Measuring smart city performance in COVID-19 times: Lessons from Korea and OECD countries

Proceedings from the 2nd OECD Roundtable on Smart Cities and Inclusive Growth

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At a time when many cities and countries are including a smart recovery component in their strategies to rebound from the COVID-19 crisis, the simple presence of digital technologies does not mean that benefits automatically reach everyone. Measuring smart city performance is therefore critical in order to deliver policies with greater efficiency and effectiveness, identify cost-effective solutions to deliver public services, improve government accountability vis-à-vis citizens and track progress and impact. The proposed OECD Smart City Measurement Framework encompasses not only the uptake of digitalisation in cities but also how digital innovation can improve well-being outcomes, inclusion, sustainability and resilience. Furthermore, it focuses on urban residents both as recipients or users and as designers of smart cities. Building on the 2nd OECD Roundtable on Smart Cities and Inclusive Growth, the OECD will now begin to operationalise and further develop the OECD Smart City Measurement Framework.

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This paper was authorised for publication by Lamia Kamal-Chaoui, Director, Centre for Entrepreneurship, SMEs, Regions and Cities, OECD.

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Executive summary

Cities around the world are shaping their way out of the COVID-19 crisis to emerge smarter, more sustainable and more inclusive. Many cities have joined the "smart city wave" over the past two decades, and, as analysed in the OECD report on Cities Policy Responses to Coronavirus (COVID-19), many others have joined in the wake of the pandemic, with digitalisation taking centre stage in recovery strategies. Digital technologies have been critical. They have made it possible to relay real-time life-saving information, maintain the delivery of essential public services (such as healthcare through telemedicine) and bridge social isolation. With countries grappling with repeated episodes of lockdown at different scales and physical distancing requirements reshaping urban environments, many cities are expanding, accelerating and mainstreaming the use of smart city innovations. In the longer term, the capacity to leverage the benefits of digital innovation for all will be critical to help cities rebound from the crisis and accelerate the transition to a new urban paradigm for a more sustainable and resilient future.

This policy paper highlights the importance of better measures of the outcomes of smart city investments, draws lessons from existing indicator frameworks on smart cities in Korea and around the world, and identifies ways forward to shape an OECD Smart City Measurement Framework.

Key messages

- At a time when many cities and countries are including a smart recovery component in their strategies to rebound from the COVID-19 crisis, the simple presence of digital technologies does not mean that benefits automatically reach everyone. Impacts of digital innovation are also difficult to isolate, as technologies are evolving rapidly over time and digital transformation coincides with many other economic and social changes that affect well-being, inclusion, sustainability and resilience.
- Measuring smart city performance is even more critical in order to deliver policies with greater efficiency and effectiveness, identify cost-effective solutions to deliver public services, improve government accountability vis-à-vis citizens and track progress and impact.
- Several institutions, countries and cities have developed their own indicators to assess smart city performance. However, the approaches differ widely, covering different indicators (ranging from inputs, outputs and outcomes) and different dimensions of urban development (encompassing a variety of economic, environmental, social and governance dimensions). In addition, many focus on measuring the degree of digitalisation in cities but not the impact of digitalisation, particularly on key outcomes such as well-being and inclusion.
- A comprehensive and internationally comparable measurement framework is needed to allow cities to measure and improve their own performance over time but also to allow them to compare their performance over space, i.e. against each other.
- But the framework also needs to recognise different city contexts (e.g. in terms of size, culture, etc.) and the various degrees of "smartness" as starting points. It also needs to be flexible and adaptable, as technologies evolve constantly.

- Equally, the framework needs to be applicable and relevant to both national and local levels of government. While many early smart city initiatives have been powered by cities themselves, national leadership can provide a blueprint for effective national policy on smart cities, as illustrated by the experiences from Korea, Japan and Sweden.
- The proposed OECD Smart City Measurement Framework embodies these principles whilst also focusing on urban residents not only as recipients or users of smart cities but also as designers of smart cities, and encompassing, not only, uptake of digitalisation in cities but also how digital innovation can improve well-being outcomes, inclusion, sustainability and resilience.
- The three pillars (smart city dimensions, stakeholder engagement, and smart city performance) of the Framework received strong support from Roundtable participants, who welcomed in particular the importance of:
  - A comprehensive, multi-dimensional framework that can help serve national and local strategic priorities, as well as global sustainable development objectives.
  - The distinction between inputs (i.e. what "goes into" a smart city) and outcomes in terms of well-being, inclusion, sustainability and resilience.
  - Stakeholder engagement.

