension, and the sum of its scores across all dimensions constitutes the city's overall ranking in the report.

The data is sourced under the principles of objectivity, impartiality, rigour and applicability,

and mainly come from public sources, including the National Bureau of Statistics, government departments, official statistical yearbooks and bulletins published by each city, as well as research data from authoritative think tanks, universities and research institutes. The data cut-off point is the end of 2018, although some data from reliable sources is taken from a 2019 cut-off point. We refer to provincial-level data or other comparable data where the data released by a specific city is insufficient.

Observations

Chinese Cities of Opportunity 2020 has enlarged the scope of selected cities and enriched the dimensions and variables. It provides a comparatively independent observation for cities and reflects the research results under this year's specific framework, which also means the outcome of this report is not comparable with that of previous years.

According to the study results, the top ten cities are: Beijing, Shanghai, Guangzhou, Shenzhen, Chengdu, Nanjing, Hangzhou, Wuhan, Hong Kong, Zhengzhou. The second tier of ten are: Changsha, Suzhou, Xi'an, Xiamen, Chongqing, Tianjin, Qingdao, Ningbo, Kunming, Jinan. The third tier of ten are: Hefei, Macao, Foshan, Zhuhai, Wuxi, Taiyuan, Guiyang, Shenyang, Fuzhou, Dalian. The remaining 12 cities are: Nanchang, Zhongshan, Urumqi, Shijiazhuang, Changchun, Nanjing, Harbin, Haikou, Lanzhou, Baoding, Tangshan, Hohhot.

In respect of scale and development quality, the "Beijing, Shanghai, Guangzhou and Shenzhen" quartet are now China's "super first-tier" cities, each having its own influence on the international stage. In recent years, the "new first-tier" cities, among them Chengdu, Nanjing, Hangzhou, Wuhan and Zhengzhou, have also demonstrated ample growth drivers and talent attraction capabilities. In several dimensions, these "new first-tier" cities made their way into the top five places. For example, Changsha and Nanjing place third and fourth, respectively, for "intellectual capital and innovation", while Nanjing and Suzhou are joint-first and third for "transportation and urban planning".



The competition for mid-table has always been fierce; generally speaking, because each city has its own attributes, the overall ranking and the individual dimension ranking reflect each city's growth in different ways, so taking the multiple aspects of the results into account will provide a more informative and meaningful view of the cities.

Resilience is a key dimension this year, Hong Kong, Shanghai, Macao, Guangzhou, and Tianjin are the top five cities, which can be attributed to the significant efforts made by the respective local governments in relevant areas such as healthcare and disaster response measures, as well as their economic strengths and abundant resources. This gives these cities a certain edge and resilience in areas such as effective risk response and rapid recovery, which, in times of rising uncertainties and risks, naturally makes them a more attractive destination for investors. In the dimension of “sustainable development”, the top five are Shenzhen, Guangzhou, Ningbo, Changsha and Xiamen, which highlights that these cities possess the drivers and the foundation for sustainable development in terms of natural environment and population.

Due to space limitations, the report cannot provide in-depth analysis on each individual city. Those who are interested are welcomed to take a deeper look at the different variables and rankings, as well as the development strengths, industrial base and social environment of each city, thus identifying the opportunities that best reflect the development patterns of each city.

In-depth interviews

The *Chinese Cities of Opportunity 2020* is privileged to include insights from the following distinguished scholars, entrepreneurs and social elites.

Liu Shijin, vice chairman of the China Development Research Foundation, economist, shares his thoughtful observations on the future development direction of China's urbanisation. His topic is “Two pillars of green urbanisation: accounting and technology”.

Liu Zhibiao, director and chairman of the Yangtze Industrial Economic Institute (IDEI) of Nanjing University, also a distinguished professor of the Chang Jiang Scholars Program, analyses “Regional integration trends in the Yangtze River Delta” and challenges in the process of regional integration.

Yang Weimin, dean of China Institute for Development Planning at Tsinghua University, and deputy director-general of the Economic Committee of the CPPCC, stresses continuous improvement of urban governance is a key issue as China is steadily advancing its urbanisation. His topic is “Three distinctions essential for refined urban governance”.

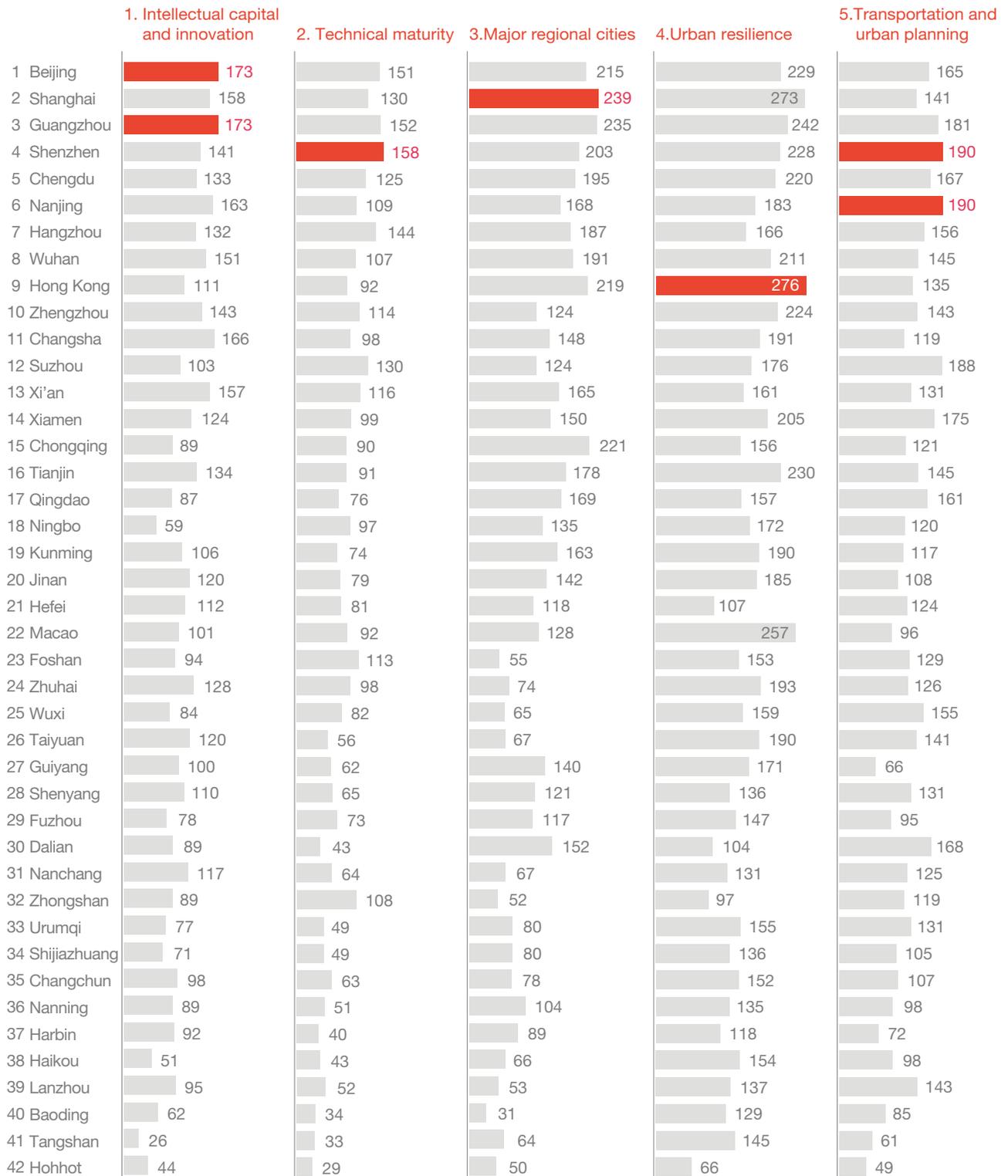
Zhao Dan, senior engineer of the Research Department of Planning, Beijing Municipal Institute of City Planning and Design, shares her findings in “A study of comprehensive risk assessment and urban resilience strategy for Beijing”, from perspective of urban planning and risk prevention and management, offering insights on megacities' resilience planning and practical experience.

Long Ying, researcher and PhD supervisor of the School of Architecture of Tsinghua University, shares his views on the application of smart city and new-generation information technology to improve city resilience in “Technology and the city: Enhancing urban resilience through smart city technology”.

Rao Xiang, president of Axon Technology Co., Ltd, shares his experience from perspectives of technological application in improving urban resilience, as well as business environment and social responsibility. His topic is “Smart governance helps improve urban resilience”.

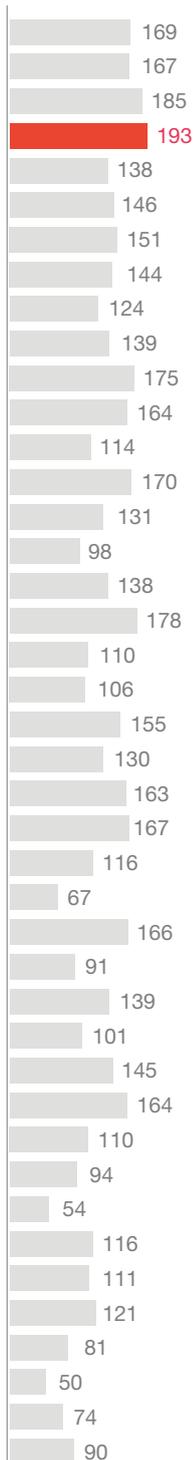
Our report is created from the standpoint of building social responsibility, and all participating interviewers share this vision. The views and visions from multi-dimensional perspectives of national think tanks, academic research and business management have broadened our vision on urban development and offered diversified insights to readers.

Comparison and analysis of ranking

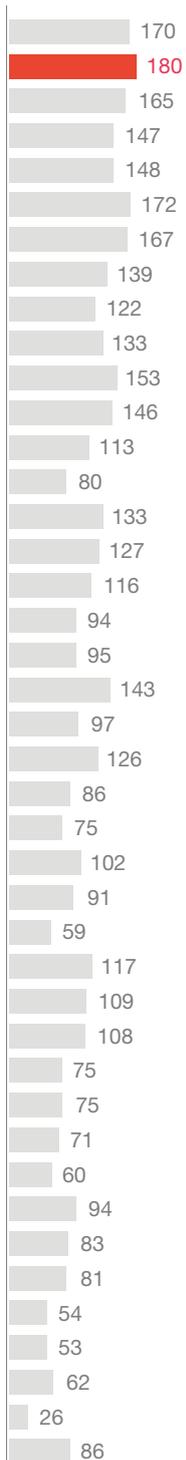




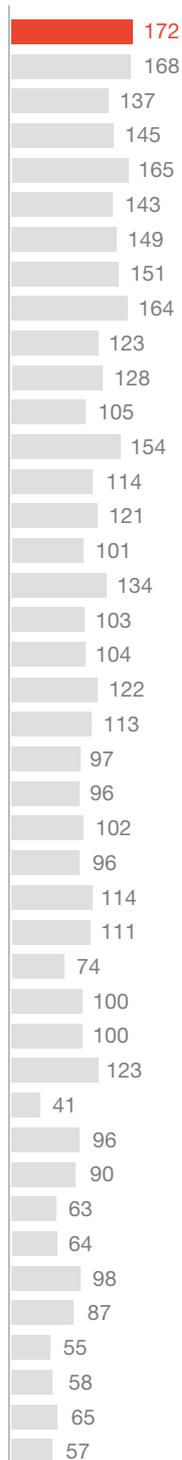
6. Sustainable development



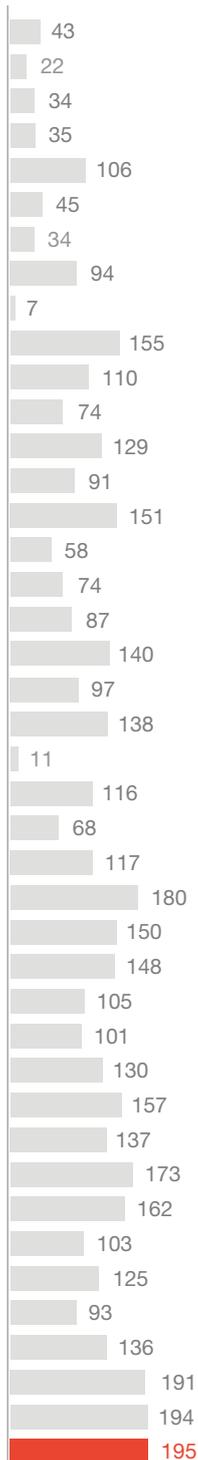
7. Culture and quality of life



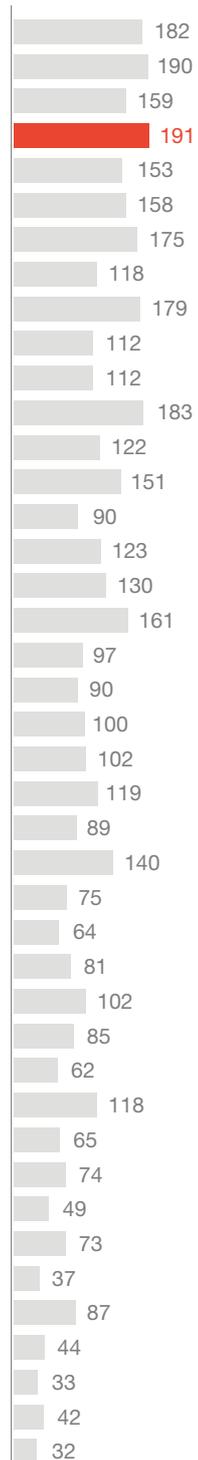
8. Economic clout



9. Cost



10. Ease of doing business



Score



1. Intellectual capital and innovation

The “intellectual capital and innovation” dimension includes two aspects and five variables. Firstly, the dimension measures the development of a city’s intellectual capital based on its educational resources and human capital. The “turnover rate of full-time teachers” measures the mid-to-long-term rate of change in investment for a city’s basic education resources. This reflects the change in the city’s demand for basic education resources, whereas the “educational level” and “scale of higher education” assess the current and future overall talent reserves of a city. Secondly, it observes the city’s investment in improving the support capacity of scientific and technological innovation, including the two variables of “state key laboratories” and “spending on science and technology”.

In this dimension, Beijing and Guangzhou are tied for first, followed by Changsha, Nanjing and Shanghai. While Beijing and Guangzhou share the same rank, each has their own unique strengths. Beijing has a significant advantage in scientific research and R&D investment, whereas Guangzhou continues to lead in terms of scale of higher education. The development of a city is linked to its reserves of talent, and many cities have in recent years joined the “war for talent” to strive for a greater competitive advantage. To a certain extent, the “turnover rate of full-time teachers” also reflects this trend of talent mobility. In addition to Shenzhen, Zhuhai and Suzhou, Xiamen ranks first by virtue of the quality of its basic education, while the attractiveness of Foshan continues to rise under the influence of its integration with Guangzhou, allowing it to place fifth. Changsha and Zhengzhou, two provincial capitals in central China, also perform well, ranking fourth and seventh, respectively.

Apart from Guangzhou, Zhengzhou, Wuhan and Jinan (all with a traditional reputation for education), Chengdu ranks fourth among the top cities in “scale of higher education”, as it continues to increase its funding, promoting the construction of “Double First-Class” colleges and universities and the development of vocational education, while strengthening the integration of industry and education, school-enterprise collaboration, and the rapid development of higher education. Bulwarking the strength of higher education is a city’s potential human capital reserves, which play an important role in a city’s high-

quality development into the future. At present, Chinese cities are in transition between old and new growth drivers, raising the requirements for the support of innovative talents. The growing proportion of highly educated and highly skilled population is increasingly important in building a city’s core competitiveness. Along with Guangzhou and Changsha, Shenyang ranks third in the “educational level” variable, with the city’s strong cultural foundation heavily supporting its industrial transformation and modernisation.

