Smart cities in 2050:

Rebuilding the future of Japanese cities

pwc

www.pwc.com/jp/en

Introduction

In the thirty years between 2015 and 2045, the population of Japan is projected to decrease by about twenty million. This population decline is expected to have an impact on many industries. To keep the economy from shrinking, companies will need to increase their productivity. However, they face the challenge of securing the necessary workforce in the aging society that accompanies this decline in population.

Japanese social infrastructure was developed during the period of rapid economic growth during the 1950s-1970s, based on the assumption that the population would increase. However, as the population has decreased significantly in recent years, it is becoming difficult to maintain Japanese infrastructure at its current level.

Such changes in the economic environment are serious social issues that Japan must address. At the same time, however, these issues present opportunities for Japan to lead the world by creating a society and mechanisms that can manage problems such as a decreasing population and an aging society and contribute to the achievement of the Sustainable Development Goals (SDGs).

PwC's purpose is to build trust in society and solve important problems. With this in mind, we have put together this report as part of our efforts to take on Japan's social issues.

Norio Katayama
Energy & Utilities Industry Leader, PwC Japan Group,
Smart City Solution Lead Partner, PwC Consulting LLC

Contents

1

Issues facing Japanese cities

Unavoidable demographic changes

Declining general populations, shrinking working-age populations and higher ratios of senior citizens

Japan's population peaked in 2008 and has since entered a period of decline in the overall population. In 2045, Japan's total population is expected to be 106.42 million, which represents a decrease of over 20 million compared to 2015. This is equivalent to losing the entire populations of Tokyo and Chiba Prefecture, and this trend is expected to continue until 2050 and onwards.

Although Japan's birth rate has recently experienced a slight recovery, this is not enough to stop the demographic change The working-age population (defined as people aged 15-64) is expected to decrease to 52.5% of the total population, which means a significant reduction in the size of the workforce. With human lifespans estimated to reach 100 years, the ratio of senior citizens in the population will grow to 36.8% by 2045. This will lead to an increase in social security expenses which, alongside the decrease in the working-age population, will accelerate the increase in the related burden on the working age population.

Other industrialized countries such as the Scandinavian nations and France have recovered their overall birth rates to around 2.0 through significant support and subsidies for childbirth and child rearing, together with the social acceptance of different forms of parental relationships.

The US and the UK have succeeded in stalling the fallsimilar decreases in birth ratebirth rates with by providing supportive career environments after parents return from childbirth and childcare leave. Examples from other countries indicate that fundamentally improving fundamental improvement of birth ratesbirth rates in ways that are not affected by temporary external factors such as market sentiments takes one toor two decades excluding temporal improvement by external factors such as economic sentiment. Japan has implemented improvement measures, but it will take time for the effectiveness to become visibleto see the results. As the second-generation baby boomers born between 1971 and 1974 enter theired late -40s and the population at childbearing age is constantly decreasingchildbearing-age population continues to decrease, a slight recovery in the birth rate will not be enough to boost the birth rateincrease the number of babies being born. In the face of these issues, accepting more immigrants will would not only increase the working- age population, but would also also will improve the overall birth rate considering the generally higher birth rate among the immigrants. However, social acceptance of an increase in immigrants immigration without other possible measures make relatively slow progressmight prove difficult, and it also would take time for such measures to result in improvementsto see the improvement.

In light of these circumstances, this demographic change—that is, the decrease in the total population and the working-age population and an increase in the ratio of senior citizens—is unavoidable, regardless of any measures taken for improvement.

Figure 1.1 Demographic changes

106.42 million people
(Decrease of 20.67 million people)

A significant decrease in the total population

The total population of Japan peaked in 2008 and is expected to decrease to 106.42 million by 2045. This represents a decrease of 20.67 million over the three decades beginning from 2015, or the equivalent to losing the entire populations of Tokyo and Chiba Prefecture.

52.5%
(Decrease of 21.44 million people)

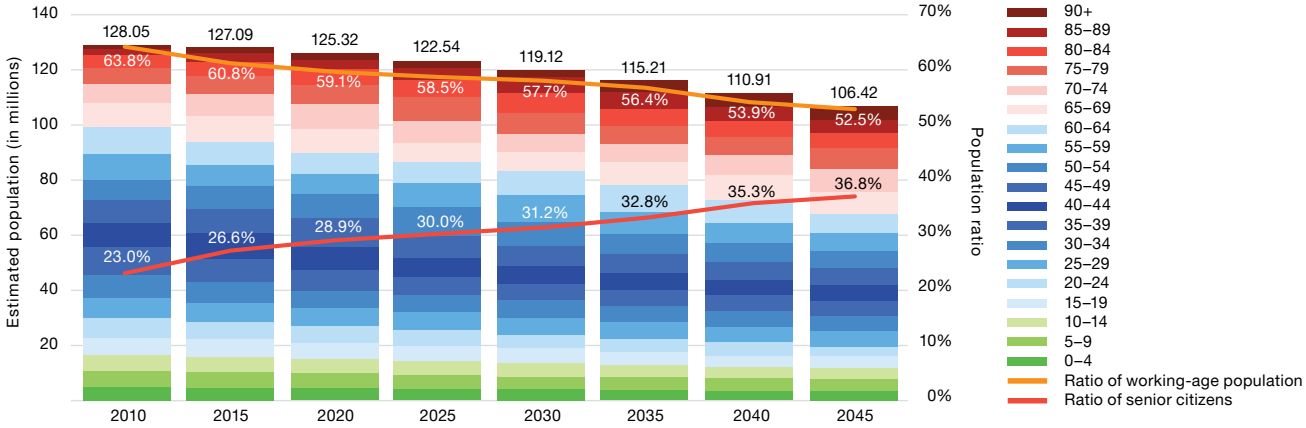
A decrease in the working-age population

The working-age population is expected to decrease by 21.44 million, which exceeds even the ratio of decrease in the total population. Consequently, about half of the total population will fall outside of the range currently considered 'working age', as the ratio of the population from 15 to 65 years of age falls from 60.8% in 2015 to 52.5%.

36.8%
(Increase of 5.32 million people)

One in 2.7 people will be aged 65 or above

In contrast to the decrease in the working-age population, the number of people aged 65 and above will increase by 5.32 million in the three decades beginning from 2015. This will increase the proportion of the population aged 65 and above from 26.6% (one in 3.8 people) to 36.8% (one in 2.7 people), which is an increase of about 10 percentage points.



Prepared by PwC based on *Regional Population Projections for Japan* (March 2018) by the National Institute of Population and Social Security Research

Social infrastructure at risk of collapse

The uncertain future of safety and security

At the national, municipal and regional level, every community requires the assurance of safety and security for all residents. Without this assurance, residents cannot generate the vibrancy that vitalizes a society. However, demographic changes mean that it might soon be difficult for communities to ensure the safety and security that are the minimum necessities for a physically and mentally healthy life.

Social security at the risk of collapse

One example of the risk of collapse caused by demographic changes can be seen in the social security system. A larger proportion of senior citizens means more residents receiving pension, long-term care and hospital treatments that result in larger social security expenses. A shortage of nurses and doctors will also lead to rising costs of health or medical care. At the same time, a smaller working-age population means less social security income from insurance premiums. Lower productivity of the workers and corporations that pay these premiums is also an issue, as it results in lower per-capita incomes, which are the source of social insurance premiums. Insurance revenue alone is already unable to cover Japan's increasing social security expenses, and the national and local governments are attempting to fill the gap with government bonds and tax revenue. If the balance of Japan's social security system deteriorates further, the risk of collapse is all too real.

The difficulty of maintaining public services

Public services are also becoming difficult to maintain. The decrease in Japan's total population has lowered the demand density, making location-based services such as hospitals, fire stations, police stations and schools difficult to maintain. Fire stations, police stations and schools are already being integrated with their nearby counterparts, and this trend is likely to accelerate. Consequently, when there's a fire, for example, the fire engines mobilised to handle the incident might originate from a station far from the scene, and it may take a much longer time than before to respond. Similarly, patients may have to be transported to hospitals that are further away to get treatment for the illnesses and injuries.

Maintenance cost for network services such as utilities, communications, public transport, roads, bridge and tunnel development, and forestry and flood management projects will rise due to the falling demand density caused by the decrease in the total population. A lower number of working-age people in these industries could lead to delays in the renewal or maintenance of aged equipment, which in turn might make it difficult to secure residents' lifelines. For example, disruptions of power and water services, cancellations of public bus routes, closures of damaged roads and bridges and the occurrence of floods might become more frequent.

Public services that have previously been taken for granted in Japan are now at risk. These services will become increasingly difficult to maintain due to demographic changes, which could decrease their convenience significantly.

Because demographic changes differ from city to city, the resulting issues also differ. On the next few pages, we will take a closer look at the separate issues facing regional cities and large metropolitan areas.

Figure 1.2 The uncertain future of safety and security

Vibrancy

Functions that attract both residents and outside parties to the society

Security

Functions that enable residents to live comfortably, free of physical or mental concerns

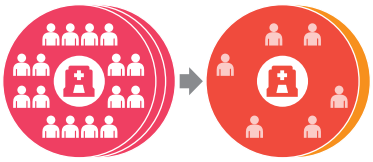
Safety

Functions that meet the most basic needs of all residents. Residents enjoy these functions unconsciously as ordinary and indispensable elements of their lives.

Figure 1.3 The difficulty of maintaining public services

Location-based services

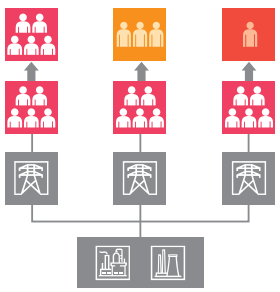
Healthcare facilities (hospitals, dental clinics, long-term care facilities etc.) and educational facilities will become difficult to maintain. As facilities are closed or integrated with nearby facilities, some areas will become less convenient than others.



Decrease in total population

Network-based services

Rising per-user maintenance costs of infrastructure and network services such as energy supply (electricity, gas etc.), communications, water and sewage and public transport make these services more difficult to maintain.



The negative cycle facing regional cities

Outflow of working-age population to metropolitan areas

City-level demographic changes indicate that the population is shifting from smaller regional cities to core regional cities where prefectural governments is located, and even greater shifts are occurring to central cities such as Sapporo, Sendai, Hiroshima and Fukuoka and to the three major metropolitan areas (the 23 wards of Tokyo, Osaka and Nagoya) and their suburbs. Working-age people comprise the majority of these urban migrants, accelerating the decrease in the working-age population in regional cities.

Gaps in safety and security between cities

The continuous population outflow that regional cities are seeing leads to a decreased demand for public services and a decline in income from service fees. With the working age population comprising the majority of the outflow to larger cities, regional economies stall or contract, leading to additional decreases in regional tax revenue. A decrease in the total population results in increased per-user costs for infrastructure maintenance and for the renewal of aging equipment. On top of this, a smaller working-age population makes it difficult to secure personnel who can provide maintenance for public services and infrastructure, and an increased proportion of senior citizens leads to an increase in the expenses allocated to long-term care-related services, thereby leading to a decrease in profit for the regional economy. Consequently, the quality of infrastructure maintenance and facility renewal are also compromised, and when a disaster occurs, recovery takes more time. The closure and integration of public service facilities also leads to a decline in quality and convenience for the public services they provide. Ultimately, the gap in quality and in user expense among cities increases, even for those public services that form the base of safety and security, which leads to further outflow of regional populations to larger cities. Regional cities are falling into this negative cycle.

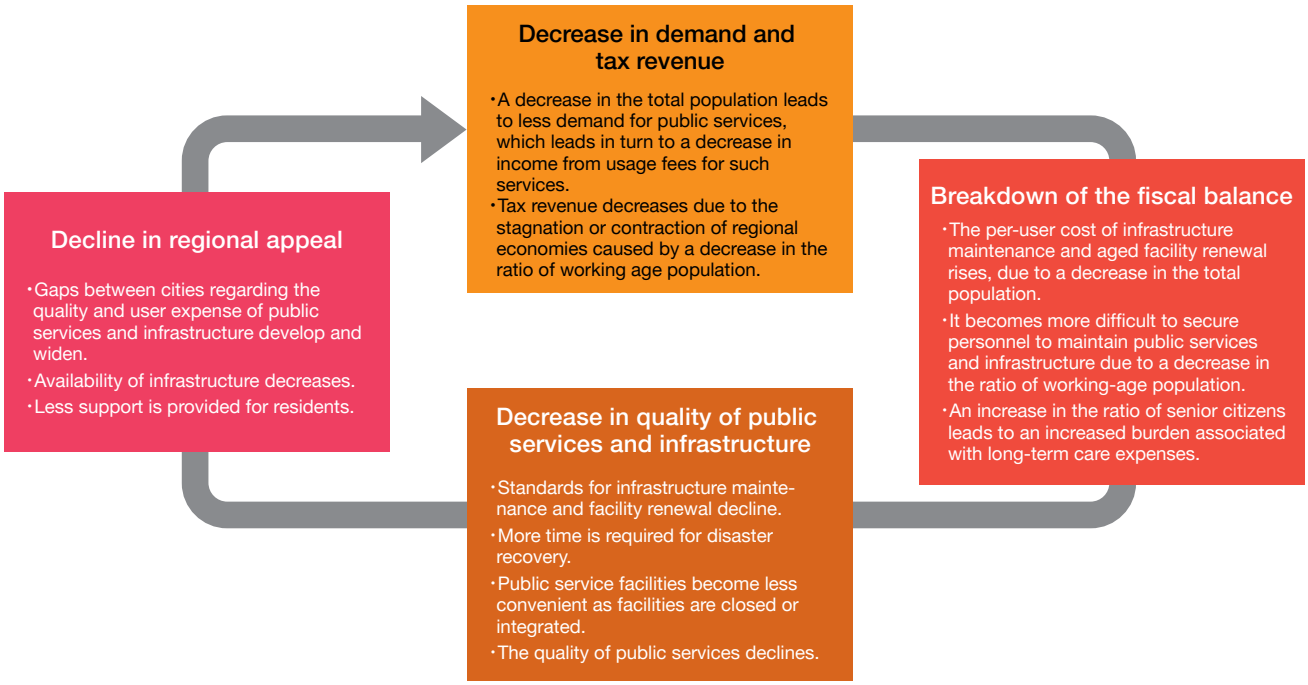
The interrupted economic cycles of regional cities

When we look at the economic cycles of regional cities, we see that these cities invest in educating their children, but once their generation reaches working age, these children migrate to larger cities to find jobs with better working conditions, or to get a higher education in order to obtain such jobs. Regional cities invest their tax revenue in educating local children but are not receiving the return in the form of those children becoming local taxpayers once they reach working age.

In the short term, household consumption from regional cities is flowing to larger cities through the payment of utility bills to companies based in large cities, and through the consumption of goods and services at large commercial facilities operated by companies in large cities. Regional economies, which are already shrinking as the result of the decline in the total population, are suffering further outflow of capital due to the behaviour of local residents as consumers. This leads to a breakdown in the circular flow of economic activity within the region.

Consequently, regional cities are becoming significantly dependent on financial transfers such as local grant taxes. In many cases, however, cities use the capital obtained through financial transfers on the construction of unprofitable buildings, out of concern that if they do not use the full allotted amount, their budget will be decreased for the next fiscal year. Without giving enough thought to the creation of an ecosystem that facilitates a cycle of economic activity to produce revenue from outside, such buildings will not generate enough income to cover their own maintenance and management costs, and will exhaust the regional economy further.

Figure 1.4 The negative cycle facing regional cities



Regional cities also face numerous individual issues

Different types of regional cities also face different issues. Cities whose economies are based on a primary industry, such as agriculture, forestry or fishery can generate income from outside by selling their products to consumers in large cities. However, these workers' income tends to be low, except for the few that have created successful brands. Many small-scale operators such as individuals or family-operated enterprises are unable to introduce technologies such as automation and mechanisation. This limits their ability to reduce production costs and to establish a distribution model that increases business income, which in turn leaves these operators with significant intermediary expenses. Many agricultural communities tend to focus on rice production, and many farmers have second jobs, which leaves them unable to grow produce with higher unit prices, which tends to require more involvement and technology.

Many manufacturing-based industrial cities, such as those that have developed around plants owned by large corporations, have experienced a decrease in employment due to factory automation, the shift of production sites to developing countries as the globalisation of supply chains progresses, and declining business due to the decreased competitiveness of Japanese manufacturers. Employment at plants that manufacture consumer products becomes less stable as the total population of the areas where the goods are consumed decreases, thereby leading to further downsizing and integration of plants.

Cities based on service industries and tourism are in a similar situation to that of cities based on primary industries in that while they can secure income from outside, their business operators tend to have low income. The tourism industry mainly consists of accommodation, restaurant service, retail and entertainment businesses, and except for luxury segments, such as hotels in large cities or those with foreign capital, average revenues tend to be low. This is because, like primary industries, the sector consists mainly of small-scale businesses that have been unable to introduce cost-cutting technologies, resulting in a labour-intensive business structure. In addition, infrastructure development has not been able to keep up with the recent tourism boom, resulting in traffic congestion, crowded public transport and an increase in waste processing, which are detrimental to both tourists and local residents.

Among these service sector-based cities, core regional cities including prefectural capitals and the two to three largest cities in each prefecture are currently maintaining their populations with inflow from the surrounding cities. Between 2020 and 2030, however, the supply of human resources from surrounding cities will gradually dry up, and the population will only flow out to large metropolitan areas. Regional core cities have traditionally used their positions to play the role of regional financial centres, serving as home to the headquarters of regional banks and, as a result, many branch offices of companies in other industries. However, as regional banks have been subject to restructuring, these cities are gradually losing their core positions, and are likely to become unable to maintain employment. Unless new industries that take advantage of unique regional characteristics can be developed, these core cities may end up in the same situation as other regional cities facing serious depopulation.

The economies of cities located in mountainous areas and on remote islands tend to be based on primary or tertiary industries. Particularly for those of these cites that lack both a foundational industry and resources such as agricultural, forestry or fishery resources and tourism resources, we expect severe decreases in total population, increases in the ratio of senior citizens and decreases in the working age population that accelerate the negative cycle described on the previous page. These cities will be unable to cover the cost of maintaining the safety and security functions that form the foundation of a city, including public transport, logistics, disaster prevention and response, long-term care and medical services. As a result, covering these expenses will put significant financial pressure on local governments, which also face labour shortages. The lack of a foundational industry results in poor earning power, which in turn makes it difficult to secure capital for covering costs, threatening the very survival of the city.

These individual issues faced by certain regional cities are also significant factors that contribute to the negative cycle.

Figure 1.5 Examples of individual issues facing regional cities

Type of regional city	Individual issues
Agriculture, forestry, or fishery-based economy (Mainly primary industries)	・Low income for workers in the main industry - Mainly small businesses that are making slow progress when it comes to improving efficiency - Significant intermediary costs before products reach consumers - Inability to produce expensive products that require involvement and technology
Manufacturing- or construction-based economy (Mainly secondary industries)	・Decrease in employment due to automation and the relocation of plants overseas ・Lack of industry to replace the manufacturing and construction sectors
Service sector-based economy (Mainly tertiary industries)	<Tourism-based economies> ・Low income for workers in the main industry, which is labour intensive ・Inability of infrastructure to keep up with the increase of tourists - Traffic congestion - Crowded public transport - Increase in waste processing volume
	<Regional centres such as prefectural capitals (with economies based on the financial sector)> ・Acceleration of the decrease in the total population and the working age population when the supply of human resources from surrounding cities is depleted ・Difficulty of maintaining employment due to loss of status as the regional centre and the accompanying closure of regional bank headquarters and corporate branches
Other (Cities with no strong core industries)	・Lack of regional earning capabilities and employment for the working age population ・Heavy financial burden associated with the maintenance of safety and security infrastructure for residents

The many urgent issues facing large cities

Declining convenience and usefulness of public services

Large metropolitan areas attract working age population from regional cities, which has created various issues due to the excessive concentration of the population. Commuter trains are constantly overcrowded, and commuting times are very long compared to regional cities. Traffic congestion has a negative impact on the logistics industry, as the labour costs account for large portions of total logistics costs. Residents who seek government services must visit municipal offices during the daytime on weekdays, and must wait for a long time if those offices are crowded. Similar situations can be observed at hospitals. Large cities face a different kind of decline in the convenience and usefulness of public services than that faced by regional cities. As a result, workers have become less productive, and the employment rate among married women has fallen.

The extreme concentration of workers in centralised areas also results in severe impact when a natural disaster or bad weather strikes one of these areas. Serious issues occur, for example, when public services such as power supply or public transport services are interrupted. Such interruptions can lead to the suspension of business, and in difficulty ensuring the safety and security of a large number of employees that cannot return to their homes.

Low birth rates in metropolitan areas: one of the major causes of Japan's falling population

Large metropolitan areas that have an inflow of working age population from regional cities also tend to have lower birth rates. The reasons for this include long commuting times and a shortage of childcare facilities despite the high demand generated by a large number of families consisting only of parents and children. Lower birth rates in metropolitan areas contribute to the decrease in the total population, and in several decades will eventually result in a decrease in the working-age population.

Many issues requiring individual response

Global competitiveness is also an issue for the three major metropolitan areas (Tokyo, Osaka and Nagoya) and the core regional cities that form the centre of Japanese economy due to the fact that many business enterprises are located there. As domestic consumption declines due to the decrease in the total population, these cities must ensure their competitiveness against overseas rivals and secure income from overseas in order to maintain their social infrastructure. However, ensuring this competitiveness brings additional challenges that require urgent action. For example, access to central business districts from international airports is often poor, and accommodations aimed at overseas executives and wealthy individuals are limited. These cities' ability to attract and train talent capable of performing at a global level is also limited, and the investment environment for start-ups is insufficient. In other words, the necessary environment for increasing income from overseas has not yet been established.

The population inflow to commuter cities surrounding the major metropolitan areas has tapered off in comparison to the rapid economic growth period when these cities were developed. We therefore expect that the competition among these cities to attract population will only increase. The majority of these cities' residents moved there in order to work in the nearby metropolitan area, and tend to be less attached to where they live. As a result, the populations of these cities tend to be highly fluid. These residents decide where to live by logically compare factors such as accessibility to central business districts, real estate prices, income levels and living environment. A lack of attractive city planning in these cities can lead to the risk of losing their working age population, which leads in turn to the same issue faced by regional cities—decrease in the total population with a lower ratio of working age population and a higher ratio of senior citizens.

Figure 1.6 Examples of issues faced by large cities

Type of large city	Examples of common issues	Examples of individual issues
The three major metropolitan areas and core regional cities	• Declining convenience and usefulness of public services - Constantly overcrowded commuter transport - Constant traffic congestion - Long waiting times and insufficient services for government procedures - Long waiting times and inefficient reception services at hospitals - Failure of infrastructures including transport and power, suspension of business and a large number of employees that cannot return home in the event of a disaster • Low birth rate (caused by childcare shortages, long commuting times, inflexible workstyles, etc.)	• Low global competitiveness - Poor access between international airports and central business districts - Lack of accommodation for executives and wealthy individuals - Inability to attract and train global talent - Insufficient investment environment for start-ups
Commuter cities		• Intensified competition among commuter cities caused by slower population inflow • High resident fluidity due to lack of attachment to the community (risk of population outflow/aging without attractive city planning)

Working towards 2050

Japan's issues today are the world's issues tomorrow

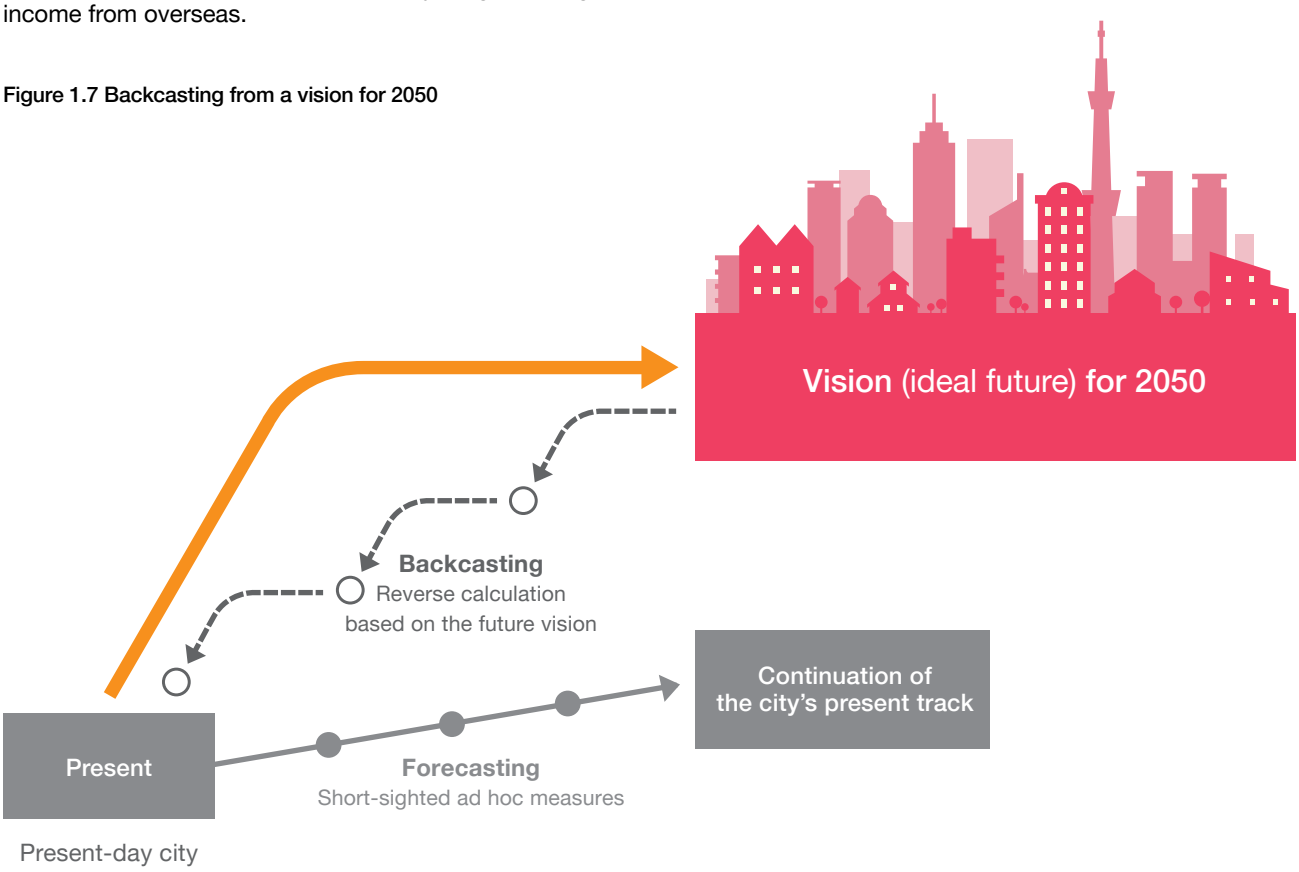
Japan is one of several countries in the world experiencing the simultaneous rapid emergence of three phenomena: a decrease in the total population, a decrease in the ratio of working age population and an increase in the ratio of senior citizens. Regional cities and large cities in Japan are currently facing a number of issues that arise from these macro trends, which we expect to see throughout the world in the near future. In North Americas and Europe, these three phenomena are not expected to be seen as quickly as in Japan due to factors including immigration. However, we expect that these regions will also face the same phenomena in several decades' time. In China, which has experienced rapid economic growth, and in other Asian countries that are competing to follow China's path, these phenomena might arise in a shorter time frame as the result of rapid economic growth. All of these countries are considering measures to take against the three phenomena that they will eventually face. It is important for the cities in Japan that are already facing these phenomena to serve as pioneers by performing deep analysis, considering hypotheses for resolution, reviewing the results and implementing measures with 2050 as their goal. Not only will these initiatives solve the cities' own problems, but the process itself has the potential to become a new core industry for generating income from overseas.