Next steps

- Building on the Roundtable, the OECD will now begin to operationalise and further develop the OECD Smart City Measurement Framework by:
  - Determining the scope and range of specific indicators for each pillar;
  - Identifying the optimum and appropriate scale of analysis (e.g. municipality or functional urban area, FUA);
  - Identifying sources of data, including through potential new surveys and other tools; and
  - Collecting and disseminating data to allow cities, local and national governments to track and compare performance.
- Core principles that will govern the implementation of the framework include:
  - Recognising that not all cities are starting with the same resources, framework conditions, or capacities; some differentiation is therefore needed within the framework to allow for comparisons across similar cities as well as all cities.
  - Engaging with all stakeholders to fill data gaps. There are differences in data availability across cities, and local, national and international data initiatives can help fill data gaps.
  - Ensuring data privacy and accessibility. Smart city measurement needs to protect data privacy, which the OECD through its work on data governance, privacy and digital security, can help to ensure.

1 Analytical overview of indicator frameworks for smart cities performance

Revisiting smart cities in light of the COVID-19 crisis

The OECD defines smart cities as "cities that leverage digitalisation and engage stakeholders to improve people's well-being and build more inclusive, sustainable and resilient societies" (OECD, 2020[1]). This definition underlines that digitalisation and digital innovation are not an end in itself, but rather aim to improve people's lives to achieve greater inclusion, sustainability and resilience. By seizing the opportunities offered by the digital transition, including those coming from artificial intelligence, cloud computing and Big Data, smart cities can improve the lives of millions of urban residents, especially considering the COVID-19 emergency responses and the recovery phase.

Cities have played a major role in battling the COVID-19 crisis, and digital technologies at the city level have been essential in this endeavour. Among the major challenges that the pandemic has unveiled, many revolve around public health infrastructure and managing public health data, as well as logistical challenges related to the global supply chain. Artificial Intelligence (AI), Internet of Things (IoT), Big Data and other new technologies have come to the fore in the fight against the pandemic. Smart cities have also gained renewed traction as vehicles to achieve resilience, sustainability and inclusive growth in the long term.

Recent examples of the use of digital tools in cities in response to the COVID-19 crisis have shown that many cities are going beyond the technology and supply-driven approach that used to prevail in the past and are adopting a human-centric approach to advance more sustainable urban development. The city of Bilbao (Spain), for instance, gave a positive perspective on how the current context brings opportunities in fostering more innovation to the city. Among the many examples that were analysed in the recent OECD policy note on cities' responses to the COVID-19 pandemic, several of them are particularly telling:

- **Seoul** (Korea) is pioneering driverless cars and delivery of goods through robots.
- **Tokyo** (Japan) is providing online learning and telemedicine.
- **Florence** (Italy) is aiming to provide universal access to the internet, the so-called "right to the network".
- **Montreal** (Canada) is using shared mobility to facilitate people's access to local fresh food.

The simple presence of digital technologies does not mean, however, that their benefits are automatically reaching everyone. For example, evidence shows that, during lockdown in the UK, children from wealthy families spent 30% more time on home learning than the children from poorer families. Discussions during the Roundtable highlighted that in order to identify if smart city initiatives increase the well-being of everyone, there is a critical need to measure the performance of smart cities, especially at a time when

many cities and countries are including a smart recovery component in their recovery strategies. Such measurement should be included in smart city strategies from the outset rather than as an afterthought.

Assessing smart city performance also helps ground policy intervention in solid evidence by guiding decision makers, both at national and local levels, in setting realistic targets, understanding where cities stand vis-à-vis their objectives, tracking progress and adjusting policy interventions for greater efficiency and effectiveness. In this respect, measuring smart city performance is a way to implement Principle 11 of the OECD Principles on Urban Policy, which were welcomed by mayors and ministers of urban policy across OECD countries in March 2019: "*Foster monitoring, evaluation and accountability of urban governance and policy outcomes*"[1]. Ultimately, smart city measurement enhances accountability and helps citizens monitor how governments deliver on their commitments.