In addition to Beijing and Shanghai, the top-ranking cities in “state key laboratories” have made outstanding achievements in the construction of state key laboratories by taking advantage of their ample university resources and combining them with the unique development of local industries. State key laboratories are essential for cities in assembling leading talent and enhancing their technological competitiveness. They act as a strong support for a city’s independent capabilities for innovation. These leading cities also play an important role in tackling key core technologies in the future. “Spending on science and technology” reflects the willingness of local governments to invest in innovation. Macao, Shenzhen, Zhuhai, Beijing and Shanghai rank among the top five, indicating that these cities have invested heavily in scientific and technological innovation. It’s also worth mentioning that Shenzhen allocates one-third of its research funding towards foundational research every year, fully giving free rein to the guiding role of science and technology funding.

From a regional perspective, with the rise in the number of “new first-tier” cities, the gap in innovation capabilities between the eastern and western, the coastal and inland regions of China have gradually narrowed. Besides Beijing, Guangzhou, Shanghai and Shenzhen (all of which enjoy first-mover advantage), leading cities in the “intellectual capital and innovation” dimension include rising stars in central and western regions of China such as Changsha, Xi’an, Wuhan, Zhengzhou and Chengdu. In terms of urban innovative competitiveness, we see a trend of urban agglomeration and multi-polar coordinated development among leading cities and city clusters.





	Turnover rate of full-time teachers	Scale of higher education	State key laboratories	Spending on science and technology	Educational level	Score
1 Beijing	20	31	42	39	41	173
1 Guangzhou	22	42	37	32	40	173
3 Changsha	39	34	35	18	40	166
4 Nanjing	25	36	40	31	31	163
5 Shanghai	23	28	41	38	28	158
6 Xi'an	26	35	38	21	37	157
7 Wuhan	4	40	39	35	33	151
8 Zhengzhou	36	41	21	16	29	143
9 Shenzhen	41	3	21	41	35	141
10 Tianjin	17	29	34	26	28	134
11 Chengdu	32	39	31	19	12	133
12 Hangzhou	30	21	34	34	13	132
13 Zhuhai	37	8	9	40	34	128
14 Xiamen	42	11	24	28	19	124
15 Jinan	27	38	21	14	20	120
15 Taiyuan	15	22	21	25	37	120
17 Nanchang	24	33	14	22	24	117
18 Hefei	21	27	21	33	10	112
19 Hong Kong	14	9	36	10	42	111
20 Shenyang	8	20	31	11	40	110
21 Kunming	33	30	26	13	4	106
22 Suzhou	40	14	1	37	11	103
23 Macao	35	1	14	42	9	101
24 Guiyang	29	19	24	23	5	100
25 Changchun	3	23	34	8	30	98
26 Lanzhou	5	26	29	9	26	95
27 Foshan	38	6	1	27	22	94
28 Harbin	1	33	26	6	26	92
29 Chongqing	10	37	29	12	1	89
29 Dalian	9	16	24	24	16	89
29 Zhongshan	31	2	1	36	19	89
29 Nanning	28	24	14	2	21	89
33 Qingdao	19	18	27	20	3	87
34 Wuxi	18	4	14	29	19	84
35 Fuzhou	13	17	15	17	16	78
36 Urumqi	7	13	9	15	33	77
37 Shijiazhuang	12	25	21	5	8	71
38 Baoding	34	12	9	1	6	62
39 Ningbo	16	10	1	30	2	59
40 Haikou	2	7	14	4	24	51
41 Urumqi	11	15	1	3	14	44
42 Tangshan	6	5	1	7	7	26

Interview

Two pillars of green urbanisation: accounting and technology



Liu Shijin

Vice Chairman of the
China Development
Research Foundation

The 14th Five-Year Plan period (2021- 2025), is an important period for China's green transformation. During this period, China should strive to build a basic framework for green development and establish the "multiple pillars" in building ecological civilisation, including development concepts, policy goals, key areas, and institutional mechanisms. There is still room of about 20 percentage points for improvement in China's urbanisation process, with metropolitan areas and urban clusters showing the greatest potential for economic growth and restructuring in the long run. For the 14th Five-Year Plan period and the periods beyond, green urbanisation will be a main carrier of green development. Given the strong rigidity of urban construction, once an incorrect choice is made, the cost of correction will be extremely high. Therefore, green urbanisation strategies must be implemented unswervingly with foresight.

Green accounting and green technology constitute two pillars in accelerating green urbanisation and both are key areas that require prioritised attention.

Green accounting is to solve the "accounting" problem in green development. "Accounting" is the cornerstone of green development. Green GDP and other accounting methods have made meaningful attempts to incorporate environmental factors into GDP accounting, but there are defects or deficiencies with these methods such as lack of unified accounting dimensions, artificial rather than market-based methodologies to determine prices, and difficulties in applying accounting results, which are yet to meet the requirements of green transformation. To speed up the building of ecological civilisation and green development, we must pass the hurdles of green development, especially the "accounting" of the value of ecological capital services. First, we must find ways to make the value of ecological capital services measurable and accountable, and further solve the problem of monetisation and tradability of ecological capital services.

In this context, after several years of continuous efforts, one of our research teams, proposed and developed an accounting system for calculating the value of ecological capital services based on the "eco-element". Taking the value of ecosystem regulation services as the accounting object, this approach uses the value of solar energy as the

accounting dimension, and “eco-element” as the basic unit of accounting. First, it calculates the corresponding value of ecological capital services in the initial state not affected by human activities, i.e., the “eco-element”; then it considers the impact of environmental pollution treatment and ecological and environmental treatment on the value of ecological capital services respectively to make adjustments to the “eco-element” for devaluation and revaluation, and finally prices the “eco-element” based on appropriate market-based trading mechanisms. On this basis, the research team has explored multiple application scenarios employing digital technologies such as big data, artificial intelligence and block chain, hence providing effective support for real-time observation and calculation of the value of ecological capital services, green development performance assessment and evaluation, ecological compensation, ecological governance and investment decision-making, green finance. Currently, pilot projects have been launched in cities such as Xi’an and Shenzhen.

The second pillar of the green development framework is green technology promotion, with the focus on accelerating the promotion of major green technologies that are rather mature and those that can bring significant economic and social benefits. It is fair to say that the shift from traditional development through industrialisation to green development is driven by green technologies.

The China Council for International Cooperation on Environment and Development has brought together experts from China and abroad to conduct in-depth research and has proposed

20 major green technologies in six main sectors in the process of urbanisation, including water, energy, transportation, land use and planning, construction and food. We suggest that these technologies need to be promoted to the whole country during the 14th Five-Year Plan period, these technologies shall be included in the national, provincial and city 14th Five-Year Plans and special development plans as an important part of promoting green development. Meanwhile, it is necessary to improve the corresponding laws, plans, standards, information disclosure, fiscal and tax policies and financial policies to provide effective incentives for the promotion of green technologies. In mitigating the impact of the pandemic and restoring the economy and building new momentum for growth, priority should be given to the application and promotion of green technologies. In this regard, we need to make great efforts to build exchanges and cooperation platforms for domestic and foreign policy makers, and for enterprises and expert groups. We need to draw lessons and learn from international successful cases, technologies and policies in building green cities and carbon neutral communities. At the same time, we should also share China’s successful cases and experiences in promoting green technology with other countries to make green technology play its role in economic recovery and sustainable development.

2. Technical maturity

“Technical maturity” measures a city’s level of technological development. These technologies should be relatively mature, with large-scale applications or already ready to put to commercial use. The current generation of information technologies represented by big data, cloud computing and artificial intelligence has been gradually applied in a wide range of scenarios in urban life, with the digital economy becoming one of the key factors supporting quality urban development. As a result, this year’s analysis on the development of urban technologies will focus more on variables that reflect the degree of a city’s digital development, including the mobile Internet and digital industries. This dimension comprises four variables: “mobile phone penetration rate”, “mobile payment”, “Digital China (Index)” and “number of granted patents”.

The top five cities in this dimension are Shenzhen, Guangzhou, Beijing, Hangzhou and Shanghai. With its goal of building a capital of innovation, entrepreneurship and creativity with global influence, Shenzhen leads the pack and boasts a forward-looking deployment of emerging industries such as 5G and artificial intelligence. It ranks first in the two variables of “number of granted patents” and the “Digital China” index. In 2019, Shenzhen ranked second among China’s major cities in number of disclosures of domestic patents for invention in next-generation information technologies. Among them, the city ranked first in the number of patent disclosures in the field of 5G, enjoying significant advantages in its deep integration of technological innovation and socio-economic development.

Guangzhou performs well in the two variables of “mobile phone penetration rate” and the “Digital China” index, reflecting the high popularity and application of the mobile Internet and digital technologies in city life. Beijing has a solid digital foundation, particularly due to its leading position in the level of digitalisation of its industry, and it’s clear that the industrial Internet drives the digitalisation of the city. With its strong consumption of digital culture and the early start of its e-government services, Beijing maintains a leading position on the “Digital China” index. As the “city of mobile payments” Hangzhou relies on its foundational advantages in the informatisation of mobile payments to realise the integration of different

application scenarios such as commerce, government affairs and public services, while establishing a city-based cloud platform with mobile payments as its hub. Shanghai also posts outstanding performance in mobile payments and urban digital development.

What’s also noteworthy is that Suzhou ties for fifth place with Shanghai in this dimension, and ranks fourth in “number of patent grants”, which is directly tied to Suzhou’s efforts to promote the development of its intellectual property management and service system. Suzhou has set up a number of industrial intellectual property operation centres in its industrial concentration zones in order to build an international intellectual property operations and transactions centre, and to accelerate the transformation of scientific and technological achievements into real productivity. As a newly-added city this year, Changchun ranks sixth in “mobile phone penetration rate”, while Zhongshan and Urumqi rank fifth and ninth respectively, turning in outstanding performances in this variable.

“Technical maturity” can showcase the development feature of a certain region, the Guangdong-Hong Kong-Macao Greater Bay Area, with its overall strengths, takes a significant lead in the field of technological innovation. In terms of “number of granted patents”, Shenzhen, Zhongshan, Zhuhai, Foshan and Guangzhou all rank within the top ten, as the benefits of building an international technological innovation centre are gradually realised. Central and western cities are quickly catching up in the field of mobile payment, with Wuhan, Chongqing, Tianjin and Zhengzhou ranking fourth, fifth, sixth and 11th respectively in “mobile payment”, while demonstrating strong momentum. China’s urban digitisation process exhibits a tendency to cluster, relying on the market and the resource advantages of core cities to drive urban agglomeration and the development of surrounding cities. Among them, the growth rates of Beijing-Tianjin-Hebei, the Yangtze River Delta and the Guanzhong Plain urban clusters all exceed 90 percent, higher than that of western China, which got its start later. With the outbreak of the COVID-19, cities have accelerated the pace of “new infrastructure” construction led by 5G, and the industrial digitalisation potential of the western regions is expected to become further realised.

	Mobile phone penetration rate	Mobile payment	Digital China (Index)	Number of granted patents	Score
1 Shenzhen	39	36	41	42	158
2 Guangzhou	41	35	39	37	152
3 Beijing	33	40	42	36	151
4 Hangzhou	36	41	32	35	144
5 Shanghai	18	42	40	30	130
5 Suzhou	28	33	30	39	130
7 Chengdu	29	31	36	29	125
8 Xi'an	32	27	31	26	116
9 Zhengzhou	24	32	33	25	114
10 Foshan	31	16	28	38	113
11 Nanjing	16	34	27	32	109
12 Zhongshan	38	14	15	41	108
13 Wuhan	15	39	29	24	107
14 Xiamen	19	29	20	31	99
15 Changsha	23	20	34	21	98
15 Zhuhai	35	17	6	40	98
17 Ningbo	17	28	18	34	97
18 Hong Kong	40	1	38	13	92
18 Macao	42	2	37	11	92
20 Tianjin	1	37	26	27	91
21 Chongqing	3	38	35	14	90
22 Wuxi	13	23	13	33	82
23 Hefei	6	30	17	28	81
24 Jinan	11	21	25	22	79
25 Qingdao	10	19	24	23	76
26 Kunming	27	8	22	17	74
27 Fuzhou	5	26	23	19	73
28 Shenyang	21	10	19	15	65
29 Nanchang	8	24	12	20	64
30 Changchun	37	5	11	10	63
31 Guiyang	25	9	10	18	62
32 Taiyuan	26	13	9	8	56
33 Lanzhou	30	6	4	12	52
34 Nanning	14	18	16	3	51
35 Urumqi	34	4	2	9	49
35 Shijiazhuang	7	15	21	6	49
37 Dalian	9	11	7	16	43
37 Haikou	22	12	5	4	43
39 Harbin	12	7	14	7	40
40 Baoding	2	22	8	2	34
41 Tangshan	4	25	3	1	33
42 Hohhot	20	3	1	5	29

3. Major regional cities

The world today is undergoing a period of great change not seen in a hundred years, along with an extremely complex international environment. In order to effectively prevent the economic risks that may result from a severing of the global industrial chain and the reshuffling of supply chain, China proposes to accelerate the establishment of a “dual circulation” development pattern in which domestic economic cycle plays a leading role while international economic cycle remains its extension and supplement. At the meso level, the major regional cycle will play a key role in establishing this major domestic cycle. By advancing spatial reconstruction, infrastructure connectivity and the policy coordination of urban clusters, central cities with integrated overall strengths can leverage the advantages of their local resources to optimise the regional industrial structure and spatial layouts, forming unique advantages in industrial and supply chain in the region. Meanwhile, it will also help the city amplify its own influence and radiation effect and promote the coordinated development of regional integration, thus creating more opportunities for the city to undertake the nation’s regional coordinated development strategy. The “major regional cities” dimension has six variables: “star-graded hotels”, “international tourists”, “inbound and outbound flights”, “passenger capacity”, “freight volume” and “exhibition economy” to analyse how cities, as the key carriers of urban agglomeration, play a role in regional influence and spread.

Not surprisingly, Beijing, Shanghai, Guangzhou, Shenzhen and Hong Kong are leaders in this dimension. Strikingly, Chongqing and Chengdu rank third and seventh, respectively. The Chengdu-Chongqing urban cluster has become one of the important economic growth regions in China, and along with Wuhan, represent the urban cluster in the middle reaches of the Yangtze River. Together with the Guanzhong Plain urban cluster represented by Xi’an, these cities form an important support for the coordinated development of China’s eastern, central and western regions. Chongqing turns in an outstanding performance in “passenger capacity”, “freight volume” and “star-graded hotels”. Thanks to Chongqing’s strategic importance in the “Belt and Road”, the Yangtze River economic belt, the new western China land-sea corridor and the China-Europe rail assembly centre, in particular, its “freight volume” ranks first among all cities. With the aim of transforming into a global transportation

hub city, Chongqing will play an increasingly critical role in supporting the participation of western regions in international economic cooperation by taking the advantages of the development opportunity of the Chengdu Chongqing urban cluster.

In addition, Kunming ranks fifth in “inbound and outbound flights”, with its robust air passenger capacity playing an important role in supporting the flow of its logistics and passenger exchanges with other regions. Guiyang ranks second and sixth in “passenger capacity” and “freight volume” respectively, continually bringing forth the advantages of a comprehensive rail hub. The implementation of the master plan for a new western land-sea corridor further enhances the positional advantage of Guiyang, as its main channel. Together with Kunming, Guiyang should become an important gateway city for China to the south and southwest.

Among the three major regional development strategies, the Guangdong-Hong Kong-Macao Greater Bay Area has demonstrated the strongest comprehensive strength. As its central cities, Guangzhou, Hong Kong, and Shenzhen rank second, fourth and sixth, respectively, and the development level of each variable is relatively balanced. A solid foundation has been laid for achieving high-quality regional integration. Shanghai, Hangzhou and Nanjing in the Yangtze River Delta rank first, ninth and 12th, respectively, with Shanghai clearly as the lead driver, while Jiangsu and Zhejiang provinces fully leverage the comparative advantages of their respective central cities. In the future, cross-regional coordination and interaction can be further enhanced. The synergies of the Beijing-Tianjin-Hebei as a whole need further optimisation. Beijing and Tianjin rank fifth and tenth, respectively, yet the overall strengths of the cities in Hebei province are not strong. The high-quality construction of the Beijing Municipal Administration Centre and the Xiong’an New Area should accelerate the coordinated development of Beijing-Tianjin-Hebei region. In addition, we should fully leverage the advantages of the Beijing-Tianjin-Hebei region, the Yangtze River Delta, the Guangdong-Hong Kong-Macao Greater Bay Area and the Hainan Free Trade Port, which are at the forefront of opening up, to drive the development of “Belt and Road” and advance the mutual promotion of internal and external economic cycles.