The need to develop a design vision for 2050

The issues that Japanese cities are facing ahead of the rest of the world cannot be solved merely with the kind of short-sighted emergency measures or gradual improvements that could provide results during a person's current stage of life or current job, or during a mayor or city councilmember's term of office. Instead of resorting to ad hoc measures, these cities must first define a vision (an ideal future state) for 2050, and then develop specific measures to fill in any gaps between the vision and the current situation. To identify these gaps, they need to start with the vision and work backwards, through a process called 'backcasting'. All stakeholders related to the city must make a long-term commitment to steadily implement the measures specified through this process.

The next chapter discusses smart cities as a methodology for achieving this vision. You may think of smart cities simply as convenient cities equipped with advanced technology. However, at PwC, we propose that smart cities are cities that focus on their residents in order solve issues and realise an ideal vision for the future.

Figure 1.7 Backcasting from a vision for 2050



2

Smart cities of the future

PwC's smart city concept

Smart cities: More than just convenient

These days, we often hear smart cities mentioned as a means to solve social issues related to city planning and regional revitalisation. When you hear the phrase 'smart city', you might imagine a convenient city where everything is connected through the internet, where data on our behaviour is gathered and accumulated without our knowledge, and where optimal solutions are automatically produced by using AI to perform big data analysis.

Convenience is certainly a good thing, but is that all that our vision for future cities entails? Is the use of advanced technologies itself the goal, rather than means? Let's go back the basics and re-examine what people want out of their cities and what will make people want to live in and visit a specific city in the future.

How we see smart cities at PwC

At PwC, we believe that smart cities are not just cities that look or behave a certain way. They are cities with mechanisms in place to resolve social issues. We define a smart city as:

a city that has mechanisms for solving social issues,

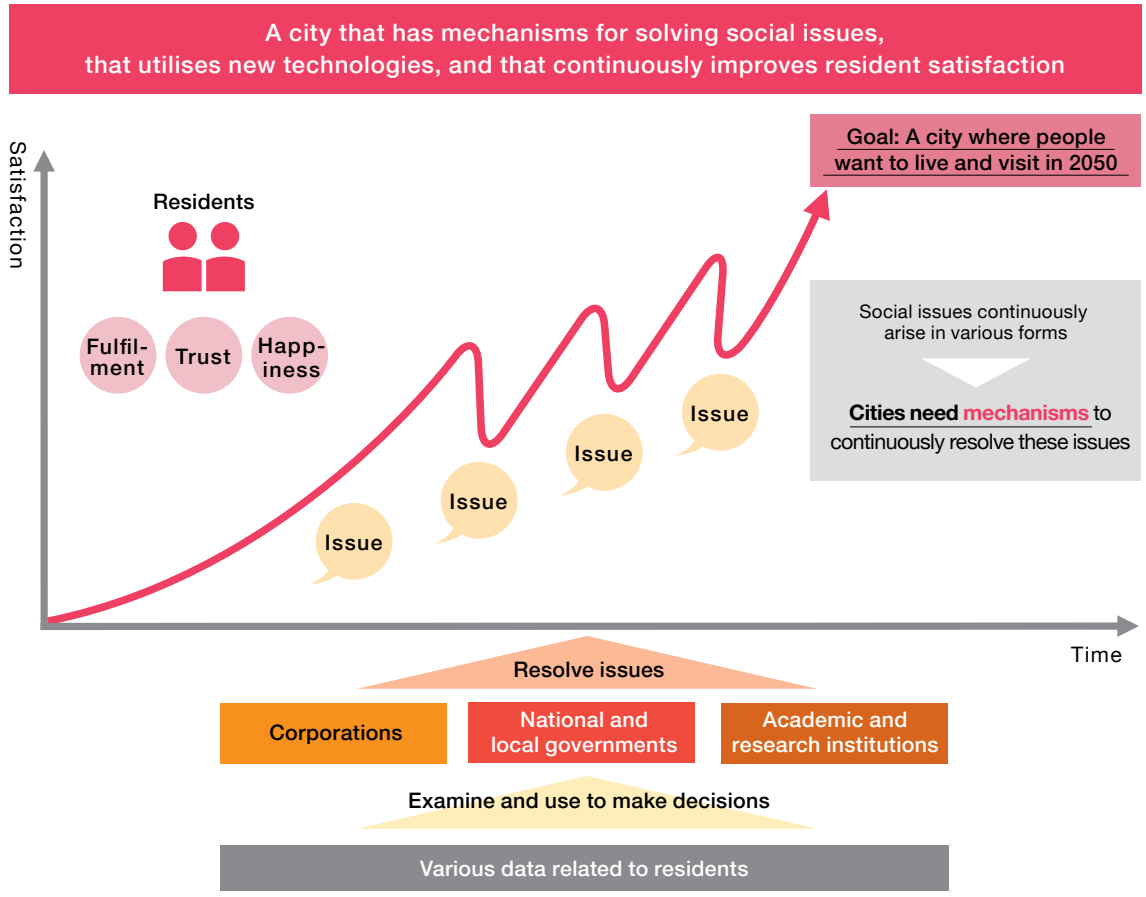
that utilises new technologies,

and that continuously improves resident satisfaction.

Smart cities are also able to continuously resolve the various social issues that arise on a daily basis, including environmental and population issues, and to provide a sense of happiness and fulfilment to their residents. To resolve issues, the local government and/or service and solution providers examine various data related to the residents, and use it to make decisions regarding responses and solutions.

We believe that smart cities are cities that possess the kind of mechanisms that make them places where people will want to live and visit in 2050.

Figure 2.1 PwC's smart city concept



The evolution of smart cities

Smart cities up to now

The smart city was a concept initially developed in response to a heightened awareness of environmental issues including global warming. The original goal of smart cities was to promote the efficient use of renewable energy to achieve a low-carbon society. Smart cities were based on energy-related initiatives, and aimed to achieve city-wide energy efficiency by using a mechanism called a smart grid to optimise the management of energy supply and demand. (See the 'Environmental coexistence approach' section in the figure below.)

The concept then expanded to include the utilisation of resident data not only for energy but also in the areas of public services, healthcare, agriculture and mobility. The emergence of various technologies including IoT, AI and big data made it possible to collect, analyse and utilise various forms of data that had previously been overlooked. This kind of convenient and comfortable city planning is still being carried out all over the world. (See the 'Technology-driven approach' section in the figure below.)

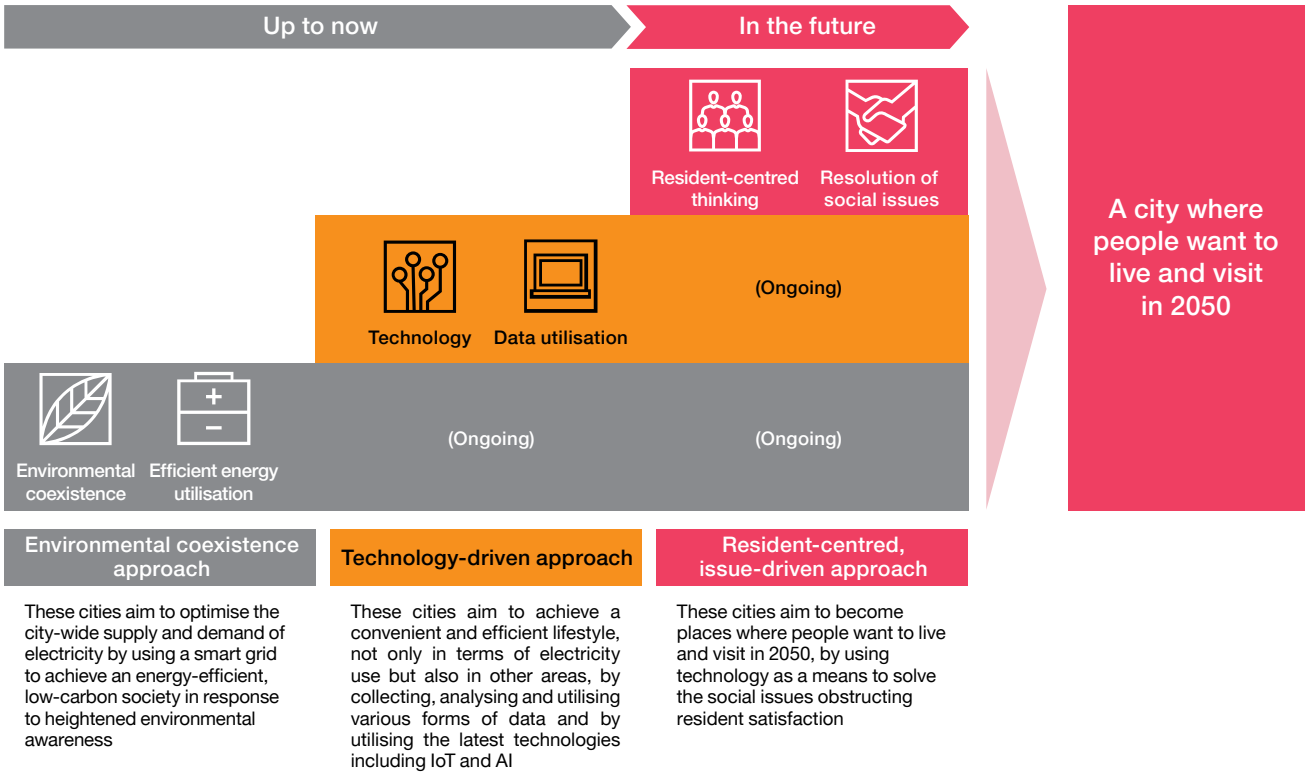
These initiatives sometimes result in a technology-driven approach, where the latest technologies are adopted first, and then the social issues to be resolved by using these technologies are selected.

Smart cities of the future

We believe that future smart cities should be based on consideration for the residents. The goals of developing smart cities are to resolve social issues and improve resident satisfaction. Technologies are the means by which these goals are achieved. Future smart cities should take a resident-centred, issues-driven approach, where the social issues obstructing resident satisfaction are identified first, and then the appropriate technology is selected according to the identified issues.

Fulfilment, trust and happiness: these are the parameters we believe should be used to evaluate the residents' degree of satisfaction with life in their city. By prioritising resident satisfaction, we can make cities more appealing, and transform them into places where people want to live in 2050. Of course, new technologies are also appealing, but we must always ensure that the residents are at the centre of our thoughts when considering the smart cities of the future, so that we don't forget the true purpose of city planning.

Figure 2.2 The evolution of smart cities



Smart cities of the future: The importance of residents' perspectives

Different perspectives

Recent initiatives to promote the spread of smart cities have used technology from various fields to make lifestyles more convenient, to a certain degree. These initiatives have been collaborative efforts among various stakeholders. For example, national and local governments have overseen the planning process and provided financial support through budget efforts and subsidies. Corporations have provided their own technology and solutions. And academic and research institutions have provided their knowledge and expertise.

However, when we take a closer look at each initiative, we see that each stakeholder tends to focus too closely on their own perspective. As a result, they might postpone activities with little prospect of short-term return on investment, implement solutions that only partially resolve the issues, or implement solutions in only one area, even when the issue in question affects multiple areas. Of course, public works projects are not charities. National and local governments must select the best initiatives that are within their limited budgets, by also considering profitability. Corporations must create profits through their know-how, products and services and universities must produce results in their field of research.

However, if each stakeholder focuses only on their own goals, it will be very difficult to achieve the true objective of a smart city: becoming a place where people want to live and visit in 2050.

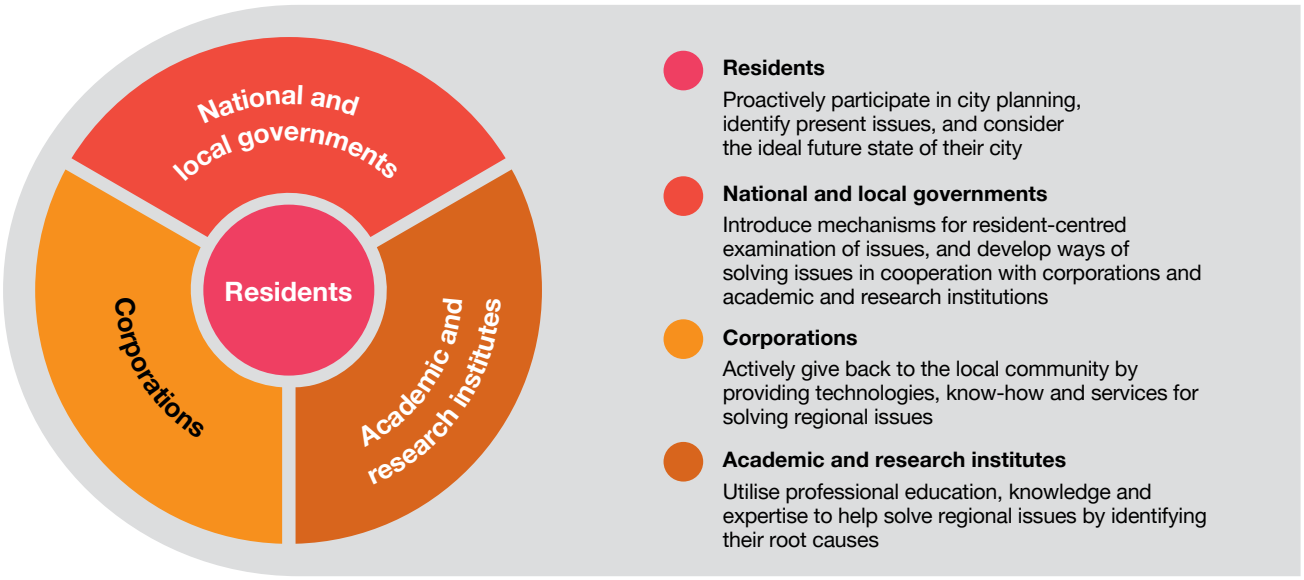
Understanding the opinions and needs of residents

When a social issue comes to light, dialogues with residents can help the stakeholders to understand the problems and inconveniences that the residents are experiencing. However, residents' opinions on their own might not be enough to reveal the true cause of the issue, and not all residents' opinions accurately represent the issues facing the city as a whole. Therefore, the expertise of professionals in each relevant area is also important. For this very reason, national and local governments, corporations, academic and research institutions and other experts should lead efforts to identify the essential issues, deploy methods for resolution and select initiatives, based on the opinions and needs of the residents.

Of course, each individual stakeholder may not be able to contribute beyond their own role. However, understanding the needs of the residents will make it easier to identify the effective solutions and relevant markets.

For these reasons, future smart cities should be built on a resident-centred model, through cooperative and collaborative relationships among national and local governments, corporations, and academic and research institutions. This resident-centred approach will also improve resident awareness of city planning and improvement. We also expect that this approach will make smart cities more appealing, thereby helping them to become places where people want to live and visit in 2050.

Figure 2.3 Smart city stakeholders



Utilisation of resident data

When we think about building the smart cities of the future, technology is an essential means. To make accurate decisions regarding initiatives and to select the technologies to be used to resolve social issues, it is crucial that smart cities utilise various data on their residents. Therefore, cities looking to become smart cities must be able to ensure the quality, volume, freshness and security of such data.

This data includes a wide variety of information about the residents, from the attributes and personal information (such as age and gender) that have traditionally been the main targets of data utilisation to information about their lifestyles and behaviour. This might include the time and volume of their electricity use or their shopping attributes, movement patterns and amounts of activity. An enormous volume of accumulated data (big data) is used to consider and determine the methods to be used to resolve social issues. The variety of data that is available directly determines the range of available options, and the volume and freshness of the data improve the accuracy of decision-making.

By using data as an objective decision-making factor, unscientific factors that sometimes have a negative effect on decision making, such as powerful lobbies and political considerations, can be eliminated. This should make it possible to resolve issues in ways that contribute to improving resident satisfaction.

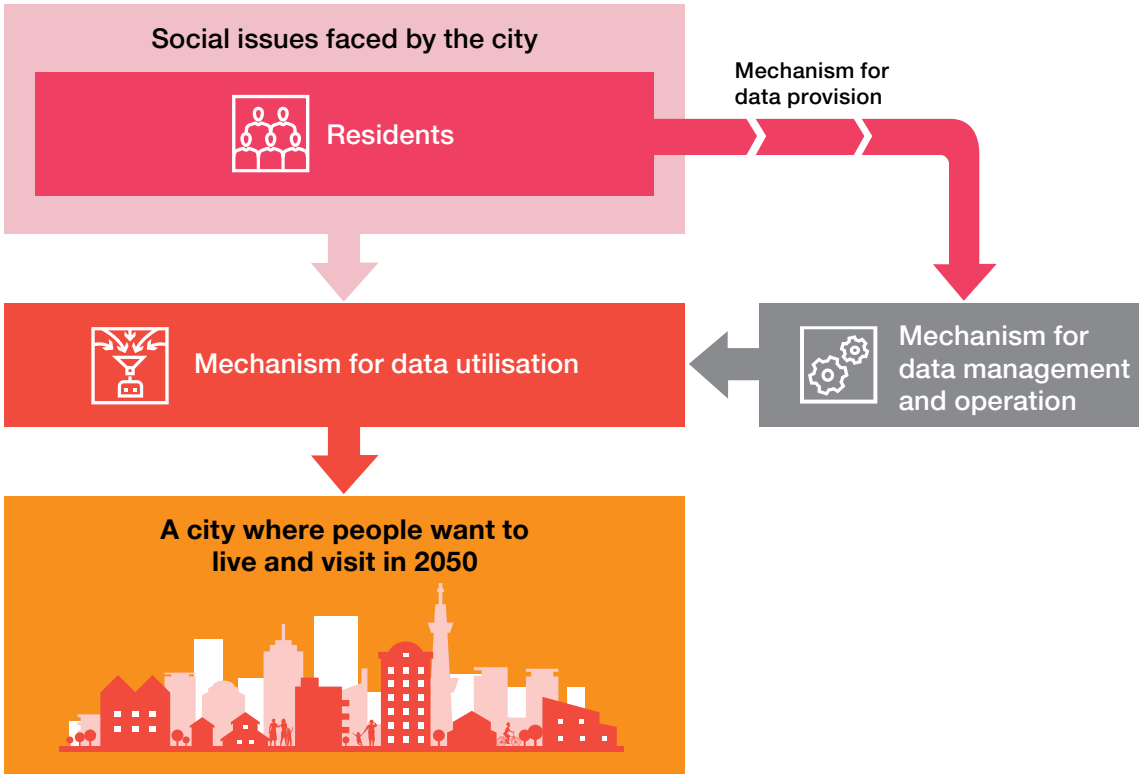
Mechanisms for resolving social issues

As we explained previously, PwC defines a smart city as a city that has mechanisms for solving social issues, that utilises new technologies, and that continuously improves resident satisfaction. Here, we want to emphasise the significance of mechanisms for resolving issues.

Past city planning examples show that when one issue is solved, the next arises, and the situation changes daily in ways that reflect the social background of the time. For example, during Japan's period of rapid economic growth, air and water pollution were serious problems. In response, the government established environmental regulations and raised awareness, thereby mitigating that issue. However, a series of new issues have since arisen, including issues related to landscaping and biodiversity and damage from flooding and natural disasters.

Temporary initiatives are not enough to address the various social issues that continue to arise, reflecting the times and the regional environment. Instead, mechanisms must be established to provide continuous support. Future smart cities must incorporate mechanisms by which residents provide data, mechanisms to ensure the appropriate management and operation of this data, and mechanisms by which this data is utilised to consider the initiatives to be used to address social issues.

Figure 2.4 Mechanisms for resolving social issues



To become a city where people want to live and visit in 2050

A positive cycle to build an attractive city

The goal of a smart city is to become a city where people want to live and visit in 2050. But what does this mean?

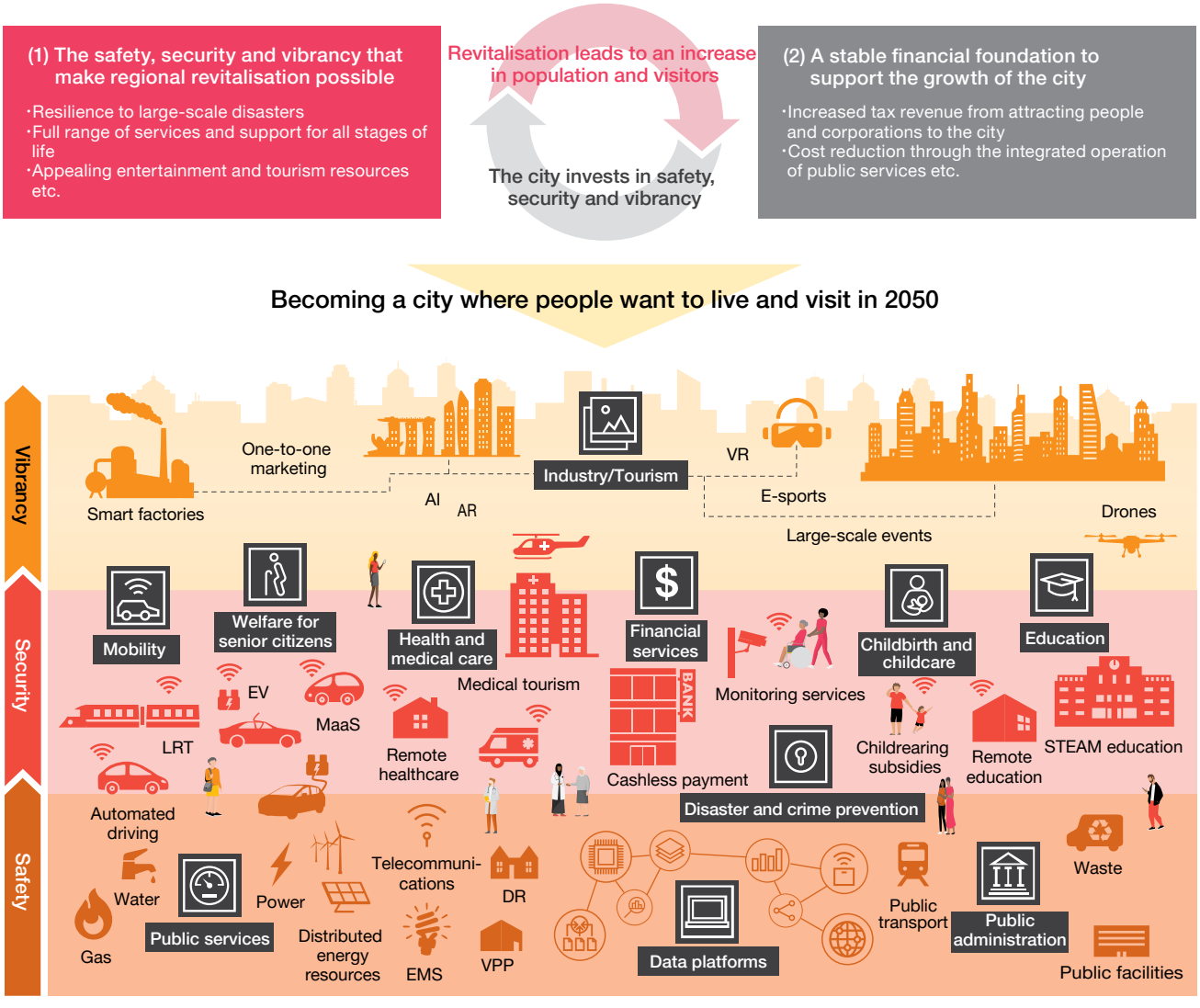
To create an attractive city, we believe that there are two essential elements: the safety, security and vibrancy that make regional revitalisation possible, and a stable financial foundation to support the growth of the city.

Achieving the first element, safety, security and vibrancy, will lead to the recovery of the city population and the number of visitors. This can help the city to control or delay the issues of a decreasing total population, a decreasing working age population and an increase in the population of senior citizens caused by the demographic changes we discussed in the previous chapter. On the next page, we explain the three layers (safety, security and vibrancy) that constitute the framework for considering how to achieve this, as well as the eleven functions to be included in this framework.

Ensuring the safety, security, and vibrancy of the residents will lead to an increase in the population, the workforce (the number of corporations) and the number of visitors. This will improve the tax revenue for the city, which ultimately contributes to the second essential element: a stable financial foundation to support the growth of the city. These financial resources can then be utilized to further develop the first element, thereby continuing to build an attractive city.

Establishing this positive cycle is essential for creating a city where people want to live and visit in 2050.

Figure 2.5 A city where people want to live and visit in 2050



The three layers of a city

As we explained in the previous chapter, Japan is facing the risk of collapse of important social infrastructures. We believe that building up the three layers of safety, security, and vibrancy is necessary as a mechanism for the revitalisation of cities. The concept of these three layers is common to all cities, with each of the upper layers built upon the layer beneath it.