Measuring smart city performance is particularly relevant in the COVID-19 context because it can help adjust policies for greater efficiency and effectiveness, find cost-effective solutions to deliver public services, improve government accountability vis-à-vis citizens and know where cities stand vis-à-vis their objectives. The example of Korea's Epidemic Investigation Support System (EISS) and its citizens' engagement process at the local level has been essential in tackling the COVID-19 crisis. This is especially important, as the COVID-19 crisis is severely hitting municipal budgets and cities need to implement cost-effective solutions to deliver public services.

Measuring the performance of smart cities is even more critical when considering the Decade of Action for the 2030 Agenda. The challenges imposed by the current crisis are threatening the global effort to achieve global agendas and the COVID-19 pandemic poses unprecedented challenges to sustainable development. The OECD's 2021 Economic Outlook highlights that the prospects for a possible exit from the crisis have increased, with encouraging news on progress toward an effective vaccine, but that the short-term prospects remain uncertain. Before the pandemic, many cities and communities were rising to the challenge and were harnessing technologies to implement the SDGs. The pandemic also brings an opportunity for cities and the communities to revamp themselves and their planned actions through a smart, green and inclusive recovery. Smart city measurement tools can therefore help cities evaluate their progress towards meeting the SDGs, particularly considering that COVID-19 recovery efforts need to be fully aligned with the targets of the SDGs.

Analysis of existing measurement initiatives of smart cities

National governments have a key role to play in smart city policies. The 2nd OECD Roundtable on Smart Cities and Inclusive Growth shed light on several countries' experiences of smart city initiatives and measurement. National leadership can overcome scattered city-led measurement frameworks and provide a blueprint for effective national policy on smart cities. For example:

- In **Korea**, smart city initiatives are seen as essential to achieving urban goals such as decreasing energy consumption and mitigating climate change. Korea's objective is to introduce a smart city certification system to assess objectively the current progress and future potential of smart cities in three key areas: urban innovation; governance and systems; and technology and infrastructure. The Smart City Index in Korea is made of a combination of quantitative and qualitative indicators (see Chapter 2). Smart cities have also been essential in tackling the COVID-19 crisis in Korea. Korea's Epidemic Investigation Support System (EISS) builds on the country's smart city data system and was originally designed to enable the sharing of urban planning information between authorities. During the COVID-19 crisis, it was used to monitor the epidemiological spread of infection, representing an innovative and flexible application of smart city technology. The importance of citizen engagement was key to its success.

[1] For further information, see https://www.oecd.org/cfe/urban-principles.htm.

- **Japan's** Smart City Indicator aims to measure smart city performance by defining indicators based on six themes: Mobility; Safety & Security; Energy & Resources; Urban Environment; Inclusive Community; and Regional Economy. Effective evaluation indicators are critically important to assess properly the performance of specific projects. For example, this is the case of the smart solutions in Tokyo Port City Takeshiba, which are measured by corresponding indicators.
- In **Sweden,** Viable Cities, the Swedish National Strategic Innovation Program for Smart and Sustainable Cities, has experience in formative evaluation of the climate transition in cities. Viable Cities is a member organisation with members from the quadruple helix (representing cities, regional authorities, national authorities, but also companies, academia and civil society organisations). At the European Viable Cities Day, which took place on 11 December 2020, the mayors of nine Swedish cities signed the first edition of the Swedish Climate City Contract. Viable Cities is in the process of developing formative evaluation frameworks, using dialogue and participation as a starting point.

These examples show that the national government can enact framework conditions and measurement initiatives to help cities both implement smart city initiatives and measure their performance. Not only does it benefit governments at the local level in their efforts to build inclusive and sustainable smart cities, but also national smart city technologies can also help confront crises and emergencies, as can be seen in Korea's case.