	Star-graded hotels	International tourists	Inbound and outbound flights	Passenger capacity	Freight volume	Exhibition economy	Score
1 Shanghai	40	38	42	38	40	41	239
2 Guangzhou	38	40	40	37	41	39	235
3 Chongqing	39	34	34	39	42	33	221
4 Hong Kong	41	42	39	36	19	42	219
5 Beijing	42	37	41	40	15	40	215
6 Shenzhen	34	39	37	31	25	37	203
7 Chengdu	32	29	36	42	21	35	195
8 Wuhan	23	32	29	34	39	34	191
9 Hangzhou	37	28	33	32	26	31	187
10 Tianjin	29	36	26	29	36	22	178
11 Qingdao	35	26	27	18	27	36	169
12 Nanjing	26	25	32	27	29	29	168
13 Xi'an	31	27	35	33	16	23	165
14 Kunming	25	23	38	24	24	29	163
15 Dalian	36	22	22	20	34	18	152
16 Xiamen	24	35	30	15	22	24	150
17 Changsha	12	24	28	23	31	30	148
18 Jinan	23	13	19	28	32	27	142
19 Guiyang	13	5	23	41	37	21	140
20 Ningbo	33	20	9	19	38	16	135
21 Macao	31	41	7	10	1	38	128
22 Suzhou	27	31	1	35	10	20	124
22 Zhengzhou	3	14	31	26	18	32	124
24 Shenyang	29	18	20	30	14	10	121
25 Hefei	18	12	10	22	30	26	118
26 Fuzhou	10	33	17	25	20	12	117
27 Nanning	16	15	18	14	28	13	104
28 Harbin	19	10	21	21	3	15	89
29 Urumqi	14	17	25	4	13	7	80
29 Shijiazhuang	21	7	11	3	35	3	80
31 Changchun	4	16	12	17	4	25	78
32 Zhuhai	20	30	8	7	7	2	74
33 Taiyuan	18	8	14	6	2	19	67
33 Nanchang	9	9	15	11	9	14	67
35 Haikou	7	6	24	16	5	8	66
36 Wuxi	5	19	6	12	12	11	65
37 Tangshan	15	2	5	5	33	4	64
38 Foshan	9	4	4	9	23	6	55
39 Lanzhou	6	1	16	13	8	9	53
40 Zhongshan	1	21	1	1	11	17	52
41 Hohhot	2	11	13	2	17	5	50
42 Baoding	12	3	1	8	6	1	31

Interview

Regional integration trends in the Yangtze River Delta



Liu Zhibiao

Director and chairman,
the Yangtze IDEI of
Nanjing University
Changjiang distinguished
professor, Changjiang
Scholars Program

The integrated development of the Yangtze River Delta region is currently advancing at a steady pace, guided by a strategy of tackling easier challenges before moving to the more difficult issues. Jiangsu, Anhui and Zhejiang provinces and Shanghai Municipality have made significant strides in three main areas: unified planning, transportation and environmental protection. For example, they have made outstanding achievements in the coordination of provincial planning, integrated construction of demonstration zones, ecological environment protection along the Yangtze River, and connecting the roads networks. The main direction of integrated development is to increase market integration and make life more convenient for people living across the region. At a micro level, Market integration in particular is the foundation of economic integration in the Yangtze River Delta region.

Shanghai, the region's core city, is positioned to be a future world-class centre as proposed by the central government. The world-class positioning encompasses a technology centre with worldwide influence, international economic centre, international trade centre, international financial centre and international shipping centre. The main function of these centres is to provide services and their basic role is to reduce trade costs in the Yangtze River Delta, the coastal areas and China's economy in general. Meanwhile, other areas in the region are positioned to become manufacturing centres with the aim of reducing production costs. Only with the combination of minimised trade and manufacturing costs can the Yangtze River Delta truly become a world-class economic hub.

The integrated development of the region faces critical challenges in areas such as development maturity of the cities and governance. The major challenge is to change the "administrative area-based economic system" that was formed and strengthened gradually during China's transition to its current economic model. The system makes regional coordination and cooperation extremely difficult, hindering the creation of a unified, open, competitive and orderly market. In order to develop into a typical world-class city cluster, the Yangtze River Delta region must be transformed into a city cluster economy from the "administrative area-based economic system". The current system is based on administrative areas that have clear boundaries in terms of economic interests, while a city cluster economy is a market-based

integrated economic community that features cohesive internal development and external cooperation.

To break free from the constraints of the existing “administrative area-based economy”, a market-oriented approach should be adopted to drive trans-regional investment, mergers and acquisitions, and the development of consortiums among enterprises, as well as develop an integrated innovation community across different administrative areas. At the meso level, various operational organisations or community organisations with crossover coordination functions should be created so they can play a bridging role between the government and enterprises, elevating their engagement in policymaking regarding the city clusters cooperation. From a macro perspective, local governments should be encouraged to hand over part of their coordination authority to a unified institution on a voluntary and equal basis. For example, the decision-making authority for important coordination issues should be handed over to the Yangtze River Delta Joint Council of Principal Leaders. On the execution front, strategies and policies for the coordinated development of city clusters should be formulated to enable unified supervision, coordination and arbitration.

The most profound and far-reaching implication on regional integrated development brought about by the current changes in the international and domestic environments and the outbreak of the COVID-19 pandemic is the changes taking place in the global system of industrial division. Traditionally, globalisation meant that multinational corporations, guided by the theory of intra-product specialisation, conduct their

investment, production and marketing activities around the world. But nowadays, the China-US trade frictions and the pandemic have changed this model, which just focuses on economic efficiency, so that enterprises now also have to take economic security into account. Therefore, the global industrial chain may move towards a more inwardly focused development model, which means that the global value chain will likely be shortened in terms of vertical specialisation and tend to become regionally concentrated in terms of horizontal specialisation. This trend, led by multinational corporations, is most likely to give rise to a landscape featuring competition between global industrial chain clusters, and is similar to the current “dual-embedding” mode in the Yangtze River Delta, whereby enterprises are embedded into the global value chain and industrial clusters. This means that global competition in the future will comprise competition between industrial chains and clusters. Thus, the Chinese government must take measures to encourage enterprises to tighten, supplement, strengthen and solidify their industrial chains through investment, technology, the market and organisation, and build on the emerging “Head of industrial chain” and “Head of industrial cluster” systems, with a local official being appointed to take charge of one industrial chain or cluster, and transform existing industrial clusters into global industrial chain clusters.

4. Urban resilience

Cities are hosting an increasing amount of social and economic activities while facing potential crises and risks. The larger the city, the more serious the impact and potential for loss. The COVID-19 pandemic has significantly tested the integrated response of cities to major emergencies, increasing the awareness of city administrators on the importance and urgency of enhancing their city's resilience in response to various major emergencies and promoting intensive urban management. "Medical facilities", "physician resources", "public pensions", "public investment in healthcare", "public safety investment", "disaster prevention and emergency management", "loss due to disasters" and "production safety" are the eight variables that measure a city's fundamental capacity and investment in the fields of public health, natural disasters, work safety accidents and public safety, holistically assessing a city's resilience. Due to limited statistics, data from this dimension chiefly derive from two sources: a city's basic information resources and government investment related to risk preparedness. The degree of resilience is therefore tied to a city's level of economic development, with cities that with greater government resources being able to invest more.

"Medical facilities" and "physician resources" chiefly assess a city's professional institutions and staffing level to respond in the event of a crisis. Zhengzhou, Chengdu, Wuhan, Changsha, Kunming, Jinan, Hangzhou and Shenyang all show higher single variable rankings here than in their overall ranking. Shenyang ranks second in "medical facilities", far higher than its overall ranking of 33rd, demonstrating the progressive results of its medical alliance building across the city. The above-mentioned cities are also provincial capitals with relatively concentrated medical resources that can serve an entire province at a higher per capita level, and to a certain extent radiate out to the city clusters where they are located.

"Public investment in healthcare", "public safety investment" and "disaster prevention and emergency management" primarily measure a city's capacity to maintain day-to-day operations as well as the reserve emergency funds and key strategic materials needed

to continue operating and prevent possible emergencies. Hong Kong, Macao, Shenzhen and Zhuhai are among the top five in per capita expenditure on the three items, reflecting the strong economic strengths of the cities in the Guangdong-Hong Kong-Macao Greater Bay Area and the importance they attach to urban healthcare and emergency preparedness. Shanghai's overall advantages are also evident. With the goal of becoming a more sustainable and resilient eco-city, Shanghai not only relies on its economic strength to offer residents superior public services and social security, the city has also established a more complete top-level design for urban emergency response and preparedness, with balanced development across all eight variables. In addition, Tianjin ranks fifth in "disaster prevention and emergency management", as it prioritises local resources to emergencies. Urumqi ranks fifth in "public safety investment," with its public safety expenses having sustained an average annual growth rate of more than ten percent over the past ten years.

"Public pensions" measures the development level of basic public services for the elderly residents. Shenzhen has made remarkable strides in developing a high-quality pension system, ranking first in pension insurance coverage. Jinan promotes comprehensive coverage of community-based health and senior care services, ranking fifth in this variable. "Loss due to disasters" assesses the degree of economic loss resulting from disasters and reflects to a certain extent a city's ability to respond to and deal with major disasters. The top five cities in this variable are Macao, Haikou, Changsha, Taiyuan and Shanghai. "Production safety" measures a city's safeguards against major industrial accidents. Tianjin, Zhengzhou and Qingdao rank highly, with Tianjin also having allocated special funds towards work safety in support of emergency preparedness and the development of a work safety system.

Generally speaking, depending on factors such as geographical location, natural resources, industrial structure and level of development, the types of potential risks faced by cities can be different, which can in turn affect key areas of government investment.

	Medical facilities	Physician resources	Public pensions	Public investment in healthcare	Public safety investment	Disaster prevention and emergency management	Loss due to disasters	Production safety	Score
1 Hong Kong	18	22	41	41	41	42	34	37	276
2 Shanghai	34	30	27	38	37	36	38	33	273
3 Macao	1	15	34	42	42	39	42	42	257
4 Guangzhou	38	37	21	36	36	33	14	27	242
5 Tianjin	25	25	22	31	32	38	16	41	230
6 Beijing	36	42	40	23	31	21	6	30	229
7 Shenzhen	6	25	42	40	39	41	1	34	228
8 Zhengzhou	42	39	25	28	22	5	24	39	224
9 Chengdu	41	40	32	19	23	23	17	25	220
10 Wuhan	41	32	10	30	26	24	29	19	211
11 Xiamen	4	8	39	37	33	37	18	29	205
12 Zhuhai	3	14	31	39	40	40	2	24	193
13 Changsha	38	31	23	1	11	9	40	38	191
14 Kunming	28	36	13	24	25	28	33	3	190
14 Taiyuan	29	33	7	17	18	29	39	18	190
16 Jinan	32	38	38	8	15	27	15	12	185
17 Nanjing	26	36	8	33	35	20	5	20	183
18 Suzhou	19	18	15	29	34	34	10	17	176
19 Ningbo	8	20	29	34	30	17	3	31	172
20 Guiyang	18	17	12	25	29	11	23	36	171
21 Hangzhou	36	41	37	2	3	2	13	32	166
22 Xi'an	31	29	24	5	10	10	31	21	161
23 Wuxi	15	12	35	14	28	35	4	16	159
24 Qingdao	22	36	16	4	17	15	7	40	157
25 Chongqing	27	25	30	11	6	31	19	7	156
26 Urumqi	21	27	4	10	38	6	27	22	155
27 Haikou	10	27	3	27	19	4	41	23	154
28 Foshan	9	5	18	32	27	30	21	11	153
29 Changchun	30	20	9	20	13	26	26	8	152
30 Fuzhou	14	9	14	22	16	25	12	35	147
31 Tangshan	5	2	33	21	9	12	37	26	145
32 Lanzhou	20	17	5	16	21	22	30	6	137
33 Shenyang	41	28	28	12	5	1	11	10	136
33 Shijiazhuang	11	22	17	18	12	18	37	1	136
35 Nanning	16	4	1	26	20	32	32	4	135
36 Nanchang	12	3	19	35	24	3	22	13	131
37 Baoding	8	13	20	13	4	19	37	15	129
38 Harbin	34	6	11	9	2	14	28	14	118
39 Hefei	24	8	26	3	1	16	20	9	107
40 Dalian	23	12	6	6	14	7	8	28	104
41 Zhongshan	2	1	36	7	8	13	25	5	97
42 Hohhot	14	10	2	15	7	8	9	1	66

Interview

Three distinctions essential for refined urban governance



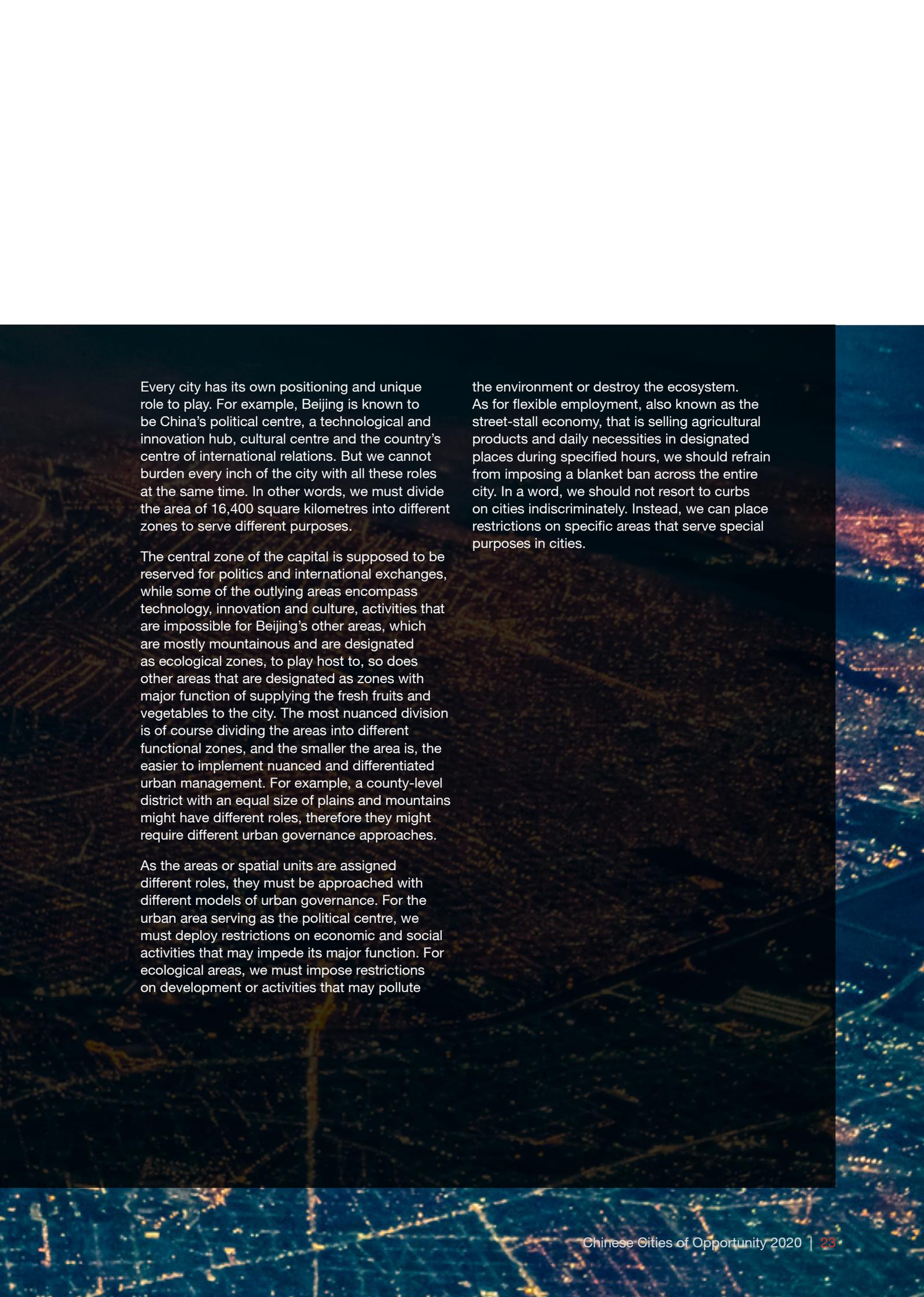
Yang Weimin

Deputy director-general,
the Economic Committee
of the National Committee
of the CPPCC

Dean, China Institute for
Development Planning
at Tsinghua University
(CIDP)

There is still much room for improvement when it comes to urban governance in China. It requires the drawing of at least three distinctions to be made: in the concept of cities; the functions of different areas or spatial units in cities; and the different ways that urban governance is applied in those areas.

