

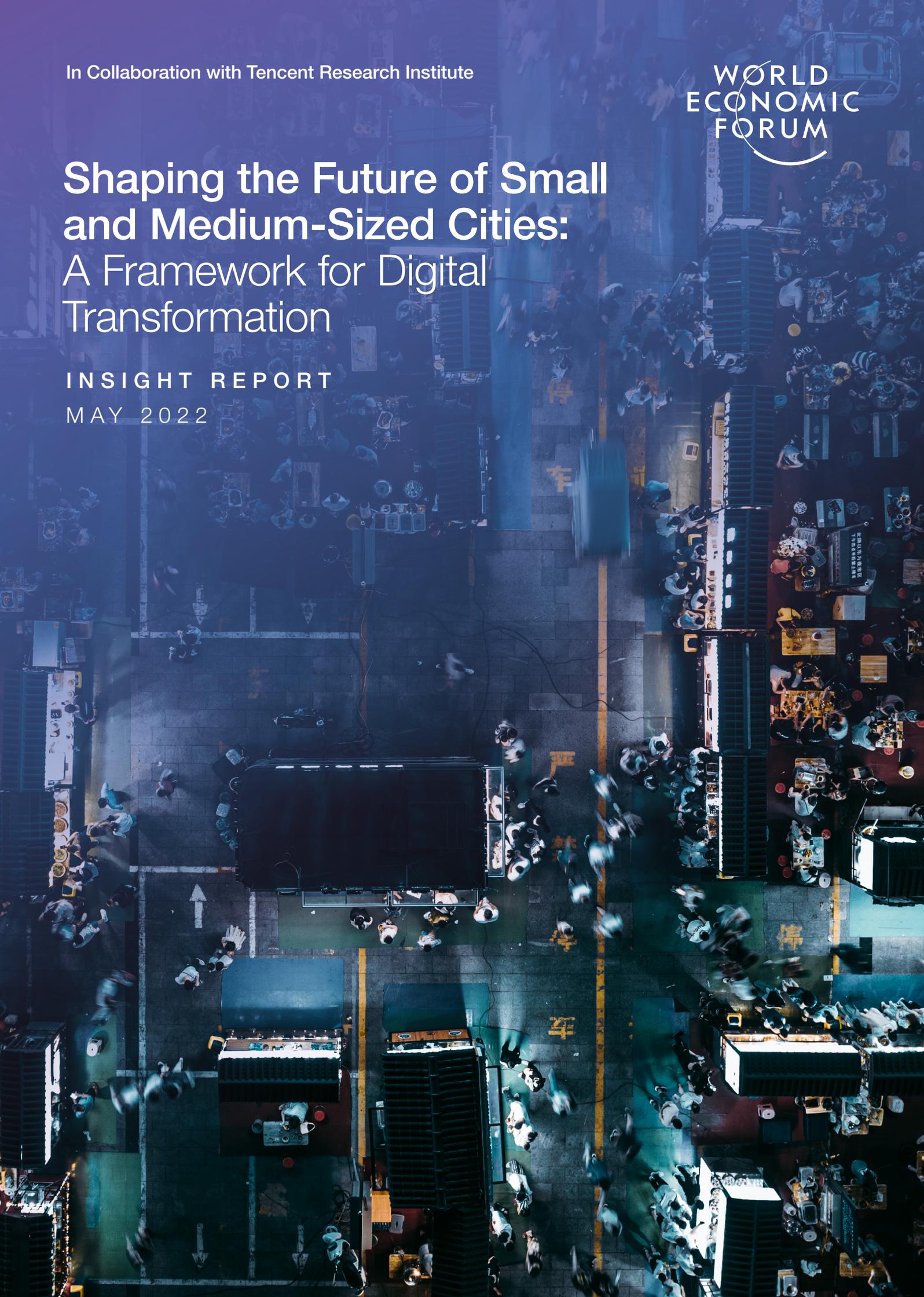
In Collaboration with Tencent Research Institute

WORLD  
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# Shaping the Future of Small and Medium-Sized Cities: A Framework for Digital Transformation

INSIGHT REPORT

MAY 2022



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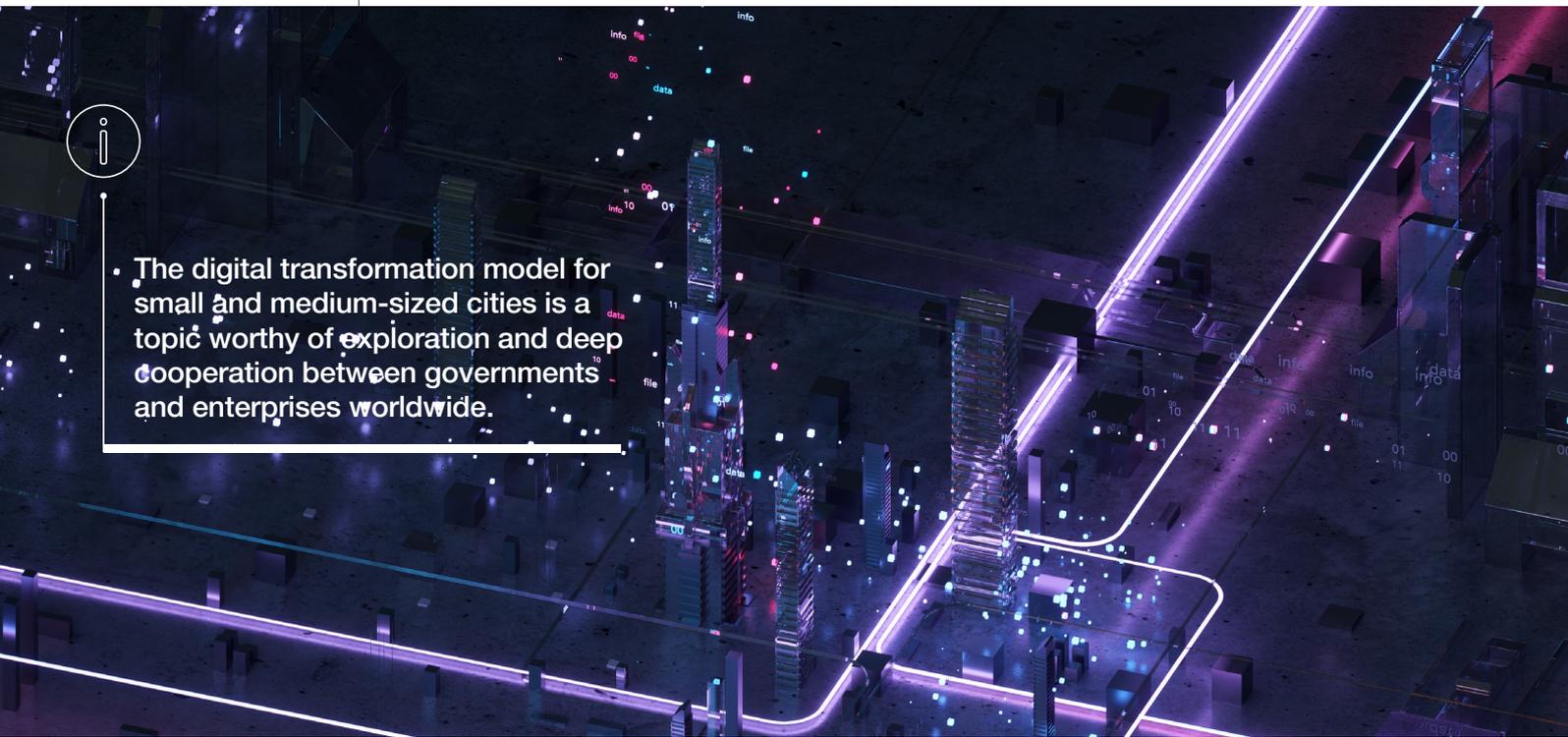
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# Foreword



The digital transformation model for small and medium-sized cities is a topic worthy of exploration and deep cooperation between governments and enterprises worldwide.