Many institutions (such as the International Telecommunication Union (ITU)) and sometimes cities themselves (such as Vienna) have worked on measuring smart cities' performance and have used a variety of frameworks (OECD, 2020[1]). Analysis of existing measurement frameworks, including those presented during the Roundtable, shows that:

- **Measurement frameworks tend to use a large number of indicators.** A recent literature review of smart city indicators identifies as many as 1 152 different smart city indicators (Petrova-Antonova and Ilieva, 2018[2]). For example, the indicator framework for sustainable, resilient and smart cities, called "Sustainable development in communities – indicators for smart cities" developed by the International Organisation for Standardisation (ISO) has 85 indicators. Another example lies in the 91 Key Performance Indicators (KPIs) for Smart Sustainable Cities (SSC), developed by the United for Smart Sustainable Cities (U4SSC), a UN initiative co-ordinated by ITU (International Telecommunication Union), UNECE (United Nations Economic Commission for Europe) and UN Habitat. CITYKeys has also developed a measurement framework on the performance of smart cities targeted at European cities that includes 75 indicators. According to ITU, a tailored framework of indicators could allow cities to benchmark with other cities with the same scale, or with the same challenges and opportunities.
- **Smart city indicators often cover many different dimensions.** For example, Petrova-Antonova and Ilieva (2018[2]) classify the 1 152 indicators that they identified into six main categories: nature, governance, economy, mobility, people and living. In their analysis of six internationally applicable standardised frameworks of smart cities, Huovila, Bosch and Airaksinen (2019[3]) list the following dimensions: natural environment, built environment, water and waste, transport, energy, economy, education, culture, innovation and science, health, well-being and safety, governance and citizen engagement, and ICT. The ISO indicator framework for smart cities has 19 dimensions, including economic, environmental and social dimensions (ISO, 2019[4]). The KPIs for SSC developed by U4SSC (2020[5]) cover three dimensions – economy, environment, and society and culture – and each of these dimensions is broken down into sub-dimensions. The CITYKeys (2015[6]) framework is broken down into five dimensions: people, planet, prosperity, governance and scalability/replicability. As pointed out during the discussions on the Roundtable, many of these dimensions are ultimately interested in the impact of technologies, not in their use *per se*.

- **Measurement frameworks also differ in the type of indicators that they use.** Some frameworks measure the *inputs* related to smart cities, i.e. the amount of resources that are allocated to smart cities. Some others assess the *outputs* of smart cities, which evaluate progress in implementing smart city solutions, for example via the percentage of households equipped with smart electricity metres. Others measure the *outcomes* of smart cities, i.e. the impact of smart city solutions on achieving smart city objectives. For example, the ISO indicator framework focuses on smart enabling technologies, while the KPIs for SSC include both output and outcome indicators. CITYKeys' indicators are mostly outcome indicators, i.e. they measure progress towards policy objectives such as CO_2 emissions per capita per year or the percentage of population living in affordable housing. As reflected during the Roundtable, there are a number of different types of indicators and it is not necessarily clear what types of measures are most useful to cities. The challenge of creating a measurement framework is that chosen indicators need to reflect cities' specific aspirations.
- **The reach of measurement frameworks varies in practice**, particularly in terms of geographic focus, scale of analysis, main target audience (city authorities, smart city developers or investors), and if and how any evaluation is carried out. For example, while CITYKeys' framework focuses on European cities, ISO's and U4SSC's frameworks aim at reaching cities globally. Many frameworks provide self-assessment tools, such as the U4SSC KPIs, CITYKeys and the ISO standards, together with recommendations for their implementation. The City of Vienna (Austria), for instance, has developed its own measurement framework. The Smart City Vienna Framework Strategy's measurement framework presented during the Roundtable captures the city's progress through quantitative and qualitative data. In order to foster partnership with various stakeholders and to mobilise citizens, the city has also developed a platform to share results.