There are at least three types of concepts in terms of cities in China. Firstly, a city is also an administrative district. For example, the area of Beijing as an administrative district is 16,400 square kilometres. Second, when we talk about cities, we usually refer to cities that are composed of districts, or designated areas. For example, Beijing used to comprise Dongcheng District, Xicheng District (Chongwen District and Xuanwu District were merged into Dongcheng District and Xicheng District, respectively), Chaoyang District, Haidian District, Fengtai District, and Shijingshan District, with Mentougou District a special case. Other administrative divisions are designated counties, which are different from the districts of a city and are therefore not considered part of urban areas in this sense. However, counties are now treated as districts and they are therefore consistent with administrative divisions in concept, which poses some challenges in terms of refined urban governance. The third concept of a city is restricted to the downtown area, or built-up area, which best represents the definition of a city. It is impossible to implement the refined urban management without clarifying these three concepts of cities. If we are going to create a policy that avoids fully negating the household registration system in megacities as we reform the household registration system, we must first define what we mean by megacities. Are we talking about them as administrative regions, designed districts or built-up areas? Chongqing, with a population of 30 million, is the largest city in China by the standard definition of an administrative region. Does that mean we cannot lift household registration system restrictions there? Actually, when we talk about retaining such restrictions, we are referring to downtown areas. Another example is regarding the regulations that prohibit the raising of pigs or chicken in urban areas. Do these restrictions apply to the districts that are mostly mountainous and far from the downtown area? If so, how can we hold the mayor accountable for supporting the “Non-Staple Food Project” in districts that used to be counties?



Every city has its own positioning and unique role to play. For example, Beijing is known to be China's political centre, a technological and innovation hub, cultural centre and the country's centre of international relations. But we cannot burden every inch of the city with all these roles at the same time. In other words, we must divide the area of 16,400 square kilometres into different zones to serve different purposes.

The central zone of the capital is supposed to be reserved for politics and international exchanges, while some of the outlying areas encompass technology, innovation and culture, activities that are impossible for Beijing's other areas, which are mostly mountainous and are designated as ecological zones, to play host to, so does other areas that are designated as zones with major function of supplying the fresh fruits and vegetables to the city. The most nuanced division is of course dividing the areas into different functional zones, and the smaller the area is, the easier to implement nuanced and differentiated urban management. For example, a county-level district with an equal size of plains and mountains might have different roles, therefore they might require different urban governance approaches.

As the areas or spatial units are assigned different roles, they must be approached with different models of urban governance. For the urban area serving as the political centre, we must deploy restrictions on economic and social activities that may impede its major function. For ecological areas, we must impose restrictions on development or activities that may pollute

the environment or destroy the ecosystem. As for flexible employment, also known as the street-stall economy, that is selling agricultural products and daily necessities in designated places during specified hours, we should refrain from imposing a blanket ban across the entire city. In a word, we should not resort to curbs on cities indiscriminately. Instead, we can place restrictions on specific areas that serve special purposes in cities.

5. Transportation and urban planning

The national urbanisation rate in China exceeded 60 percent for the first time in 2019 with the rapid pace of urbanisation in recent years. A science-based approach to city planning and traffic management is essential for promoting urbanisation, improving living standards and ensuring the availability of adequate urban functions and services to meet the needs of a growing population. This dimension comprises six variables: “road area”, “resident transportation” and “rail transit” reflect urban planning and traffic from the perspective of infrastructure building and carrying capacity; “traffic congestion” reflects the capacity of traffic management; and “green space coverage” and “urbanisation” reflect urban planning realities.

In this dimension, Shenzhen and Nanjing are tied for the top spot, followed by Suzhou, Guangzhou, Xiamen, Dalian, Chengdu, Beijing, Qingdao and Hangzhou. Nanjing ranks first for the fourth consecutive year, with its years of efforts in building the road and rail transit infrastructure continuing to pay dividends. Long-term landscaping and wetland protection have allowed green Jinling (ancient name of Nanjing), to rank in the top five in “road area”, “rail transit” and “green space coverage”. Third place Suzhou, also part of Jiangsu province, places first in “road area” and third in “traffic congestion”. With a resident population of more than ten million and an urbanisation rate of more than 75 percent, Suzhou continues to provide its citizens efficient transport facilities, reflecting the management level of its urban transport. Dalian, which ranks sixth, also turns in an outstanding performance, having built an urban-rural ecological spatial pattern known as “one ridge, two banks, multiple corridors and five gardens” and ranking high in “green space coverage”, whereas its wide rail transit coverage provides convenient travel for citizens, ranking in the top five for “rail transit”.

Traffic congestion is a common problem plaguing major cities, with Beijing, Guangzhou and Shanghai ranking 41st, 37th and 36th

respectively in this variable. Traffic congestion is the combined outcome of both urban public and private transportation. Shanghai, which ranks second in car ownership, relies on its wide rail transportation coverage to relieve pressure on its road traffic. With its high population density and high rates of vehicle ownership, Shenzhen ranks 15th, its efforts in developing intelligent transportation system in recent years have started to play a role. Ningbo, Wuxi, Suzhou, Nanchang and Zhongshan post the best performance in “traffic congestion”.

The top five cities in the “urbanisation” variable all come from the Guangdong-Hong Kong-Macao Greater Bay Area, which is consistent with its urbanisation level of more than 88 percent. Foshan and Zhongshan perform well in the variable of “road area”, while Zhuhai boasts a high rate of green space coverage. However, due to their low population densities and the interconnection of the urban clusters in the Greater Bay Area, the traffic carrying capacity required of these node cities is relatively low. “Resident transportation” and “rail transit” in these three cities therefore rank lower. Although Hong Kong and Macao have developed economies and are highly modernised, they are also constrained by their spatial patterns, and rank low in terms of road area per capita and ratio of green spaces in built-up areas.

New urbanisation is an important supporting element for domestic circulation and an important opportunity to improve urban development. However, we need to adhere to the principles of people-first, science-based planning to prevent and control “big city malaise”, improve urban infrastructure and public services such as transportation. At the same time, we can expand green space coverage and optimise planning by taking full advantage of modern technologies and intensive management to enhance the integrated development of our cities.



	Road area	Resident transportation	Rail transit	Traffic congestion	Green space coverage	Urbanisation	Score
1 Shenzhen	6	40	34	28	40	42	190
1 Nanjing	38	31	40	12	39	30	190
3 Suzhou	42	22	36	40	27	21	188
4 Guangzhou	22	42	37	6	41	33	181
5 Xiamen	39	31	12	19	37	37	175
6 Dalian	25	23	38	20	38	24	168
7 Chengdu	21	37	35	26	35	13	167
8 Beijing	4	42	41	2	42	34	165
9 Qingdao	34	31	31	31	19	15	161
10 Hangzhou	19	39	26	22	27	23	156
11 Wuxi	41	8	20	41	23	22	155
12 Wuhan	15	37	33	10	23	27	145
12 Tianjin	10	31	29	24	20	31	145
14 Zhengzhou	7	33	32	30	27	14	143
14 Lanzhou	35	19	23	33	4	29	143
16 Shanghai	1	35	42	7	21	35	141
16 Taiyuan	28	12	1	36	32	32	141
18 Hong Kong	2	24	39	26	2	42	135
19 Xi'an	31	38	22	8	16	16	131
19 Shenyang	23	34	16	17	13	28	131
19 Urumqi	11	26	9	37	30	18	131
22 Foshan	29	17	18	14	12	39	129
23 Zhuhai	13	16	11	21	27	38	126
24 Nanchang	14	4	19	39	32	17	125
25 Hefei	32	9	17	11	36	19	124
26 Chongqing	18	33	28	1	34	7	121
27 Ningbo	9	11	30	42	16	12	120
28 Changsha	16	22	24	15	16	26	119
28 Zhongshan	40	2	1	38	2	36	119
30 Kunming	5	27	27	18	29	11	117
31 Jinan	37	25	1	16	19	10	108
32 Changchun	27	16	25	5	33	1	107
33 Shijiazhuang	36	11	15	29	9	5	105
34 Haikou	24	7	1	34	7	25	98
34 Nanning	20	2	21	35	17	3	98
36 Macao	3	22	1	27	3	40	96
37 Fuzhou	17	5	13	23	28	9	95
38 Baoding	33	6	1	32	11	2	85
39 Harbin	26	19	10	4	7	6	72
40 Guiyang	8	13	14	3	8	20	66
41 Tangshan	30	3	1	13	10	4	61
42 Hohhot	12	14	1	9	5	8	49

Interview

A study of comprehensive risk assessment and resilient city planning strategy for Beijing



Zhao Dan

PhD, Senior Engineer
Research Department
of Planning, Beijing
Municipal Institute of City
Planning and Design

Editor's note: The following content was taken from speeches and related interviews at the Resilient City series seminars held by the Urban Land Institute (ULI).

Due to the complexity and increasing size of urban populations, megacities tend to become multi-risk areas prone to disasters, posing serious threats to urban security. With a diversified, mobile and complex population, megacities are particularly vulnerable in the face of uncertainties and emergencies. In addition, the tendency of overlapping urban disasters and ripple effects, as well as the continued emergence of new security risks, have had a huge impact on urban risk management and emergency response strategies.

The COVID-19 pandemic is perhaps the largest “black swan” event for public security in 2020. The outbreak highlights both the importance of managing public health emergency risks and the urgency of improving urban resilience. How to improve the ability of urban systems to adapt, withstand and recover in the face of uncertainties and to make urban planning more prescient and guidance-oriented have been the focal points for international research into urban planning in recent years. Resilient cities place a greater emphasis on the ability to tackle unknown risks and “black swan” events, providing a whole new perspective and approach for responding to urban disasters and safeguarding urban security.

In 2017, the Beijing Municipal Institute of City Planning and Design, together with Tsinghua University and other two agencies, launched a prospective study into resilient city planning guidelines for Beijing. Focusing on the nature of resilient cities, with comprehensive risk assessment and urban resilience evaluation at its core, the study constructed a complete theoretical system and technical framework for resilient city planning and proposed targeted measures and implementation paths for such planning. In particular, an in-depth study on scenarios involving flood and health risks was conducted.

Meanwhile, we also took certain health risks into consideration, mainly focusing on those associated with chronic and infectious diseases. We assessed the spatial risks and key influencing factors of typical epidemic diseases, and proposed corresponding measures to improve urban resilience. It was the first time that spatial epidemiology, urban planning and geography were combined with the intention of exploring the ways and methods for urban planning to proactively intervene to ensure public health.

In the study, we first conducted comprehensive risk assessments and zoning. We hoped to accurately record spatial information about various types of risks via risk assessment, thereby providing spatial guidance for the formulation of subsequent planning strategies. The study was conducted based on a whole-element database of 328 disaster risks, with 203 left after those that are irrelevant to Beijing, such as ocean and glacier risks, are eliminated. By exploring data from Cnki.net and utilising risk databases, we further identified 37 disaster risks that occur frequently, have a big impact, and are closely related to urban and rural planning. On the basis of single-disaster-risk assessment, we established a comprehensive risk assessment system for multi-disaster coupling, and compiled an integrated risk map for both Beijing and its downtown, which incorporated 8,291 zones classified by overall risks. Based on this, we screened and encoded high-risk zones, and set up a comprehensive risk database and information inquiry system.

Urban resilience is subject to a wide range of factors. Any possible loophole can have a huge impact on the entire system. We conducted a comprehensive quantitative assessment of Beijing

in terms of urban resilience to identify areas subject to further improvement and weaknesses in public security in the city.

Focusing on two dimensions, urban system and resilience management, we built an indicator system for resilient city evaluation covering 12 aspects and 83 performance indicators, which were then computed to produce a resilience index. Calculations showed that the overall resilience index for Beijing was 2.74 out of 5, meaning it is below the average level in terms of resilience. In particular, the city performed relatively weakly in areas such as ecological environment, ability to recover, and regional synergy. Performing the same calculations under the basis of implementing the new master plan, Beijing's urban resilience index is set to increase to 4.59 by 2035. This provides a clear roadmap and planning guidance for the construction of a resilient Beijing.

As a megacity, Beijing is densely populated with high mobility, making it a multi-risk area prone to disasters. On the other hand, as China's capital, Beijing faces higher requirements in terms of strategic positioning and livelihoods. Therefore, building a resilient city and safeguarding urban security is of paramount importance. On the basis of risk zoning and resilience evaluation, we proposed a targeted strategy for resilient city planning, focusing on four aspects including technology resilience, spatial resilience, engineering resilience, and organisation resilience. This strategy not only emphasises physical spatial planning but also stresses policy coordination and the continuous improvement of governance mechanisms.

6. Sustainable development

Against the backdrop of China's transition from high-speed economic growth to high-quality development, it's become increasingly critical to explore paths of sustainable development that both fit local conditions, while promoting coordinated development of economy, society and environment.

Environment and population are important resources in the sustainable development of cities. While economic development requires the expansion of population size, population expansion inevitably exacerbates environmental burdens, which hinders development. Therefore, with this year's dimension of "sustainable development", we pay further attention to the correlation between the environment and population, focusing on six variables: "water resources", "sewage treatment", "air quality", "population size", "population mobility" and "labour supply". The first three variables focus on evaluating the conditions surrounding the use and impact of natural resources in the process of a city's development, while the remaining three describe the condition of a city's population from different perspectives.

Shenzhen ranks first in this dimension, thanks largely to its strong population growth, taking the top spot in "population size" and "population mobility". In fact, Guangdong-Hong Kong-Macao Greater Bay Area cities generally perform well in this dimension, with Shenzhen, Guangzhou, Zhuhai, Zhongshan and Foshan placing second, seventh, tenth and 12th, respectively, mainly due to their advantages in the two variables of "water resources" and "population mobility". In terms of "water resources", the per capita water resources of cities in the Guangdong-Hong Kong-Macao Greater Bay Area are more abundant than those of northern cities, and in recent years Guangdong province has paid close attention to optimising water resource use in the Pearl River Delta. Through the Pearl River Delta Water Resources Allocation Project, Guangdong province will also guarantee stable water resources for the future development of the Guangdong-Hong Kong-Macao Greater Bay Area going forward. Zhongshan and Foshan rank second and third in "population mobility", respectively, whereas Guangzhou and Zhuhai also rank within the top ten. The region's ability to draw strong population is linked to the innovation platforms, employment

environments and inclusive atmosphere of first-tier cities such as Guangzhou and Shenzhen. Secondly, the Greater Bay Area's solid manufacturing base and gradient structure of its urban industries are conducive to attracting more high-end talent. At the same time, the high degree of integration between the central and surrounding cities allows people to move and relocate, thus the vitality brought about by population growth can be shared across the whole region.

Cities in the Yangtze River Delta also perform well in this dimension, with Ningbo, Shanghai, Suzhou and Hangzhou placing third, seventh, tenth and 14th, respectively. The city of Ningbo is an industrial powerhouse in Zhejiang province, featuring sustainable development that combines both effort and aesthetics. Ningbo's solid traditional manufacturing base of automobile, textile as well as emerging industries such as integrated circuits attract migrant workers, ranking second in "labour supply". On the other hand, in "air quality" and "water resources", Ningbo also ranks relatively high, which to a certain degree indicates that the city strikes a good balance between industrial development and ecological resource utilisation.