**Jeff Merritt**  
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Forum

Digital transformation is becoming a crucial support mechanism for countries as they respond to the COVID-19 pandemic and undergo economic rebuilding and sustained development. For small and medium-sized cities (SMCs), digital transformation is particularly important. Currently, most SMCs face the challenge of slow development. Digital transformation can disrupt traditional business models, break down geographical and spatial boundaries, and create new ways to live in the digital era. This can help improve the livelihood, economy, governance and environment of SMCs and support the conducive integration of people, industry and cities.

The World Economic Forum (hereinafter “the Forum”) is committed to promoting international cooperation and consensus on urban digital



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transformation in the public and private sectors. In 2019, the Forum took the lead in establishing the G20 Smart Cities Alliance at the G20 Summit. A Global Policy Roadmap was then developed through this global initiative, which proposes the principles and global policy norms for the responsible and ethical use of smart city technologies.

This report marks a milestone as, for the first time, SMCs become the focus of the Forum and the G20 Smart Cities Alliance. Through in-depth cooperation with Tencent Research Institute, Hitachi (China) and experts from various countries, we hope that the methodologies and recommendations presented in this report will guide the digital transformation of SMCs around the world, making them more resilient, competitive, sustainable and livable.

# Executive summary

UN-Habitat's *World Cities Report 2020* points out that urbanization will remain a driver of global growth.<sup>1</sup> Small and medium-sized cities (SMCs) are an important part of the urban system, an intermediate level between large cities and rural towns. Their functional positioning comprises four aspects: industrial development; public services; employment absorption; and population clustering.

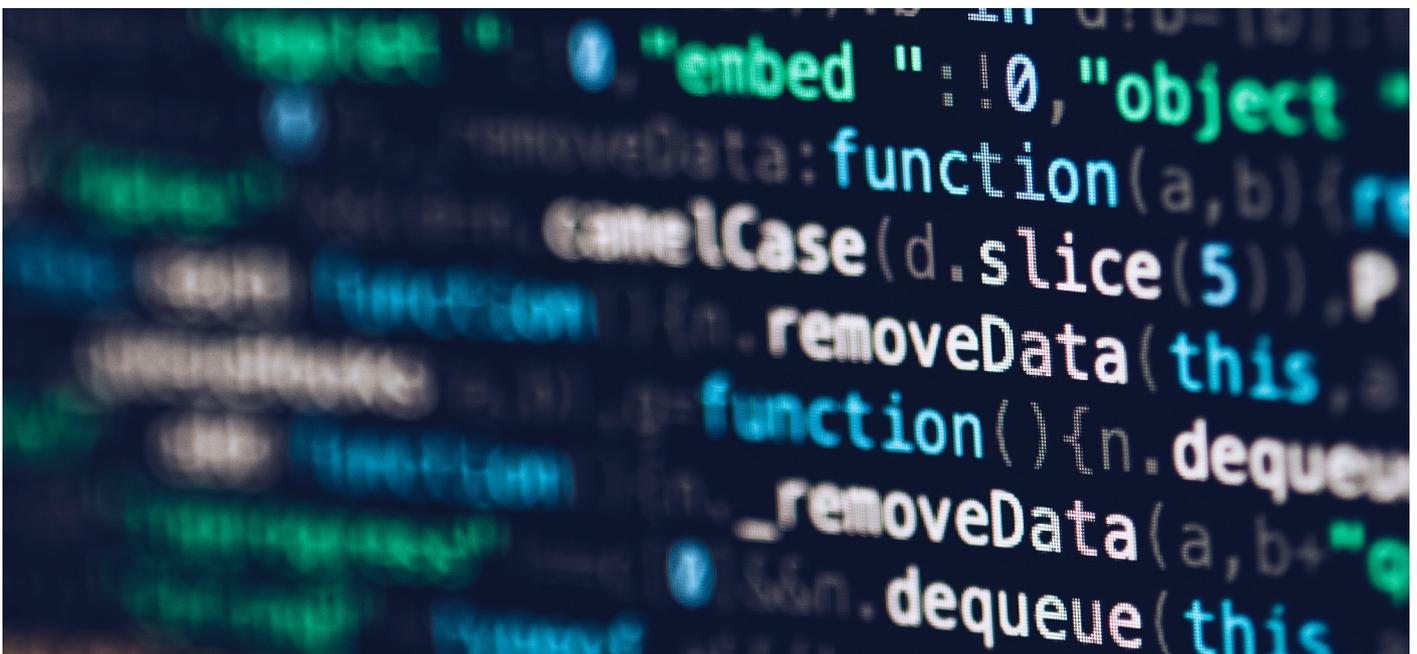
At present, most SMCs face the challenge of slow development. In the meantime, digitalization is disrupting traditional business models, breaking geographical and spatial boundaries, and creating new ways to live in the digital age. This process also provides opportunities for SMCs to rapidly improve their competitiveness in areas such as society, economy, governance and the environment.

SMCs are becoming important vehicles for digital transformation, and the study of digital transformation models and practices in SMCs has important social value for the world. The vision is to make cities a better place for people to live and work.

Through extensive research and in-depth interviews, this report analyses the challenges, needs and concerns of digital transformation in SMCs in China, Japan, Brazil and Singapore, proposes a methodological reference model for digital transformation in SMCs, provides reference cases from China and Japan, and suggests actions for various urban stakeholders.

- The challenges of digital transformation for SMCs are mainly reflected in the following aspects: lack of digital talent; insufficient funds and resources; lack of understanding and application of digital technologies; and lack of intercity interaction and cooperation mechanisms.
- The digital transformation of SMCs requires adopting an approach of "commonality and individuality"; in addition, the planning and promotion of digital transformation of SMCs should also take into account the differences between SMCs and big cities.
- The digital transformation of SMCs can be divided into seven functional areas: public and social services; industry and economy; governance; environment and low carbon; governmental effectiveness; infrastructure; and development assurance (leadership/policy). Each area can then be divided into three maturity levels (Phases 1 to 3). In their specific planning and implementation, SMCs can incorporate their resource endowment, industrial characteristics and development goals, and propose their own digital transformation based on the various methodological options available to SMCs as they undergo digital transformation. They can refer to the matrix of key digital transformation features (see Figure 3), which incorporates each of the seven functional areas listed above at the three stages of maturity (the 7x3 matrix).