Safety is the bottom layer, where functions that meet the most fundamental needs to ensure the safe lives of residents are found. Residents unconsciously enjoy these functions, which include social infrastructure, as ordinary and indispensable elements of their lives. Residents interact with this layer on a regular basis, making it a major prerequisite for a city.

The next layer is security, which enables comfortable living and drives the activities of residents. This layer incorporates functions that enable residents to engage comfortably in specific activities or actions comfortably, free of physical or mental concerns.

And the top layer is vibrancy. This is foundation that allows residents to live fulfilling lives. Developing this layer makes the city attractive to both residents and visitors.

The eleven functions of a city

We have also identified eleven basic functions that are necessary for residents to live in a city. These functions can be called the very factors that constitute a city.

By using the three-layered framework for revitalisation and these specific eleven functions, we can analyse various social issues more smoothly and efficiently, and then investigate the true causes of these issues and consider methods of resolution.

Note that the details, significance, and maturity of each function will differ depending on the city. When applying examples from one city to another, don't forget to consider the differences in these functions caused by the characteristics of each city.

Note as well that some of these functions might cover two or more of the three layers or be linked with other functions.

Three layers	
Vibrancy	Functions that attract both residents and visitors to the city
Security	Functions that enable residents to live comfortably, free of physical or mental concerns
Safety	Functions that meet the most basic needs of all residents. Residents enjoy these functions unconsciously as ordinary and indispensable elements of their lives.

Common to all cities

Eleven functions	
Industry/Tourism	Regional industry, tourism and entertainment that attracts visitors
Financial services	Lending, deposit and savings and settlement services
Disaster and crime prevention	Prevention and reduction of crimes and natural disasters
Mobility	Transport including railways and motor vehicles
Welfare for senior citizens	Support for senior citizens, including long-term care
Childbirth and childcare	Support for parents and parents-to-be
Health and medical care	Healthcare systems and institutions, health management
Education	Compulsory education, behavioural therapy, life skills education
Public services	Infrastructure to support the lifestyles of residents, including power, water and sewage
Public administration	Administrative services and city operations
Data platforms	Mechanisms for collecting, accumulating and utilising data

Differ depending on the characteristics of each city

Cross-sectoral solutions for social issues

Complex factors behind social issues

Social issues always involve complex factors. For example, the outflow of the childrearing generation from a specific area might involve a wide range of issues. Even if we only consider the direct factors, we can imagine that the necessary solutions may include establishing a comfortable environment for parents to give birth and raise children, eliminating waiting lists for childcare services and ensuring parent-friendly working environments. However, the root causes might include factors like low income levels or a fragmented community that makes it difficult for parents to consult with someone regarding their children. If this is the case, we also need to consider the bigger picture. If we focus only on a single perspective, we may miss the forest for the trees.

Social issues do not necessarily fit into a single area. The three layers and eleven functions simply provide a framework to be used as the starting point for evaluating issues. When considering the causes of an issue and the methods to be used to resolve it, understand that there will be complex factors in the background, and the issue will cover multiple areas, all of which should be considered.

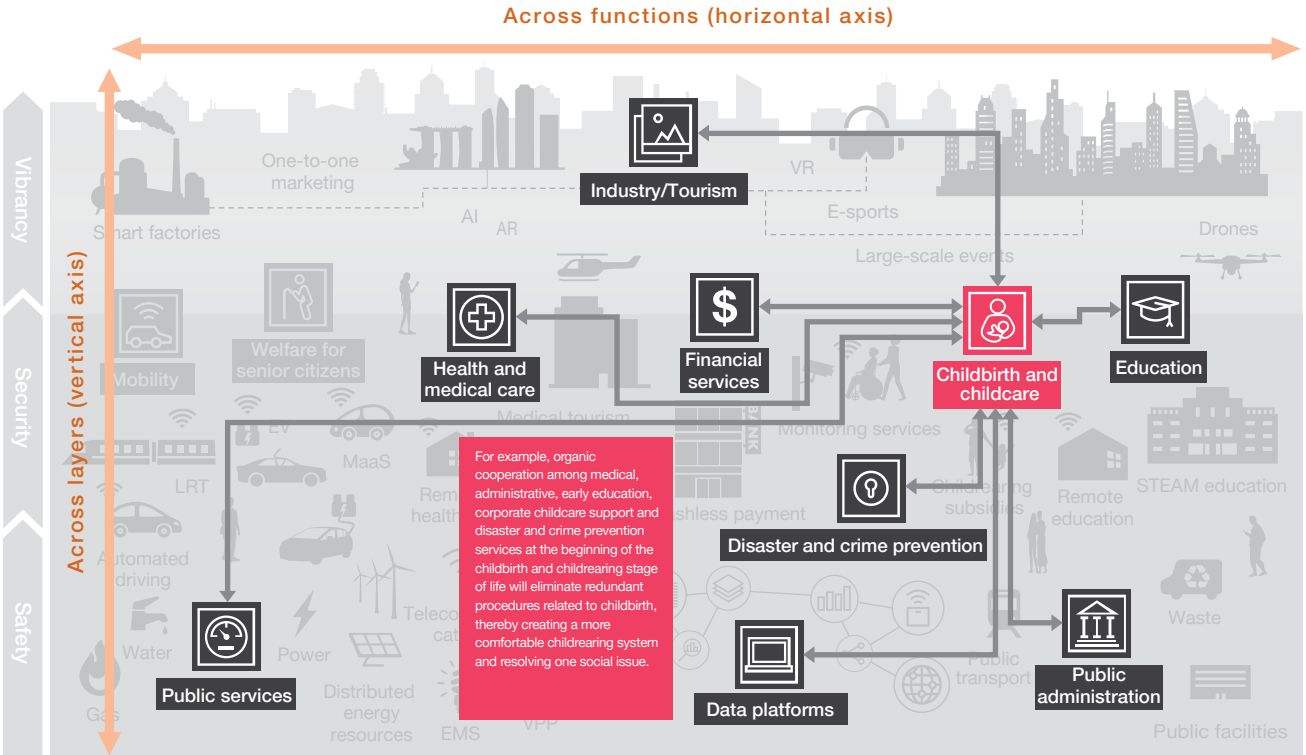
Therefore, we believe that a cross-sectoral approach and cross-sectoral initiatives are necessary for resolving issues.

A cross-sectoral (cross-layer and cross-functional) approach

If we consider the example of ensuring a comfortable environment for parents to have and raise children, you can see that the issue involves multiple functions of the city including health and medical care, disaster and crime prevention and education. If we look at the more specific issue of paediatric healthcare, a mechanism for centrally managing and sharing data from medical exams within the region can help improve the efficiency of child welfare operations, by enabling the data to be used, for example, to issue medical certificates for children. Insurance companies can use the data for pay-outs, and hospitals can easily acquire information on children's allergies and medical histories if they are brought in for emergency treatment. Currently, the child's parent or guardian must fill out similar forms and explain the same information to the doctor each time. There are many other ways in which cross-sectoral data utilisation could be implemented, but to do so requires technical cooperation among sectors such as public administration, education, childcare and crime prevention, in addition to healthcare.

A cross-layer and cross-functional approach is also necessary in order to determine the nature of each social issue, identify the true causes and consider effective actions to solve the issue. In addition to conventional function-specific initiatives, cooperation across the eleven functions (shown on the horizontal axis below) and across the three layers of safety, security and vibrancy (shown on the vertical axis below) are also essential.

Figure 2.6 Cross-sectoral solutions for social issues



Diverse city planning

Considering the features and vision of each city

As discussed in the previous chapter, the social issues that need to be resolved in order to create a smart city differ significantly depending on the size and scale of the city (for example, whether it is a large metropolis or a smaller regional city). Regarding mobility functions, for example, large cities face problems caused by an excessive number of vehicles, such as traffic congestion and air pollution. Regional cities, on the other hand, tend to have problems associated with insufficient means of transport. Various factors throughout the long history of each city have contributed to the present situation, and these factors differ as much as the individual peoples' lives. When transforming a city into a smart city, we must not only consider the size of the city, but also a diverse range of factors such as the city's environment, assets and residential culture.

Each city will, of course, also have a different vision for how to become a place where people want to live and visit in 2050. This vision could be a strong engine for accelerating the city's transformation into a smart city, but it also could be a restraint. Alongside the features of the city, the city's own vision is an important guiding principle for considering the measures to be used to solve issues.

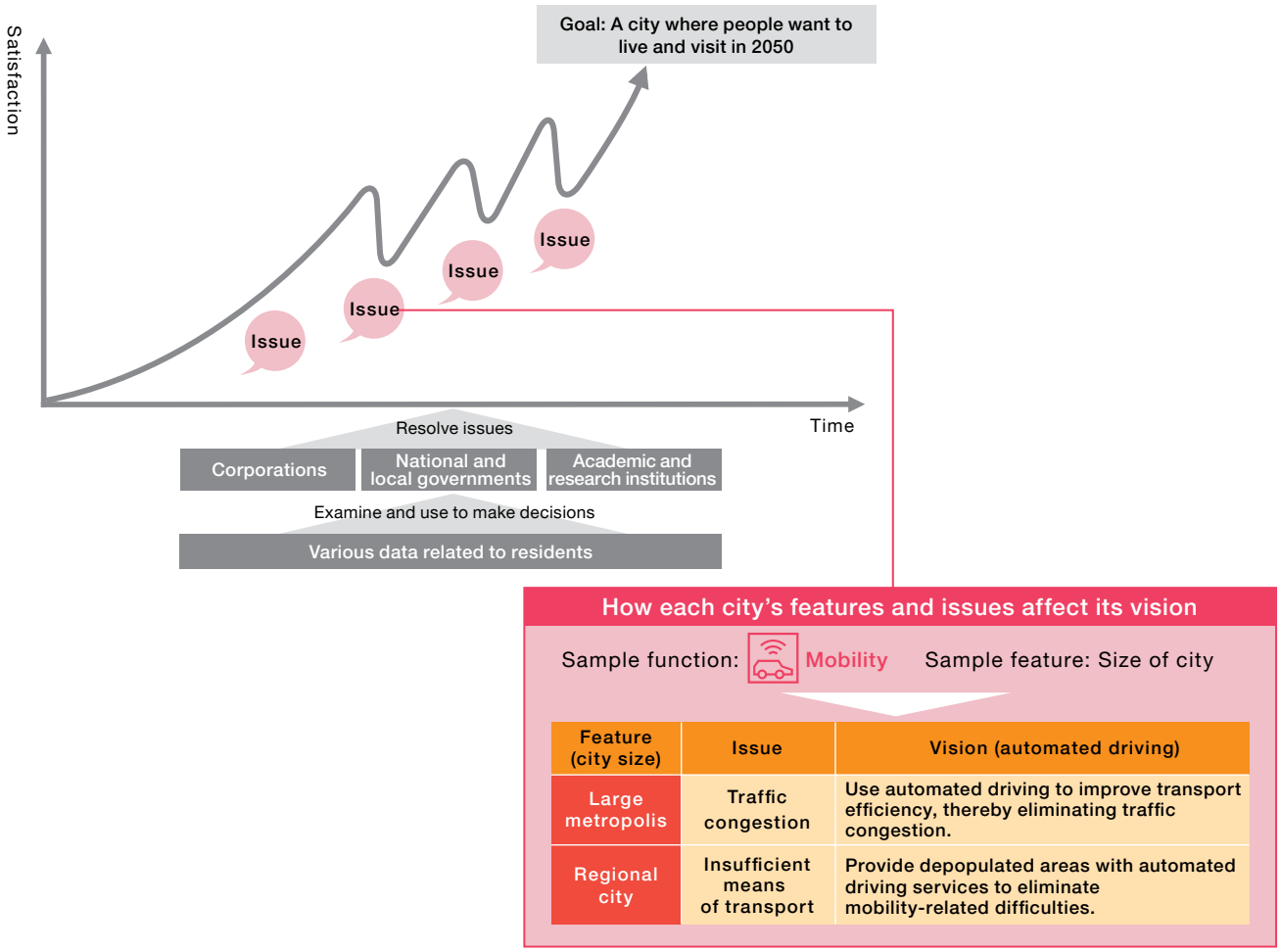
Approaches to city planning

City planning requires accurate recognition of the features and vision of the city, identification of the city's issues and the selection of appropriate initiatives and technology to solve these issues. Particularly when third parties are also involved in the process, an awareness of these issues must be shared among all parties involved.

Even if another city has successfully resolved the same issues, it is not always useful to simply copy what has been done elsewhere. The unique features and vision of each city may prevent the same initiatives from being effective in a different city.

On the other hand, you don't need to create all of the city planning processes from scratch. Although you may not be able to use an identical approach, you can identify common issues and solutions that can be used to address them. For this reason, gaining a deeper understanding of the technologies and solutions that are frequently used for city planning and development can help you in the city planning process.

Figure 2.7 How the features of a city can impact its vision



3

Technology in smart cities

Roles and value of technology in a smart city

The importance of understanding the value of technology

As we explained in the previous chapter, the use of technology is essential to transform a city into a smart city. However, we do not recommend taking a technology-driven approach. Based on the city's vision (ideal future state), you need to identify the issues that residents have with the city's functions, and analyse the causes of these issues. After analysing the causes of these issues, it's important to introduce technology with the accurate understanding of the value and benefits that such technology could provide. New technologies should be used alongside existing ones in order to improve the city's functions and create a sustainable city with a mechanism for continuous self-improvement, rather than simply implementing temporary solutions.

Technologies evolve swiftly and fluidly, so it can be hard to see what is to come. But if you don't keep up with trends and take action in a timely manner, you face the risk of being quickly left behind. Even with the uncertainty of the future, the proactive use of technology can improve the accuracy of projections. Countries around the world are responding to this situation through large-scale investment in national technological initiatives.

For example, a company that uses cutting-edge technologies to help cities become smart cities was established in North America and partnered with the governments of Canada, the Province of Ontario, and the City of Toronto in 2017 for a revitalisation project called Waterfront Toronto. Tens of millions of dollars have been invested in this project. According to the vision presented in the plan, the basic policy is to gather and analyse all the data used by the City using digital technology.

In this project, means of transport are limited to public transport, bicycles and walking, with restrictions on the use of private vehicles. Deliveries will be made by autonomous vehicles and robots. Affordable housing will be provided for low-income residents, made possible by initiatives such as the use of local timber, flexible interior design that includes space for retail shops, and the establishment of open spaces for public use. Massive amounts of digital data and technologies for analysing and adding value to this data are the keys to achieving this project.

Many other smart city-related projects are underway around the world, and there are many cases to indicate that using a combination of technology and services to support city life lead to the creation of more sophisticated services and new value. Results are particularly visible in the areas of transport and energy. The benefits of technology not only help to revitalise industry and improve the convenience of cities, but also lead to solutions to social issues such as aging populations and global warming.

The need for data security and consideration for residents

As technology is introduced, cities must also pay attention to the issues and risks accompanying the use of technology, such as the protection of privacy in a data-driven society. The Waterfront Toronto project states that a data governance plan will be established that introduces the toughest data management framework in the world, but the residents are yet to be convinced.

Many issues and risks also remain regarding the use of new technologies such as AI and drones, and the regulatory frameworks for these technologies are still being developed. It is therefore important to consider not only the value that technology can provide, but also the necessary regulatory measures.

Figure 3.1 Factors for using technology to create value for smart cities

Key technological factors	Value provided
Real-time understanding of the current situation	Devices such as camera and IoT sensors can be used to digitally capture real time information on city space to enable an accurate understanding.
Enhanced security	The monitoring of physical and digital spaces make it possible to prevent and mitigate various security risks in the city.
Multi-dimensional control and sophisticated and quick decision making	Digital data enables sophisticated processing and multi-dimensional use of physical space, leading to the effective use of city space.
Highly accurate simulations and projections	Faster computation makes it possible to use real time sensor data in ways that were not possible before and to use multi-dimensional space modelling to improve the accuracy of projections.
Maximising the value of data	The integrated management of all data necessary for maintaining and improving the city will lead to the establishment of a framework that generates more value than the data alone.

Notable technologies and applications

This section features the following technologies, which have been attracting attention recently for their use in smart cities: (1) IoT and digital twins, (2) AI and big data, (3) robots and drones, (4) next-generation mobility and MaaS, (5) next-generation power systems, and (6) data ecosystems and open data.

Technology 1: IoT and digital twins

The practical application of the Internet of Things (IoT) was made possible by the establishment of fixed and wireless telecommunications networks with a scale similar to public service infrastructure networks like power, gas and water. Various data gathered from sensors placed in cities and within buildings can be used via the internet to monitor the real-time health of the social infrastructure that makes up the city (including lifelines such as roads, bridges and water systems) and to take appropriate actions in response.

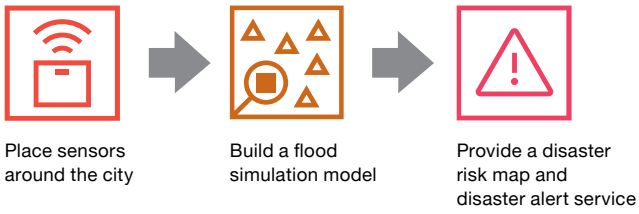
A new type of wireless telecommunication network called a low-power wide-area (LPWA) network is being developed to connect an anticipated increasing number of IoT sensors. As the name indicates, these networks can be operated by using low power at a low cost. The use of high-resolution images and 3D data is also expected to increase with the introduction of 5G, which offers maximum transmission speeds exceeding 10 Gbps.

Digital twins, which recreate physical space in cyberspace by using real-time big data obtained through IoT sensors, are already being used. In 2012, Newcastle, a city in the UK, experienced the equivalent of their typical annual rainfall over the course of two hours. This caused large scale flooding and damages equivalent to 8 million GBP. As a measure for dealing with abnormal weather phenomena, the City of Newcastle created a digital twin of the whole city by gathering data about the city on an integrated data platform, including dynamic data such as data on traffic volumes, water levels and human movement. This platform is being used to design drainage systems in anticipation or future disasters and to provide a disaster alert service to residents by using real-time data-based simulation.

Singapore has also embarked upon the Virtual Singapore project which combines real-time city data surveillance with 3D data. Residents can access the virtual space from devices such as smart phones and tablets to check the congestion levels of railways and buses or to search for accessible routes.

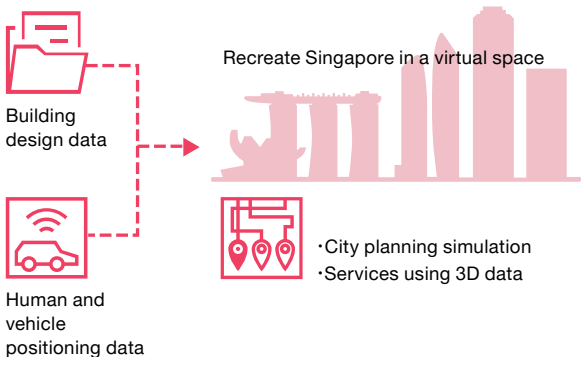
IoT enables real-time surveillance of various data about a city, and the integration of this data enables digital twin simulations. In Japan, as well, the public and private sectors are collaborating on the 3D Virtual Japan project. The goal of this project is to enable the concurrent planning and development of cities to create resilient cities that can respond to demographic and environmental changes.

Figure 3.2 IoT-based flood management in Newcastle



The city of Newcastle in the UK mainly uses IoT data obtained from a city observation project undertaken by Newcastle University. Sensors are placed around the city to monitor water levels and water pollution. The resulting platform is not only used for drainage design but also for real-time simulation to determine which buildings may be flooded, which infrastructure may be closed and which hospitals may be affected, and to provide a disaster alert service. It can also model human behaviour in the event of a disaster. The IoT data collected for the whole city is also provided to businesses and developers for the further enhancement of services.

Figure 3.3 Digital twins: The Virtual Singapore project



The Singapore government is leading the Virtual Singapore project, which was launched in 2014 for sustainable city development. The project is being promoted in three phases: virtualise, visualise, and venturise. Data on road width, roadside trees and buildings has been obtained from design data and images owned by public organizations, and the data required to recreate the flow of people and vehicles is obtained from sensors on sidewalks, buses and taxis. An experiment is also being conducted to obtain positioning data on younger people through their smartphones. The consolidation of city data in a 3D format enables city planning through simulations that include climate-related impacts such as temperature and sunshine.

Technology 2: AI and big data

Analytics, machine learning and other features of AI are indispensable in the creation of a smart city. The significant benefits of using big data can be seen in recent Big Tech trends. The accumulation of massive amounts of data to build analytics models enables autonomous decision making without human intervention, which in turn makes it possible to optimise city environmental controls and to create a system for continuous improvement. By using AI models to process large volumes of accumulated data, cities can achieve energy efficiency, enhanced mobility such as autonomous driving and improvements to the safety and convenience of city life.

From the perspective of energy efficiency, many initiatives to optimise the control of energy supply and demand are being implemented by using AI for big data analysis. Where analytics models were previously used to predict the demand of electricity and manage supply and demand, the recent spread of GPU technology and deep-learning based AI processing have made it possible to use optimised devices to improve computing capabilities. The growing prevalence of IoT has also enabled the use of big data including real-time data. These technologies have made it possible to build simulation models for optimising the balance of electricity supply and demand in much more complex situations. Examples of electricity supply and demand management include virtual power plants (VPPs) and responses to various restrictions on different energy sources (maximum and minimum output, power generation cost, power source adjustment, market trading prices, grid connection capacities and power available for trading). The significantly increased accuracy of projections has also made it possible to optimise facility management through real time projections and simulations.

In the area of mobility, AI and big data are used for autonomous driving and MaaS operations, with the goals of securing safety and optimising transport. For example, the dynamic adjustment of public transport timetables could both reduce costs and enable a reduction in energy consumption throughout society.

In terms of safety and convenience, initiatives are being undertaken to automatically recognise, identify and track the flow of people and goods for security purposes. In city planning, these technologies have enabled facility development based on the number and people flow of users; efficient maintenance of aged facilities; optimisation of traffic lights using congestion projections; and the provision of functions to improve economic activities and lives.

Japan's Ministry of Land, Infrastructure, Transport and Tourism is currently engaged in many smart city projects. In addition to mobility-related projects such as roads and railways, the ministry is engaged in energy saving projects for the houses and buildings that are the components of smart cities and geospatial development for promoting the utilisation of geospatial data.

It is important, however, to keep in mind that AI and big data are not omnipotent, and their scope of use is limited. There are technological limits to the volume of data that can be processed, and large volumes of diverse data are needed for the learning that enhances the capability of an AI to perform complex processing. Moreover, AI and big data cannot make decisions based on the values of individuals, and some models can result in black boxes whose output is difficult to explain.

Big data analysis using AI also requires the involvement of data scientists. However, human resources are not being trained quickly enough to meet the increasing demand. The systematic development of these specialists is extremely important for promoting the growth of the field.

Figure 3.4 Example of an AI framework for image recognition

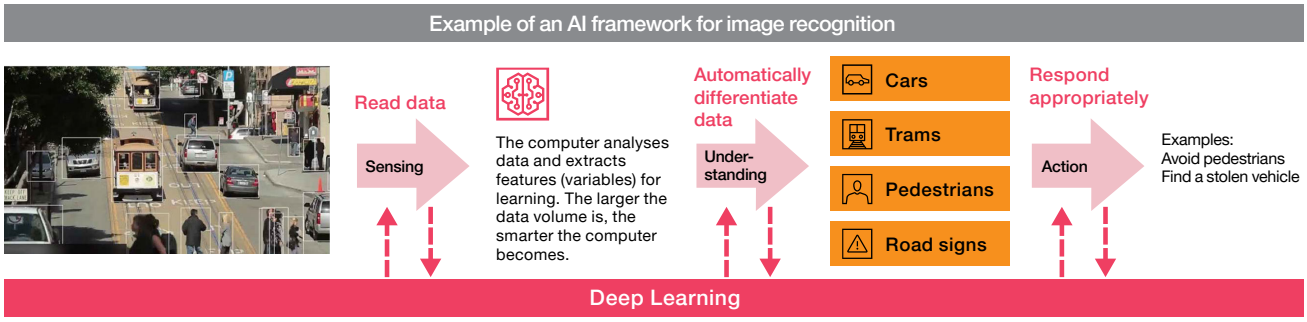
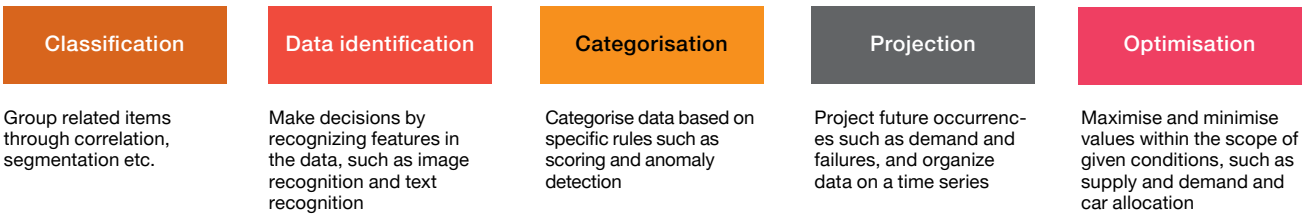


Figure 3.5 Typical AI processing



Technology 3: Robots and drones

The utilisation of robots and drones makes it possible not only to transport people and goods without human involvement, but also to use city space in three dimensions. This expands transport space, which was previously limited to cars, taxis and buses, to include the air space that is currently dominated by manned aircrafts. This could solve the serious issue of traffic congestion in large cities, as well as the resolving the labour shortages hampering transport operations in regional cities when used in combination with autonomous driving. The annual costs associated with traffic congestion in large cities in the EU is estimated to be 100 billion Euros, which means that the potential market is very large.

The operation of robots and drones requires the use of systematically safe routes and telecommunications technologies including 5G, but despite these hurdles, countries and regions in the EU have high expectations that robots and drones can be used to mitigate traffic congestions in large cities. Robots and drones may also be used for repetitive, short-distance deliveries such deliveries from metropolitan shopping malls to destinations in the suburbs.