"Air quality" could be regarded as a city's calling card of green growth. In addition to southeast coastal cities such as Haikou, Xiamen, Fuzhou, Hong Kong and Macao, which are among the top cities year-round in this variable, western inland cities such as Guiyang, Kunming and Nanning also perform well.

As the saying goes, "If we live up to the nature, nature certainly won't let us down". Guided by China's national vision of green development, an increasing number of cities have begun to explore their own path toward sustainable development, eyeing a better life of green waters and blue skies, and through industrial transformation that attracts talent from all over the world. With the progressive implementation of national environmental protection measures such as the Air Pollution Prevention and Control Action Plan and the Action Plan for Prevention and Control of Water Pollution, as well as the optimisation of policies to attract migrants, we believe that Chinese cities will release greater vitality to drive sustainable development.





	Water resources	Sewage treatment	Air quality	Population size	Population mobility	Labour supply	Score
1 Shenzhen	24	23	36	42	42	26	193
2 Guangzhou	38	16	26	40	37	28	185
3 Ningbo	27	18	31	31	30	41	178
4 Changsha	42	32	21	32	18	30	175
5 Xiamen	21	21	41	22	39	26	170
6 Beijing	22	36	20	28	35	28	169
7 Shanghai	23	13	29	25	38	39	167
7 Zhuhai	39	25	35	24	33	11	167
9 Guiyang	31	30	39	21	19	26	166
10 Suzhou	37	12	22	19	34	40	164
10 Zhongshan	35	42	33	7	41	6	164
12 Foshan	40	1	27	29	40	26	163
13 Hefei	32	38	14	26	10	35	155
14 Hangzhou	25	17	19	36	25	29	151
15 Nanjing	36	22	13	16	23	36	146
16 Nanchang	29	34	25	19	7	31	145
17 Wuhan	34	19	11	38	24	18	144
18 Zhengzhou	7	28	6	37	27	34	139
18 Fuzhou	33	2	40	21	11	32	139
20 Chengdu	28	7	16	41	12	34	138
20 Qingdao	13	24	18	28	17	38	138
22 Chongqing	15	15	23	34	2	42	131
23 Macao	14	31	38	15	31	1	130
24 Hong Kong	5	42	38	13	6	20	124
25 Haikou	17	14	42	9	28	11	121
26 Wuxi	26	29	15	3	29	14	116
26 Nanning	41	4	32	17	3	19	116
28 Xi'an	20	6	7	39	4	38	114
29 Harbin	11	9	24	35	15	17	111
30 Kunming	4	26	34	11	22	13	110
30 Urumqi	19	37	9	1	36	8	110
32 Jinan	8	33	5	24	14	22	106
33 Dalian	12	8	30	8	21	22	101
34 Tianjin	2	5	8	34	32	17	98
35 Shijiazhuang	9	40	1	31	8	5	94
36 Shenyang	30	11	12	12	13	13	91
37 Hohhot	1	39	17	5	26	2	90
38 Lanzhou	18	20	10	2	16	15	81
39 Tangshan	10	35	2	14	9	4	74
40 Taiyuan	16	10	3	7	20	11	67
41 Changchun	6	3	28	5	5	7	54
42 Baoding	3	27	4	11	1	4	50

Interview

Technology and the city: Enhancing urban resilience through smart city technology



Long Ying

Researcher, PhD supervisor

School of Architecture, Tsinghua University

Editor's note: The following content was taken from speeches and related interviews at the Resilient Cities series seminars held by the Urban Land Institute (ULI).

In the post-COVID-19 era, what role will technology play in improving urban resilience?

We currently stand at the very beginning of Industry 4.0, the fourth industrial revolution. Many technologies that have shaped the modern society and urban operations have been invented and developed during the past decade, such as bicycle/car sharing, online food or courier delivery services, let alone the underlying infrastructure technology such as 4G, all emerged in the past ten years. It can therefore be said that the past decade has been a period of rapid development for the smart city and its underlying technologies. Looking back to 2013, when the SARS outbreak took place, many of these technologies did not yet exist at that time. The COVID-19 outbreak has therefore been very different, in terms of both urban and social operations, along with general lifestyle.

We have chosen ten technological developments that have had a profound impact on the development of urban society: big data, artificial intelligence (AI), mobile Internet, cloud computing, the Internet of Things, robotics, virtual reality, smart construction, blockchain and the sharing economy. Each of these technologies has played a crucially important role in allowing society to continue to function throughout the COVID-19 pandemic.

I. Big data. During the early stages of the pandemic, big data was used repeatedly for modelling the development of the outbreak. Big data can help model the spread of infectious diseases, maintain inter-city communications, make analyses and forecasts, and even monitor and analyse the behaviour of urban residents. Big data plays a huge role in supporting areas such as government operations, macro judgements, and public perceptions.

II. Artificial intelligence. Automated and remote services are further integrating AI into our everyday lives. The role of AI within this process includes reducing the need for human resources and improving service links.

III. Mobile Internet. Mobile Internet has been one of the most effective tools for epidemic prevention and control, greatly improving the efficiency of urban operations through cloud sharing, cloud conferences, online education, and remote working.

IV. Cloud computing. Big data analysis is supported by AI, which ultimately provides support for cloud computing results. With large scale expansions from providers such as Tencent Cloud and Aliyun, cloud computing can be dubbed a real “behind-the-scenes hero”.

V. The Internet of Things (or sensing equipment). Some new applications for the Internet of Things have emerged during the pandemic, such as the monitoring of medical resources and automatic package sensing. We believe that within the next ten years, the Internet of Things will be everywhere.

VI. Robotics. Drones have been used to broadcast information for epidemic prevention and control, and robots have been used for contactless food delivery. Such innovations also help improve urban resilience.

VII. Virtual reality. Virtual reality allows users to achieve a certain degree of satisfaction through a sense of reality, granting access to natural landscapes and marvels of human civilisation without even leaving the house, and thus avoiding human to human contact.

VIII. Smart construction. Modular construction such as embedded smart systems and prefabricated housing has helped us improve the speed, consistency, stability and efficiency of construction by reducing human resource requirements.

IX. Blockchain technology. Blockchain technology works in the background to achieve a balance between privacy and efficiency, making inter-departmental collaboration possible, for example. Indeed, blockchain is still an emerging technology, and I believe there will be much support for the technology in the coming decade. Blockchain will provide support for governmental efficiency, transparency, inter-departmental cooperation, and cross-industry collaboration.

X. Sharing economy. The sharing economy can be defined as the foundation of the smart city.

The ten technological developments mentioned above have all brought considerable progress to the construction of smart cities. However, smart cities are comprised of far more than these ten technologies. The emergence of the smart city has not been achieved solely through government-led initiatives, rather smart cities are built through the determination of different actors working from different perspectives, including Internet enterprises, technology companies, real estate agents, and consulting firms. Science and technology have achieved impressive results in epidemic prevention and control, but also hold great significance for smart city empowerment and improved urban resilience.

7. Culture and quality of life

The high-quality development of cities needs to adhere to people-centric development. It involves quality improvements in multiple aspects, such as economics, livelihood and culture, hence meeting the people's rising demand for a better life. Urban culture embodies people's lifestyles. The cultural deposits of a city and the lifestyles it represents are the driving forces behind its ability to unite people, attract outsiders and achieve sustainable development. The "culture and quality of life" dimension measures the vitality of urban culture and the quality of life for residents through five variables: "cultural industry employment", "number of cinemas", "library collections", "consumption vitality" and "housing supply".

It is obvious that the quality of life and cultural atmosphere in a city is affected by many factors, such as the history, customs and level of economic development. Beijing and Shanghai have clearly stated their vision and goals of building "Cultural Centre" and "Humanistic City" in their respective 2035 Master Plans, striving to enhance their international influence in terms of urban culture. The two cities rank first in "cultural industry employment" and "number of cinemas" respectively. Nanjing, Hangzhou, Changsha, Suzhou, and Jinan are well-known for their distinctive cultural features. Compared with megacities, the above-mentioned cities have a high level of housing security, strong consumption vitality, and high-level liveability, with Jinan ranking third in terms of "housing supply".

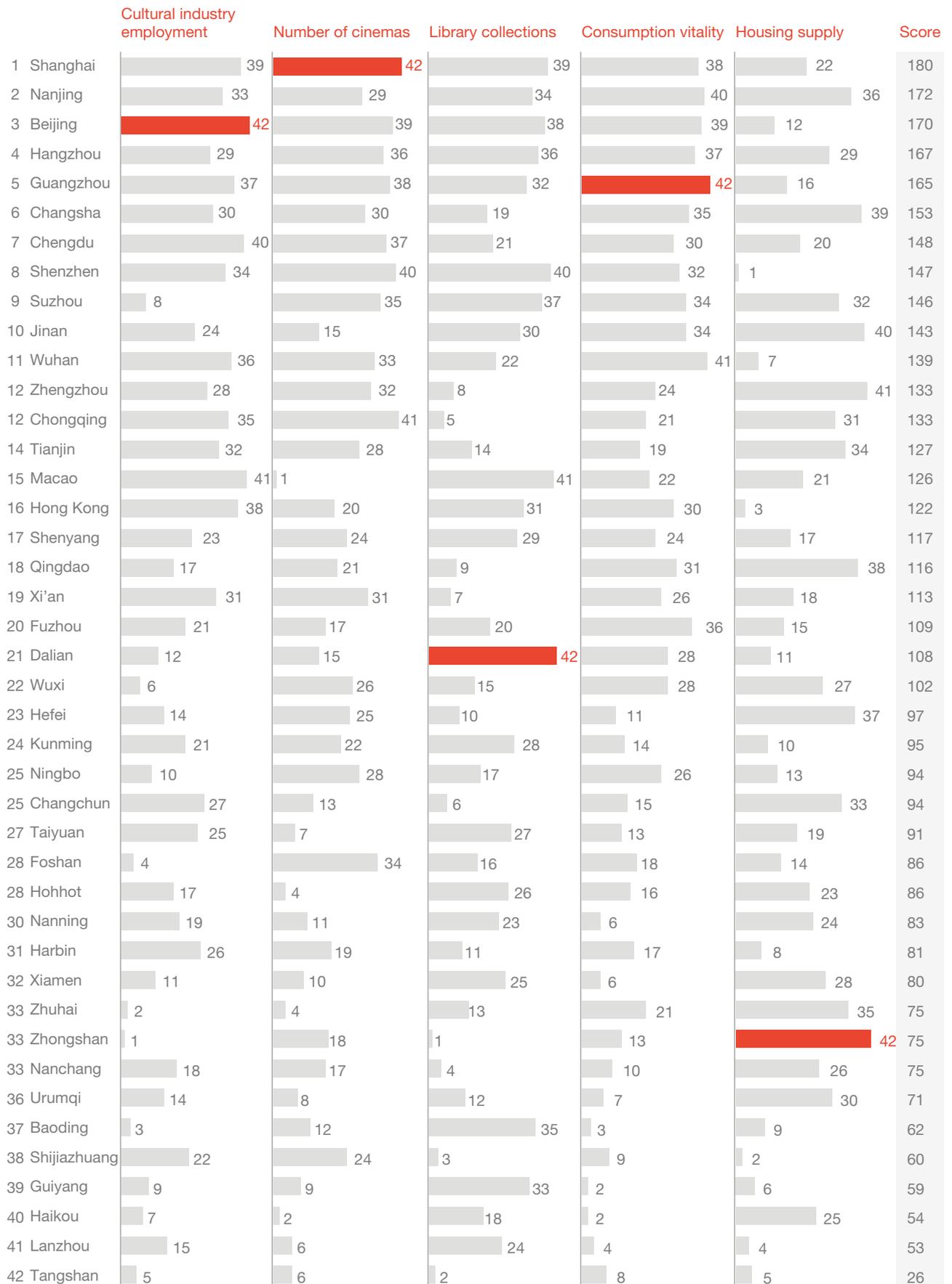
"Cultural industry employment" measures the development level of cultural and creative industries, while "number of cinemas" and "library collections" focus on the supply of cultural resources. The three variables measure the vitality of urban culture in a comprehensive way. Beijing ranks first in "cultural industry employment", closely followed by Macao and Chengdu. Macao is renowned for its gaming industry, which is an integral part of its tourism industry that has contributed over 70 percent of its GDP for many years. Chengdu is the cultural and creative centre in western China, and has formed a unique urban culture featuring animation, filming and esports. The two cities have large-scale cultural industries with their

own distinct characteristics. Dalian ranks first in "library collections", indicating that the city has a good foundation of public cultural resources.

"Consumption vitality" is one of the elements at the micro level that can best reflect the vitality of a city's population in a direct way, especially the new-type retail represented by "nighttime economy" and "small store economy", which effectively solves the employment problem for micro and small enterprises and self-employed businesses while boosts consumption and domestic economic circulation. As an international consumption centre in rapid development, Guangzhou ranks first in this variable. With the catering, online shopping and tourism have become its prominent strengths to attract consumption. With its vibrant "nighttime economy", Wuhan follows just behind Guangzhou. It is worth noting that the closing time of Wuhan Metro is only a bit earlier than that of Beijing, Shenzhen and Shanghai, which is convenient for people to travel at night and provides strong support for the thriving of its nighttime economy. Nanjing ranks third in this variable, buoyed by its strong consumption per person and exuberant local consumption demand. In addition, Fuzhou is another strong performer in this variable, ranking seventh, well above its overall ranking of 20th.

An important variable for measuring urban livelihood security is "housing supply". As the pressure to buy home increases, the trend of populations moving to economically strong and more habitable cities around megacities is becoming increasingly prominent. Adhering to the principle of "ensuring supply through multiple sources, providing housing support through multiple channels, and encouraging both housing purchase and renting", Zhongshan acts as a frontrunner in housing supply. Furthermore, the opening of the Shenzhen-Zhongshan Metro will further stimulate the city's development potential. Changsha has established a housing classification guarantee system for different groups of people, based on efforts to meet the demands for both essential and improved housing, while also implementing strict purchase restriction policies. Such actions have resulted in relatively low housing prices in "new first-tier" cities all year round, so that housing for everyone is practical and obtainable.





8. Economic clout

“Economic clout” focuses on a city’s overall strength in terms of economic development and economic clout by considering the city’s economic position, industrial structure and vitality level. It contains five variables: “well-known enterprises”, which is based on the number of top 500 enterprises’ headquarters based in each city, as published by fortunechina.com in 2019; “foreign direct investment”, the ratio between actual foreign capital used and GDP in a city; “proportion of the tertiary industry”, the proportion of the tertiary industry in each city’s GDP; and the two variables of “economic growth” and “size of economy”, where the regional GDP and its real growth rate of each city are included for comprehensive consideration of each city’s economic size and growth.

Beijing, Shanghai and Chengdu rank as the top three, Hong Kong ranks fourth, followed by Xi’an, Wuhan, Hangzhou, Shenzhen, Nanjing and Guangzhou. In this dimension, Beijing, Shanghai and Hong Kong, with their large economic size and a mature development level, have kept their economic growth stable, and also have an absolute advantage in “well-known enterprises” and “size of economy”. Chengdu ranks third, with relatively balanced scores across all variables. This has fully illustrated the good momentum that Chengdu, as the economic core of southwest China and a major regional city, has shown after setting the goal to “develop the new economy and foster the new economic drivers” in 2017.

It is noteworthy that the “new first-tier” cities, represented by regional centres such as Chengdu, Xi’an and Wuhan, as well as provincial capitals of developed eastern regions such as Hangzhou and Nanjing, are still in a rapid development period, ranking high in “foreign direct investment” and “economic growth”, respectively, and have achieved good results in the comprehensive rankings, with their overall strength and influence deepening. Additionally, with the implementation of a series of policies to expand foreign capital and encourage foreign investment into the manufacturing industry in recent years, Wuhan, as a leading manufacturing city in China, ranks high among the “new first-tier” cities in terms of “foreign direct investment” and “well-known enterprises”.

As for attracting foreign direct investment, cities in central and western China have been favoured by investors in recent years due to improvements in infrastructure and the business environment, as well as the concentration of population brought about by the transfer of various industries and modern urbanisation, with Nanchang, Xi’an and Wuhan performing well in “foreign direct investment”.