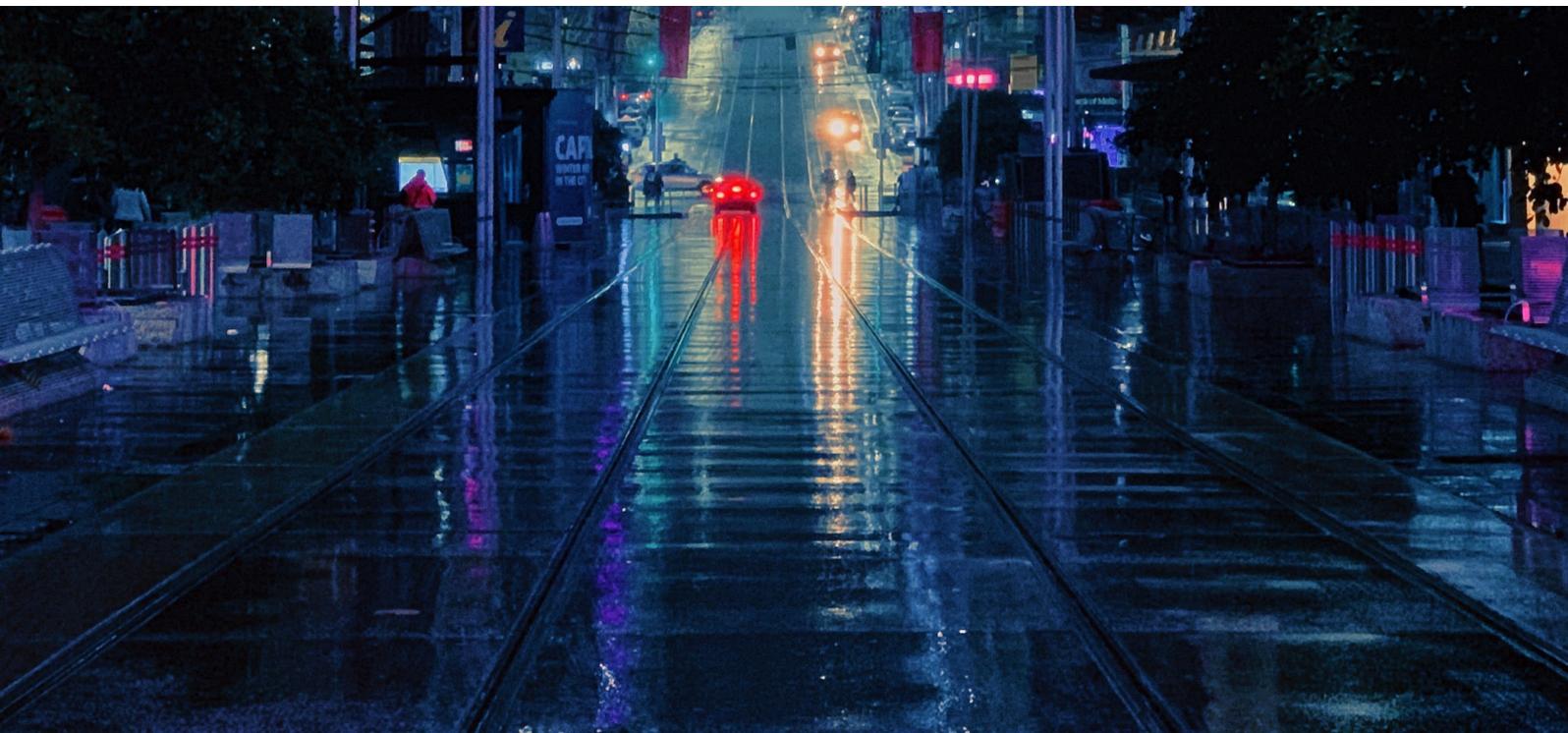
To realize the digital transformation of SMCs, governments, enterprises, research institutions and citizens need to coordinate and act together.



1

# Drivers and challenges of digital transformation in SMCs

Digital transformation will transform SMCs – but it presents challenges to be overcome.



For SMCs, digital transformation aims to:

- | Improve the quality of life for citizens
- | Develop a distinctive digital economy
- | Improve the effectiveness of urban governance
- | Enhance the ability of the urban environment (the built environment plus the ecological environment) to cope with climate change
- | Provide intelligent, refined, proactive, efficient and full life-cycle living services and business services for residents and enterprises clustered in cities
- | Support the positive integration of people, industry and cities

## 1.1 Drivers of digital transformation in SMCs

Urbanization around the world displays similar characteristics; that is, large cities have a high concentration of industries and populations and are growing rapidly. However, most SMCs have an outflow of people, an ageing population, limited resources and relatively traditional industries, and the speed of their development and their competitiveness lag behind those of large cities.

In the absence of talent, capital and technical capabilities, what are the primary drivers for SMCs to carry out digital transformation? This report considers the following four points; the first two are common to all types of cities, while the last two are unique to SMCs:

1. The need for support and guidance through national policies
2. The necessity to upgrade urban governance
3. The urgent need to transform and upgrade local industries
4. The need to resist the “Matthew effect” (of cumulative advantage) and attract talent to return to the city

For SMCs, digital transformation is inevitable if they are to improve their core competitiveness in the future.

## 1.2 Challenges of digital transformation for SMCs

At present, the digitalization level of SMCs varies greatly in different regions of the world and at different economic levels.

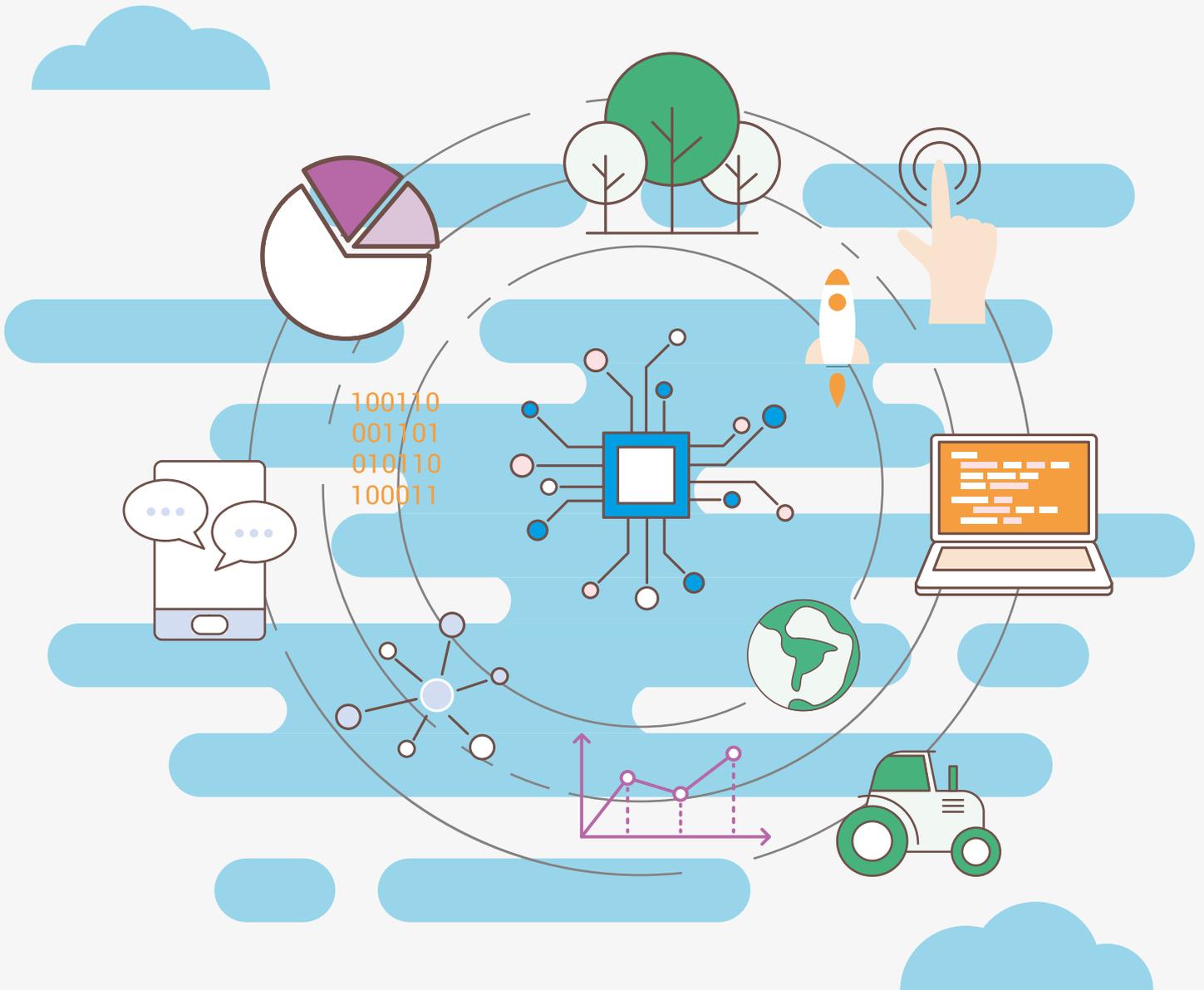
This report examines the challenges of digital transformation in SMCs from four viewpoints: society, economy, governance and environment, as shown in Figure 1.