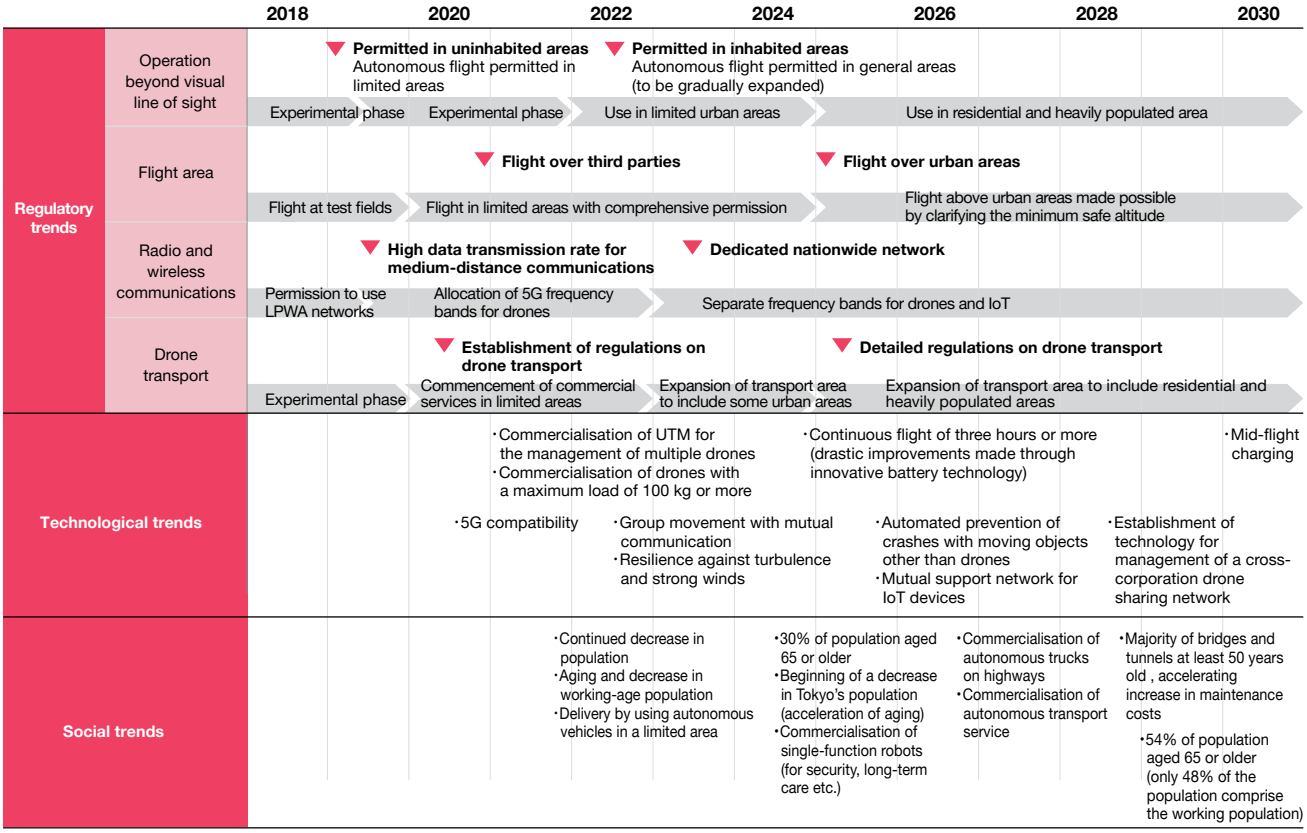
Currently, a major Chinese e-commerce company is actively utilising robots and drones for delivery. Although this service is limited to a certain area, drones are used to transport goods a distance of about 10 km, and unmanned robots (autonomous vehicles) are used for the last leg of the delivery (the 'last mile'). In the health care industry, robots and drones have proved their value by providing support to medical teams through the transport of blood and medicines between hospitals in several areas around the world.

We also expect that flying cars will be used for human transport in the future. In 2017, a US-based ride share service company made an impact throughout the world when it announced a concept for providing a ride share service using flying cars. This concept envisages users taking an elevator to the rooftop of a building, using their smartphone to pass through a gate, and taking off from a rooftop port to fly to their destination. The company plans to deploy air taxis in more than 12 cities between 2030 and 2035, and to provide services to hundreds of thousands of users per day. The key to achieving this is the ability of flying cars to be used not only as an independent application, but also one means of transportation used along with bicycles, cars, buses and railways to provide mobility as a service (MaaS).

Expectations regarding the actual implementation of these services and the value they will provide to smart cities are significantly high. But along with the development of the vehicles and services, other factors also need to be considered, such as compliance with rules and regulations concerning airworthiness certificates for the vehicles, maintenance, flight, UTM (unmanned aircraft system traffic management) and radio wave usage. With respect to vehicle development, aircraft manufacturers with experience and track records related to regulatory compliance are likely to enter the drone market and intensify competition. However, there is still lots of room in the services area, and prospective players should start considering use cases as soon as possible.

Figure 3.6 Road map for the utilisation of drones

This road map assumes that drone delivery will be available in limited areas beginning in 2020 and that transport and delivery in populated areas will be permitted beginning in around 2022.



Prepared by PwC based on the Ministry of Economy, Trade and Industry's "Roadmap towards Air Mobility Revolution," and Nikkei BP's "Technology Road Map 2019–2028: All Industries"

Technology 4: Next generation mobility and MaaS

Mobility in cities, including transport and logistics, is no longer about simply optimising transport methods. It has also become a central aspect of city planning and sustainable operation.

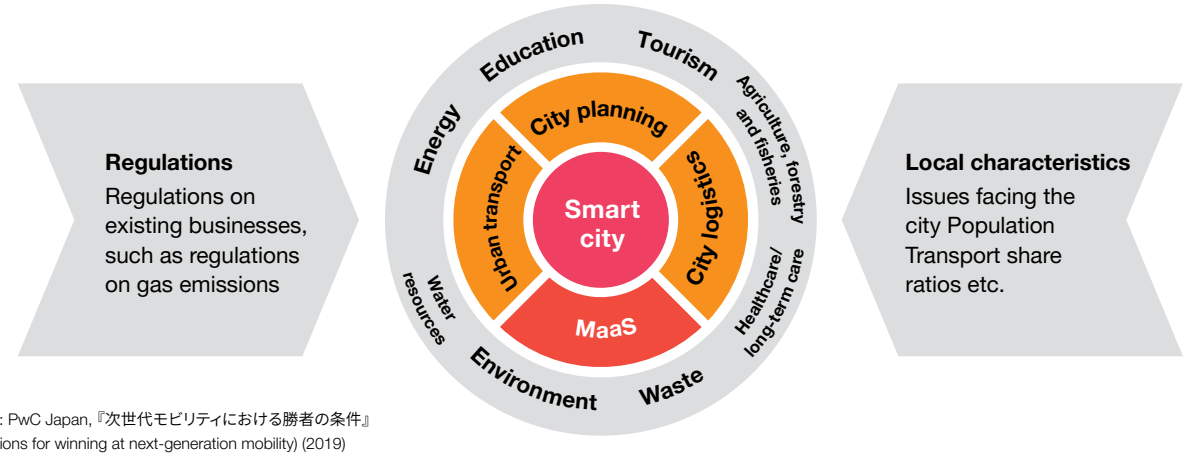
Mobility is taking on a new role of providing support for city planning and the foundation of livelihood. With the development of information and telecommunications technologies, the concept of mobility as a service (MaaS) was born to seamlessly connect all transport methods as one service. One of Finland's MaaS corporations, which is frequently cited as an advanced global case, provides a comprehensive service from providing information on various mobility methods–including trains, buses, taxis, and car sharing–to booking and payment, using smartphones. Users can move from their current position to another destination by using a single service, without the need to consider individual means of transport, which ends up reducing the time and cost burden on users.

But the concept of next generation mobility differs depending on your objective. Finland's example is not going to be the perfect model in all situations. To create and operate next-generation mobility solutions, cross-industrial and cross-functional perspectives reflecting the characteristics of the area also need to be included. Furthermore, electric vehicles (EV), autonomous vehicles, drones, and flying vehicles are mobility methods that require the development of new infrastructure such as data communication and charging stations. The transition to next-generation mobility will also require regulatory measures such as revisions to the regulations for existing businesses, as well as measures based on the characteristics of each area, such as the major industries and demographics.

Cross-industry data sharing for mobility enables dynamic pricing based on supply and demand, which makes it possible to optimize vehicle operating rates, and also enables the creation of a sharing community. If data on the movement of people and goods can be handled as complex information including financial perspective, it will be possible to more accurately predict an uncertain future, and also to provide the important information needed to realise sustainable cities.

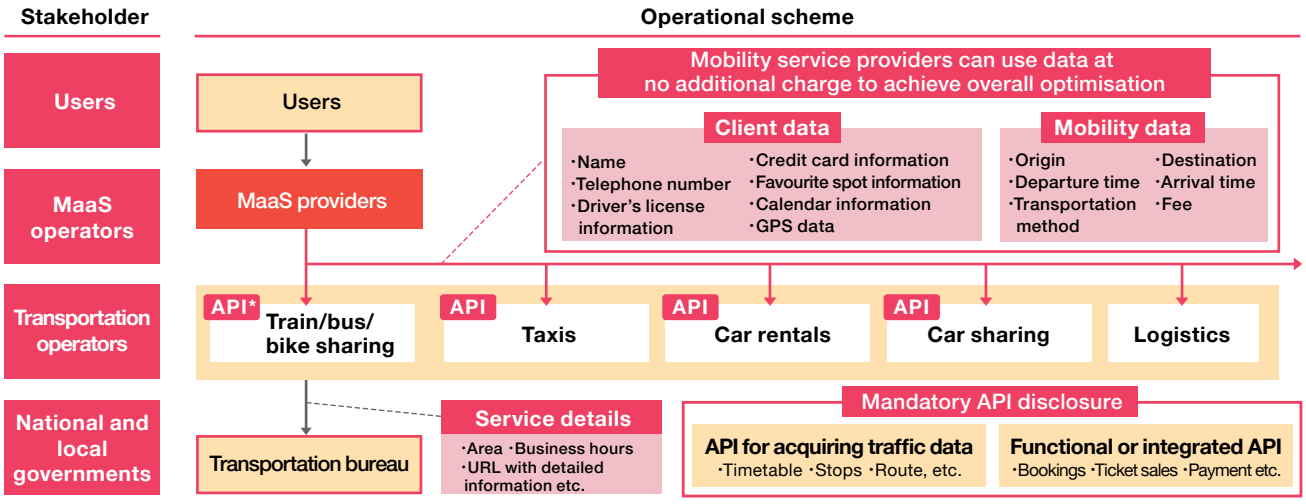
Figure 3.7 The role of MaaS in smart cities

MaaS will be implemented as a method for resolving issues in the various fields that make up a city



Source: PwC Japan,『次世代モビリティにおける勝者の条件』(Conditions for winning at next-generation mobility) (2019)

Figure 3.8 Example of a data-sharing economy based on data utilisation schemes



*API: Application programming interface

Source: PwC Japan,『次世代モビリティにおける勝者の条件』(Conditions for winning at next-generation mobility) (2019)

Technology 5: Next-generation power systems

Recently, technological innovations and sharp decreases in initial costs have helped to spread the use of distributed energy resources (DER). DER has gained a lot of attention as a method to improve the efficiency of conventional electric power systems in preparation for the large-scale introduction of renewable energy sources with highly fluctuating output. Since the Paris Agreement took effect in 2016, decarbonisation has become a global trend led by European nations, as evidenced by the large number of institutional investors withdrawing their investment from environmentally unfriendly companies. Clean technology and green innovation have also gained steam. Technological shifts from conventional large-scale power plants to DER-centric electric power systems, as well as repowering market design, are occurring on a global scale in the midst of this energy transition.

Providers are developing new energy businesses and embarking on cross-industry collaborations using digital platforms, with a focus on the components that support the repowering market design of next generation power systems that suit the power source structure of each country or region. We expect to see business expansion in the following areas in the future:

- Local generation and local consumption of power by using distributed power sources
- Integrated businesses with the mobility and health care sectors
- Procurement and control of electric power by using IoT and AI
- P2P transactions driven by an increasing numbers of prosumers
- Provision of 'electricity as a service' (EaaS) solutions that go beyond conventional electric power retail services

To achieve next-generation power reform, social reform is needed alongside next-generation vehicles and housing.

Figure 3.9 The shift from conventional to next-generation power systems

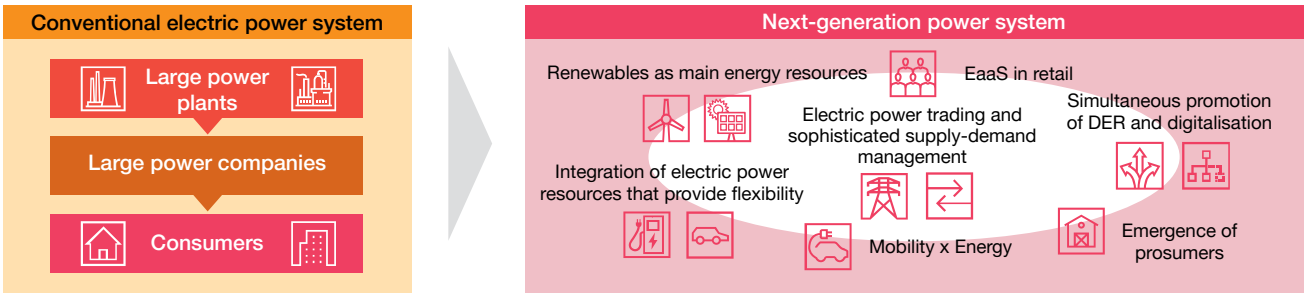


Figure 3.10 Technologies used in next-generation electric power systems

Technology	Overview	Example
Storage batteries	Demand for storage battery technology is surging with the emergence of renewable energy that has a fluctuating output. This is a disruptive technology that overcomes the basic principle of balancing electric power supply and demand. This technology applies to power grids, home battery storage and electric vehicles.	In North American and European countries where significant amounts of renewable energy have been introduced, companies bid on large-scale storage battery installation products for power grids, and winning these bids comes with prestige as the companies have proved their ability to adapt to the times. The need for efficient power generations for homes is also on the rise.
Virtual power plants (VPP) **Demand response (DR)** **Peer-to-peer (P2P) transactions**	VPP enables the sophisticated integration of DER with electric power systems, as well as the remote integration of multiple DERs through IoT-based energy management technology. DR systems enable control only on the demand side, while VPPs provide controls for both supply and demand. P2P transactions are seeing an increase in the use of blockchains.	In Germany, VPP is becoming profitable in wholesale and supply-demand adjustment markets, as well as for energy management for consumers (market premium model). Renewable energy sources capable of flexible operation, such as biogas, are incorporated into this structure.
Off-grid power systems	Off-grid power systems consist of independent power networks and power sources in areas not connected to any power grid, enabling that area to autonomously adjust its own supply and demand.	In areas of India, China and Africa etc. where no power grid is available, a number of installations of small-scale solar panels, storage batteries, and LED bulbs have been established as part of electrification promotion programs with low initial investment from consumers. Many are securing revenue by using a pay-as-you-go (PAYG) format.
Vehicle to home (V2H) **Grid to vehicle (G2V)** **Vehicle to grid (V2G)**	Electric vehicles (EVs) can be used to provide power to households (V2H), 'smart charging' can provide EVs with excess power from solar and wind power generation (G2V), and EVs can be used perform frequency adjustments and other control functions for grids (V2G). As these technologies continue to spread, they will help integrate EVs with electric power systems.	Mainly in the EU, new EV businesses are emerging that combine energy services with mobility services. Examples include services that utilise excess renewable power generated by homes by using an EV as a storage battery, and services that integrate DER with power grids by using smart charging and V2G technology.

Technology 6: Data ecosystems and open data

A data ecosystem has a wide range of roles to play in a smart city. The technologies we have previously described—(1) IoT and digital twins; (2) AI and big data; (3) Robots and drones; (4) Next generation mobility and MaaS; and (5) Next-generation electric power systems—become effective through a properly functioning data ecosystem that supports each technology.

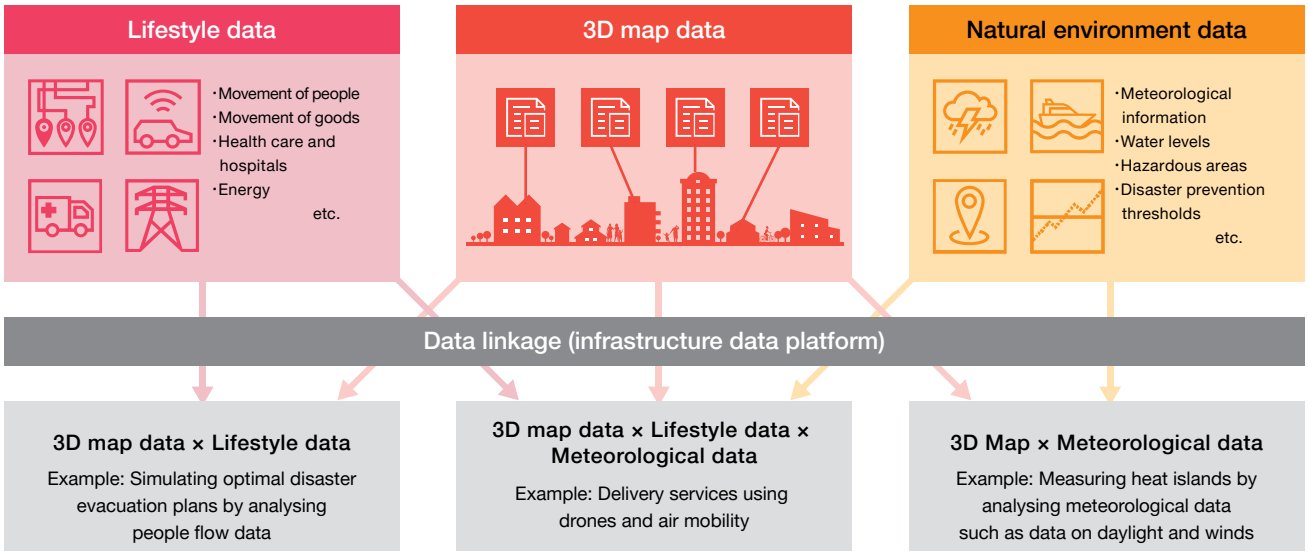
Although it has been a while since the internet has enabled access to global information, data is becoming even more valuable with the development of semiconductors that can process a large amount of data, and innovations in analytics such as neural networks and deep learning. Organisations with public data, such as national and local governments, research institutions, and academic bodies, have made many structured datasets publicly available so that they can be easily searched over the internet. In Japan, examples include public data that has been disclosed by the national government and local governments being used for disaster prevention and weather forecast services by private sector entities. For drones and flying vehicles to engage in autonomous flights, 3D maps for setting flight routes, the capability to identify vehicle locations, and operation management are all necessary. Verification tests for the establishment of air mobility routes are already under consideration. However, to achieve the practical use of this new air mobility in society, 3D data for buildings and structures as well as weather condition data will also need to be disclosed.

Progress is also being made in API-based data linkage initiatives, which enable users to extract only the data they need, only when they need it. Data owners will coordinate with each other to allow the shared use of data by applying a common calling procedure. Decentralised data management frameworks using blockchain technology, which are currently used primarily in the financial sector for virtual currency etc., have been discussed as one possible means to achieve this. We expect these data linkage initiatives to drive the joint provision of services by public and private sector entities, improved efficiency of corporate activities, and the creation of new businesses, which will lead to city-wide economic revitalisation.

Collecting a wide range of data on the city in a usable format will enable the provision of various services. However, this also means that a large amount of data collected by sensors and data that includes personal information will be also transmitted over telecommunication networks in the city. When data containing personal information is used, the privacy of the individuals involved must be protected. And the more valuable the transmitted data is, the higher the risk of cyberattacks resulting in data leaks, tampering and misuse. When we use data, a basic trade-off exists between security and convenience. To build stable digital data platforms, the necessary cyber security frameworks for cities are currently being developed, with a focus on issues such as the use of biological information, decentralised data management, and security implementation at the hardware level.

Figure 3.11 Conceptual diagram of a public-private joint data platform

The Ministry of Land, Infrastructure, Transport and Tourism is planning to use a digital twin of Japan created with 3D data to conduct disaster simulations in order to develop disaster prevention measures and technology. Currently, different types of data are being accumulated in separate databases using different formats, but the ministry's goal is to operate the digital twin as a single platform for all data. Since the platform will be open to the private sector, this is expected to facilitate the further development of services.



Technology-based outlook for issue resolution

Reaping the benefits of technology

The technologies we've introduced in this chapter have the potential to resolve issues caused by the excessive concentration of the population in large cities; convert the negative cycle faced by regional cities to a positive one; build a sustainable social security system and public services; and identify the appeal of each city.

The two keys to resolving issues faced by cities are to examine issues through a cross-industry perspective and to create a framework that can be adapted to future changes, rather than only implementing temporary fixes. We can also see two general trends in technology: the transition of cities from materialistic to data-centric (through IoT and digital twins, AI and big data, and data ecosystems and open data), and the utilisation of dynamic infrastructure (robots and drones, next generation mobility and MaaS and next-generation electric power systems). By making the transition to data-centric cities while utilising dynamic infrastructure, cities can simultaneously carry out city planning and operations in accordance with changes in the natural environment and demographics.

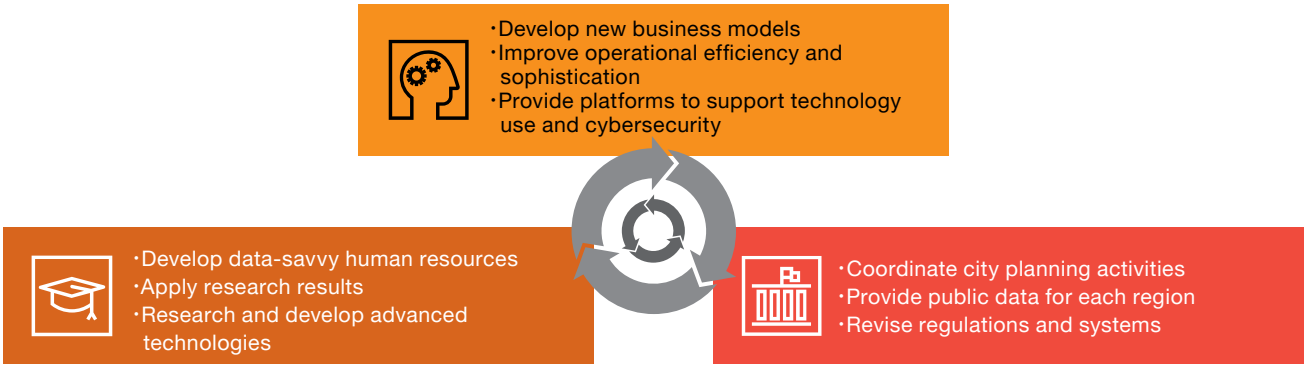
We expect various technologies based on digital data to evolve quickly and to spread rapidly. At the same time, however, existing regulations are lacking in many areas, and cybersecurity also needs to be strengthened. Technology is a necessary component for transforming cities into smart cities, but it is only a means to achieve the city's vision. If cities only link their data and introduce new tools such as drones, not only will this not create results, but it may end up creating new problems. Technology is only beneficial when security measures are developed through proofs of concept (PoCs) and frameworks for securing safety are designed in stages, with the goal of achieving the city's vision for 2050.

In some cities where smart city initiatives are already making progress, collaborative projects among the public, private and academic sectors are already underway, and the open exchange of data and new infrastructures have become a reality. The use of project management and cyber security frameworks and the encouragement of discussion among the various players based on shared recognition and language are the keys to producing significant effects.

Figure 3.12 Issues facing cities and value provided by technology

Issues facing cities	Examples of technological applications	Value provided by technology
Inability to respond to demographic changes and climate change ・Aging of city infrastructure ・Collapse of the social security system caused by a shrinking working age population and an aging population	・Constant surveillance using IoT sensors ・Big data analysis using AI ・Alternative operations using drones and robots	**Realisation of a safe and energy-efficient city infrastructure** ・Energy-efficient infrastructure maintenance operations ・Accurate simulation of the impact of disasters ・Transportation services and camera monitors for senior citizens
Population flow to large cities and urban decay of regional cities ・Large cities: Failure of city functions when traffic congestion and large-scale disasters occur ・Regional cities: Lack of sufficient labour resources to support commercial and public services and industries, deteriorating economy	・City planning and development using digital twins ・Urban transport using air mobility ・City traffic optimisation using MaaS ・Public-private development projects using open data	**Realisation of resilient and attractive cities** ・Continuous improvements to public service ・Reduced traffic congestion and shorter commuting times ・Highly satisfying logistics network free from delays ・New lifestyle services reflecting regional characteristics

Figure 3.13 Roles of the public, private and academic sectors in utilising technology

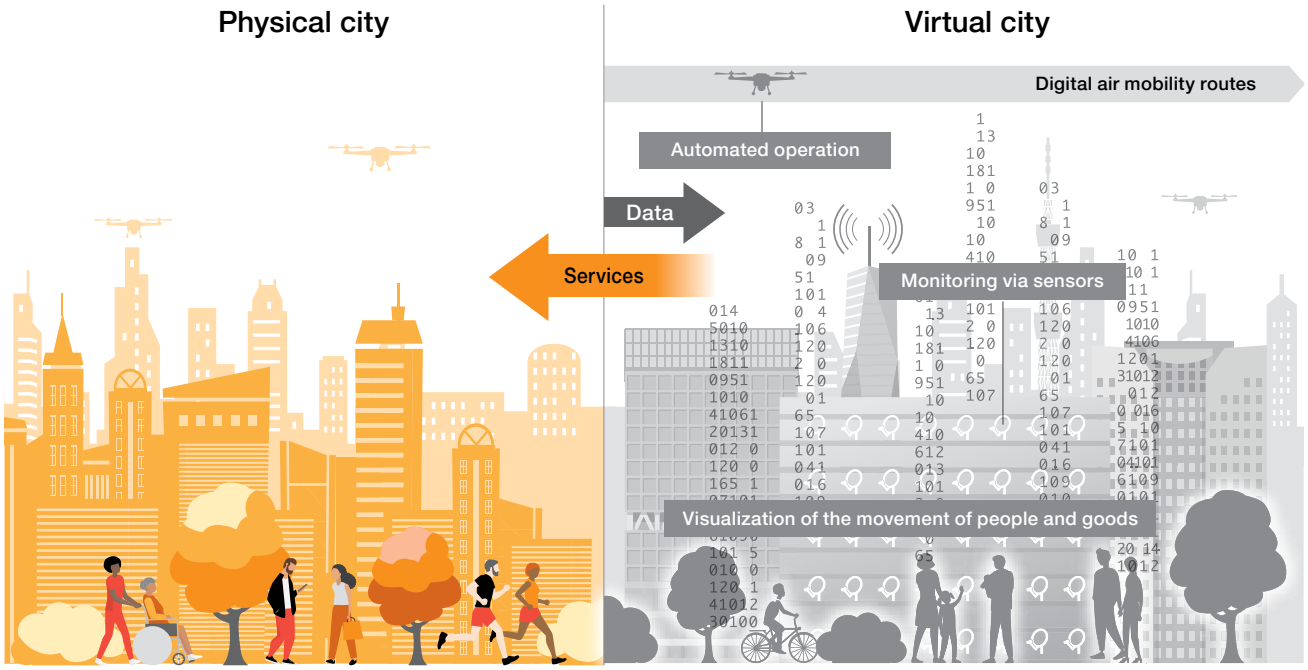


Cities of the future made possible through technology

In the future, the linkage of large amounts of physical data will make it easier to virtualise and visualise cities, which enables the provision of services based on integrated data. Digital data will become an intrinsic element working in the background of each city. As the volume of data exceeds that which can be handled by humans, technologies such as drones and AI will be used to create a city that develops autonomously and organically.