Under the impact of industrial transfer in recent years in eastern regions and amid the rapid development of big data and electronics industry, some southwest provincial capital cities such as Kunming and Guiyang, as well as Nanchang and Hefei in central China, have experienced rapid economic development and rank high in “economic growth”, foreseeing huge development potential in the future.



	Well-known enterprises	Foreign direct investment	Proportion of the tertiary industry	Economic growth	Size of economy	Score
1 Beijing	42	34	40	15	41	172
2 Shanghai	40	31	37	18	42	168
3 Chengdu	32	32	33	33	35	165
4 Hong Kong	41	42	41	1	39	164
5 Xi'an	29	37	30	35	23	154
6 Wuhan	34	36	14	33	34	151
7 Hangzhou	38	30	32	16	33	149
8 Shenzhen	39	18	21	27	40	145
9 Nanjing	36	16	27	33	31	143
10 Guangzhou	37	14	38	10	38	137
11 Qingdao	20	38	24	25	27	134
12 Changsha	14	33	15	38	28	128
13 Zhengzhou	20	25	18	34	26	123
13 Nanchang	25	40	3	40	15	123
15 Jinan	29	21	26	25	21	122
16 Chongqing	34	29	12	9	37	121
17 Xiamen	36	19	19	28	12	114
17 Taiyuan	31	2	30	41	10	114
19 Hefei	20	23	8	38	24	113
20 Guiyang	11	27	22	42	9	111
21 Suzhou	31	11	9	18	36	105
22 Kunming	29	8	17	36	14	104
23 Ningbo	25	24	5	20	29	103
24 Zhuhai	20	39	6	33	4	102
25 Tianjin	25	22	20	2	32	101
26 Fuzhou	20	6	13	39	22	100
26 Dalian	25	26	16	14	19	100
28 Harbin	11	35	34	5	13	98
29 Macao	3	41	42	4	7	97
30 Wuxi	14	17	10	25	30	96
30 Urumqi	25	1	35	29	6	96
30 Foshan	29	28	2	12	25	96
33 Shijiazhuang	11	13	25	25	16	90
34 Haikou	11	9	39	27	1	87
35 Shenyang	11	10	28	7	18	74
36 Tangshan	20	12	1	12	20	65
37 Nanning	3	20	23	7	11	64
38 Changchun	11	3	11	21	17	63
39 Baoding	14	15	4	20	5	58
40 Hohhot	11	4	36	3	3	57
41 Lanzhou	3	5	31	14	2	55
42 Zhongshan	11	7	7	8	8	41

Interview

Smart governance helps improve urban resilience



Rao Xiang

Chairman of Axon
Technology Co., Ltd

Smart technologies have tremendous potential in helping improve refined urban governance. In terms of urban resilience, smart tools can provide predictive analytics based on big data and historic information, enabling proactive monitoring, tracking and mitigation of risks, thus enhancing urban antifragility. They also serve as a technical foundation for refined governance and sustainable development of a city.

Data-based and intelligent technologies help us identify and predict risks. We can utilise data-based analytics tools to quantify the costs of potential risks and enhance preparedness. Furthermore, these tools can help minimise casualties and economic losses through data-powered calculations. Although the rapid development of technology has made the accurate prediction of some natural disasters such as typhoons and hurricanes a reality, in-depth predictions are just the beginning. The ultimate goal of such an endeavour is to leverage data in ways that allow us to scientifically prevent potential risks or disasters. For example, a nuclear accident caused by an earthquake or a tsunami can partly be attributed to significant deficiencies in the design of a nuclear power plant's safety features. Although the occurrence of a catastrophic tsunami is extremely unlikely, there are still some coastal nuclear power plants that have managed to avoid casualties by building more solid defensive capabilities.

Preparedness and data-driven preventive measures can also help boost the safety of urban areas. Through extensive research and analysis, we have found that many fires occurring in shopping malls and office buildings and even the fire at the Notre-Dame Cathedral in Paris, were essentially triggered by the same cause. Such accidents happen chiefly due to the inadvertent sparks produced by welding conducted during maintenance which can accidentally ignite surrounding flammable materials. For the sake of prevention, it is thus necessary to adjust maintenance processes and introduce more stringent safety precautions during such projects. Another proactive solution would be to deploy fire control facilities near the maintenance site in advance. By conducting analysis on urban fire data and utilising sensors and Internet of Things (IoT) for coordinated fire protection efforts, the allocation of fire control resources can be dynamically optimised. Thus, we will be in a better position to mitigate the adverse effects of disasters by adopting intelligent technology-enabled means. With regards to enhancing the safety of urban life, technology can also be used to help protect and manage the elderly. For example,



big data can be used to analyse the distribution of the urban elderly population based on their location, medical history, and current medical conditions. Cities can optimise their distribution of emergency resources for strokes, heart attacks, and other common diseases among the elderly by analysing the data, which can be anonymised to protect the privacy of those concerned. By doing so, the allocation of ambulances and equipment such as automated external defibrillator (AED) can be determined based on the distribution of elderly population and the probabilities of sudden outbreaks of diseases among them. The data-driven approaches can help maximise the efficient utilisation of scarce resources.

Our current response to the COVID-19 pandemic also highlights the necessity for proactively monitoring and tracking risks. On the one hand, if we were to increase our monitoring of seafood imported from overseas, it would incur more governance costs, but on the other hand, those costs would pale in comparison to the potential economic losses associated with the risks of another outbreak. In order to best mitigate the risks of a second wave of COVID-19 in the winter or another outbreak of some other new virus in the future, decision-makers need to adopt data-driven thinking and probability analysis. Only in this way will they be able to accurately predict and quantify the costs of risks, as well as calculate the required budget for prevention efforts. It is not just about the economics of the current situation because even a one-in-a-thousand risk may result in trillions of yuan in economic losses.

Smart technology can help decision-makers, from perspective of chaotic system, identify the major risks emanating from challenges such as pandemics, inflation, income inequality and even climate change, and then help them calculate

the risk-based weighted costs of such perils. However, we cannot and should not rely on artificial intelligence (AI) to plan everything for us. The refined management ultimately needs to be driven by our scientific thinking and a touch of humanism, in a way that combines our governance expertise with AI-powered big data capacity. Simply put, we must leverage modern means to integrate top-level planning with community-level experiences. By improving the governance of villages, towns and streets and incorporating them into top-level planning as well as carrying out benchmarking through open and distributed planning, we can replicate the best practices, thus improving the distributed governance capacity. We have already seen how big data and IoT can be used to improve customer experience in retail. Now we should look to apply similarly transparent, traceable and systematic approaches to urban governance. Only then can we effectively enhance the refined governance of our cities and quality of life for urban residents.

Realising sustainable urban development needs to face challenges head-on and tackle them in a proactive manner. Antifragility and ESG (environmental, social and governance)-oriented approaches are also proven formulas to sustainable urban development. Antifragility can create a wider scope for enterprises. For instance, manufacturers of masks and other medical protective products can maintain their daily production levels in normal times and play an enormously significant role in creating new development and employment opportunities during times of emergency. By evaluating all enterprises against ESG criteria and using big data to monitor them, we can help improve the overall sustainable development of a city through targeted and systematic government subsidies, among other measures.

9. Cost

The “cost” dimension, consisting of five variables, the “consumer price index”, “cost of public transport”, “cost of housing rental”, “cost of business occupancy” and “average salary”, depicts the cost of doing business and living in a city from perspectives of both investors and employees, and thus measures the city’s attractiveness to investors and talent. The ranking of the last four variables is based on the absolute value of their indicators. For example, Hong Kong ranks lowest among cities in “cost of business occupancy” with the highest business occupancy costs. “Consumer price index” is based on the overall rate of change in the consumer price index over the five years from 2014 to 2018, it is for the overall measurement of medium and long-term price turbulence, which can serve as a reference for investors and employees on cost risk. For example, Macao, the last-ranked city, witnessed the highest CPI increase in the five-year period.

By examining the “cost” dimension, we find that the economic development of a city remains highly correlated with its cost level. With a more developed economy and higher costs, the first-tier, coastal, and southern cities rank lower in this dimension, consistent with our usual subjective perceptions. For example, the overall top-ranked cities such as Beijing, Shanghai, Guangzhou, Shenzhen, Nanjing and Hangzhou all rank last in the “cost” dimension, indicating that higher operating costs do not limit urban development, which is a natural consequence along with development. In this context, we measure costs only on the basis of prices or price indices without considering the impact of production efficiency on output. High costs in developed cities may further drive the transformation of economic structures towards more intellectually intensive and higher value-added industries, accelerating the upgrading of industries of surrounding cities. Meanwhile, prices are a double-edged sword. Salaries are on the one hand the cost of labour for enterprises, on the other hand, the income of residents. High prices to a certain extent can

promote a rapid economy cycle and give rise to a new type of economy driven by consumption.

The “cost” dimension does not necessarily remain consistent in the face of fluctuations in urban economic development. For example, Chinese inland cities such as Chengdu, Wuhan, Zhengzhou, and Changsha have grown rapidly in recent years but still maintain relatively reasonable cost levels, boding well for continued growth opportunities in the future. There are different causes for cities where costs don’t cohere with economic fluctuations. For example, Hong Kong receives a ninth overall ranking this year, but it still maintains the last place in the “cost” dimension as in previous years, indirectly reflecting the stickiness of costs in the face of economic downside risks. On the other hand, Haikou ranks 28th in this dimension, with relatively high costs compared to its overall ranking, partly reflecting the role of Hainan’s pillar industry, tourism, in supporting prices. The planning of Hainan’s free trade zone also brings a broader economic development prospects for Haikou in terms of consumption, trade, modern services and high-tech industries, with prices showing a significant upward sensitivity in the face of economic development opportunities.

Considering various cost variables, Zhengzhou, Wuxi, and Zhongshan have a great advantage in “cost of business occupancy” in terms of their economic development level. For cities surrounding Beijing such as Shijiazhuang, Tangshan, and Baoding, “average salary”, namely the labour costs, is growing but still have some room. “Cost of housing rental” in Taiyuan and Guiyang is still at a relatively low level, helping attract talent. A city’s potential development opportunities are always a comprehensive consideration for investors with different preferences.

	Consumer price index	Cost of public transport	Cost of housing rental	Cost of business occupancy	Average salary	Score
1 Hohhot	37	40	39	39	40	195
2 Tangshan	35	35	41	42	41	194
3 Baoding	30	36	42	41	42	191
4 Taiyuan	41	37	38	32	32	180
5 Shijiazhuang	33	31	40	32	37	173
6 Changchun	34	30	31	34	33	162
7 Zhongshan	39	6	37	37	38	157
8 Zhengzhou	22	39	25	38	31	155
9 Chongqing	38	34	26	23	30	151
10 Guiyang	32	26	36	29	27	150
11 Shenyang	24	32	35	28	29	148
12 Kunming	26	25	28	26	35	140
13 Hefei	21	42	29	30	16	138
14 Urumqi	16	41	33	25	22	137
15 Lanzhou	40	38	20	15	23	136
16 Nanchang	11	24	32	35	28	130
17 Xi'an	42	27	24	16	20	129
18 Harbin	27	13	22	24	39	125
19 Wuxi	13	19	34	40	11	117
20 Foshan	15	4	30	33	34	116
21 Changsha	29	22	27	19	13	110
22 Chengdu	36	21	17	14	18	106
23 Fuzhou	31	20	11	17	26	105
24 Nanning	20	15	21	22	25	103
25 Dalian	12	29	14	27	19	101
26 Jinan	6	33	23	21	14	97
27 Wuhan	23	23	18	13	17	94
28 Haikou	3	28	16	10	36	93
29 Xiamen	25	16	8	18	24	91
30 Ningbo	18	10	13	36	10	87
31 Suzhou	10	17	15	20	12	74
31 Qingdao	14	14	19	12	15	74
33 Zhuhai	19	8	12	8	21	68
34 Tianjin	17	11	10	11	9	58
35 Nanjing	4	18	9	7	7	45
36 Beijing	28	7	3	2	3	43
37 Shenzhen	9	12	4	4	6	35
38 Guangzhou	7	9	7	6	5	34
38 Hangzhou	8	3	6	9	8	34
40 Shanghai	5	5	5	3	4	22
41 Macao	1	1	2	5	2	11
42 Hong Kong	2	2	1	1	1	7

10. Ease of doing business

“Ease of doing business” refers to a city’s soft power in attracting investors and incubating start-ups, as well as being an important part of the city’s economic vitality and potential. This dimension includes five variables, namely a city’s “entrepreneurial vigour”, “reliance on foreign trade”, “logistics”, “fiscal balance” and “business environment”. “Ease of doing business” measures the attractiveness of cities to relocating companies and the opportunities available for them to develop locally. It adopts the methods used in PwC’s *2018 Chinese Cities Business Environment Quality Report*, with more than 90 percent of the data coming from small and medium-sized private enterprises, reflecting the cities’ ability to support innovation and entrepreneurship. “Entrepreneurial vigour” measures the number of non-state-owned listed enterprises in each city, reflecting the potential of private enterprises aiming to grow locally. “Reliance on foreign trade”, “logistics” and “fiscal balance” illustrate the readiness of the environment a city has prepared for business development in terms of the export-oriented economy, producer services and government financial support respectively.

Shenzhen has been one of the leaders over the past years in “ease of doing business”, and this year it comes out on top. Shenzhen has a reputation of being a strong supporter for enterprise development. In 2019, the city made China’s first “approval-in-seconds” business licence, showing its speed and determination to improve the ease of doing business. In recent years, Shenzhen has stepped up efforts in the construction of new-types infrastructure, making targeted investments in informational infrastructure based on the next-generation information technologies, integrated infrastructure and innovative infrastructure in accordance with the city’s characteristics. The efforts will help it play to its strengths and make up for its shortcomings. This has created a good environment for enterprises to innovate and develop and shows Shenzhen’s long-term planning for maintaining economic vitality into the future. This year marks the 40th anniversary of the establishment of the Shenzhen Special Economic Zone and the first anniversary of the construction of a demonstration pilot zone for socialism with Chinese characteristics. The innovative system and expansion of

opening-up would bring more opportunities for businesses in Shenzhen.

In “ease of doing business”, five cities – Suzhou, Ningbo, Wuxi, Foshan and Zhongshan – have shown through their advantages that they have exceeded their overall rankings. Each city’s ranking in this dimension has increased by a few places, compared with their overall rankings. Looking at the variables, except for Ningbo and Foshan that have maintained similar places to their overall rankings in terms of “entrepreneurial vigour” and each city’s unstable performance in terms of “business environment”, the remainder have significantly outperformed their overall rankings. The five cities are in the Yangtze River Delta Economic Zone and the Guangdong-Hong Kong-Macao Greater Bay Area, the two most economically vibrant and export-oriented city clusters in the country. The excellent performance of cities other than the central cities in this dimension reflects the leading role of the city clusters and the strong supporting ability of the surrounding cities. The city cluster pattern of the Yangtze River Delta and the Greater Bay Area serves as a good reference point for the coordinated development of the Beijing-Tianjin-Hebei Region. The coordinated development of different regions relies not only on the transfer of industries led by state-owned enterprises and government-invested projects, nor is it only about allowing enterprises to move to surrounding cities by virtue of low costs, but more about optimising the overall quality of the region’s business environment to attract enterprises to settle there.

In the foreseeable future, COVID-19 will continue to have an impact on economic activities and restrict the population mobility, making trade even more dependent on modern logistics systems. The excellent performance of cities such as Guangzhou, Hangzhou and Shenzhen in e-commerce and logistics also acts as a reference for other cities. At the same time, in the face of the complex international situation, making domestic demand the driving force of economic growth will bring stable and lasting development, and a city’s logistics system and the development of e-commerce will in turn help boost domestic demand.