Based on research and interviews with government departments in 12 Chinese cities, five research institutions, 21 representatives of companies providing urban digital solutions or services, and six other company representatives, the following five areas were identified as the most challenging:

1. The need for sustainable innovation and business models
2. The need for sufficient funding and resources
3. The need for digital inclusion
4. The lack of a framework for public-private partnerships
5. The lack of localized planning, design and ideas

During a session on “Challenges and Solutions for SMCs to Promote Digital Transformation” at the 19th European Week of Regions and Cities event, participants talked about the challenges of digital transformation in SMCs. These included the small size of government digital teams, limited financial resources, insufficient education and skills and the lack of digital talent. In addition, intra- and intercity interoperability issues in services were also a common concern among representatives of SMCs from the EU and other regions.<sup>2</sup> Tiago Faienstein, Head of Smart Cities at the Brazilian Agency for Industrial Development (ABDI), and Luciano Cunha, Head of Digital Transformation at the Brasilia Government, identified in their interviews that the lack of digital talent and funding is a pain point for Brazilian SMCs. As a result, they proposed that the digital transformation of SMCs requires the implementation of effective digital transformation policies, improved understanding of digital transformation and improved digital infrastructure.

FIGURE 1 | Challenges of digital transformation for SMCs



1

### Society

- Need for popular support and feedback
- Need to achieve digital inclusion
- Insufficient digital literacy education and citizen participation in public affairs

2

### Economy

- Need for sustainable innovation and business models
- Need for a framework for public-private partnership and division of labour
- Need for adequate investment of funds and resources
- How digitalization can promote employment
- How digitalization can facilitate international trade and economic cooperation

3

### Governance

- Need for localized planning, design and ideas
- Need to develop an internationally recognized and flexible development framework
- Need to understand and use digital technology
- Need for corresponding government structure and KPIs
- Need for international interaction and cooperation mechanisms
- Need for international case studies and policy toolboxes

4

### Environment

- How to handle the relationship between sustainability and digital transformation
- How digitalization can contribute to the greening of the environment
- How low carbonization of digitalization can be achieved

Source: Tencent Research Institute

2

# General digital transformation principles of SMCs

This report argues that SMCs in different countries have common needs and experiences when undergoing digital transformation, despite their geographical, cultural and national differences.



This chapter outlines some suggestions in terms of the general principles for the digital transformation of SMCs.

## 2.1 ‘Human-centric’ as the core

The UN-Habitat *World Cities Report 2020* emphasizes that a true smart city is human-centric.<sup>3</sup> Currently, “human-centredness” has become a common concept in the digital transformation of cities around the world.

At the launch meeting for this report, Ying Sheng, Country Officer of UN-Habitat’s China Office, introduced six principles for “human-centric smart cities”, providing reference points for the digital transformation of SMCs:

1. Focusing smart-city activities and procurement on the needs of people, rather than the marketplace
2. Developing digital services with a collaborative, multistakeholder approach
3. Providing universal access to affordable digital skills and digital infrastructure
4. Enhancing the digital capacity of staff in all areas
5. Adopting an inclusive and engaging design approach to building digital infrastructure and services
6. Assessing the issues of fairness, environmental justice and social justice in smart cities

Chinese experts and industrial representatives also expressed similar views at the meeting. In addition, Tencent's WeCity project, at the heart of Tencent's contribution to the construction of smart cities, takes "human-centredness" as its core value scale,<sup>4</sup> with a view to supporting cities to meet the current and future needs of people in all scenarios in a responsive and sustainable manner through digital transformation.

## 2.2 Sustainability as the goal

Among the UN's Sustainable Development Goals (SDGs) 2030, Goal 11 is to "make cities and human settlements inclusive, safe, resilient and sustainable", Goal 9 is to "build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation" and Goal 13 is to "take urgent action to combat climate change and its impacts".<sup>5</sup> These three goals require cities to provide good governance of the economy, public and social services and environment (built environment and ecosystem) to improve social inclusion, while being able to respond well to the mismatch between population growth and resource consumption, enhance resilience to adapt to a changing external environment and provide affordable, high-quality services and support for all people.

In 2016, to achieve Goal 11 above, the United Nations International Telecommunication Union (ITU) and the United Nations Economic Commission for Europe (UNECE) jointly launched the United Nations for Smart Sustainable Cities (U4SSC) initiative.<sup>6</sup> This initiative received the joint support of 14 departments within the UN system covering environment, culture, poverty alleviation, and urban, economic and industrial development.

For SMCs, an important goal of digital transformation is for cities to achieve coordinated and sustainable economic, social and environmental development.

## 2.3 Suitability and cooperation as the key

The digital transformation of SMCs requires close collaboration among the city's public and private institutions and citizens. Joint efforts include identifying the city's challenges and transformation goals, formulating plans and policies, defining transformation projects and entry points, conducting feasibility assessments, organizing promotion and implementation, participating in research and development and evaluating transformation effects.

In summary, the key points of digital transformation for SMCs are as follows.

1. **Needs-oriented development:** SMCs' characteristics of commonality and individuality should both be considered in the design of digital transformation schemes. Different SMCs share common goals in terms of public and social services, governance and infrastructure, so the effective practice of one SMC can be significant

in guiding other cities. However, the process of industrial and economic transformation varies greatly from city to city – each city should develop digital transformation schemes based on its own needs, capabilities and goals.

2. **Establishing a promotion mechanism:** The participation of multiple social stakeholders is required to promote the digital transformation of SMCs in an efficient, healthy and collaborative manner.
3. **Clear entry points:** Digital transformation should be demand-oriented and scenario-driven and should kick off in an industry that is economically significant for the city.
4. **Public-private cooperation:** A new model for long-term public-private cooperation between government, industry and academia is needed to promote the iterative upgrading of projects.

## 2.4 Considering the differences between SMCs and big cities

It is important to consider the difference between SMCs and big cities when planning and promoting the digital transformation of SMCs. The departure of young people from SMCs causes an overall ageing of the demographic in these regions, and so the uptake of digital services is insufficient. As a result, citizens of SMCs prefer services that integrate online and offline options. In comparison, in big cities, young and middle-aged residents make up a large proportion of the urban population, and as daily travel is more costly than in SMCs due to the larger land area to be covered, residents are more inclined to use online services (for example, while SMC residents are more inclined to visit a bank in person, those in big cities usually prefer online banking). In addition, because young people tend to have a more natural mastery of digital technologies, tech-based business models prosper in big cities.