The following figure shows a role model of a city that invests in achieving a sustainable society where residents can achieve self-fulfilment and are committed to protecting the environment, based on drastically improved productivity at the city, business and individual levels.

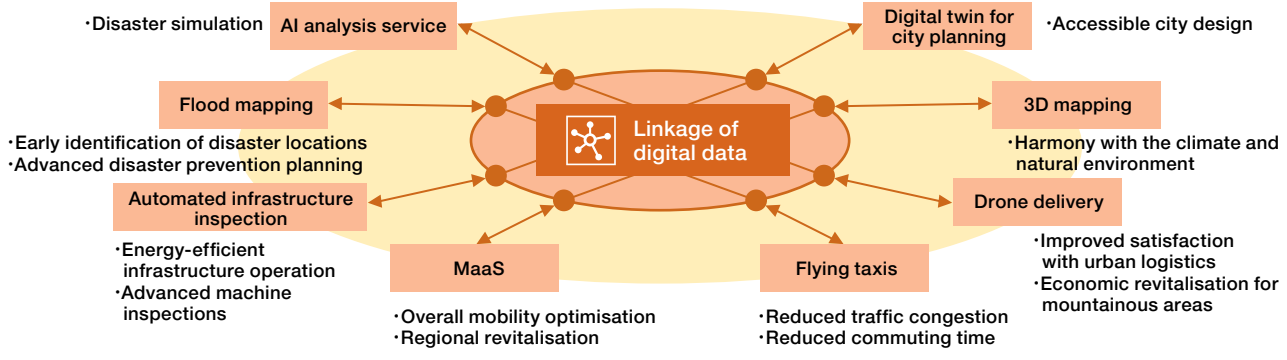
Figure 3.14 A city of the future made possible through technology



Virtualised city
- A 3D digital replica of the whole city and its infrastructure is virtually simulated based on design data.

Visualised city
- The actual state of the city can be checked in real time by using sensors.

Expand data-driven services to make the city more attractive



4

Trends in overseas smart cities

Trends in overseas smart cities

Overseas smart city development initiatives

The first overseas smart city development initiatives commenced in the early 2000s. As we explained in Chapter 2, these initiatives began with the goal of improving energy efficiency to build a sustainable society. In Europe, a strong interest in renewable energy to address global warming led to many cities promoting smart city initiatives.

More recently, many cities in countries outside Europe have also launched smart city initiatives. With the development of new technologies, the scope of these initiatives has now grown beyond energy and expanded to wider area of economy. Examples include efforts in the Middle East to become less dependent on fossil fuel production, and efforts in Asia where urbanisation is accelerated due to the rapid growth in population and economy.

The processes used to promote these initiatives varies depending on the size and historical background of each city, the development environment, and the national and local authorities. There are no correct textbook answers to the smart city development process, and it is important to understand these processes in light of the characteristics of the individual cities.

Differences in development methods

There are many ways to proceed with development. In this section, we will focus on the following two points.

(1) The range of stakeholders involved

Some smart city projects are led by national or local governments, some achieved through collaboration between corporations and research institutes, and some based on community-centric approaches involving residents and communities.

(2) Difference in development fields

Greenfield and brownfield developments

In Europe, greenfield developments, where a new city is created from scratch, are underway in some areas, but most smart city projects are brownfield developments in existing cities. Development is carried out not only by the national and local governments and businesses, but also by the local residents, who playing an important role. Residents willingly participate in discussions and make proactive changes by focusing on the issues facing their cities. This creates a consistent and strong drive to implement the processes that have been agreed upon, even if the project's leadership changes. However, leadership by the city government and/or the corporation in charge is also needed in order to reach a consensus when varying needs and opinions arise.

In emerging countries such as China and India, city planning is mostly led by national and local governments, and a relatively large proportion of smart city projects are greenfield developments. Strong leadership by national and local governments is used to set forth and promote a future vision that gives due consideration to the issues and needs of the residents. This enables a more comprehensive approach and can help to speed up the process. Rather than trying to catch up with cities in developed countries, these countries aim to surpass the developed countries and to promote efficient and sustainable cities by using more advanced technologies.

Other examples include industry-led projects headed by conglomerates or large IT corporations, and projects headed by research institutions including universities. These players are capable of leading national and local governments with their capital and technical capabilities. Initiatives taken by corporations and research institutions are very important factors.

In this chapter, we will analyse some leading smart city cases from around the world, including their success factors. Our findings may provide hints for conducting smart city development in Japan in a way that suits the history and environment of Japanese cities.

Figure 4.1 Types of smart city development around the world

Creating industry through innovation: Initiatives in Helsinki, Finland

Helsinki aims to become the most functional city in the world by 2021, using the whole city as a testing site to support the creation of innovative services and products by applying digital technology. It also seeks to seamlessly provide comprehensive services under the key concept of 'city as a service' (CaaS).

Innovation through disclosure of city information and use of digital twins

The city established the Helsinki Region Infoshare in 2011 to improve administrative services and processes, and to promote smart city development. A wide range of information concerning the city, including data on public transport, structures, economy, taxation, culture, and health, is publicly available to support the development of new services, and many such services have been developed in the areas of transport, tourism, education and health, among others. For example, a digital twin—a 3D model of the entire city—has been used to simulate the efficient installation of solar panels, the impact of new construction on sunlight and shade, and wind speed and direction.

MaaS solutions to improve mobility in the city and suburbs

One of the services created through the use of city data is Whim, provided by MaaS Global, Ltd. In this service, a single application provides a one-stop service that lets users do everything from searching for multiple transport routes to their destination to booking tickets and paying for everything in a single transaction. After the release of this application, the number of public According to a city officer, after the release of this application the number of public transport users in the city increased drastically, and the number of passenger vehicles decreased by half.

The Kalasatama and Jätkäsaari districts of Helsinki are newly developed areas mainly comprised of multifamily housing complexes. These districts have been used as testing sites for smart mobility initiatives, and residents are also participating in PoCs. For example, an autonomous robot bus is being used as a last-mile transport solution on a set route in the area, and an electric cargo bike sharing service is also being tested. Residents use these services in their daily lives, participating in their development by providing feedback for improvement.

The suburbs of Helsinki are facing the same issues as Japan when it comes to securing mobility for senior citizens and others, and regional MaaS is one of the solutions being used to resolve these issues. Finnish municipalities have the obligation to provide public transport that enables people to travel for healthcare purposes and to commute to elementary, junior high and high schools, and subsidies for bus and taxi use have become a financial burden on the government. Kyyti Group, Ltd provides on-demand ride share services that group individual mobility needs based on time and location, achieving efficiency and cost reduction through demand-based vehicle allocation.

A system for supporting the success and expansion of start-ups

Finland also provides strong support for entrepreneurship and business expansion. Slush, which has grown to become the world's largest entrepreneurship-supporting event with 25,000 participants each year, started as an event held by the students at Aalto University in 2008. The university has programs such as A Grid and Aalto Startup Center that support ventures launched at the university, offering networking opportunities that connect students with alumni and businesses, a co-working space (Startup Sauna), facilities such as labs, and business collaboration programs. This is a collaborative initiative by industry, government, and academia for supporting start-ups. Helsinki has also established entrepreneur support programs such as Helsinki Business Hub and New Co Helsinki to revitalise the economy. These programs provide services that offer comprehensive support for starting and expanding a business in terms of people, goods, capital, and information, such as matching and networking services for talent and corporations, free use of office space, and funding support. The city is also making an active effort to attract entrepreneurs from overseas, thereby successfully promoting entrepreneurship and business expansion in Finland.

Basic information	
City overview	The capital of Finland, with about 640,000 inhabitants, and the centre of politics, education, finance, and culture. Recently, the information and communications industry has become one of the city's main industries.
City features	The city is promoting an industrial shift to technology- and data-intensive industry by using ICT for industrial diversification. They also provide active support for entrepreneurs through the national government and support collaboration between industry and academia to create innovative industries.
Key initiatives	Industry and tourism, mobility and data

Autonomous robot bus used in a PoC in Kalasatama

Co-working space at Aalto University (Startup Sauna)

Resolving social issues through resident participation: Initiatives in Amsterdam, the Netherlands

Amsterdam, the capital of the Netherlands, aims to achieve a 40% reduction in its greenhouse gas emissions by 2025, against a 1990 baseline. To this end, Amsterdam develops solutions to solve its issues by promoting smart city projects through cooperation among government, industry, academia and residents in the areas of digitalisation, energy, mobility, circular city initiatives, administration and education and resident life.

Resolving social issues through participatory innovation

Amsterdam Smart City (ASC) is a consortium established in 2009 through public-private investment to develop smart solutions in the city. In the beginning, this consortium mainly shared information on corporate-led projects in the energy field. Since then, however, their approach to building a smart city has changed to one where residents, as 'smart citizens', are aware of issues concerning their residential environment and actively participate in projects to address these issues in order to enjoy the benefits of resolution. In accordance with this change, ASC converted its operation to an open-platform format that encourages public participation. This agile operational approach has been a factor in the success of community management. More than 90 mutually collaborative projects are underway on this platform, through partnerships among industry, government and academia and residents. Residents participate in these projects by presenting issues concerning their residential environment and providing feedback on prototypes.

Intermediary support organizations such as the Waag Society also playing a role in building bridges between residents and industry, government and academia by providing laboratories in the city where residents can access the latest technology, thereby boosting citizen-centric open innovation. Digital education programs for adults, which were started in 2017 at a science and technology facility called NEMO, also contribute to smart citizenship by providing opportunities for residents to learn about privacy and ethics in digitalisation.

Boosting flood resistance through digital technology and the provision of resident data

Since about half of the land in the Netherlands lies less than a meter above sea level, floods are a major problem for cities, who address this risk by flood control technologies. It can even be argued that the development of the nation was linked with the development of flood control technology. From 2011 to 2015, Waternet and Siemens conducted a PoC in Amsterdam's Ring Dyke area to develop a system that uses sensors, digital simulation and AI analysis of big data to estimate rising water levels and the related impact, and issues alarms. Other areas in the Netherlands are also hopeful that such systems for flood prevention will be deployed to their cities as well. Amsterdam is also promoting 'rainproof' city planning to deal with drainage issues during heavy rainstorms caused by climate change. The idea is to establish a system where rainwater stored underground and on rooftops is used for gardening and other purposes. Instead of only draining this rainwater, the city will absorb it like a sponge to adjusts the amount of water that flows into rivers and dams. Based on rainfall data gathered through sensors placed at various locations as well as reports sent by residents through apps, the city obtains accurate rainfall information on each subdivided area, which enables sophisticated remote management of water storage and drainage by utilising IoT.

Using digital technology and personal information for senior citizens' welfare and healthcare

Amsterdam has been awarded a four-star rating (the highest rating) from the EU government on the development, implementation and advancement of innovative and feasible measures for healthy and active aging. Examples of these measures include the wide-spread use of E-Health, a system that allows patients to receive medical services at home by using telecommunication technologies and wearable devices. As a result, senior citizens have come to appreciate the convenience of more frequent remote healthcare services using digital technology from home, as opposed to in-person appointments. A platform for the central management of personal medical data is scheduled to be established by mid-2020. This is expected to further improve the convenience of medical and insurance services.

Basic information	
City overview	The capital of the Netherlands, with about 860,000 inhabitants, and the centre of the Dutch economy. The headquarters of many large Dutch companies are located in Amsterdam, and both commerce and tourism are flourishing
City features	The city's smart city efforts are coordinated by Amsterdam Smart City, with an open platform facilitating the many projects that are underway through partnerships between industry, government, academia, and residents.
Key initiatives	Administration, welfare for senior citizens, public services (water supply)

The Waag Society's offices and labs are located in this former weigh house, where resident-participation programs are also held

Economic growth and issue resolution: Initiatives in Copenhagen, Denmark

Copenhagen started its initiatives in the energy field to achieve carbon neutrality by 2025, and has since drawn attention as a global leader among smart cities as it expands the scope of its initiatives to other areas.

An energy system focused on 'decoupling' and intangible aspects

Triggered by the 1970s energy crisis, Denmark made the decision to promote renewable energy including wind power. State of Green is a public-private partnership that has been running this project since 2008. Copenhagen also is promoting smart city initiatives to control the unstable supply of renewable energy and has introduced cogeneration systems in each area of the city. Heat conduits are installed in 95% of residential areas, and 60% of the fuel for the cogeneration system is biomass.

These initiatives not only aim to reduce CO_2 emissions as a social justice cause, but also to achieve the 'decoupling' of economic growth from environmental impacts. As a result, Denmark has increased its GDP by more than 90% while reducing CO_2 emissions by 40% since 1980.

These initiatives take into account not only physical frameworks but also social and cultural frameworks, and their planning involves considerations on how to incorporate new technologies into society rather than simply introducing them. For example, the new waste incineration plant Copenhill uses the energy recovered from incineration for cogeneration to supply heat to the area, and the building itself is used as a ski slope and a wall climbing site. Although waste incineration plants are typically considered 'NIMBY' (not in my back yard) facilities, Copenhill attracts many visitors, skiers, and climbers, bringing vitality to the area.

Cross-sectional and cross-regional wastewater processing efforts

The water in the Port of Copenhagen used to be heavily polluted, but about three decades ago, the city, under strong mayoral leadership, decided to clean the waterfront environment. This project not only established a wastewater processing facility but increased the real estate value of the area through energy recovery initiatives and improvements made to the waterfront environment. The Port of Copenhagen has now become a high-end residential area with a shopping mall, and another example of decoupling economic growth from environmental impacts. The city also built the Copenhagen Harbour Baths, recreational swimming and diving facilities for residents and tourists.

In the northern suburb of Nordhavn, which was previously an unclean and unsafe port area, a similar initiative is underway. In addition to wastewater processing, the area is being developed as a testing site for new technologies including smart chargers for electric vehicles (EV) and grid control using storage batteries installed under multi-level car parks, with the aim to create both industry and an improved residential environment. Nordhavn also plays a role in solving issues faced in central Copenhagen. Climate change has resulted in more frequent storms and increased rainfall, causing a shortage in wastewater processing capacity for the city centre. The situation is monitored by using IoT, and excess wastewater from central Copenhagen is processed in Nordhavn. Energy equivalent to 1.7 times the energy used for wastewater processing is also recovered and used as a regional power source.

Partnerships among industry, government, academia and residents

In Denmark, cities also have authority over childcare, primary education, senior citizens' welfare, healthcare and public services (utilities and waste processing). Dialogue with citizens is very important in driving innovation for these functions, and the Copenhagen Solution Lab acts as a hub for collaboration among public, private and academic organisations and residents. It also serves as a platform to discuss the significance of smart city initiatives and the city's vision, and to gather opinions on the privacy policy for utilising lifestyle data. Citizens can use this platform as a forum to raise issues and needs regarding the city, and to test and provide feedback on the solutions implemented by businesses and by the government.

Basic information	
City overview	The capital of Denmark, with about 620,000 inhabitants. Copenhagen, located at the border of Scandinavia and continental Europe, represents the largest Scandinavian market and offers a stable economic environment, a favourable tax system and labour costs, and a superior talent pool.
City features	Copenhagen aims to become the world's first carbon neutral capital by 2025, and is implementing initiatives to rebuild the vision for the city in cooperation with the national government, as well as promoting smart city initiatives in many areas
Key initiatives	Industry and tourism, disaster and crime prevention, public services

The waste incineration plant Copenhill also serves as an activity centre

Smart citizenship and open data: Initiatives in Aarhus, Denmark

Aarhus is the second largest city in Denmark, but the smallest of the cities introduced in this chapter, with a population of about 340,000. Smart Aarhus is the platform by which residents, the local government, businesses and experts promote Aarhus's smart city initiatives.

Dokk1: A library for improving public digital literacy

Denmark has long accepted the idea that a city's issues cannot be solved unless its residents become technologically literate. For example, the government issues notifications to residents through an email system called e-Boks. The information sent via e-Boks is not sent in hard-copy format, and even senior citizens are expected to possess enough digital literacy to check these emails. Public libraries function as a safety net for residents by providing easily accessible information free of charge, and in Aarhus, the new Dokk1 library serves this function. In today's society, however, where readers can easily search for books on the internet, the city has redefined the library as a place for residents to gather freely and improve their IT and digital literacy. Although some residents had complaints during the transitional period, the city commented that residents can make their lives more convenient by adapting to new social environments regardless of ages.

Dokk1 also provides a regional communication space. It is a playground for kids, a study place for students to work on homework assignments together, and a place for adults to talk about their lives—very different from the quiet public libraries in Japan. Inside this regional communication space, a facility for accessing and experiencing new technologies is located. This facility, called DokkX, holds exhibitions on different themes every six months, offering the residents an opportunity to deepen their understanding of each theme. For example, the theme of active aging and support for senior citizens helped to eliminate reluctance to adopt new technology, and enabled the sharing of knowledge on active aging and long-term care. For businesses, this library is a place to demonstrate the effectiveness of their products and services, to teach residents how to use them and to receive feedback on prototypes, which leads to the creation of new products and services.

Building a regional healthcare system for the future aging population

The Danish government is integrating and reorganising its public hospitals based on the concept of a 'super hospital' to prepare for the future aging of the Danish population. This concept promotes a medical system in which regional clinics, general practitioners, and home-based care providers are kept in contact with one another. In Aarhus, medical practitioners in the city offer diagnoses, treatments, and advice by using a medical database containing photographs, videos, and diagnostic surveys, which enables residents to manage their own health without visiting a hospital. The Center for Telemedicine and Telehealthcare, operated by the members of Smart Aarhus, is developing a self-help-style digital healthcare system that residents as well as medical practitioners can participate in.

Establishment of an open data platform

An open data platform called Open Data Aarhus has been established to create services and initiatives that improve resident satisfaction in Aarhus. This platform enables businesses and research institutions to develop and research digital services in areas including transport, health and welfare, and recreation. This initiative is different from many in Japan, which are often carried out only by the local government. The platform has a hierarchical structure consisting of three levels: local data, national data (Open Data DK), and data from cities throughout the EU. The shared platform has enabled Aarhus to attract global companies such as Google despite its comparatively small size. Each data area has an ambassador that facilitates innovation by providing guidance on the accumulation of data, data contents and the location of data.

Basic information	
City overview	The second largest city of Denmark, with about 340,000 inhabitants. Trade has long made Aarhus the centre of regional economy, with headquarters of major domestic companies and many universities, research institutions and cultural facilities located in the city.
City features	As the regional centre, Aarhus has been promoting smart city initiatives including open data projects in cooperation with the surrounding areas and successfully attracting global corporations despite its smaller size.
Key initiatives	Senior citizens' welfare, health and medical care, administration and data

DokkX (inside Dokk1) provides a place for learning and playing with technology

Improving traffic congestion and security: Initiatives in Hangzhou, China

Hangzhou is located about 200 km southwest of Shanghai and has been an important economic and cultural city since ancient times. It boasts the second highest GDP in the East China region after Shanghai, with China's largest high-tech company, Alibaba, headquartered in the city and playing a leading role in its smart city initiatives.

Using the 'eyes' and the 'brain' of the city to improve traffic congestion

As the result of population growth and economic development, Hangzhou's traffic congestion was ranked as the 5th worst in China and the 30th worst in the world in 2015. This traffic congestion, together with an increase in traffic accidents, had become a serious issue.

To resolve this issue, in 2016, Alibaba developed the ET City Brain system which was provided to the city as a pilot project at a minimal charge. The city was equipped with many CCTV cameras that act as the 'eyes of the city' to constantly gather various information. However, without a brain, these 'eyes' could not analyse the information to make decisions in real time. The ET City Brain collects a wide range of data including vehicle traffic information captured by the surveillance cameras, taxi usage records from drivers' applications, railway passengers' IC card information, and various data held by the government. Based on the analysis of these data, 80,000 traffic lights in the city are controlled in real time, and traffic congestion has significantly improved. Hangzhou's traffic congestion is now ranked only 57th in China; the time it takes for ambulances and fire engines to arrive has decreased by 50%; and traffic speeds have risen by 15%. Based on this successful case, Alibaba is using various data from Hangzhou to actively provide solutions to other issues including security and tourism.

Improving security with video recognition technology

According to a representative of Alibaba, the city is safe enough for women to walk alone late at night, making it more secure than many cities in developed countries. This indicates that regional security in Hangzhou has also improved.

Hangzhou's police collaborated with Alibaba to introduce video recognition technology to the security monitoring system, which allows the real-time tracking of suspicious people and vehicles. This video recognition technology enables the quick matching of surveillance camera images and personal information, and residents report a significant increase in their feeling of security.

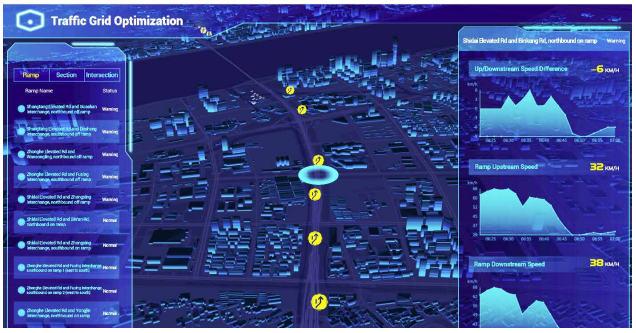
On the other hand, such city surveillance involves the privacy of individuals and the handling of personal information. As information leaks can damage the base of trust in a corporation, Alibaba has adopted a policy of not accessing personal information, and has focused only on building the system. Information that can be linked to individuals is handled only by public agencies such as the police.

Using social media comments to improve the electronic administration system

The Hangzhou government is working to further digitalise its administrative functions by using e-government. The linkage of data held by various government departments has led to a significant improvement in the efficiency of administrative services, but this e-government initiative is not yet completed, and its functions are to be enhanced and updated as it is used. Although Hangzhou does not have a platform for public participation and feedback like those used in Europe, the e-government system's developer, Alibaba, analyses social media comments and applies the results to address public needs. In this unique way, the system is constantly updated to solve issues.

This enables the city to offer efficient administrative services. For example, it used to be very time-consuming and expensive to establish a company, and the associated procedures required many visits to different government offices. But now, all of those administrative procedures can be completed at once.

Basic information	
City overview	Capital of Zhejiang Province in China, with about 9,800,000 inhabitants (making it the tenth largest city in China). Hangzhou has the second highest GDP in East China after Shanghai. It is one of China's eight historical capitals , and was the largest city in the world in the 13th century.
City features	China's largest high-tech company, Alibaba, is headquartered in the city and is heavily involved in promoting smart city initiatives.
Key initiatives	Mobility, disaster and crime prevention, administration



Using ET City Brain to control traffic congestion and traffic lights

PoCs for cutting-edge technology: Initiatives in Xiong'an New Area, China

A large smart city called Xiong'an New Area is being developed in an area covering Xiong County, Rongcheng County, and Anxin County in Hebei Province, located about 100 km south of Beijing. A wide-area development plan described as 'one body, two wings' is underway to solve overpopulation in the national capital of Beijing. Beijing is the 'one body', which provides the minimum necessary functions as the capital, and the two surrounding districts, Tongzhou District and Xiong'an New Area, are the 'two wings'. Administrative functions are to be transferred to Tongzhou District in east Beijing, and economic functions are to be transferred to the Xiong'an New Area. The development of Xiong'an New Area commenced in fiscal year 2017 as a greenfield project with favourable treatment provided by the national government. Companies including China's leading tech firms Alibaba, Baidu and Tencent, as well as the three major telecom carriers are already conducting PoCs there for cutting-edge technologies such as 5G, autonomous driving and unmanned delivery.

City-sized testing site for cutting-edge technologies

The part of Xiong'an New Area that is already developed is not the area that will handle the abovementioned economic functions, but is a testing area for cutting-edge technologies. In other words, it is an experimental city for conducting PoCs–which are generally performed only in a certain part of a city–on a city-wide scale. Most residents are employees the of high-tech companies that are conducting the PoCs and members of the Xiong'an Management Committee. The three-storey Public Services Center, which provides the minimum necessary functions to support administration, business and livelihood was built by using modules that can be dismantled and reused. The new bullet train connecting Xiong'an New Area and Beijing Daxing International Airport, which is scheduled to commence operations by the end of 2020, will terminate at Xiong County Station and will not be extended to the this already-developed area. The role of this area is to host PoCs, with temporary strategic offices for attracting investment. Although major initiatives are underway in this area, it is only expected to be used for about a decade depending on the development status of the area around the new terminal station.

PoCs for autonomous driving, delivery robots, drones and incentivized waste sorting solutions have already been conducted in this area, and the results are expected to be used in the city area (around the bullet train station) that is to be developed for the purpose of transferring economic functions.

A development method that seeks a midpoint between top-down and bottom-up approaches

China's smart city development and city planning are typically led solely by the government, but a new type of city planning is being used for Xiong'an New Area. Because most residents of the area are employees of high-tech companies and members of the Xiong'an Management Committee, their opinions are also being incorporated into the initiative.