	Entrepreneurial vigour	Reliance on foreign trade	Logistics	Fiscal balance	Quality of business environment	Score
1 Shenzhen	40	39	40	32	40	191
2 Shanghai	42	37	39	34	38	190
3 Suzhou	37	41	37	41	27	183
4 Beijing	41	36	35	31	39	182
5 Hong Kong	15	42	38	42	42	179
6 Hangzhou	36	25	41	39	34	175
7 Ningbo	24	35	34	35	33	161
8 Guangzhou	40	28	42	13	36	159
9 Nanjing	33	24	33	38	30	158
10 Chengdu	38	23	28	27	37	153
11 Xiamen	28	40	30	33	20	151
12 Wuxi	34	31	31	37	7	140
13 Qingdao	31	30	19	29	21	130
14 Tianjin	36	32	15	17	23	123
15 Xi'an	31	27	18	11	35	122
16 Foshan	18	29	27	36	9	119
17 Wuhan	25	9	32	30	22	118
17 Zhongshan	22	33	36	23	4	118
19 Changsha	33	8	24	16	31	112
19 Zhengzhou	26	26	29	14	17	112
21 Fuzhou	15	22	23	24	18	102
21 Macao	2	18	1	40	41	102
23 Hefei	21	19	26	21	13	100
24 Kunming	18	13	12	28	26	97
25 Jinan	21	7	25	25	12	90
25 Chongqing	31	20	4	3	32	90
27 Zhuhai	13	38	22	10	6	89
28 Haikou	11	17	9	22	28	87
29 Dalian	11	34	10	20	10	85
30 Shenyang	13	11	16	26	15	81
31 Taiyuan	18	21	13	18	5	75
32 Shijiazhuang	27	14	20	5	8	74
33 Nanning	21	15	14	4	19	73
34 Urumqi	2	12	7	19	25	65
35 Guiyang	8	4	8	15	29	64
36 Nanchang	8	10	21	12	11	62
37 Changchun	8	16	5	6	14	49
38 Lanzhou	8	3	2	7	24	44
39 Tangshan	24	6	3	8	1	42
40 Harbin	11	2	6	2	16	37
41 Baoding	8	5	17	1	2	33
42 Hohhot	8	1	11	9	3	32



Variables

1. Intellectual capital and innovation

Turnover rate of full-time teachers

The turnover rate of full-time teachers is measured by calculating the ratio of full-time teachers of middle and primary schools in 2018 to the respective figures in 2013. Data sources are the statistical yearbooks of respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Scale of higher education

Higher education students are an important reserve of urban human capital in the future. The number of students enrolled in the institutions of higher education in each city in 2018 is used as a measure of future human capital reserves. Data sources are the statistical yearbooks and bulletins published by the statistics bureaus of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

State key laboratories

This variable examines the cities' technical reserves for innovation and research potential based on the statistics of state key laboratories in each city. Data are sourced from the Ministry of Science and Technology, the Ministry of Education, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Spending on science and technology

Fiscal spending on science and technology is calculated by dividing each city's 2018 fiscal spending on science and technology by the permanent population to measure the city's spending on scientific and technological innovation. Data sources are the statistical yearbooks and the finance bureaus of respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Educational level

The educational level of the population is measured by calculating the proportion of the permanent population with junior college degree or above and the proportion of illiterate people in the permanent population on the basis of the China's sixth National Economic Census (2010). These are included in an overall analysis to evaluate the educational level of the entire population in each city. Data sources are the sixth National Economic Census Bulletins in 2010, the 2011 Census Results disclosed by the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR, respectively.

2. Technical maturity

Mobile phone penetration rate

The mobile phone penetration rate is measured by calculating the ratio of mobile phone users to permanent population at the end of 2018, i.e. the per capita number of mobile phone owners, to evaluate the level of penetration of mobile phones and mobile Internet technology among the city's population. Data sources are the statistical yearbooks and bulletins published by the statistics bureaus of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Mobile payment

This variable uses the Mobile Payment Growth Index, with data sourced from the *2019 Report of Mobile Payment Growth in China* published by the State Information Centre, China Economic Information Service and Ant Financial Services Group. It measures the level of growth in mobile payments in each city through three dimensions: informatisation infrastructure, commercial consumption, and payments in government affairs and civil life. For cities of which this index is not published, we use data with consistent standards.



3. Major regional cities

Digital China (Index)

This variable uses the Digital China Index, with data sourced from the *2019 Digital China Index Report* published by the Tencent Research Institute. It measures the level of development of each city in the digital industry, digital culture and digital governance. Data for Hong Kong and Macao are sourced with consistent standards.

Number of granted patents

This variable measures the level of innovation by the number of granted patents every 10,000 people in each city. The calculation method is the number of granted patents divided by the permanent population in 2018. Data sources are the statistical yearbooks and bulletins published by the statistics bureaus of the respective cities, the Census and Statistics Department of Hong Kong SAR, and the Economic Bureau of Macao SAR.

Star-graded hotels

This variable measures the supply and demand and market saturation levels of star-graded hotels. Data sources are the *2018 Statistical Bulletin on Star-graded Hotels in China* released by the Ministry of Culture and Tourism, the statistical yearbooks and bulletins, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

International tourists (number of days the inbound visitors stayed in one city)

The appeal of the cities to international tourists is assessed by the number of days that the inbound visitors stayed in each city. Data are sourced from the *China Tourism Statistics Yearbook 2018*, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Inbound and outbound flights

This variable aims to reflect demand in each city for air passengers and cargo transportation. The ranking is based on the number of inbound and outbound flights to and from the cities' main airports. Figures include international and domestic flights for civilian use, cargo flights and non-revenue flights (excluding military aircraft). Data are sourced from the *2018 Civil Aviation Airport Production Statistics Bulletin*. One point is given to cities have yet to have an airport. Data of Hong Kong are from the Civil Aviation Department of Hong Kong SAR; those of Macao are from the statistics released by the Macao International Airport.

Passenger capacity

Passenger capacity spans railroads, civil aviation, highways and water transport. It is used to indicate the size and carrying capacity of passenger transport of the cities in 2018, which indirectly reflect each city's function as a regional hub. Data sources are the statistical yearbooks and bulletins of each city, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

4. Urban resilience

Freight volume

Freight volume includes the total volume of freight transported by railways, civil air, highways and waterways to show the scale of freight operations and carrying capacity in each city in 2018, which indirectly reflects each city's function as a regional hub. Data sources are the statistical yearbooks and bulletins of each city, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Exhibition economy

This variable is based on the composite index of urban exhibition development in the *2018 China Exhibition Data Statistical Report*, released by the China Convention and Exhibition Research Society. It aims to evaluate the developments of the exhibition industry of every city. The ranking of Hong Kong and Macao is based on manual calculations of several indicators, such as the number of specialised exhibition halls, area of indoor exhibition halls and number of exhibitions held annually etc. Data are collected from the convention and exhibition industry profile released by the Hong Kong Trade Development Council, the information disclosed by Hong Kong Exhibition & Convention Industry Association and the Macao quarterly report of conferences and exhibitions.

Physician resources

This variable uses the number of available practising physicians in the medical institutions per 10,000 residents and the total number of available practising physicians in each city in 2018 as the sub-indicators. It measures the scale of physicians as a whole and the per capita availability. Data sources are the statistical yearbooks and bulletins of each city, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Medical facilities

This variable uses the total number of hospital beds, number of hospital beds per million residents and the total number of "Grade III, Level A" (i.e. top-level) hospitals in each city in 2018 as the sub indicators. It gives an overall measurement of the extent of the medical resources and facilities in each city. Data sources are the statistical yearbooks and bulletins of each city, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Public pensions

Retirement pension coverage is defined as the proportion of the permanent population with basic endowment insurance, including the urban employees as well as urban and rural residents. This variable is used to measure the development level of the basic endowment insurance as part of the public services provided in each city in 2018. Data sources are the statistical yearbooks and bulletins of each city; those of Hong Kong and Macao are collected from public available information.

Loss due to disasters

This variable uses the ratio of compensation expense to premium income of property insurance to determine the economic loss caused by disasters. The observed cities are ranked in an increasing order of the ratio. Data sources are the statistical yearbooks and bulletins of the respective cities, the Insurance Authority of Hong Kong SAR and the Monetary Authority of Macao SAR.

Public safety investment

This variable is calculated by dividing the general public safety budget by the permanent population in each city in 2019. It aims to measure the per capita financial spending in each city. Data are collected from the finance bureaus of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Public investment in healthcare

This variable is calculated by dividing the general healthcare budget by the permanent population in each city in 2019. It is used to measure the per capita healthcare spending in each city. Data are collected from the finance bureaus of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

5. Transportation and urban planning

Disaster prevention and emergency management

This variable is calculated by dividing the budget on general disaster prevention, control and emergency management by the permanent population in each city in 2019. It aims to measure the per capita spending in each city. Data are collected from the finance bureaus of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Production safety (the death rate from accidents in production per 100 million yuan GDP)

This variable refers to the death rate from accidents in production per 100 million yuan GDP. It is calculated by dividing the number of deaths in production accidents by the local GDP in each city in 2019, thus measuring the level of production safety in each city. Data are sourced from the statistical yearbooks and bulletins of each city and their emergency management bureaus, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Road area

Road area per capita is used to assess the development level of road facilities of each city. Data are sourced from the *China Urban Construction Statistical Yearbook 2018*. The data of Hong Kong and Macao are collected from the Planning Department of Hong Kong SAR and the Cartography and Cadastre Bureau of Macao SAR.

Resident transportation

This variable uses the per capita bus (or tram) passenger volume and vehicle ownership as the sub-indicators, giving an overall picture of local mobility of residents in each city. Data are sourced from the *China City Statistical Yearbook 2018* and public statistical bulletins published by governments of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Transport Bureau of Macao SAR.

Rail transit

This variable is calculated by dividing the mileage of rail transit lines by the area of built-up land as a measure of rail transit development in every city. The data are collected from the *China Urban Construction Statistical Yearbook 2018*, MTR's annual report and the Planning Department of Hong Kong SAR, the Cartography and Cadastre Bureau of Macao SAR.

Traffic congestion

This variable is based on the list of the top 100 most congested cities nationwide in the *2019 China Urban Transportation Report* published by Baidu Maps. It is used to measure the congestion and traffic flow efficiency in each city. Data for Hong Kong and Macao are from sources with consistent standards.

Green space coverage

This variable includes two sub-indicators, the green space and the green space coverage rate in built-up areas, both of which are included in the *China Urban Construction Statistical Yearbook 2018*. It gives an overall picture of the green development of the built-up areas in each city and reflects the overall performance of the liveability of a city's urban environment. The data of Hong Kong and Macao are collected from the Planning Department of Hong Kong SAR and the Environmental Protection Bureau of Macao SAR.

Urbanisation

This variable uses the ratio of the urban permanent population to the overall permanent population for 2018, i.e. the urbanisation rate of the permanent population to measure the urbanisation level in each city. Data sources are the statistical yearbooks of respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

6. Sustainable development

Water resources

This variable is measured by the per capita domestic water consumption which reflects the utilisation of water resource in each city. The data are from the *China Urban Construction Statistical Yearbook 2018*, the Water Supplies Department of Hong Kong SAR and the Marine and Water Bureau of Macao SAR.

Sewage treatment

This variable uses the sewage treatment rate of each city in 2018 to measure the utilisation efficiency of natural resources and the extent of development of the circular economy in each city from the perspective of sewage treatment. The data are from the *China Urban Construction Statistical Yearbook 2018*, the Drainage Services Department of Hong Kong SAR and the Environmental Protection Bureau of Macao SAR.

Air quality

This variable adopts the composite index of average annual air quality to assess the overall air quality of each city. The index evaluates levels of six pollutants namely; fine particulate matter (PM_{2.5}), inhalable particles (PM₁₀), sulphur dioxide (SO₂), nitrogen dioxide (NO₂), ozone (O₃) and carbon monoxide (CO). Data are calculated based on the average value of the index captured from the monthly air quality reports (2018/12-2019/11) released by the China National Environmental Monitoring Centre.

For Hong Kong and Macao, the rankings are manually calculated based on data collected from the report issued by the Air Monitoring

Network of the Guangdong, Hong Kong, Macao and the Pearl River Delta.

Population size

This variable includes two sub-indicators, the ratio of the 2018 year-end non-resident permanent population to the 2013 year-end non-resident permanent population in each city in the end of 2018. It gives an overall picture of the population changes and the overall population size in each city. Data are collected from the statistical bulletins published by the statistics bureaus of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Population mobility

The variable is measured by the ratio of the permanent population to the registered population in each city in 2018, reflecting the inflows and outflows of the population. Data are collected from the statistical bulletins published by the statistics bureaus of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Labour supply

This variable includes two sub-indicators: the number of people employed and the year-on-year increase in the number of people employed in each city at the end of the year, giving an overall estimate of the labour supply in each city. The data are sourced from the *China City Statistical Yearbook 2018*, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

7. Culture and quality of life

Cultural industry employment

This variable uses the number of people employed in cultural, sports and entertainment industries to measure the scale of development of the cultural industries in each city. The data are sourced from the *China City Statistical Yearbook 2018*, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Number of cinemas

This variable uses the total number of cinemas in each city by February 2020 to measure the scale and activity of the development of the movie and television culture in each city. Data are sourced from the number of cinemas published on Maoyan.com; data for Hong Kong and Macao are from public available statistics.

Library collections

This variable uses the per capita number of books possessed in public libraries in 2018, measuring the level of public cultural resources in each city. Data are collected from the statistical bulletins published by the statistics bureaus of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

8. Economic clout

Consumption vitality

This variable includes two sub-indicators—the total retail sales of consumer goods and the per capita retail sales of consumer goods in each city in 2018 to reflect the overall performance and potential of consumption in each city. Data sources are the statistical yearbooks of respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Housing supply

This variable is used to measure the residential housing supply and support. The calculation method is the surface area of completed commercial residential housing developed by the property development companies in 2018 divided by the permanent population, namely the per capita newly increased floor space completed. It reflects the level of residential housing supply in each city. Data sources are the National Bureau of Statistics, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Well-known enterprises

This variable uses the number of registered headquarters of top 500 companies in every city to measure each city's degree of economic development and its economic clout. Data are sourced from 2019's "World Top 500 list" and "China Top 500", released by Fortune's Chinese website.

Foreign direct investment

The variable uses the ratio of the paid-in foreign direct investment to regional GDP in 2018 to evaluate the appeal of the city to foreign investors and its development level of the externally-oriented economy. The data are sourced from the statistical bulletins of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Proportion of the tertiary industry

This variable uses the proportion of the added-value of services in the regional GDP in 2018 to evaluate the development level of the tertiary industry and the industry structure of each city. The data are sourced from the statistical bulletins of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Economic growth

This variable uses the real growth rate of the regional GDP in 2018 to measure the economic growth of each city. The data are sourced from the statistical bulletins of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Size of economy

This variable uses the local GDP of each city in 2018 to measure the overall scale and size of the city's economy. The data are sourced from the statistical bulletins of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

9. Cost

Consumer price index

This variable uses the overall rate of change in the consumer price index from 2014 to 2018 to measure the changes in overall prices and cost of living. The observed cities are ranked in an increasing order. Data are sourced from the statistical bulletins published by the statistics bureaus of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Cost of public transport

This variable uses the standard fares of for-hire taxis in each city at the end of 2019, as well as its average radius of mobility, to calculate the average unit price per kilometre of taxi ride to measure the cost of local mobility. The observed cities are ranked in an increasing order. Data are sourced from the development and reform commissions of respective cities and DiDi Chuxing big data; those of Hong Kong and Macao come from public available information and data with consistent standards.

Cost of housing rental

This variable uses the average urban residential rent per square metre in each city in 2019 to measure the cost of residential housing. The observed cities are ranked in an increasing order. Data are sourced from the China Real Estate Association; those of Hong Kong and Macao come from public available information.

Cost of business occupancy

This variable uses the average urban rent per square metre of the office buildings in the downtown area of each city in 2019 to measure the cost of commercial real estate. The observed cities are ranked in an increasing order. Data are sourced from the China Real Estate Association; those of Hong Kong and Macao come from public available information.

Average salary

This variable uses the level of average wage of current employees in towns and cities in 2018 to measure the cost of employment in each city. The observed cities are ranked in an increasing order. Data are sourced from the statistical bulletins published by the statistics bureaus of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

10. Ease of doing business

Entrepreneurial vigour

This variable uses the total number of non-state-owned enterprises listed on the Shanghai and Shenzhen exchanges (A-shares), Hong Kong and the U.S. and those listed on the New Third Board (NEEQ) in each city in 2018, measuring the level of convenience and ease of doing business of each city's entrepreneurial environment. Data are sourced from Wind.