In previous research, Tencent Research Institute proposed that the digital transformation of SMCs differs compared to that of big cities in terms of: the existing digital infrastructure; the complexity of urban governance; the focus of public services;

the development path of the digital economy; the ways in which information infrastructure is constructed; digital transformation implementation; digital government readiness (such as tech talent in governments and the correct organizational structure for a digital transformation).<sup>7</sup>

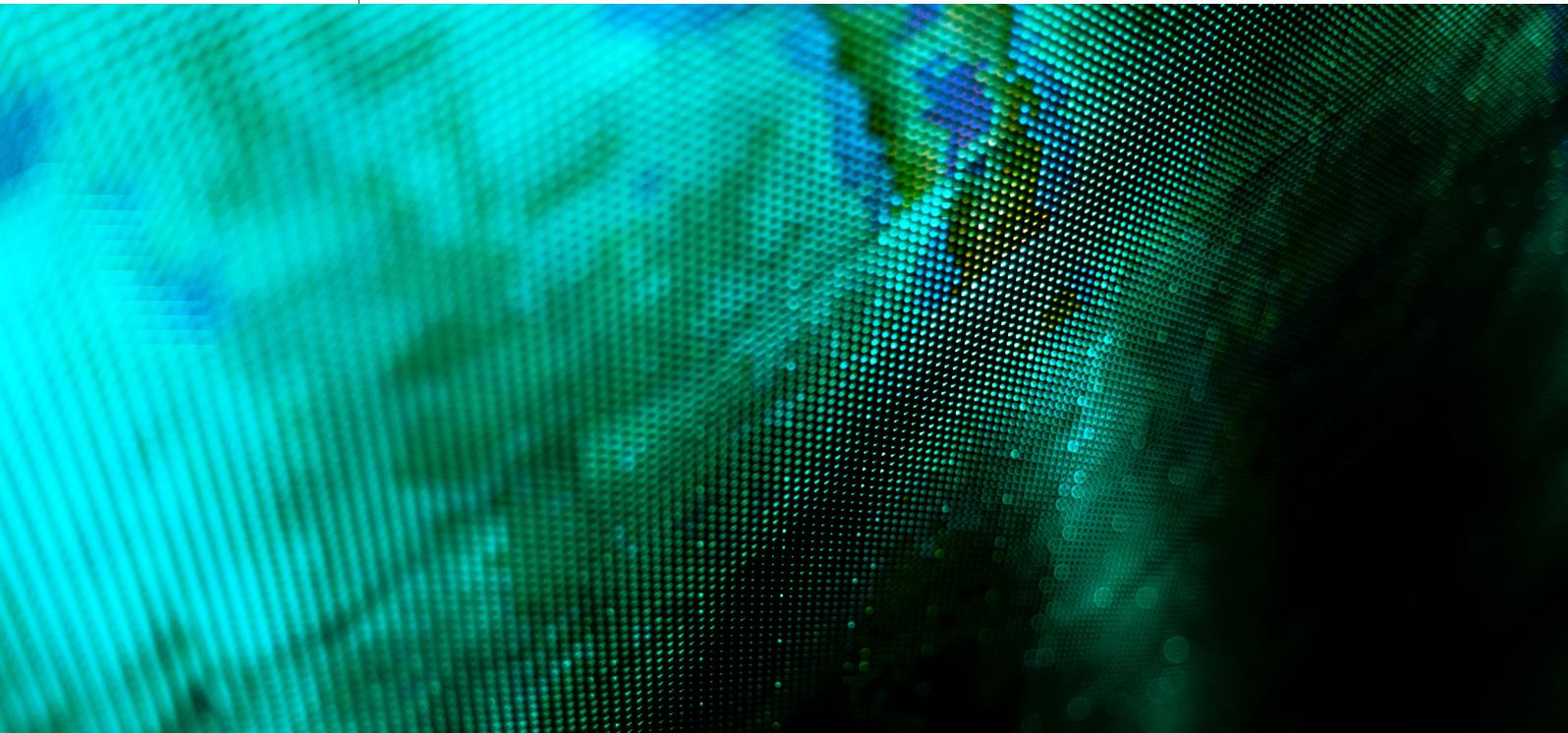
In terms of urban digital transformation, big cities have more advantages with regards to capital, talent and technology, and they already have a certain level of digital infrastructure in place and established digital application foundations. Most SMCs, in comparison, are weaker in these aspects. Therefore, this report argues that SMCs should adopt flexible and resilient urban digital transformation models because cities vary greatly in their resource endowments, development paths and goals. They should also explore sustainable public-private partnership and business models. Specifically, SMCs that lack capital, talent and technology are advised to begin the digital transformation process at specific entry points and advance step by step.



3

# The digital transformation model of SMCs

The digital transformation of SMCs is a continuous evolutionary process. This chapter analyses what it requires and proposes a practical reference model.



## 3.1 The need to analyse digital transformation in SMCs

This report argues that the functions of cities can be categorized into six main areas: public and social services; industry and economy; governance; environment and low carbon; governmental effectiveness; infrastructure. The digital transformation of SMCs also revolves around these six functional areas. In addition, city authorities should provide a series of supportive

measures such as policies, funding, talents and standards to facilitate urban digital transformation. Such measures are referred to in the report as “development assurance (leadership/policy)”. In summary, the report examines the digital transformation needs of SMCs in the context of these seven areas.

FIGURE 2 The seven areas involved in the digital transformation of SMCs



Source: Tencent Research Institute

According to research conducted by the authors of this paper, the level of concern among stakeholders about the seven digital transformation areas ranked from highest to the lowest as follows: public and social services; industry and economy; governmental effectiveness; governance; infrastructure; development assurance (leadership/policy); environment and low carbon. This ranking is outlined below, with the items perceived to be “most important” in each area listed.

- 1. Public and social services:** smart public services, smart medical care, smart community
- 2. Industry and economy:** smart industrial parks, smart agriculture, smart manufacturing, smart energy industry
- 3. Governmental effectiveness:** data sharing/openness/security, interdepartmental

coordination, governmental collaboration with enterprises and citizens

- 4. Governance:** smart city operations management, smart rural governance, smart city emergency response
- 5. Infrastructure:** municipal infrastructure intelligence, digital infrastructure, e.g. internet of things (IoT), cloud, artificial intelligence (AI), data platforms, urban cybersecurity facilities, smart transportation facilities
- 6. Development assurance (leadership/policy):** digital talent, digital organization mechanisms, digital policy/planning
- 7. Environment and low carbon:** smart environmental protection, smart energy solutions, smart water solutions



## 3.2 Digital transformation methodology for SMCs

The evolution and maturity of digital transformation in SMCs can be divided into three stages.

- Phase 1 is characterized by technology-driven and localized development. The vision for this stage is to improve the local business efficiency of governments or enterprises through the application of digital technologies, tools and products.
- Phase 2 is characterized by application-oriented and systematic development. In this stage, services are no longer constrained by physical space because people and multiple sectors are connected with each other through scenario-driven digital applications.
- Phase 3 is characterized by innovation iteration and the development of a business ecosystem. In this stage, human needs are at the centre of urban governance. When governments, enterprises, research institutions and the public work collaboratively and innovatively together, it is possible to achieve the most efficient use

of city-level resources and effectively fuse the digital realm with the real world. This helps the city to become more responsive and better able to adapt to change.

For SMCs, digital transformation can be planned and implemented in all seven functional areas according to these three developing stages.

This report presents a variety of digital transformation methods for SMCs: Figure 3 shows the matrix of key features in each of the seven functional areas at three stages (the 7x3 matrix). SMCs can assess their current status in the seven functional areas according to the diagram, selecting one or more areas as the entry point for their digital transformation. Then the phased development vision can be identified, along with the gap between the current state and each SMC's vision. Subsequently, SMCs can clarify the content and goals for improvement in the selected areas before, finally, developing specific transformation plans and implementation programmes.

## 3.3 Public and social services

Public and social services include but are not limited to public, educational, medical, social security, cultural, tourism and catering services. Service providers include local government, enterprises and other social organizations. The service target groups include elderly people, disabled groups, pregnant women and children. The scope of services needs to cover the integration of urban and rural services and the ability to provide services between cities.