For example, opinions and feedback from residents on public services have been incorporated to improve the convenience of the services and of administrative procedures, and it is now possible to complete the majority of administrative processes online. Such e-government system design has also been employed by the Beijing City Government. Xiong'an New Area aims to attract two million residents in the next three decades. In addition to providing preferential treatments for talent and for corporations, the Xiong'an government must pay attention to the residents' opinions and incorporate them into city planning to appeal to general residents.

In the past, the Chinese Central Government was a significant driving force in city planning. However, current smart city development is no longer a one-sided government initiative, and public opinions are now incorporated to resolve issues. As the case of Xiong'an New Area shows, one of the key factors for success is a combination of top-down and bottom-up approaches.

Basic information	
City overview	The 19th such 'new area' being developed about 100 km south of Beijing, covering Xiong County, Rongcheng County and Anxin County of Hebei Province since 2017. Xiong'an New Area is expected to become a large city, with an expected population of 2 million by 2030 and 10 million by 2050.
City features	Large corporations including Alibaba, Baidu, and Tencent are conducting PoCs in Xiong'an New Area with the goal of transferring the economic functions of the national capital Beijing, which faces problems with overpopulation.
Key initiatives	Mobility, public services

Xiong'an New Area represents one of the 'wings' in the 'one body, two wings' plan for Beijing

An autonomous robot operating in the current development area (Photograph of the same model)

Data utilisation: Initiatives in New Delhi, India

India has been promoting projects to improve the quality of life of residents in 100 cities under the Smart City Mission advocated by the Ministry of Housing and Urban Affairs (MoHUA) since 2014. As of 2019, Smart City Mission 2.0 is underway as the second phase to realise smart city initiatives for 4,000 smart villages, towns, and cities. In addition to the promotion of phase one policies, the introduction of smart water meters, smart agriculture, and smart parking was announced at a conference based on the theme of 'smart technology for a smart and sustainable Earth' during the second phase. These smart city initiatives will be developed further in the future.

Aadhaar, a public service platform for all residents in India

India developed its infrastructure by using a digital service platform provided by the central government. This national biometric authentication system, called Aadhaar, brought about a large financial inclusion ecosystem. It enabled people from social classes that were formerly unable to produce personal identification to open their own bank accounts and start businesses. This system has now developed further to become India Stack, a service platform providing verification and payment functions. APIs have been released for five services including eKYC (personal identification), eSign (electronic signature), Digital Locker (data storage), UPI (money transfer), and Aadhaar, which can be utilized by municipalities and private enterprises to develop various services. The strong promotion of digitalisation has played an important part in India's smart city development.

Supporting service development by encouraging the use of open data

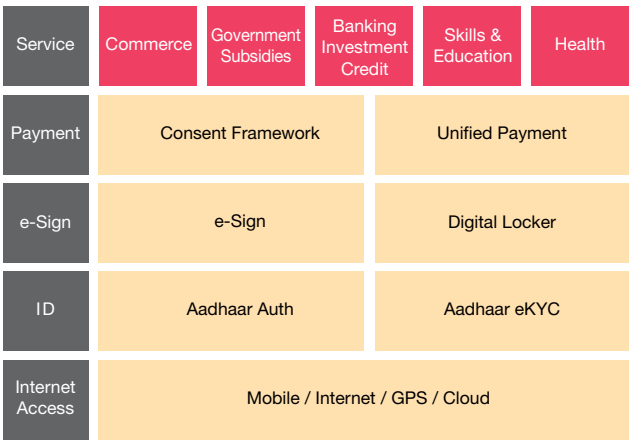
Although India already has a public service platform that is used for services by the private sector via APIs, MoHUA has begun to consider standardising the data structure used for smart cities with the launch of the India Urban Data Exchange (IUDX). The goals of this standardisation are to improve the efficiency of developing and monitoring smart city systems, and to enable the use of open data.

India has also announced its concept for the National Urban Innovation Stack (NUIS), a framework to further enhance the development of services by the private sector (e.g., large corporations, startups, and communities) based on a standardised data structure, and has defined the concept of smart city as a living lab.

Smart city initiatives through public participation in New Delhi

New Delhi is the political centre of India, located in the middle of the National Capital Territory of Delhi. It is one of the most advanced cities in the area of smart city development in India. The New Delhi Municipal Council (NDMC), the administrative organization governing the city, is involved in improving the city environment in various areas under the slogan 'To be the Global Benchmark for a Capital City', in cooperation with the national and National Capital Territory governments. In terms of resident engagement, more than 10 million opinions from 95% of residents have been collected through a number of methods such as workshops, project idea proposals, electronic voting via an administrative portal application, and social media. New Delhi was the first city in India to introduce smart power meters, and also been actively promoting the use of renewable energy to supply power to the city. The city is also attracting attention as a centre for new service development, as well as for the central government's EV policy.

Basic information	
City overview	The National Capital Territory of Delhi is the political and economic centre of India, designated as a union territory equivalent to a state. It consists of eleven administrative districts including New Delhi, which functions as the national capital, with about 19,000,000 inhabitants.
City features	The city is promoting smart city development in the areas of crime prevention, education, healthcare and welfare, and electric power systems. Traffic and crime data is aggregated at a large surveillance office with a full time police presence, and individually focused education using tablets is underway mainly at private schools.
Key initiatives	Administration, data, public services, financial services



Five APIs used in India Stack (Source: Prepared by PwC based on the India Stack website)

Success factors from these leading cases

The cities described in this report provide useful perspectives, but it's important to keep in mind that Japanese cities cannot simply imitate or apply these overseas initiatives as they are because the history, background and environment of each city is different. Nonetheless, referencing these initiatives can be beneficial in discussing the visions to be used for smart cities in Japan.

Each city in this report resolves their issues through cooperative efforts between local governments and businesses using technologies such as IoT, AI and telecommunication. However, it is not only the use of technology, but also the following four points that appear to be the key success factors when developing mechanisms to create a smart city:

A clear vision

Each of the cases we described shows the significance of a clear vision. These cities have identified their current and imminent issues and have clarified the ideal future state, or vision, that they want to achieve. Issues and visions differ from city to city, but each of the cities we discussed has clear ideas about what their goals are. Nowadays, cities face various complex issues that are not easy to solve. However, by clearly identifying their own issues and goals, successful cities have managed to actively lead innovations and new technologies that can help solve their issues.

Coordination of stakeholders by a designated organisation

Each of these leading cities have multiple ongoing projects that align with their visions, and the scale of each operation gets larger year after year. Local governments, corporations, research institutions, and residents must coordinate with one another so that each project progresses smoothly. Each of the cities we discussed has established a public-private joint council or consortium that leads the coordination of smart city initiatives. As permanently designated organisations with full-time staff, these governing bodies do not just arrange meetings, but roll out smart city initiatives by utilising the funding and know-how of the public- and private-sector stakeholders involved in each project.

Promotion of resident-centric projects

Despite the large number of stakeholders, many of the leading cities take a resident-centric approach to their projects. Comprehending the needs and incorporating the opinions of the residents makes it possible to implement the initiatives that the residents truly want and need. The cities are also providing support to improve their residents' digital literacy. By offering various educational programs at libraries, schools and in the community, these cities are working to ensure that all residents can benefit from the new systems. Steady, ongoing efforts also have been made to eliminate psychological resistance to data utilisation and remote operation.

From PoC to practical use

Many cities are encouraging PoC projects as a means of attracting corporations that possess new technologies and solutions. For these efforts to succeed, it is important that each city clearly presents its vision, positions itself as a testbed or a living laboratory, and involves its residents in these projects. It is also important that they promote the development of technology by providing the appropriate open data. But local governments and residents also need to be willing to make the leap from the experimental stage to full-scale use. If an experimental project proves that a given technology is capable of contributing to the city, the local government and residents must support the full implementation of the technology through active participations in discussions on how to roll out the technology in the region and how to allocate costs.

Figure 4.2 Four success factors from the leading cases examined in this section

5

Obstacles related to the commercialisation of smart cities

A frustrating volume of PoCs

Many smart city projects stall at the PoC stage

As we have stated in the previous chapters, smart cities are drawing renewed attention from many sectors as a new type of city that can resolve various issues. Recently, data-driven smart cities in particular are attracting not only key players from previous smart city projects such as real estate, ICT, and energy sector companies, but also start-ups and academic and research institutions. These various players see data-driven projects as opportunities for innovation based on data utilisation, and participate with the goal of advancing technological development and PoCs.

Although it has been almost a decade since smart city related projects began in earnest in Japan, the adoption of the energy management systems (home energy management systems etc.) that initially served as the core technologies has not been sufficient. Recently popular data-driven smart city projects also run a high risk of ending up as mere social experiments.

Even some leading overseas smart city projects that were to be driven by resident data have stalled several years after their launch. For example, Toronto, Seattle, and Cheonggyecheon in South Korea, which is known as the Ubiquitous City, have been developing various applications led by giant data platformers, but these project have faced difficulties due to existing regulations or objections from residents about the use of data related to their lives.

Close to half of the cities in Denmark have launched smart city projects, but these projects are now facing ‘pilot sickness’, where industry is being logged down by a large number of projects that have still not reached the commercialisation stage. Denmark is now making efforts to remove some of the barriers to commercialisation.

Complex and deep-rooted issues

Smart cities are initiatives involving real societies with real residents, and the local governments that embark upon these initiatives do so not only to provide a testing site but also to improve their residents’ quality of life beyond the experimental period. If businesses and research institutions, on the other hand, view these projects as merely an extension of their regular technological development, many issues will arise during the social implementation phase. Some players are aware of the need to change their mindset, but resolving these issues can be extremely difficult depending on their complexity and depth. As a result, a sustainable model is yet to be established anywhere in the world.

In this chapter, we will analyse the obstacles related to the commercialisation of smart cities and present possible perspectives for a solution.

Obstacles related to the commercialisation of smart cities

Smart city projects must identify the expected obstacles to a certain degree, and address each of them in the appropriate order. For example, many projects that do not engage residents or that fail to design an appropriate data management framework face significant difficulties during the commercialisation phase.

In general, current smart city projects both inside and outside Japan have four main factors that lead to obstacles at the commercialisation stage. This page provides a summary of each factor, and the following pages provide details, including possible countermeasures.

Lack of technological literacy

The first obstacle for commercialisation is a lack of technological literacy, which includes both a lack of IT literacy on the part of the residents and a lack of sufficient talent who can design a smart city from both the 'smart' and the 'city' perspectives at both the local government and at the participating companies. A lack of IT literacy on the part of the residents leads to two different types of obstacle: 'hard' issues related to residents' inability to operate digital devices, and 'soft' issues related to fear or psychological reluctance to share data about their daily lives.

Incompleteness of systems

The second obstacle has to do with the use of data. For smart cities, this includes both a narrow definition of 'incompleteness'—incomplete databases due to the difficulty of integrating data in different formats used in different fields and regions—and a broader definition, which refers to the risks of data leakage and security vulnerabilities that occur when various types of data are digitalised.

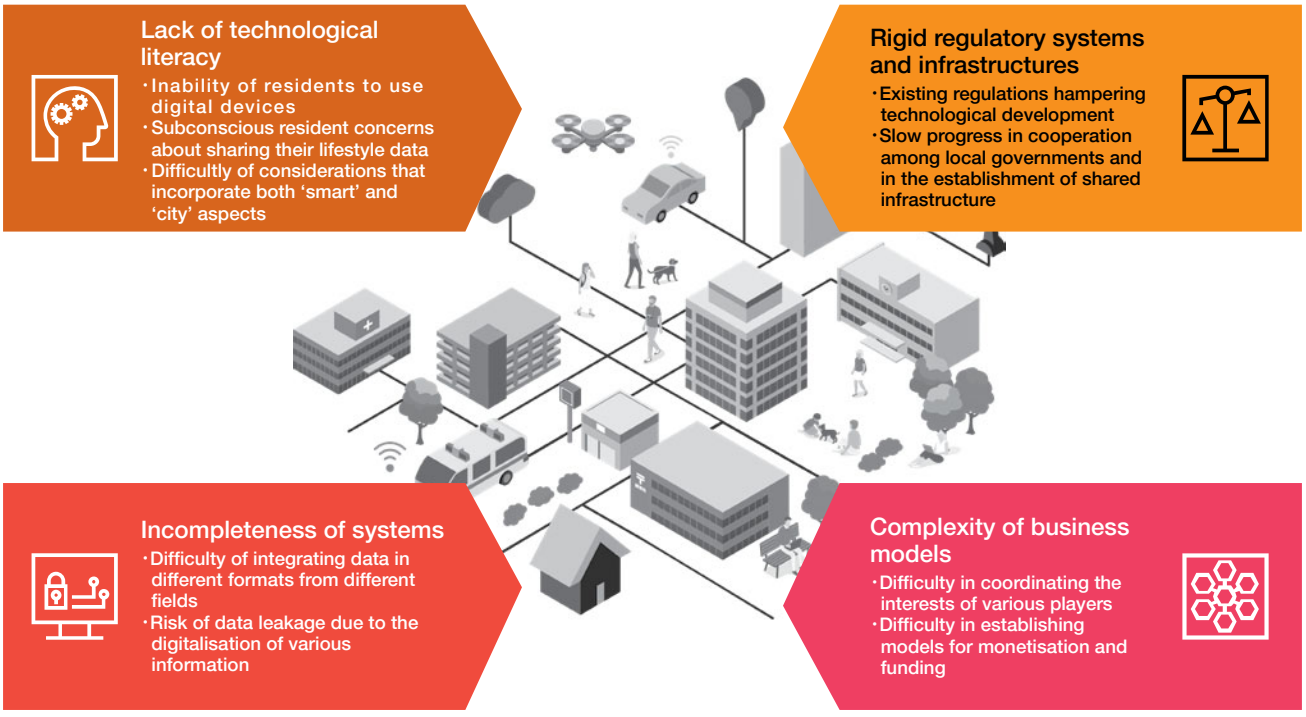
Rigid regulatory systems and infrastructures

The third obstacle is related to the establishment of common regulatory systems and infrastructures. Regulatory system reforms tend to lag behind technological developments, which can make it difficult for some projects to progress beyond the PoC stage. The regional integration and standardisation of infrastructure are also a challenge, especially for wide-area initiatives.

Complexity of business models

The last obstacle relates to business models. Issues related to this obstacle can be broadly categorized as problems related to business schemes, such as the coordination of the interests of various players, and problems related to recovering investments, such as monetisation and financing.

Figure 5.1 Obstacles related to the commercialisation of smart cities



Shifting the focus from a ‘smart city’ to ‘smart citizens’

Smart citizens: Residents act as sensors for a smart city

The term ‘smart citizen’ was used as a keyword at the World Economic Forum’s annual meeting (commonly known as the Davos forum) in 2018, where industry experts discuss economy on a global scale. ‘Smart citizens’ refers to the concept of residents performing the functions of sensors for smart cities as they record various information through their daily lives.

These days, residents carry around excellent sensor devices during their daily lives. Smartphones and wearable devices record a wide range of information including position data, payment data, and graphic data captured with their cameras. Data from such devices could be useful for keeping records of the status of the city and its residents.

Many such services have already been commercialised, such as surveillance services where residents use their smart phones to notify the relevant government offices when public waste bins are full, or services that use wearable devices to monitor the health and safety of senior citizens. Overseas initiatives encourage the incorporation of residents into surveillance functions as part of the smart city.

Simultaneous improvements to IT literacy and interfaces

In Japan, however, it may be difficult even to get residents to use these digital services. Since smart city components are built on technology, many local governments and businesses are keenly aware that advanced services cannot be widely appreciated unless they match the IT literacy of the residents.

To address this issue, simultaneous improvements must be made to the residents’ IT literacy and to the service interfaces, and transformation, including transformation of the residents’ mindsets, is particularly important. Simply giving residents the capability of using the latest devices is not enough to make smart cities a reality. Residents must understand how and why their lifestyle data is being used, in order to eliminate the subconscious concerns they have over the use of their data. Because such problems cannot be solved by only improving interfaces, the improvement of the residents’ IT literacy, including psychological factors, is essential.

Regional cities must first make their local governments technologically strong

Typical initiatives to improve IT literacy involve structural support, such as offering favourable treatment to qualified personnel and providing training. These activities should ideally be led by the national or local government, but this is not possible if the government workers themselves are not IT literate. Some regional cities are trying to promote smart city initiatives before their own local governments achieve literacy. In these regions, even if smart city projects progress smoothly up to the stage of private-sector service development, it normally takes time to raise awareness and to actually roll out services in the city.

Regional cities in particular have a larger number of senior citizens, and it can be difficult for them to accept technology such as touch panel interfaces and credit card-based payment services. Residents with low IT literacy cannot be educated remotely by using IT, and require face-to-face contact in the beginning. One significant role of the local government in these cases is to improve the IT literacy of government employees, because residents in these areas tend to frequently visit municipal offices.

Denmark and China support residents through a drastic digital shift

In Denmark, local governments have adopted an approach in which they first make a drastic digital shift in public services such as primary medical care, and then help their residents to catch up. Rather than continuing to use existing methods for residents with low IT literacy, they create an environment where residents cannot use the services unless they catch up. As a safety net, libraries have been equipped with IT education functions. A similar approach has also been adopted in China. Although these countries have different political principles than Japan, these examples present one possible approach.

Figure 5.2 Examples of measures to improve residents’ IT literacy

Securing talent for smart cities

Shortage of talent who can design a smart city from both the 'smart' and the 'city' perspectives

The other obstacle related to IT literacy is the shortage of talent with cross-sectoral knowledge. In particular, barriers tend to exist between talent in physical fields such as real estate, construction and infrastructure, and those in ICT and digital fields. When developing a smart city project, discussions are needed in the context of construction, real estate and city planning. At the same time, knowledge of data utilisation and digital technology is necessary in order to consider how the city data is to be collected, analysed, and used for city planning. However, these two areas tend to be completely separate in terms of business and the underlying academic fields, and the players in these two areas essentially do not speak a common language. This makes it difficult to simultaneously consider both the 'smart' aspect and the 'city' aspect of smart city planning. A shared cross-industry language is necessary, and in many cases, professional firms with comprehensive and cross-sectoral knowledge, such as PwC, provide protocols for collaboration among these parties.

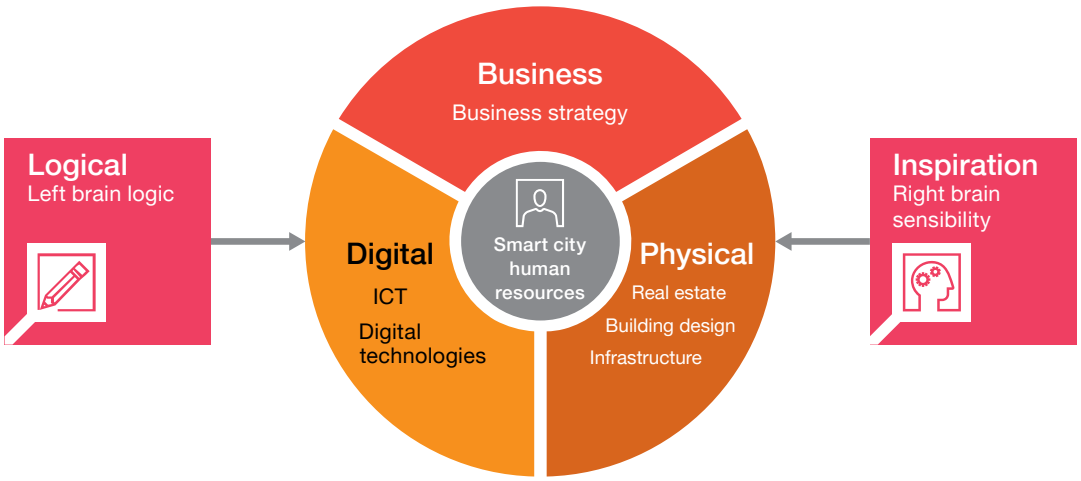
Another challenge involves a shortage of talent who can discuss strategy from both business and technological perspectives. Knowledge related to city planning and to IT, as discussed above, is technological knowledge. However, a sustainable smart city cannot be realised without also considering business models. For example, most smart cities at least require investments for the introduction of new systems. It is therefore necessary to discuss business models including financing for necessary investments, while taking into account complicated relationships among stakeholders such as investors and beneficiaries.

Securing a talent pool that contains all of the necessary capabilities

It is essential for smart city projects to secure talent capable of discussing city planning from the perspectives of various fields such as real estate and construction, IT and digital technology, and business. It is also important for society to develop such talent through collaboration among industry, government and academia. As it would be difficult to immediately find individuals who meet all of the requirements, a talent pool can help satisfy these requirements in the form or organisations or teams.

This talent must also be able to use both their right and left brains. Just as this report looks ahead to 2050, smart city considerations always include visions of cities decades into the future. This requires not only left brain-based logic to derive social trends from facts, but also right brain-based intuition and sensibility to find answers to challenging questions. Smart cities may be a new field, but the old adage 'city planning is people planning' still applies.

Figure 5.3 Capabilities required of smart city talent



Metadata management to address data fragmentation

Data fragmentation and information leakage risks as obstacles to digitalisation

The second obstacle preventing the social implementation of smart cities is related to data management issues. Data management refers to various approaches concerning the management of the data that is to be utilised in order to generate value. Data integration and data security are particular concerns when it comes to the full-scale launch of a smart city.

Fragmentation among fields and regions, and incompleteness of data

In terms of data integration, smart cities encompassing diverse industries often face the problem of data fragmentation. This makes it difficult to provide services by using integrated data. In particular, three types of fragmentation are creating technical barriers.

The first one is the fragmentation of data from different fields. Smart cities should be able to provide highly convenient services to each resident by using various data related to the individual. In reality, however, the use of diverse data is not so simple. This is because data from different fields, such as the data managed by local governments, medical facilities and retail businesses, is managed in different formats, which can make it difficult to integrate.

The second type of fragmentation is fragmentation by region. As with the fragmentation of data from different fields, it can be difficult to utilize data over a wide area because City A and City B might use different data management formats. For the same reason, many corporations face difficulties in expanding their businesses when services developed for City A cannot be used for City B.

The third type of fragmentation stems from the incompleteness of the data itself. For example, power saving sensors located on infrastructure such as roads and power grids have different data transmission intervals depending on the type of equipment for which they are used. Even the same type of sensors may not use the same timing for data acquisition, which makes it impossible to acquire data at the same interval. To use data from these sensors at a particular point of time for services, a system for dealing with the data gaps between sensors is necessary.

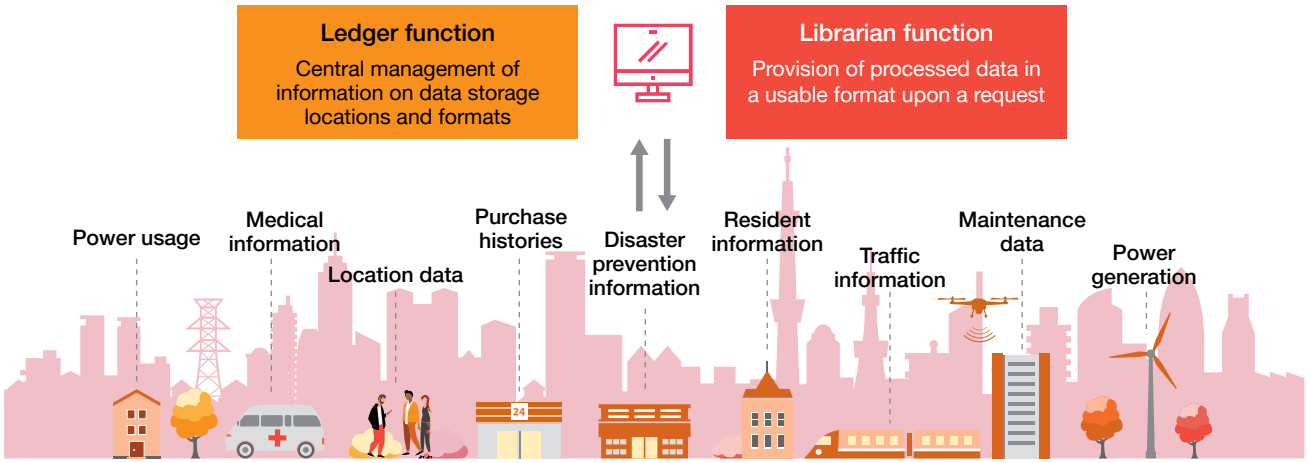
Focusing on metadata management alongside data standardisation

Japanese smart city initiatives have fallen behind in addressing these three types of data fragmentation. In many cases, when services are developed, their developers are overconfident that it will be possible to implement the services, despite the lack of human resources with the necessary technical expertise. Integrating data after a service has been developed requires a great amount of effort, and typically involves the use of data integration systems such as ELT (extract, load, transform) tools, resulting in high costs.

In other countries, data standardisation is underway in order to address such issues. In Japan, however, as data collection mechanisms are already established for different fields, it would be unrealistic to attempt to enforce an integrated standard for all business entities.

In Japan, one effective approach would be to apply the concept of ledger management, where existing data owned by local governments and medical institutions is managed at a higher layer, or to assign the smart city's governing body a librarian function to manage the location of necessary data. To design such metadata management functions, the participation of data utilization experts from the early stages of smart city concept design is essential.

Figure 5.4 Two functions of metadata management



Designing data management organisations

Stricter regulations for personal information protection

In general, the data owned by cities can be categorised into operational data, related to public resources and the provision of public services such as maps and bus services, and identifiable data, such as individual positioning data and personal purchase histories. In recent years, the management of these two types of data has been clearly divided, and the data is managed in opposite ways. Operational data is being increasingly disclosed as open data, while identifiable data has been subject to increased protection. The EU has established the General Data Protection Regulation (GDPR) to enhance the protection of personal information, and Japan is expected to enhance its regulations as well.

One particular focus of enhanced regulations in Japan is likely to be the opt-in user consent process for use of personal information. Many people in Japan are likely to click the 'Agree' button without reading the privacy policy in detail when registering their information in a new app. Going forward, policy providers will be strongly encouraged to explain the contents to users in an easy-to-understand format and to seek consent based on proper understanding.