Reliance on foreign trade

The variable uses the ratio of each city's total value of import and export to regional GDP to evaluate the scale and level of development of foreign trade activities in each city, thus reflecting level of convenience of doing business. Data are sourced from the statistical yearbooks of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Logistics

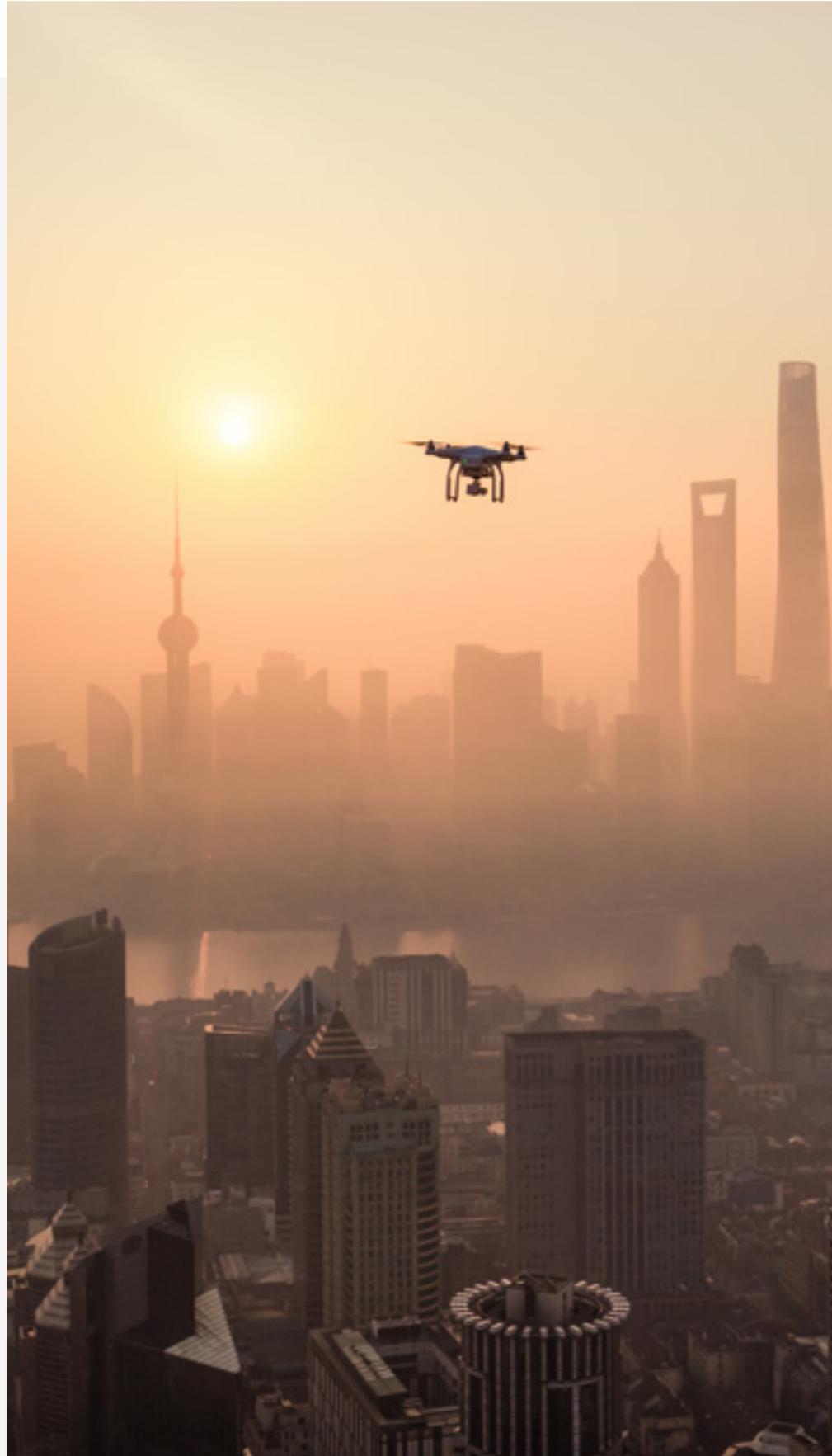
This variable is the per capita volume of courier services. It is the ratio of the courier service volume to the permanent population in each city in 2018, reflecting the city's logistics efficiency. Data are sourced from the State Post Bureau, the Census and Statistics Department of Hong Kong SAR and the annual report of Macao Post.

Fiscal balance

The ratio of local general budget revenue to local general budget expenditure is used to measure the fiscal balance. The data sources are the statistical bulletins, the finance bureaus and the National Bureau of Statistics of the respective cities, the Census and Statistics Department of Hong Kong SAR and the Statistics and Census Bureau of Macao SAR.

Quality of business environment

This variable uses the business climate index of major Chinese cities published in PwC's *2018 Chinese Cities Business Environment Quality Report* to measure the overall business climate in each city. For cities of which this index was not published, we use figures with consistent standards.





Supplement:

PwC launches urban resilience Index

The COVID-19 pandemic has caused great uncertainties all over the world since its outbreak in early 2020 and will continue to be a factor of uncertainty for the rest of the year and even further. Shortly after the initial outbreak, we have witnessed prompt responses from the Chinese central and local governments, which have developed and implemented various prevention and containment measures and mobilised the entire society in an effort to curtail spread of the disease, to minimise its impact on cities as well as its damage to the economy and the whole society. In the second half of 2020, COVID-19 prevention and emergency plans have gradually become the new normal of daily life in all cities across the country, with the economy being effectively stabilised and everyone's life being brought back to normal.

Back in March this year, PwC, together with the China Development Research Foundation (CDRF), published their first feature report on urban resilience through PwC's WeChat platform. In the report entitled *Improving emergency preparedness and management capabilities; Increasing resilience in China's city development*, PwC presented an overall framework for assessing urban resilience based on the unique development characteristics of Chinese cities. In subsequent studies, we further proposed a comprehensive set of benchmarks for measuring urban resilience from the perspectives of all participants of the cities, which has taken response measures in the entire pre- and post-emergence process into consideration. Our purpose is to provide a systematic approach for evaluating city's sustainability, as well as for a dynamic monitoring system of the city's resilience level and capabilities.



About the Index

Considering the specific characteristics of city development and governance structure in China, city administrators usually face severe challenges in their emergency response efforts in terms of city management and effective coordination and mobilisation of all the existing social resources, to engage all city residents to collaborate in emergent situations. Meanwhile, the condition of city infrastructure and timely provision of funds and supplies are also very relevant.

PwC's evaluation approach reflects the actual conditions of city development and structure of governance in China. From the standpoint of the diverse participants and stakeholders of the city, it provides a comprehensive assessment of urban resilience from eight dimensions, namely, city leaders and management systems, strategies and action plans, disaster relief organisations and professionals, businesses, city dwellers, non-government organisations, city infrastructure, funds and strategic supplies, and it covers three major categories of emergencies commonly seen in modern cities, i.e. natural disasters, public safety and public health events, with 27 core dimensions, 64 detailed items and 334

specific indicators, hence providing a comprehensive and objective analysis and evaluation of the city's overall emergency management, including emergency prevention, preparedness, response and recovery and their actual implementation based on daily city management models in China.

The resilience of a city manifests in many ways, and requires constant improvement on multiple levels, including top-level system design, basic planning, and governance and implementation, so that the city can be better prepared for risks, guarantee its normal operations and retain a high standard of living for its residents. Therefore, a comprehensive assessment of a city's resilience must consider the unique characteristics of city development in China and incorporate all the above-mentioned factors so that a set of effective benchmarks can be established for an improved policy-making process by local governments, professional responses by city planners, and increased public awareness. It can also provide a new way of thinking and can serve as a reference framework for the building of resilient cities which align with the Chinese characteristics.

Urban Resilience Index

Participants	Core dimensions	Detailed items		
1. Resilience of leaders and management systems	1.1 Leader capabilities and experience	1.1.1 Experience in emergency management 1.1.2 Training experience in emergency management capabilities		
	1.2 Resilience of management systems	1.2.1 Emergency leading, executing, and commanding agencies		
		1.2.2 Responsible, coordinating and supporting agencies for critical emergencies		
		1.2.3 Community-level emergency response agencies and personnel		
		1.2.4 Risk monitoring system		
		1.2.5 Risk reporting and early warning systems		
		1.2.6 Emergency response and management measures		
		1.2.7 Cross region/level/border government cooperation 1.2.8 Information disclosure and public opinion monitoring		
2. Strategies and action plans for mitigating risks	2.1 City development strategy and planning	2.1.1 City overall planning and development strategy - relevant to city resilience 2.1.2 Specific strategy/planning - relevant to city resilience		
		2.2 Action and contingency plans	2.2.1 Action and contingency planning systems 2.2.2 Action and contingency plans for different types of emergencies 2.2.3 Quality of the contents of action and contingency plans 2.2.4 Training, drills, and communications of action and contingency plans 2.2.5 Operation result of action and contingency plans 2.2.6 Regular update of action and contingency plans	
	3.1 Public health emergency - disaster relief organisations and professionals		3.1.1 Medical and health organisations: facilities and quantity, etc. 3.1.2 Disease prevention and control institutions: research outcomes and dedicated fundings 3.1.3 Public health teaching and research institutions: labs and research results, etc.	
			3.2 Public health emergency - professionals	3.2.1 Quantity and ratio of doctors and nurses 3.2.2 Quantity and composition of disease prevention and control professionals 3.2.3 Quantity and composition of public health researchers
				3.3 Natural disasters - disaster relief organisations
	3.4 Natural disasters - professionals			3.4.1 Quantity and composition of professional natural disaster rescue teams 3.4.2 Quantity and composition of non-government sources for emergency response in natural disasters 3.4.3 Composition of emergency rescue expert teams for natural disasters
			3.5 Safety incidents - disaster relief organisations	3.5.1 Research funding and rescue equipment for production safety
			3.6 Safety incidents - professionals	3.6.1 Quantity and composition of professional rescue teams for safety incidents 3.6.2 Quantity and composition of non-government forces for safety incidents 3.6.3 Deployment of emergency rescue expert forces in safety incidents

Participants	Core dimensions	Detailed items
4. Businesses	4.1 Regular businesses (select a number of representative businesses)	4.1.1 Emergency preparedness and response - 1-Development and amending of emergency plans 4.1.2 Emergency preparedness and response - 2-Scale of emergency rescue teams 4.1.3 Recovery and rebuild - Financial provision - Emergency funds 4.1.4 Recovery and rebuild - Employee placement - Flexible working schedules and psychological intervention 4.1.5 Recovery and rebuild - Securing government support
	4.2 Businesses related to the production and distribution of essential life and rescue supplies	4.2.1 Local distribution and inventory of essential life supplies 4.2.2 Local distribution and inventory of essential rescue supplies
5. City residents	5.1 Raising public awareness	5.1.1 Knowledge of emergency response and relief: education systems and communication channels
	5.2 Basic education	5.2.1 Knowledge of emergency response and relief: Course schedules in the mandatory education phase
	5.3 Training and drills	5.3.1 Civilian training courses schedules and format 5.3.2 Schedule and frequency of emergency drills
6. Non-government organisations	6.1 Duly registered and properly operating social organisations	6.1.1 Types and quantity of social organisations 6.1.2 Details of each type of social organisations
	6.2 Community services	6.2.1 Quantity and coverage of community service centres
	6.3 Self-governance organisations	6.3.1 Quantity and coverage of community-level self-governance organisations
7. City infrastructure	7.1 City emergency shelters	7.1.1 Quantity and size of city emergency shelters
	7.2 City construction quality	7.2.1 Earthquake-resistant grade of constructions
	7.3 City transit systems	7.3.1 City transit emergency plans and recovery mechanisms
	7.4 City communications systems	7.4.1 City communications emergency plans and recovery mechanisms
	7.5 Utilities (water, power, natural gas, heating)	7.5.1 City utilities emergency plans and recovery mechanisms
8. Funding and strategic supplies	8.1 Financial budget funding	8.1.1 Financial expenditure level - Total expenditure, proportion in overall financial expenditure, etc.
	8.2 Charitable disaster relief funds	8.2.1 Operation and management capabilities - Total number and fundings of charitable organisations
		8.2.2 Operation and management standardisation - 1- Disclosure and transparency of donations received
		8.2.3 Operation and management standardisation - 2- Disclosure and transparency of donations used
		8.2.4 Operation and management standardisation - 3-Third party audit and review
	8.3 Social and commercial insurances	8.3.1 Social insurance - Coverage of healthcare, occupational injury and employment insurances
		8.3.2 Social assistance - social assistance plans for disadvantaged groups
		8.3.3 Commercial insurance - Coverage and premiums, etc.
	8.4 Emergency supplies reserve	8.4.1 Government emergency reserve authorities and emergency reserve systems
		8.4.2 Soundness and execution of emergency reserve plans
8.4.3 Standardisation in the distribution and utilisation of emergency supplies		
8.4.4 Feedbacks on the recovery, use and effectiveness of emergency supplies		



Acknowledgements

The following individuals in PwC, China Development Research Foundation contributed to this report:

Advisory group

Jiantuo Yu

Deputy Secretary General of the China Development Research Foundation

Deputy Director of Beijing Bozhi Economic and Social Development Institute

Thomas Leung

PwC Mainland China & Hong Kong Markets Leader

Daniel Li

PwC Mainland China & Hong Kong Assurance Leader

Xing Zhou

PwC China North Markets Leader & Beijing Office Lead Partner

Elton Huang

PwC China Central Markets Leader & Shanghai Office Lead Partner

Jim Chen

PwC China SOEs Leader

Jun Jin

Partner, Consulting
PwC China

Research team

Carrie Zhang (PwC)

Yiwen Chen (PwC)

Eleen Zhang (PwC)

Jerry Liang (PwC)

Ran Zhang (PwC)

Fan Li (China Development Research Foundation)

Qiwen Li (China Development Research Foundation)

Xiaoxu Yan (China Development Research Foundation)

Project management

Faye Ji (PwC)

Minna Yang (PwC)

Ziqiang Hu (China Development Research Foundation)

Xue Wang (China Development Research Foundation)

Editorial team

Lan Lan (PwC)

Shan Liang (PwC)

Sherry Liu (PwC)

Design

Ran Zhang (PwC)



For further information

In recent years, PwC has continued to track urban evolution and development opportunities of Chinese cities. We have gained abundant practical experience in areas of business environment optimisation, comprehensive study and analysis of urban development, and regional development strategies. We have developed a scientific and systematic methodology of urban resilience and smart cities. We hope to provide practical and in-depth forward-looking analysis in the process of China's urban development and help improve the quality of development, governance capability and sustainability of Chinese cities.

Please contact us if you wish to know more about our research methods in urban development or in the above areas.

Urban development research team

Jun Jin

Partner, Consulting
PwC China
+86 (10) 6533 2977
jun.jin@cn.pwc.com

Carrie Zhang

Associate Director, Consulting
PwC China
+86 (10) 6533 7569
carrie.zy.zhang@cn.pwc.com

Yiwen Chen

Manager, Consulting
PwC China
+86 (10) 6533 7529
yiwen.y.chen@cn.pwc.com

For cooperation enquiries, please contact

Faye Ji

Director, Government Affairs
PwC China
+86 (10) 6533 7013
faye.ji@cn.pwc.com

Lan Lan

Senior Manager, Marketing and Communications
PwC China
+86 (10) 6533 8759
lan.l.lan@cn.pwc.com

For media enquiries, please contact

Christy Liang

Senior Manager, Marketing and Communications
PwC China
+86 (10) 6533 8708
christy.liang@cn.pwc.com

www.pwccn.com

This content is for general information purposes only, and should not be used as a substitute for consultation with professional advisors.

© 2020 PwC. All rights reserved. PwC refers to the China member firm, and may sometimes refer to the PwC network. Each member firm is a separate legal entity. Please see www.pwc.com/structure for further details.