The digital transformation of public and social services is a commonly prioritized area in SMCs. The characteristics of the three developing stages are as follows.

In phase 1, the body offering urban services is the public service department of the government, and the content of service mainly includes the digital application of decentralized public services such as education, medical care, housing, pensions and community services. Citizens can apply for services through an app or digital service terminal in certain areas; their role is mainly to be the receiver and user of services.

In phase 2, the main supplier of urban services will not be the public service departments of the government alone. Instead, there should be a

government-led, unified urban service platform that aggregates not only all public services but also commercial services offered by enterprises. This platform can provide citizens and tourists with various services related to clothing, food, housing and transport through one-stop access. In terms of user experience, users are not only the receivers of these services; the platform offers a two-way communication mechanism that enables users to express their needs and provide feedback (e.g. whether they are satisfied with the service).

In phase 3, urban services will be a joint effort of the government, enterprises, social organizations and citizens, which boosts the agility and iterative innovation capacity of urban city services. In terms of content, the supply of urban public services can be more highly customized, precise and proactive because citizens' feedback is collected regularly and analysed intelligently through digital platforms, online communities and sensor devices. At the same time, services can be automatically optimized and adjusted based on the constant monitoring of service effects. In terms of user experience, while all service target groups are covered by urban public services, new technologies such as AI and augmented reality can be used to provide differentiated services to public and private enterprises through an immersive fusion of virtuality and reality.

FIGURE 3 | Matrix of key features for digital transformation by SMCs

	Phase 1 Technology-driven, localized	Phase 2 Scenario-driven, systematic	Phase 3 Innovation iteration, ecosystem
Public and social services	<p><b>Service provider:</b> Department of Public Services  <b>Service content:</b> Decentralized public services  <b>User experience:</b> Passive; few participation channels</p>	<p><b>Service provider:</b> Government and enterprises  <b>Service content:</b> City-level integration of online and offline aggregation services  <b>User experience:</b> Passive and active, few participation channels</p>	<p><b>Service provider:</b> Government, enterprises and other groups  <b>Service content:</b> City-level hybrid service for digital reality  <b>User experience:</b> Passive and active, rich participation channels; digital inclusiveness</p>
Industry and economy	<p><b>Implementer:</b> Leading enterprises  <b>Digital content:</b> Localized production, sales, management systems  <b>Digital effect:</b> Zero barrier in logistics, capital flow, information flow</p>	<p><b>Implementer:</b> Government and enterprises of all levels  <b>Digital content:</b> Industrial internet platform and production, supply and marketing cloud services  <b>Digital effect:</b> Demand-driven supply and collaboration among enterprises</p>	<p><b>Implementer:</b> Government and enterprises at all levels  <b>Digital content:</b> Cross-industry digitalization (upstream and downstream, peripheral service industries) and city-level innovation platforms  <b>Digital effect:</b> Integrated development of industry and city</p>
Governance	<p><b>Executor:</b> Government  <b>Target:</b> Urban components and events  <b>Method:</b> Management of local business areas</p>	<p><b>Executor:</b> Government, enterprises and citizens  <b>Target:</b> People and events in the city  <b>Method:</b> Cross-departmental, regional and system services</p>	<p><b>Executor:</b> Government, enterprises, citizens and social organizations  <b>Target:</b> People, events and trends in the city  <b>Method:</b> Services including forecasting (e.g. epidemic situation prediction and analysis, traffic congestion indicators)</p>
Environment and low carbon	<p><b>Implementer:</b> Department of Environmental Protection  <b>Digital content:</b> Pollution reduction targets, monitoring and assessment information  <b>Effect:</b> Localized online monitoring</p>	<p><b>Implementer:</b> Multiple departments related to environmental protection  <b>Digital content:</b> IoT, big data and AI-based applications  <b>Effect:</b> Smart management of atmosphere, water, energy, etc.</p>	<p><b>Implementer:</b> Government, enterprises and citizens  <b>Digital content:</b> Smart and low-carbon development of environment, projections and urban life  <b>Effect:</b> Digital management of carbon emissions and energy</p>
Governmental effectiveness	<p><b>Internal collaboration:</b> Mismatch between online and offline services; interdepartmental independence  <b>Data sharing:</b> Diverse and disordered data  <b>Scientific decision-making:</b> Localized data-driven decision-making</p>	<p><b>Internal collaboration:</b> Cross-sector and cross-level platform for collaboration  <b>Data sharing:</b> City-level basic data  <b>Scientific decision-making:</b> Data-driven decision-making across departments</p>	<p><b>Internal collaboration:</b> Synergy within the government and the ability to coordinate with non-governmental elements  <b>Data sharing:</b> City-level, orderly sharing  <b>Scientific decision-making:</b> City-level, data-driven decisions</p>
Infrastructure	<p><b>Digitalization of traditional infrastructure:</b> Gradual application of display screens, cameras, etc.  <b>Digital infrastructure:</b> Self-built server room and data platform, or cloud-based decentralized infrastructure  <b>Information security capability:</b> Security of each industrial client, represented by hardware firewalls</p>	<p><b>Digitalization of traditional infrastructure:</b> Municipal affairs and transportation facilities  <b>Digital infrastructure:</b> City-level government clouds, data platforms, AI platforms, etc.  <b>Information security capability:</b> City-level, integrated, secure operational capabilities</p>	<p><b>Digitalization of traditional infrastructure:</b> Digital twin-based infrastructure  <b>Digital infrastructure:</b> City-level digital base plus edge facilities  <b>Information security capability:</b> Intercity joint defence and linkage to address all cyberspace security issues</p>
Development assurance (leadership/policy)	<p><b>Organizational mechanism:</b> City authorities as facilitators  <b>Policy/planning:</b> Decentralized single-area planning  <b>Digital literacy:</b> Owned by closely engaged digital personnel  <b>Security mechanism:</b> Compliance with data security and personal information-protection regulations</p>	<p><b>Organizational mechanism:</b> City-level organization on digital transformation  <b>Policy/planning:</b> Integrated, city-level policy/planning  <b>Digital literacy:</b> Government officials  <b>Security mechanism:</b> Compliance with data security and personal information-protection regulations</p>	<p><b>Organizational mechanism:</b> Multiparty engagement  <b>Policy/planning:</b> Integrated, long-term, city-level policy/planning  <b>Digital literacy:</b> Government, enterprises and citizens  <b>Security mechanism:</b> Compliance with data security and personal information-protection regulations</p>

Source: Tencent Research Institute

## 3.4 Industry and economy

In terms of SMCs, this category refers to city-based regional economic elements that rely on one or more segments of agriculture, industry and service. Compared to big cities, whose industry tends to be rich and diversified, SMCs typically have a more homogeneous industrial structure and fewer local enterprises.

The digital transformation of economically significant industries is a commonly prioritized area among SMCs. The characteristics of the three developing stages are as follows.

Phase 1 of digitalization is mainly carried out by leading local enterprises under their own initiative, focusing mainly on the construction of their own digital systems in production, sales and management, as well as the construction of information infrastructure such as private clouds and primary information security facilities. Digital transformation at this stage breaks down barriers in the internal logistics, capital flow and information flow of the enterprise, which significantly improves its production and operational efficiency.

The implementers of digital transformation in phase 2 are government and enterprises. The government focuses on tailoring the establishment of the internet platform to specific industries and promoting an integrated production-supply-sales mechanism among the relevant enterprises and customers of the industrial chain. The effects are as follows: to begin with, the overall efficiency of the distinctive industry chain is improved. In addition, the customer-centred capabilities of upstream and downstream enterprises are enhanced; these include intelligent agriculture, agile manufacturing, cloud collaborative manufacturing, large-scale customization and demand-based production.