How to obtain consent for the use of personal information

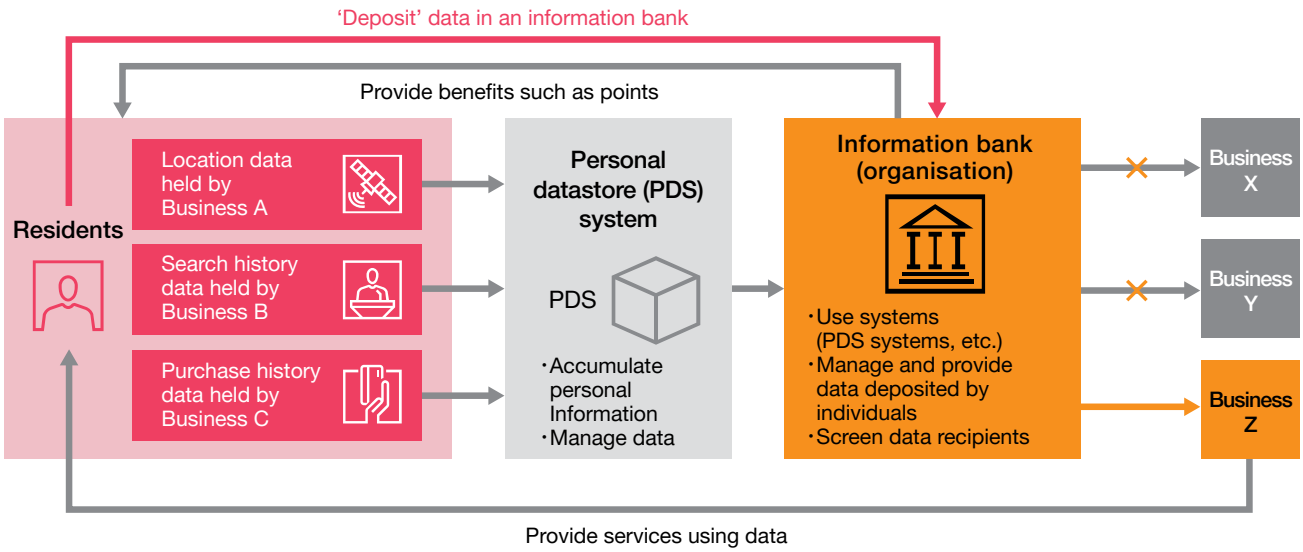
Smart cities face a unique problem in responding to stricter regulations for the protection of personal information. Unlike general internet services, smart city services do not have an 'entry point'. For example, internet services ask users to agree to their privacy policy when the user registers for the service for the first time. At a hotel, guests may be asked to consent to the use of their personal information when they check in. However, it is difficult for a smart city to ask for consent at the point of entry. Stricter regulations may therefore make it even more difficult to share data across services.

Assigning data management functions to information banks

One potential solution is an information bank. An information bank is an organization that centrally manages lifestyle data (e.g. behaviour and shopping history data) about residents under a high level of security and provides data to the appropriate businesses within the scope of consent of the residents. Residents can prevent their private data from being used for unanticipated purposes while still enjoying services that make recommendations based on their data.

In addition to enhancing the protection of personal information and improving convenience for residents, information banks are also a means to compete with Big Tech companies, which have tremendous stocks of personal data, and the Japanese government has also begun to lead these initiatives. Data platform providers and financial institutions were among the first certified information banks announced in June 2019. Some regions have already implemented models that promote use of data by assigning an information bank function to their smart cities.

Figure 5.5 Concept of data management by an information bank



System design born from the city's vision

Efforts to mitigate delays in regulatory reform

Stakeholders in the development of smart cities would likely agree that existing regulations are hindering their efforts to make smart cities a reality. Particularly in the areas of data utilisation, transport, and energy, regulatory issues became apparent early in the history of smart cities, and governments have addressed them with measures including special zoning. However, such regulatory reforms were limited to resolving issues in individual areas such as transport or energy, and governments tend to put off actual systemic reform in order to prioritize other urgent issues.

With these issues in mind, a Japanese government advisory panel called the Expert Advisory Panel for Realising the Super City Concept has identified three key principles: regulatory reform covering all aspects of life (as opposed to individual areas); legislation that leads the realisation of life in a future society; and the pursuit of an ideal future society from the residents' perspective.

A bill submitted to the Diet based on the above policies in FY2019 was discarded because the majority parties could not agree on the contents. However, we expect that a similar bill will be discussed again in FY2021. (Note, however, that some experts think that an open API platform such as India Stack will become the focus of the discussion going forward.)

Systemic design based on a vision from the residents' perspective

Municipal system design tends to focus on issues that have already arisen, and regulatory reforms tend to be put off. To address this problem, systemic design using the residents' vision as a starting point will be crucial both for local governments and for the national government. A vision should be established first, and measures addressing the obstacles to realising that vision should be prioritized, including regulatory measures.

Smart city-related technologies are particularly diverse, and theoretically, they can be used to achieve many things. This means that the prioritisation and selection of goals and technologies are very important, and priority criteria for system design should be defined according to a vision of an ideal future from the perspective of local residents.

For this purpose, the process to be used to create this ideal vision should be a key point for discussion. This may seem like a nice concept, but it is not easy to achieve. Residents do not routinely think about ideal cities, so listening only to their opinions may result in lack of future perspective.

Creating a vision through organization with resident participation

Kawanishi Town in Yamagata Prefecture may provide some hints for the process of creating a vision that incorporates the residents' perspective. This town, which has 2,600 residents and more than 700 households, has been working to establish a vision for the future through resident participation, led by an NPO with 100% household membership. This organisation started as a voluntary study group formed in response to the municipality's financial difficulties. The grassroots activity expanded through cooperation among local PTAs and commerce and industry associations, and has become an autonomous city planning organisation with resident participation. The organisation works to create a vision for the town as well as engaging in city planning and execution of the plans.

To promote smart city initiatives, establishing such a co-creation function in which residents can participate and building a framework for creating a vision together with the smart city talent we disused previously is essential. Based on this vision, the government can design systems and implement regulatory reforms that will lead to a sustainable smart city.

Flexible system design

With respect to issue of accelerating regulatory reform, a flexible system design is essential. It is difficult to see how future regulatory reform by the national government and cutting-edge technological innovations will develop in the future, an this uncertainty is a practical issue faced by local governments who seek to revise their own systems to promote smart city initiatives. To face these issues, local governments need to build flexible systems by, for example, setting guidelines with the assumption that they will be updated and establishing a highly flexible dedicated organization as the main operating body of the smart city.

The two-pronged approach of regulatory reform and improved IT literacy

Finally, when promoting deregulation for the purpose of smart city development, local governments cannot ignore opinions from key local figures including the city council. If these key persons are wary of new technologies, it will be difficult to get them to understand the need for deregulation. Therefore, municipalities must actively work to improve IT literacy, as well as designing systems.

Cross-regional cooperation starts with cooperation among businesses

The increasing need for cross-regional cooperation

With regard to cross-regional cooperation among local governments, the national government is now discussing the concept of regional administration, which would introduce new administrative units and system designs. The objective of regional administration is to promote organic cooperation in and beyond the administrative units, which consist of several municipalities, so that they can share the administrative duties that formerly needed to be carried out by each individual municipality. The history of regulatory frameworks indicates that broader cooperation with strong enforcement is essential these days. Shared infrastructure and cross-regional data linkage are expected to become even more significant in smart city initiatives.

Barriers to cross-regional cooperation in regional cities

For cross-regional smart city initiatives, difficulties in cooperation and infrastructure-sharing among municipalities tend to become a barrier to realising a smart city. These difficulties are caused by two separate issues.

The first issue is with financing schemes. Each municipality has its own sources of funding for public services such as health care and utilities, but if a shared service is to be provided by multiple municipalities, they must coordinate the related cost allocation and profit distribution.

The second issue is regional identity. In areas where regional identities remain strong, policies tend to become partially optimised by each administrative division, and a united effort to promote cross-regional initiatives could be difficult. This problem also applied to the many cities that were created by combining smaller cities, towns and villages during the Heisei era (1999-2006).

Generating 'quick wins' in cross-business collaboration

If the local government takes a top-down approach to promoting a cross-regional smart city operation among regions with different identities, various conflicts may arise among residents and among commerce and industry associations.

Bottom-up inertia is essential for the promotion of an industry-wide initiative, and minor successes ('quick wins') in cross-business collaboration can drive this inertia.

Figure 5.6 Regulatory changes affecting cross-regional cooperation

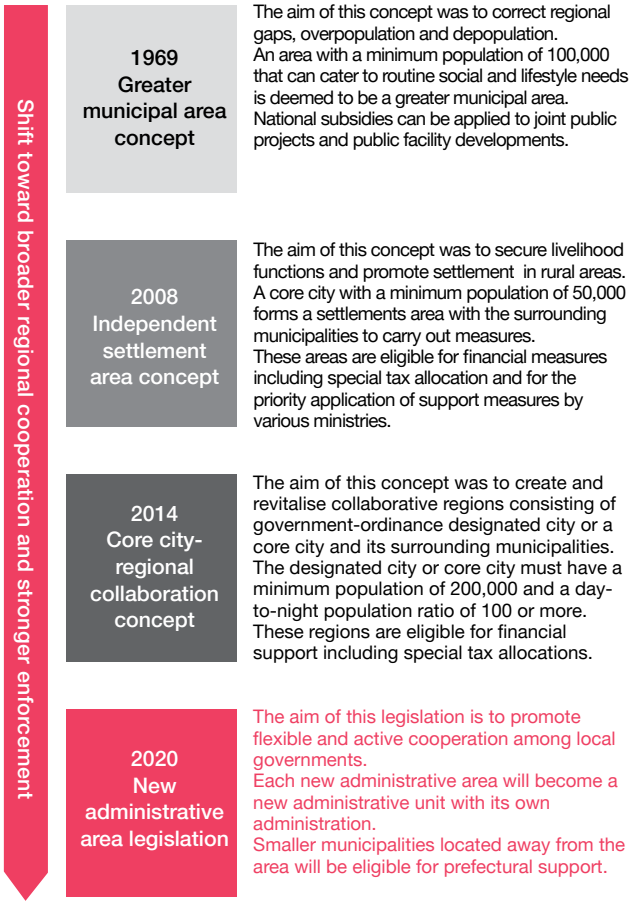
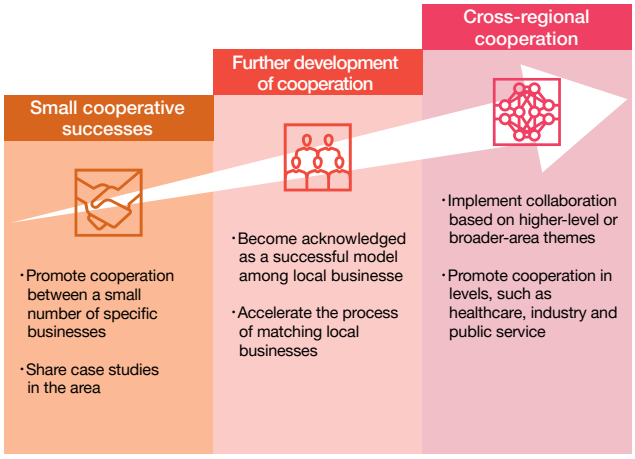


Figure 5.7 Cross-regional cooperation led by businesses



Relationships between smart cities and regional economies

Complex stakeholder interests unique to smart cities

In addition to ICT-related businesses, local governments and the real estate industry, smart city projects involve diverse stakeholders unique to city planning, such as landowners and residents.

Regional cities have even more complex sets of stakeholders, because the protection of local industries is also an important consideration. Smart city schemes must be developed with an understanding of the concern that the local service industry might be taken over by remote services provided by global corporations, as well as the anxiety and wariness residents might feel at the possibility of local businesses being run out of business by newcomers. If these concerns are not addressed, it will be difficult to secure the cooperation of local governments and residents at later stages.

Local commerce and industry associations have vast influence in many regions, and their interests are not necessarily aligned with those of the local government. If a project is promoted solely based on communication with the local government, friction with local businesses and landowners may result. Smooth project promotion in regional cities depends on establishing communication with important local players at an early stage.

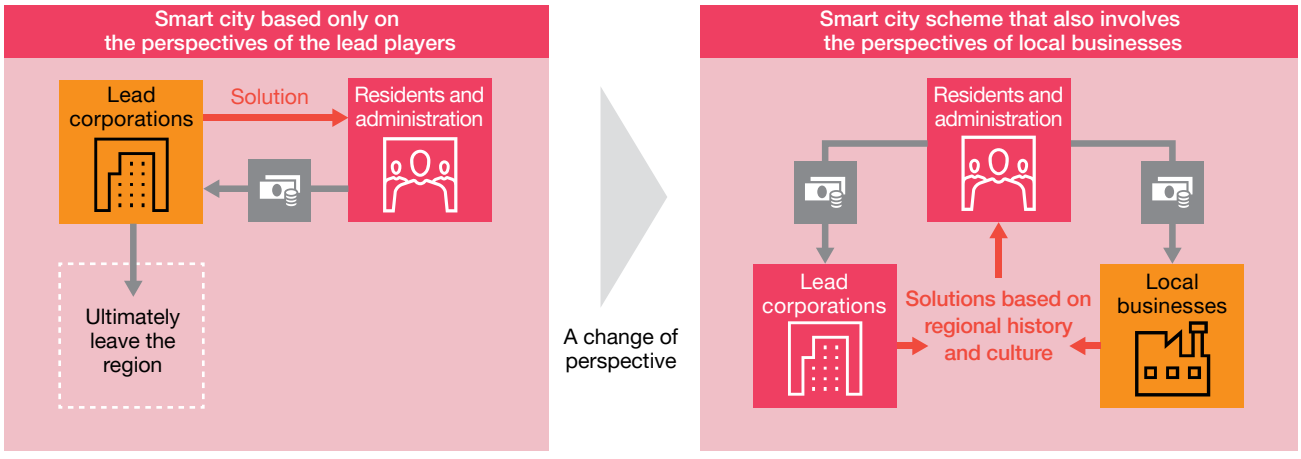
Local industry development through smart cities

As smart city initiatives in regional cities focus on the protection of local industries, local businesses may be expected to be involved in some smart city schemes. Recently, some corporations are also using smart city initiatives as an effort to contribute to regional revitalisation.

When local businesses are to be involved, it is important to consider how to involve them in the project. Because digital analytics is the main area of technological development needed for a smart city, the capabilities of local businesses might not match the functions that are needed. Many municipalities tend to try to attract companies from large cities, without addressing such gaps at the local level. This results in the failure to create income for local businesses, and if the powerful corporations and start-ups from large cities do not remain in the area, this may leave the region without any established industry.

To involve local businesses, it is important to identify a unique winning pattern for the region and to facilitate the development of industry in certain areas. In particular, distinctive solutions must be identified by considering how to combine technology with the unique history and culture of the region. Services based on regional features tell stories that appeal to the media, and also make it easier to generate support from residents and from local commerce and industry associations.

Figure 5.8 Necessary perspectives for a regional smart city



Bad

When initiatives are led only by corporations based in large cities, they do not provide income for local businesses.

When these corporations then leave the region after a period of time, the region is left with no industry.

Good

When the smart city scheme helps local businesses to flourish, it leads to regional revitalisation.

This leads to the creation of unique services, and to industry development such as cross-regional expansion.

A governing body representing all stakeholders

The need to seriously consider investment-recovery models for smart cities

As we stated at the beginning of this chapter, smart city projects around the world have a tendency not to progress beyond the PoC stage. One of the reasons for this may be that many smart cities do not have a clear investment-recovery model, which results in corporations seeing smart cities as merely testing sites for new services. And the very concept of a testing site is that the participating players making initial investments in systems, etc. in exchange for the ability to develop new services.

But can such testing sites really be called cities? To establish a smart city as a form of sustainable city, it is important to seriously consider investment recovery models.

Complexity of smart city business models

Complexity of business models is what makes the discussion of smart city investment recovery models difficult.

In most cases, initial investment for data management systems, etc. is necessary in order to create a smart city. Who should make these investments? And who should recover the investment, when and how?

It is often difficult for smart cities to secure external financing due to the difficulty in making decisions regarding large-scale investments in projects where complex factors make revenue projection difficult.

In terms of investment recovery, the companies that provide the services and the companies that benefit from them are not always the same. For example, an IT firm might enhance the value of a city by providing public services, only to have a real estate company benefit from the windfall of increased asset value. Smart cities also involve many joint services provided by multiple entities, which makes it necessary to consider revenue allocation schemes.

A cross-stakeholder organisation to coordinate investment and recovery

As stated above, smart cities require financing and revenue allocation functions. But how can these functions be implemented for a whole city?

These functions should be performed by a cross-stakeholder organization. For example, a joint venture can be established by the local government and the participating corporations. The joint venture can provide the initial investment capital, and allocate the revenue from the long-term asset value growth to the relevant stakeholders. Compensation received for various services can be used for investing in new services. This model is similar to the kind of portfolio management schemes used by a holding company. This kind of 'smart city holding organization' can be established to coordinate the balance between investment and recovery.

The ideal governing body differs depending on the region

To ensure smooth operation of the cross-stakeholder entity, it might be effective to allocate responsibility based on each stakeholder's commitment rather than having all stakeholders bear equal responsibility. The players that takes on leadership roles will vary from region to region.

Data platform providers are leading some smart city initiatives in North America and China, but in Japan, players from the 'city' side, such as developers and local governments, may be better suited for this role.

For example, leadership by developers is likely to be effective for projects in larger cities with a large prospect for asset value growth. For projects aiming to improve convenience in residential areas, a governing body that includes resident participation, similar to a condominium association's board, might be more appropriate. And in a smart city project for a regional city aiming to reduce the cost of public services, the local government that will benefit from the project should make the initial investment. We will further discuss the ideal form of these governing bodies in Chapter 6.

Figure 5.9 Issues related to investment recovery models based on a governing body

Difficulty in establishing investment recovery models		Issues for consideration
Initial investment	・Initial investment is needed for data management systems, etc. ・Local governments and similar entities have limited capital for independent investment.	How should the capital be funded?
Difficulty in making decisions regarding initial investment	・Revenue projection is difficult due to the complexity of multiple business projects involved. ・The difficulty of conducting feasibility studies makes external funding difficult.	
Input and output of capital involves different parties	・The entities that provide the service and those that receiving the benefits may differ. For example, an IT company might improve the value of the city and a real estate company might enjoy the benefits.	How should the revenue be allocated?
N2N business model	・This is a cross-industry model, unlike a simple B2C or B2B model. ・Revenue allocation models among the participants are complex.	

Eliminating obstructions to commercialisation

Obstructions to commercialisation			Perspectives for eliminating obstructions	
Lack of technological literacy	Insufficient IT literacy among residents	・Residents who are incapable of using digital equipment ・Residents who are subconsciously concerned about sharing their lifestyle data with businesses	Diversification of educational opportunities	・IT education provided at libraries ・E-learning and other opportunities
			Designing qualification programs	・Design of IT-related qualifications and favourable treatment for qualified individuals ・Revisions teaching guidelines for compulsory education
			Improved environment for skills acquisition	・IT device development workshops with resident participation ・Building a community of mutual teaching ・Distribution of IT devices to residents
			UI that incorporates residents' perspectives	・Revision of UI (user interface) design to reflect the improved IT literacy of residents, with a focus on physical interfaces particularly in regional cities
	Difficulty in cross-sectoral discussions	・Difficultly of discussions that consider both ' smart' and 'city' aspects	Encouraging the participation of smart city professionals	・Inclusion of third-parties with the capacity consider a project from technological ('smart'), city planning ('city'), and business aspects
			Long-term talent development	・Development of a system to cultivate talent capable of cross-sectoral thinking within corporations or communities
Incompleteness of systems	Fragmentation of data among fields	・Difficultly of integrating data from different fields in different formats	Metadata management (ledger management and librarian functions)	・Establishing a ledger management function for management of data owned by municipalities and medical institutions at a higher layer; and a librarian function for managing the location of necessary data
	Vulnerability of systems	・Data leakage risk caused by digitalising various information	Implementation of an information bank function	・An information bank function that centrally manages resident data under a high level of security and provides appropriate businesses with data within the scope to which the residents have consented
Rigid regulatory system and infrastructure	Sluggish regulatory reforms	・Slow regulatory reforms hamper technological development	Reform based on the residents' vision	・Defining a vision with resident involvement by using a backcasting approach to prioritise the regulatory reforms necessary for achieving an ideal future state
			Flexible system design	・Guidelines designed with the assumption that they will be updated ・Establishment of a flexible special entity as the governing body of the smart city project etc.
	Difficulty in cross-region cooperation	・Slow progress in cooperation among municipalities and sharing of infrastructure	Expansion of business cooperation to cross-regional cooperation	・Creation of small success cases (quick wins) among businesses to generate a cooperative atmosphere in the region, followed by the expansion of business cooperation to cross-regional cooperation
Complexity of business models	Difficulty in coordinating conflicts	・Complex stakeholders unique to smart cities that make coordination difficult ・Difficulties involving local businesses in regional cities	Building relationships with local key players	・Building relationships with key players including local businesses and landowners from an initial stage, rather than limiting communication to that with local governments
			Considerations for the perspective of developing local industry	・Considering solutions that combine the history and culture of the region with technology, as well as involving local businesses from the initial planning stage
	Shortage of operating capital	・Monetisation and funding models cannot be established	Governing body representing all stakeholders	・Establishment of a joint venture among the local government, local businesses, and participating companies for investment recovery and adjustment

6

Establishing a sustainable business model

Business models for metropolitan areas

As stated in the previous chapter, the complexity of smart city business models presents a significant obstacle for the promotion of smart city projects. Without clearly establishing a governing body to promote the project and or determining how funding is to be secured, smart city initiatives tend to be fragmented and ununified. In this chapter, we will introduce examples of sustainable business models that reflect the characteristics of the specific city. We hope that these models will to contribute to the realisation of future smart cities.

Governing bodies for smart city projects in office areas and commercial areas

In large cities, a series of large-scale redevelopment projects are currently underway in office and commercial areas. In many of these areas, stakeholders, including local governments and landowners, cooperate to establish an 'area management organisation' that creates added value, improves international competitiveness, and works to resolve regional issues. These area management organisations lead discussions over city planning and smart city development.

Although real estate developers eager to get an early start on smart city businesses play central roles in many regions, smart city projects require an governing body that enables the involvement of all stakeholders including industry, government, academia and residents citizens. Volunteer organisations such as councils are often not sustainable, as they are driven by the participants' good will or interests and are likely to stall when faced with an obstacle. For this reason, an independent entity capable of building a clear business model is necessary.

Some office and commercial areas do not have many actual residents who live in there, but similar opinions can be gathered from workers and students who spend a lot of time in the area as part of the community.

Creating added value in office and commercial areas

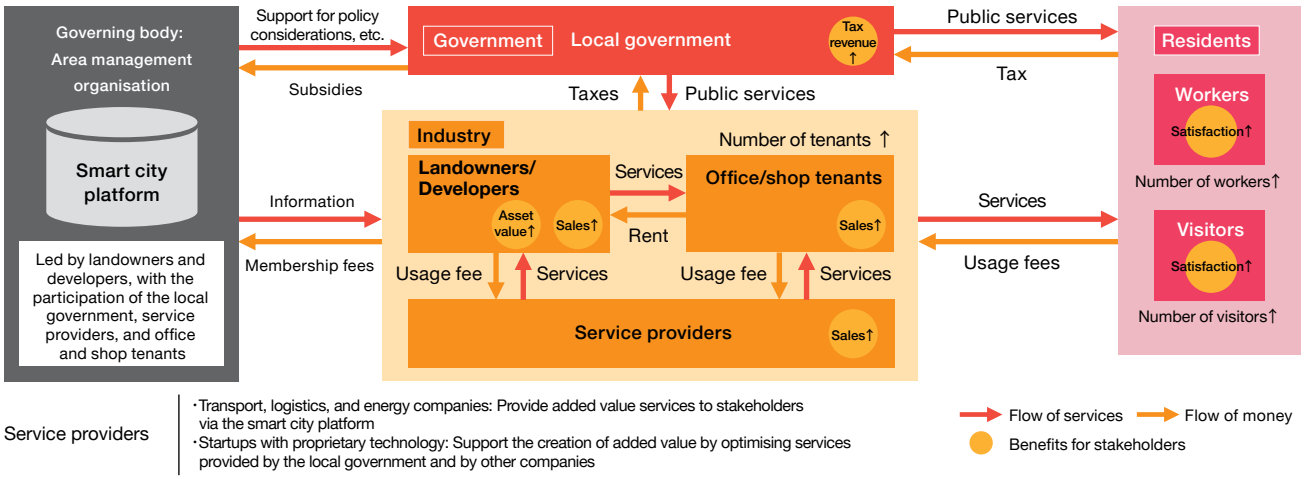
Smart cities in office areas of large cities can provide workers and visitors with new services that improve convenience, disaster prevention and safety. This makes the area more attractive for prospective workers and shoppers and improves the business performance of companies with offices there. As a result, the local land value and rent will increase, which creates added value in the form of asset value growth.

Methods of creating added value and business models

Creating added value with smart cities involves the creation of mechanisms for data gathering, management and operation and usage, as described in Chapter 2. As this chapter concerns the governing bodies that operate smart cities, we shall refer to these three mechanisms as a 'smart city platform', a system that can be used by all stakeholders including the local government and landowners. Corporations that possess new technologies create new added value by providing various services through this smart city platform, and the area management organisation of a smart city project provides or shares the smart city platform with other stakeholders, and collects membership fees or service fees from landowners and others who reap the benefits of the platform.

Because the establishment of a smart city platform requires a certain level of initial investment, active involvement by the local government is essential. Local governments should consider providing incentives, such as easing restrictions on floor area ratio, because a smart city platform is likely to improve public functions such as disaster prevention. As the area becomes more attractive, land prices and rent will rise, leading to increased tax revenue for the municipality. Some cities in Japan are already considering models similar to the business improvement district (BID) systems used in North America and Europe, where part of the tax revenue is returned to the area management organisation. For local governments, providing incentives to the area management organisation is key.

Figure 6.1 Business model for an office area in a large metropolis



Governing bodies in residential areas

Smart city projects are also being conducted in residential areas such as commuter towns. In many cases, however, when these projects are led by local governments or by only some of the participating corporations, they end up becoming no more than a PoC that ends after a certain period of time, without actually realising a smart city or bringing benefits to the community.

For smart city initiatives in residential areas, various objectives are set. These objectives might include improving convenience, safety, and crime prevention; eliminating traffic congestion; and creating harmony with nature and the environment. These initiatives aim to preserve or improve the city environment. Residents and local businesses should also play a central role in the realisation of such a smart city, rather than depending on the local government or on large corporations.