The implementers of digital transformation in phase 3 are similar to those of phase 2, but the content is more concerned with cross-industry digitalization. For example, in addition to the upstream and downstream aspects of the industrial chain, digital transformation will also link to and radiate among the surrounding service industries and will establish a city-level digital innovation platform. This platform will support individuals, enterprises and research institutes inside and outside the city to participate in the city's industrial and economic innovation. It will help generate synergistic development between the SMCs and the central cities of the region or other surrounding SMCs through industrial cooperation. This allows the flexible flow of resources (e.g. talent) within the region to match industrial demand. Mature digital transformation in this phase also breaks the geographical barrier and enables efficient, instant remote collaboration.

In the process of digital transformation, SMCs can choose one or more distinctive areas in which to carry out those tasks, taking into account their respective industrial and economic characteristics. The scenarios mentioned in this dimension of the methodology include but are not limited to the digitalization of traditional industries such as agriculture, manufacturing, resource-based industries, logistics services, cultural and tourism industries, and the development of digital industries such as cloud computing, big data, AI and blockchain. This process applies not only to intracity applications but also to the development of cross-city industrial clusters within city clusters and metropolitan areas.



## 3.5 Governance

Urban governance is concerned with the management of urban infrastructure, public service facilities and social public affairs associated with urban planning, construction and operations. This includes but is not limited to urban management, municipal governance and grassroots governance.

The aim of digitalizing urban governance is to create a human-centric, data-driven urban governance model based on the comprehensive use of cloud computing, IoT, 5G, big data, AI, blockchain, digital twins and other new-generation information technologies. The digital transformation of governance is a commonly prioritized area among SMCs. The characteristics of the three developing stages are as follows.

In phase 1, the executors of urban digital governance are government departments in, for example, urban planning, municipal management, public emergencies, market management, traffic, public security and/or natural resources. The governance target is mainly the planning and management of urban components such as roads, bridges, the physical environment, emergency responses and the market environment, as well as imposing penalties for causing disruptions to urban management operations. With regard to governance methods, the management style is highly decentralized and interdepartmental collaboration is limited, with government departments taking charge only of those issues for which they are responsible.

In phase 2, aside from cross-departmental, cross-regional and cross-system governmental collaboration, the digital governance executors are complemented by the joint participation of city residents and enterprises. The target of governance is extended to all kinds of people, events and components in the city. The governance method will be transformed from a government-oriented model to a customer-oriented model. With the aid of digital technologies such as IoT, big data and AI, the subtle changes in the operation of the city can be automatically sensed, followed by scientific and efficient need analysis and government response. This can help achieve rapid reactions and adaptations to urban changes.

The digitalization executors of urban governance in phase 3 will be more diverse, including government departments, enterprises, citizens and other organizations. In addition to its effects on various types of people, events and components in the city, the governance target will also be extended to prediction and analysis of the city's future operations, which can achieve cross-regional governance and integrated governance between rural and urban areas. As a result, this governance method is more global, intelligent and proactive; cities can be governed as a continuously evolving living organism. Based on digital concepts, thinking and technology, the physical, social and digital spaces are gradually integrated, which promotes self-awareness, self-starting, self-learning, self-evaluating and self-optimizing behaviour in city governance. Thus, the city can respond to subtle changes in all city elements – e.g. people, events and dynamics – in a more responsive manner.

## 3.6 Environment and low carbon

The urban environment and low carbon strand focuses on ecological and environmental quality, resources and environmental carrying capacity, green lifestyles and carbon neutrality levels. Improving these indicators helps cities adapt better and respond to climate change. Urban management in this area includes but is not limited to green energy and monitoring and surveillance of the urban natural environment.

For SMCs, digital transformation in the environmental and low-carbon areas has become an important support for current and future sustainable urban development. Especially for cities that rely on traditional resource-based or manufacturing industries, achieving green production transformation and strengthening ecological governance have become high-priority

tasks. In this functional area, the characteristics of the three developing stages are as follows.

In phase 1, digital transformation is mainly concentrated on urban environmental protection. The main implementer is the environmental protection department of the city government, and the content of digital transformation is the monitoring and management of water, the atmosphere, solid/hazardous waste, soil, noise and sanitation in the city. The expected effects will achieve localized monitoring and management of the natural and built environment of the city.

In phase 2, digital transformation will be promoted by the city's multiple departments related to environmental protection. As for the content of digital transformation, technologies such as IoT,

big data and AI will play an imperative role in the comprehensive and real-time perception of the urban ecological environment. In addition, digital transformation will begin to support the greening of urban energy. The intended result will mainly be the aggregation and overall intelligent management of information on urban air, water and energy facilities.

In phase 3, the implementer will be extended to government departments, enterprises and citizens; these share the goal of creating a carbon-neutral city. The content of digital transformation will cover all aspects of ecology, the environment, agricultural and manufacturing production, life and governance.

## 3.7 Governmental effectiveness

The main concern of digital transformation in governmental effectiveness is how to realize online collaborative work and scientific decision-making mechanisms through digital concepts, thinking and technologies within the government, in order to improve administrative efficiency, administrative effectiveness and government performance. Therefore, although the digital transformation of governmental effectiveness is an independent process, it is closely related to digital transformation in other fields.

Digital transformation in governmental effectiveness covers data sharing, business collaboration and digitally assisted decision-making. This is an area of common concern for all types of SMC. The three developing stages in this functional area are characterized as follows.

In phase 1, the government has not yet reached a high level of internal synergy: online and offline services are separated, and interdepartmental coordination is relatively limited. Data is shared only among certain departments in a point-to-point manner; there has not yet been a comprehensive data-sharing mechanism among government departments. In addition, in certain departments that have gone online through digital apps, data-driven decision-making is made possible.

In phase 2, the government has established an interdepartmental and cross-level digital collaboration platform. In terms of data sharing, it has established the mechanisms, workflow and technical means for sharing basic data resources at the city level among its departments on the basis of ensuring data security and personal privacy. In addition, in some cross-governmental scenarios, data-driven decision-making mechanisms have been introduced.

In phase 3, the government has achieved integrated and single-network collaboration among all internal personnel, making it possible for personnel from various government departments in the city to communicate, interact and collaborate instantly, conveniently and autonomously, transcending departments, levels and system boundaries. In addition, a digital mechanism for real-time communication and interaction between government personnel and enterprises and citizens has also been established. In terms of data sharing, on the basis of ensuring data security and personal privacy, a city-level, open and orderly mechanism for public administrative data sharing has been established, along with the capacity and platforms to do so. In terms of scientific decision-making, data-driven decisions can be accomplished in cross-government sector scenarios at the city level.

## 3.8 Infrastructure

The digital transformation of infrastructure in SMCs covers:

1. Digital infrastructure capacity building, such as cloud, data platform, IoT facilities, AI
2. The intelligent transformation or construction of infrastructure such as municipalities, security and transportation facilities

For SMCs, digital transformation in infrastructure provides basic technological and elemental support for the digital transformation of cities. The three developing stages in this functional area are characterized as follows.

In phase 1, the digitalization of traditional facilities is reflected in the gradual application of display screens, cameras or intelligent municipal equipment in localized scenarios such as traffic and security. As for the construction of digital infrastructure, some government departments have built their own server rooms and data platforms or realized infrastructure capabilities through cloud services. The information security capability at this stage refers to the ability to settle the security problems of each industrial client. Tools represented by hardware firewalls are developed in a decentralized manner by corresponding industries, showing information silo architecture and industry-based characteristics.

In phase 2, the digitalization of traditional services is reflected in the intelligent transformation of municipal facilities, transportation and other facilities. The city's digital infrastructure has been equipped with common digital support capabilities such as city-level government cloud, data and AI platforms, which can support the construction and operation of digital application scenarios in many other fields. The information security capabilities have been extended from the local departmental level to the city level, showing a comprehensive security operation capability.

In phase 3, cities have established digital twin facilities with fine mapping and real-time interaction with physical entities, which can sense the operation status of urban infrastructure in real time and perform certain reverse control and simulated

optimizations of infrastructure as needed. Digital infrastructure in different fields and functions of cities has been integrated intensively, forming a city-level operating system that can support all kinds of digital scenarios. Aside from such integrated construction, if a city has little existing digital infrastructure, the city-level operating system may be built from scratch. The information security capability already has the characteristics of intercity linkage, and can solve security problems in the whole domain of cyberspace, including cloud computing, big data, IoT, mobile internet and AI.

It should be noted that SMCs with smaller population sizes and weaker economic bases should establish digital infrastructure systems based on the existing resources of their provinces and municipalities, while giving priority to cloud-based solutions.

### 3.9 Development assurance (leadership/policy)

Development assurance (leadership/policy) includes but is not limited to organizational mechanisms, policy, planning, funding, talent, digital literacy and standards. Its main role is to provide guidance, support and guarantees for digital transformation in the six areas outlined in this report: public and social services, industry and economy, governance, environment and low carbon, governmental effectiveness and infrastructure.

No matter which of the above areas SMCs choose as the entry point for their digital transformation, development assurance (leadership/policy) is generally an indispensable supporting element, especially for data security and privacy protection. The digital transformation-related organizational mechanisms, policies, planning, funding, talents, digital literacy, standards, etc. will have different characteristics at different stages of development.

In phase 1, the digital transformation of SMCs is usually promoted by the city informatization department or other specialized departments such as city management, environmental protection, emergency response, transportation or education. Digital planning and policy are formulated by corresponding departments and are aimed at certain areas. Only the personnel involved in informatization construction have digital literacy. In addition, city authorities are required to pay a great deal of attention to data security and privacy protection, and relevant regulations are followed.

In phase 2, cities will have established a digital transformation organization led by the city's top government leader (such as the mayor or head of the elected municipal administration) and participated in by all departments. The corresponding funding and operation mechanisms have also been considered. A city-wide digital transformation-related policy or plan has been formulated to provide guidance from the perspective of the whole city. In terms of digital literacy, officials at all levels across different departments will have particular knowledge and skills relating to digital transformation. Furthermore, mechanisms for data security and privacy protection are in place.

In phase 3, cities have established a specialized digital transformation organization, explored mechanisms such as chief data officers, and have an overall plan for funding and operation mechanisms for the organization. Aside from the government, citizens and enterprises can also participate in the formulation of policies, planning and urban design, and jointly form a roadmap for urban digital transformation. In addition, the government, citizens and enterprises all have the basic cognitive and practical skills needed to pursue digital transformation thanks to the provision of adequate training. Thus, the mechanisms of data security and privacy protection are further improved.

4

# Suggestions for the participation of various stakeholders

To achieve digital transformation in SMCs, governments, enterprises, research institutions and citizens need to work together.



This chapter will briefly introduce the roles and recommended actions of four types of stakeholder – government, citizens, enterprises and research institutions – in the seven functional areas of digital

transformation: public and social services; industry and economy; governance; environment and low carbon; governmental effectiveness; infrastructure; and development assurance (leadership/policy).

## 4.1 Government

The government plays a core role in all seven functional areas to ensure that the digital transformation of each area promotes and supports the others. In the case of China and Japan, it can

be observed that governments currently play a comprehensive leading role. However, the digital transformation and sustainable development of cities is a process that requires the joint promotion

of multiple stakeholders. Hence, it is to be expected that companies, citizens and social organizations will lead the way in a city's digital transformation.

The digital transformation of SMCs should be human-centric, aiming to meet the various needs of urban residents in the present and future. Initially, the government can carry out digital transformation to drive changes in governance, lifestyle and agricultural and manufacturing production, solidify the city's digital infrastructure, improve governmental effectiveness, generate a work synergy within the government and collaborate with the outside world to achieve city-level data sharing and promote data-driven scientific decision-making. In addition, the government

should establish a good governance mechanism and the affiliated supporting policies, regulations and other assurance measures needed to improve demand-based governance capabilities, so as to provide targeted services for everyone and efficient handling of every matter. The government can also optimize city services using multiple channels (e.g. mobile phones, PCs and the dashboard that acts as the "city brain") and by establishing an inclusive digital environment, cooperating with enterprises to promote the integrated development of local industries. Last but not least, the government should consolidate resources to build a carbon-neutral city, strive for the effective use of energy and produce an overall design based on the optimal control and management of energy consumption.

TABLE 1 Engagement roles of different stakeholders

	Public and social services	Industry and economy	Governance	Environment and low carbon	Governmental effectiveness	Infrastructure	Development assurance (leadership/policy)
Government	●	●	●	●	●	●	●
Citizen	●	●	●	●	●	●	●
Enterprise	●	●	●	●	●	●	●
Research institute	●	●	●	●	●	●	●

## 4.2 Citizens

Citizens play a core role in two areas – public and social services, and environment and low carbon – while playing an auxiliary role in the five areas of industry and economy, governance, governmental effectiveness, infrastructure and development assurance (leadership/policy).

Citizens can participate in the digital transformation of public and social services by providing feedback

about their needs with regards to services, participating in service design and evaluating service quality. Additionally, citizens can keep abreast of government work and the status of city operations through unified public service platforms and interactive data analysis tools. They can also use digital tools and services to help them adopt low-carbon lifestyles in a variety of areas, including travel, finance, employment, education and healthcare.

## 4.3 Enterprises

Enterprises play a core role in four areas – public and social services, industry and economy, environment and low carbon, and infrastructure – while playing an auxiliary role in the remaining three areas of governance, governmental effectiveness and development assurance (leadership/policy). Enterprises should focus on public-private collaboration, social responsibility and industrial innovation, and contribute to the digital transformation of SMCs through the provision of technology applications.

Enterprises providing digital technologies, products and services can explore the development of distinct industrial economic models based on digital thinking and technologies while providing a variety of public and social services relating to travel, food and beverages, and e-payments. Furthermore, they can cooperate with governments through public-private partnerships (PPP), provide data services and participate in digital infrastructure construction. They can also focus on contributing to a clean environment and sustainable development, reducing energy consumption expenditure and improving the efficiency of energy resource usage through digital technologies.

## 4.4 Research institutes

Research institutes play a key role in the area of development assurance (leadership/policy) and an auxiliary role in the other six areas: public and social services, industry and economy, governance, environment and low carbon, governmental effectiveness and infrastructure.

Research institutes strengthen digital transformation models and digital technology research, helping governments to actualize, for example, urban digital transformation policies, planning and standards, while guiding technology applications by enterprises and the government. Research institutions, governments and enterprises will cooperate in the long term to continuously

make digital projects iterative and upgradable, and jointly create an agile and resilient urban digital transformation pathway that promotes the sustainable development of cities.

In conclusion, this report suggests that SMCs should adopt the digital transformation pathway that best suits their local characteristics and development objectives. The report is innovative in its focus on SMCs and the three-phase methodology it presents. In the future, the World Economic Forum will engage in in-depth global cooperation with key stakeholders on the digital transformation of SMCs, to help make cities become more livable, sustainable and inclusive.



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# Endnotes

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