In such areas, it is essential to establish an organisation that operates the smart city initiative with the residents playing a central role. This kind of organisation led by residents to preserve and improve their residential environment is similar to a condominium association's board. A condominium association's board collects fees from the residents to maintain and preserve the residential environment, with a focused on shared assets, and commissions a management company to provide various services. A well-managed condominium tends to hold its asset value over the years. On the other hand, a poorly managed condominium sees its asset value significantly decrease even if the interior and the condition of an individual unit is good. This is similar to the way in which smart cities aim to preserve and improve the city environment. Therefore, the governing body should represent all stakeholders, rather than only some of the participating corporations and residents, and should have a mindset focused on creating added value for preserving and improving the community environment.

Of course, it would not be easy for individual residents or a single company to establish such an organisation. The local government and leading local businesses are expected to play a central role in setting up the organisation. However, the residents should then take on a leadership role in its operation.

Creation of added value and business models for residential areas

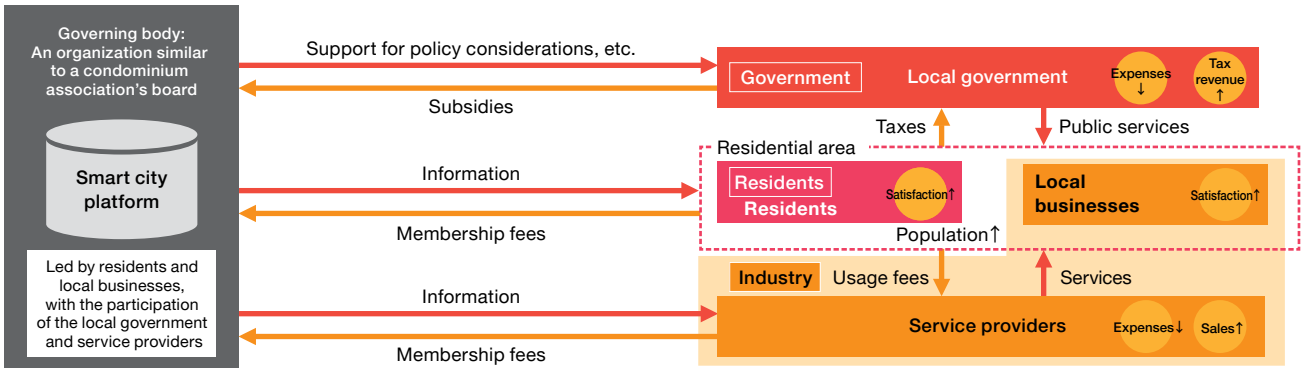
The added value created by smart cities in residential areas is not necessarily directly linked to economic value as it is in office and commercial areas. However, resolving issues leads to an improved residential environment, and those improvements are considered added value. The aim is the same as for office areas: to create added value through establishing the data utilisation mechanisms that make up a smart city platform. As we explained in the example of a condominium association's board, smart city operations based on contributions and responsibilities of residents will form the foundation of the business model.

A sustainable business model also requires the collection of membership fees and smart city platform usage fees from the stakeholder companies that provide services to residents. The data processed by the smart city platform can be aggregated and analysed, and then used to reduce the cost or to improvement the efficiency or quality of the services provided to residents. For example, if a delivery service provider can use this data to determine whether residents are at home at a given time, they can significantly reduce their labour burden. Real-time projections of the number of people currently in the area may help retailers and restaurants reduce their losses. And data on the flow of people and traffic can be important for retailers and restaurants when developing strategies to open a new store, and can also be reflected in business hours and merchandising.

A smart city business model can be built by receiving compensation for added value from prospective beneficiaries. As the volume of data increases, services that use the smart city platform to convert the data accumulated during the daily lives of residents into meaningful data will have greater potential. Sufficient discussion is therefore necessary on topics such as what data will be used to what extent in order to preserve and improve the city environment, and what data should be protected in what way.

The most significant difference between smart city operation in residential areas and a condominium association's boards is the comparatively high hurdle for reaching agreement. In general, a condominium association's board is formed when construction of the condominium is complete and units go on sale, and residents purchase and move into their units with the understanding that they will also become members of the board. On the other hand, because many smart city initiatives are brownfield residential redevelopment projects, they face a higher hurdle for achieving agreement among the stakeholders, including residents. The hurdle cannot be avoided, however, as it is clear that Japanese cities will enter a difficult phase as the result of demographic changes. Each resident will therefore need to think about what they want from the city where they live, and how they should get involved.

Figure 6.2 Business model for a residential area of a large metropolis



Service providers
- Transport, logistics, and energy companies: Provide added value services to stakeholders via the smart city platform
- Startups with proprietary technology: Support the creation of added value by optimising services provided by the local government and by other companies

Business models for regional cities

Smart city operators in regional cities

Some regional cities have reached the stage where they are unable to maintain the public services that are the foundation of safety and security. It will be difficult for such cities to develop a smart city based on the idea of added economic value. Active involvement of the local government is necessary, but the governing body should be an organization independent from the local government that enables cooperation among industry, government, academia and residents.

The most important reason for this is to generate the sense of ownership among residents. As we explained in the previous chapters, regional cities tend to have more issues that must be overcome together with the residents to promote smart city initiatives, including a lack of IT literacy and insufficient collection of data that can be used for public services. These issues cannot be overcome solely by depending on the local government.

Another reason is the need to overcome the siloed nature of organisations within the local government. Having an independent governing body to lead the smart city project makes it possible to efficiently execute rational policies based on data from various previously-siloed divisions of the local government.

Creating added value in regional cities

Regional cities that are significantly affected by demographic changes must still provide a certain level of public services. However, declining population density leads to inefficiency, creating a heavy burden on regional cities. A smart city platform can utilise data about the status of the city to visualise the cost performance of public services, thereby clarifying the necessary level of service and the costs involved, and enabling discussions on improving efficiency. The governing body should play an important role as the facilitator of such discussion, rather than leaving such discussion to only the residents and the local government.

For example, when multiple smaller municipalities are to be merged, necessary discussions may include whether municipal offices and public facilities based on the previous administrative districts should be maintained, whether there are any facilities or infrastructure services with an extremely small number of users, and whether all of these sparsely used facilities and services should remain after the merger. It may also be necessary to discuss whether public services provided by the municipality can be automated by using remote surveillance and control, and whether each municipality should continue to provide these services on their own, or whether joint services can be provided with neighbouring municipalities. The governing body of the smart city project must conduct a fundamental review of the relevant public services and make the necessary changes to reduce costs while also maintaining a level of functionality that contributes to the safety and security of the residents.

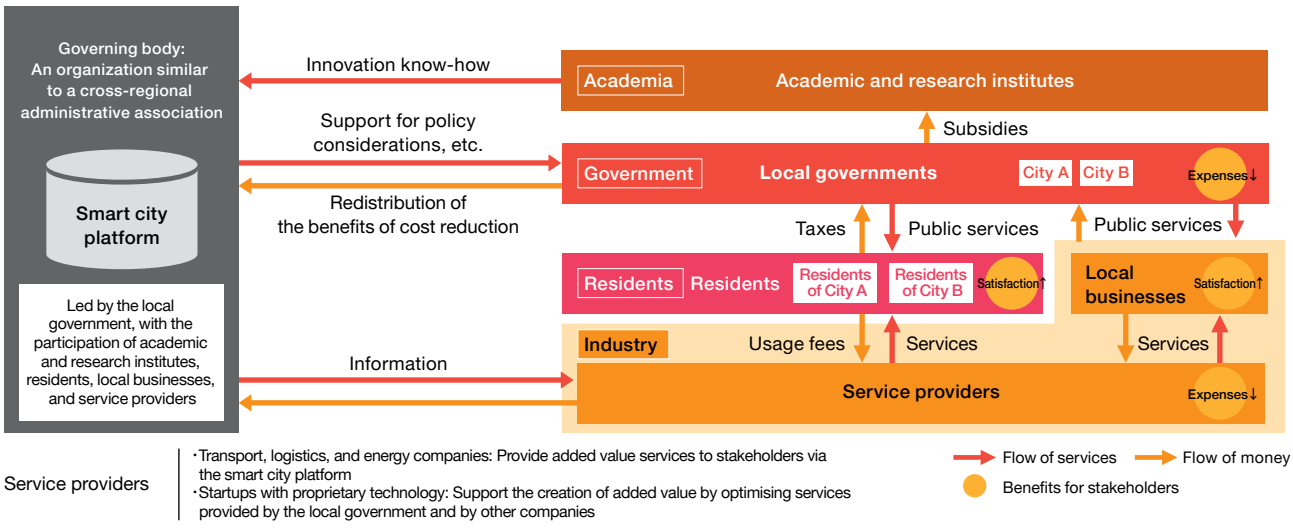
Business models unique to regional cities

Regional cities can find it more difficult than large metropolises to promote smart city initiatives, due to the smaller potential for added economic value and the smaller number of participating corporations. For a regional cities to establish a smart city business model, the service providers, such as local government, need to redistribute the benefits of reducing the cost of public services to the smart city operators.

Because many regional cities share the same issues, the smart city platform for data utilisation can be standardized. There is no need for each city to independently develop functions when established functions can be deployed from other cities. For example, initial investment can be controlled by jointly using a system developed by another city that has improved its versatility through diverse applications, or through joint development and operation with neighbouring cities. Such methods can not only help to control the expenses of the governing body, but also make it easier for businesses to participate as the market for their services becomes larger.

Another approach is to have academic and research institutes provide know-how on driving innovation, or to attract startup companies. Some of these initiatives are attracting global talent through residents' cooperation and collaboration with local industries for technological development, in addition to support from local governments.

Figure 6.3 Business model for a regional city



Roles of a smart city's governing body

In this chapter, we analyse the separate models for large metropolises and for regional cities that make it possible to establish and sustain the operation of smart city initiatives as an independent project in each city.

All smart city projects include the following three factors which must be considered when promoting smart city initiatives in each city or region.

Governing body	Who will lead the smart city operations?
Added value	What added value will be provided?
Methodology	How will the added value be created?

The need for an governing body that leads cooperation among industry, government, academia and residents

In both large metropolises and regional cities, resident awareness of social issues is the starting point for the smart city as a framework to solve those issues. It is important to accept these issues and, when necessary, engage in dialogue with residents to identify issues, or reflect these issues in municipal policies and in technologies and services provided by corporations.

The business models we summarised in this chapter assume that each smart city project will be governed by an independent organization with the cooperative involvement of industry, government, academia and residents. This governing body should be an independent organization that involves all four types of stakeholders rather than only some of them.

Strong candidates to fill this role are often area management organisations comprising developers, local businesses and municipalities that have been involved in area redevelopment and city planning. If arranging corporate participation is difficult, an organization similar to Germany's Stadtwerke (municipal utility service providers), which collaborate closely with local governments to operations local infrastructure businesses, can also be a good option.

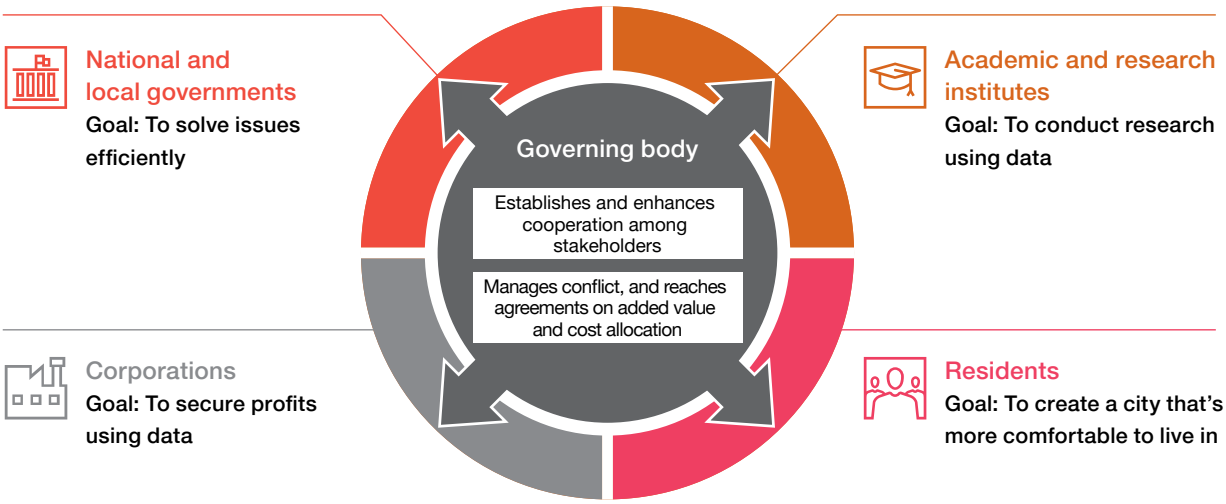
Role of a smart city's governing body

The governing body needs to play two major roles as a facilitator.

The first role is to build and enhance cooperation among the stakeholders, mainly through initiatives that use residents' opinions to identify issues facing the city as well as the ideal vision for the city. This resident participation, in a nutshell, entails various efforts including discussing the vision, sharing issues, transforming the residents' mindset and improving their IT literacy. Each of these efforts requires continuous work.

The second role is to mediate discussion among different stakeholders to achieve the shared understanding of shared value that is needed to reach agreement on the necessary costs and human resource allocation. It may be easy to secure support for the general business model of a smart city which resolves social issues and creates added value. But reaching an agreement may be more difficult when it comes to specific discussions such as cost allocation. As we explained in the example of area management organisations in office and commercial areas of large cities, the parties that bear the cost of creating the added value and the parties that reap the benefits are not always the same, and it can sometimes take time to generate added economic value. For these reasons, it can be challenging to reach a consensus. As smart city business models tend to differ from simple B2B and B2C models, the governing body must act as a buffer to bridge such gaps and promote smart city development as a comprehensive project involving various stakeholders. The operator must also play an important role in preparing a portfolios of initiatives as necessary, in order to balance initiatives that can achieve short-term results and those that will take longer to produce effects and benefits.

Figure 6.4 Roles of a smart city's governing body



Mechanisms for creating added value

Two types of added value to be achieved

With the goal of resolving social issues, a smart city can provide added value in many forms to stakeholders including the residents, local government and businesses. As we discussed in the business models for large metropolises and regional cities, there are two types of added value: increasing value and reducing costs.

'Increasing value' involves increasing economic value such as real estate value or uneconomic value such as convenience and functionality in transport, health care, welfare, and other areas that lead to a better city environment for residents and businesses.

'Reducing costs' refers to the reduction of costs for public services such as waste collection and administrative procedures. By improving municipal finances, the local government can distribute the benefits in the form of budget allocation for more important measures and better services for residents.

Although the governing body must play a role in facilitating agreement among stakeholders on added value and the relevant cost allocation, it is relatively easy to reach an understanding and agreement when it comes to measures to reduce existing costs. Therefore, focusing on cost reduction to build a smart city business model may be more effective for regional cities.

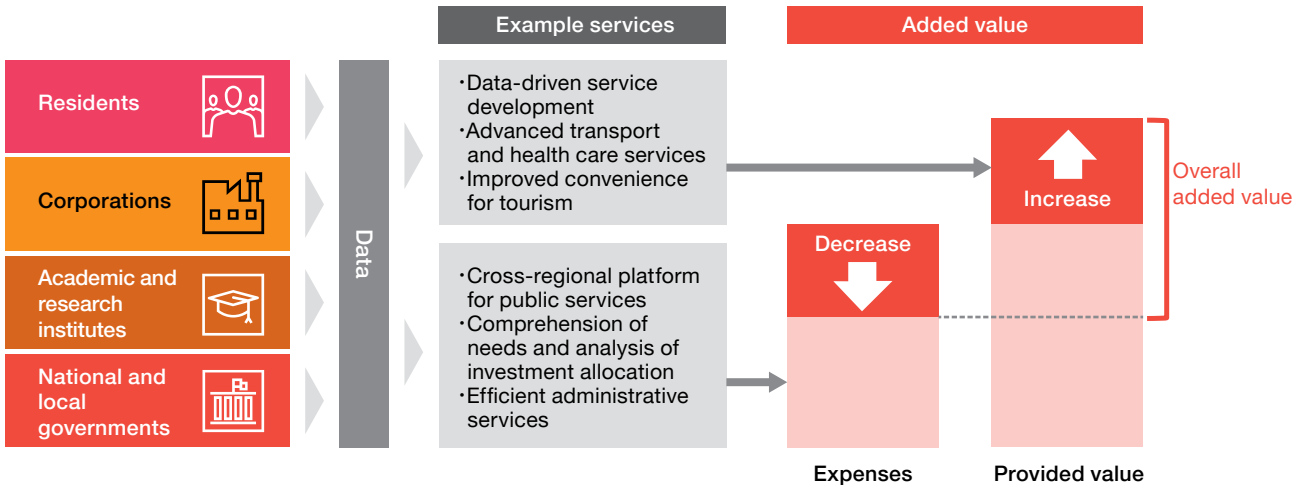
Mechanisms and methods for creating added value

Smart city initiatives differ from conventional city planning in that they aim to actively utilise various city data and new technology, for both large metropolises and regional cities.

The smart city platform we defined in this chapter requires open data provided by the local government as its foundation. However, access to diverse data held by residents and businesses is also important. To solve complex issues facing cities across multiple sectors including transportation and energy, data must be collected and mechanisms developed for its use before it is possible to create added value. The governing body that provides this platform does not necessarily provide services using the platform, but the platform must have the necessary functions and mechanisms that allow it to act as a hub for attracting new services.

As we have mentioned before, the promotion of smart city initiatives is not an easy task, and the necessary mechanisms can take a very long time to construct. For this reason, the following three elements are essential: a governing body that continues to lead the initiative, clear definitions of the value to be provided, and mechanisms for creating added value. In this report, we introduced some examples of how this might be achieved, but there is no absolute answer when it comes to the business model. Stakeholders must cooperate with each other to build a business model that is suitable for each city.

Figure 6.5 Added value to be achieved in smart cities



Conclusion

Creating mechanisms to resolve issues ahead of the rest of the world

Japan to take the lead in issue resolution

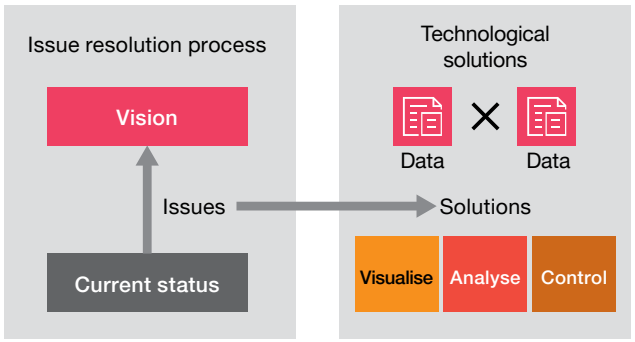
Japan is experiencing a decrease in its total population, a decrease in the proportion of working-age population, and an increase in the proportion of senior citizens, which other countries around the world are also expected to experience in the future. If these issues are not resolved, Japan's future seems grim. On the other hand, if Japan is able to establish mechanisms for solving these issues, it can send a strong message to the world. This is a significant opportunity that mirrors the history of Japan's recovery from the aftermath of WWII, when it also provided a model for other developing nations to become industrialized. It is therefore crucial for Japan to take on these issues in an active and positive way.

However, no one knows how cities will change in the future. Smart city initiatives may therefore face opposition from some residents who are worried about the future. Some stakeholders may feel that a detailed plan is necessary to obtain the understanding of all residents before taking action. However, the issues surrounding cities keep changing, and new issues may emerge while such a detailed plan is being developed. A flexible, issue resolution-centred approach and regional empowerment are therefore the two keys to success.

Smart cities with a focus on issue resolution and execution

Many cities that aim to become smart cities spend a lot of time trying to prepare a perfect plan, but then fail to execute the plan that they have created. This is often the result of using a technology-driven approach where the focus is on using the developed technology and collecting data. Technology is a tool for resolving issued, so cities must first establish a vision and identify the issues that need to be solved in order to achieve that vision.

However, the issues faced by modern society are complex, and it can be difficult to plan solutions through only deskwork. Instead, an agile approach is required: presenting a hypothesis for a solution and quickly implementing it, even if only on a small scale, with adjustments made based on feedback. Many advanced cities take this 'living laboratory' approach and actively incorporate PoCs as part of their projects. To do this, the results of the PoCs should be quickly applied to deregulation initiatives and to system design and revision.



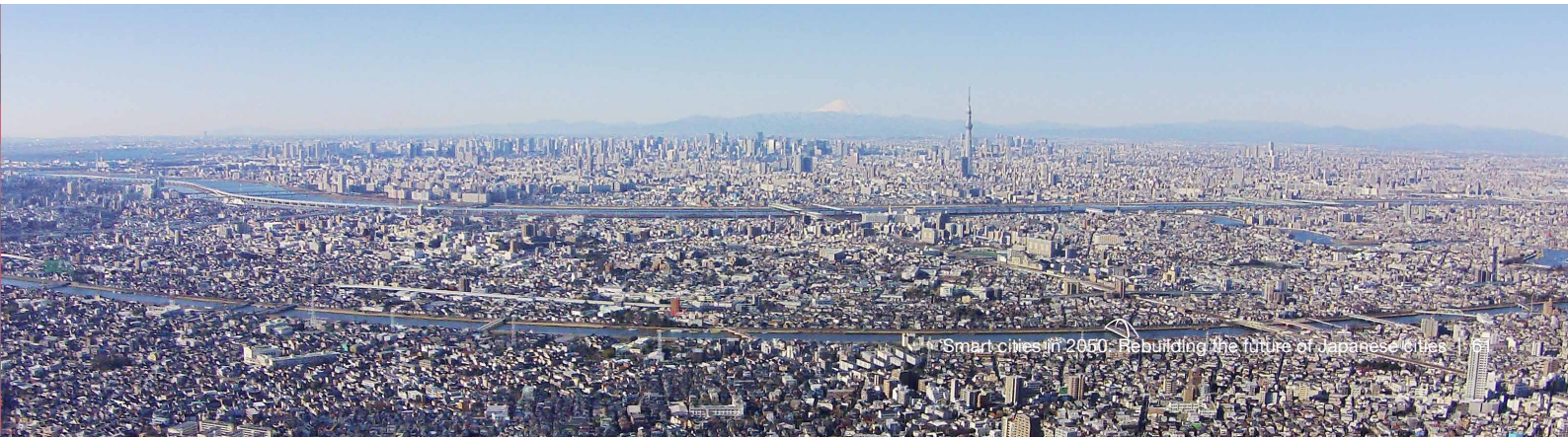
Using innovation to resolve issues in regional cities

As we stated in Chapter 1, regional cities have a large number of issues to address. However, this also means that the promotion of smart city initiatives in regional cities has significant meaning and potential. While each city has unique features, different cities also share many common problems. The resolution of these issues through smart city initiatives with the use of innovative new measures could serve as a model case for the whole of Japan.

To tackle megatrends, such as the decreasing total population and working-age population and the increasing number of senior citizens, technology must make up for shortages in talent and labour. The introduction of AI and robotics, for example, can readily lead to incentives. If the promotion of smart city initiatives can be used to develop sustainable models for regional cities, Japan may be able to become an exporter of smart city projects that offer many solutions.

Working towards a sustainable society

The goals to be achieved by smart city initiatives for regional cities and for large metropolises, and for Japanese cities and for cities elsewhere in the world, are not all the same. However, all people and regions share the common aspiration to build a safe living environment and a sustainable society. The intensification of damages caused by climate change, in particular, is causing serious changes to living environments in Japan and around the world, requiring urgent countermeasures. A smart city is not a competition to see who is the most technologically adept, but a venue for realising shared hopes and aspirations. That is why it is important now more than ever for all people and organisations to cooperate beyond their borders.



Contacts

PwC Japan Group

https://www.pwc.com/jp/en/contact.html

Author

Norio Katayama Partner
Energy & Utilities Industry Leader,
PwC Japan Group,
Smart City Solution Lead Partner,
PwC Consulting LLC

Takayuki Miyagi Partner
Public Services Industry Leader,
PwC Japan Group,
Smart City Solution Lead Partner,
(Co Lead)
PwC Consulting LLC

Akira Yasuda Director
Energy, Utilities & Mining
PwC Consulting LLC

Yoshinori Oyama Director
Customer Transformation
PwC Consulting LLC

Shuhei Iwahana Director
Technology
PwC Consulting LLC

Ryo Ishii Director
Capital Project & Infrastructure
PwC Advisory LLC

Liu Qian Senior Manager
Energy, Utilities & Mining
PwC Consulting LLC

Akira Naito Senior Manager
Energy, Utilities & Mining
PwC Consulting LLC

Katsumi Ito Manager
Energy, Utilities & Mining
PwC Consulting LLC

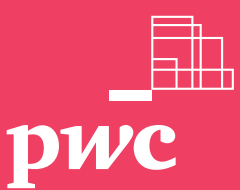
Katsumi Masaoka Manager
Energy, Utilities & Mining
PwC Consulting LLC

Shoichiro Noda Manager
Customer Transformation
PwC Consulting LLC

Takayasu Yano Associate
Energy, Utilities & Mining
PwC Consulting LLC

www.pwc.com/jp/en

PwC Japan Group represents the member firms of the PwC global network in Japan and their subsidiaries (including PricewaterhouseCoopers Aarata LLC, PricewaterhouseCoopers Kyoto, PwC Consulting LLC, PwC Advisory LLC, PwC Tax Japan, PwC Legal Japan). Each firm of PwC Japan Group undertakes its business as an independent and separate corporate entity.
To address complex and diversified business challenges, PwC Japan Group consolidates expertise of assurance, consulting, deal advisory, tax and legal services as well as enhances its structure in order to cooperate organically. As a professional service network with a total number of about 9,000 partners and staff, PwC Japan Group provides quality client services to meet their needs and expectations.
At PwC, our purpose is to build trust in society and solve important problems. We're a network of firms in 155 countries with more than 284,000 people who are committed to delivering quality in assurance, advisory and tax services. Find out more and tell us what matters to you by visiting us at www.pwc.com



PDF of this report is available here. www.pwc.com/jp/en/japan-knowledge/thoughtleadership.html
Published: May 2021 Control No: I202011-03