The analysis of some existing measurement frameworks on smart cities demonstrates the variety of approaches to assess the performance of smart cities. It also suggests the many complexities faced when attempting to gauge the performance of smart cities (OECD, 2020[1]). For example, such complexities are related to:

- **Measuring the performance of smart cities *per se***: Some indicators measure the *degree* of digitalisation in cities, but not the *impact* of digitalisation. Other indicators measure the performance of cities against broad policy objectives that are not necessarily linked to smart city initiatives. Furthermore, it is difficult to assess the link between digitalisation and its impacts on the various dimensions of well-being. For example, some frameworks measure the percentage of households that are equipped with smart energy meters, and other frameworks measure energy consumption per capita, but evidence of the impact of smart meters on energy consumption at the city level remains scarce.
- **Reflecting all dimensions of smart cities' objectives:** Some indicators measure certain dimensions of quality of life (e.g. environmental, economic, social), but they are often incomplete and miss other key aspects such as *inclusion*.
- **Capturing stakeholders' engagement:** Most frameworks or indicators do not consider the degree of *stakeholders' involvement* (e.g. governments, civil society, private sector, academia, etc.) in the design of smart cities. Putting people at the centre of smart cities means co-constructing policies with residents throughout the policy cycle, but this dimension is often omitted in their measurement.
- **Building frameworks that all levels of governments can use:** It is a challenge to shape fully harmonised smart city measurement frameworks that both national and local governments can deploy to measure the performance of smart cities.
- **Comparing cities among themselves:** The lack of harmonised territorial units of analysis often limits international comparability across cities, which in turn constrains the potential for peer-to-peer learning, monitoring progress and partnerships. It is important for cities to be able to

benchmark themselves, considering their geographical location, history and cultural, social and economic environment.

Advancing the measurement of smart city performance calls for a comprehensive, multi-dimensional and flexible framework that serves local and national strategic priorities, as well as global sustainable development objectives. The OECD Smart City Measurement Framework that was presented during the Roundtable endeavours to respond to fundamental questions such as what to measure and how, and for whom the framework is intended. In particular, it aims to encompass not only the degree of digitalisation in cities, but also the level of stakeholders' engagement, and how both contribute to improving the well-being of all urban residents and building inclusive, resilient and sustainable cities. The measurement framework needs to serve as a tool to guide local and national governments in their efforts to reshape city governance, business models and stakeholder engagement through digital innovation (for more details on the proposed OECD Smart City Measurement Framework, see Chapter 3).

The next chapter puts the spotlight on the practices for smart city performance measurement in the specific case of Korea. It discusses the evolution of Korea's smart city indicator framework over time and recent policy changes for better measurement of smart cities' performance.

2 Spotlight on smart city performance measurement practices in Korea

Korea's smart city policy

Since the early 2000s, Korea has implemented various smart cities pilot projects and has laid the foundation to develop technologies and infrastructure by establishing a legal framework for smart cities. Three periods can be distinguished in Korean smart city policies: (i) the construction stage (2003-2013); (ii) the connecting stage (2014-2016), focusing on connecting smart city services and building governance structure; and (iii) the enhancement stage (2017-2020), during which the government is putting emphasis on innovative smart cities and creating a smart city ecology (KRIHS, 2018[7]) (Table 2.1).

Table 2.1. Characteristics of smart cities in Korea, by stage

	Construction stage (2003-2013)	Connecting stage (2014-2016)	Enhancement stage (2017-)
Goal	To create new growth engine by combining ICT with construction industry	To provide high quality service by integrating existing infrastructure and service	To solve urban problems and create innovative jobs
Information	Vertical information integration	Horizontal information integration	Cloud based information integration
Platform	Closed platform	Public platform (open to relevant organisations)	Open platform (open to private sectors)
Legal framework	Law of Ubiquitous City Construction	Law of Ubiquitous City Construction	Law for Smart City Creation and Promotion of Industries
Main agents	Ministry of Land, Infrastructure, and Transport	Ministry of Land, Infrastructure, and Transport; Ministry of Science and ICT; Ministry of Trade, Industry and Energy	Smart city governance
Target	New towns	New towns, existing cities	New towns, existing cities, declining cities
Projects	Integrated Operation Control Center(IOCC), physical infrastructure	Smart city platform, service integration	National smart city pilot projects, Smart city platform, smart city R&D, smart city challenge(for existing cities), smart urban regeneration (for declining cities)
Resource	Profits from Residential district development projects	Government budget	Government budget, resource from private sectors

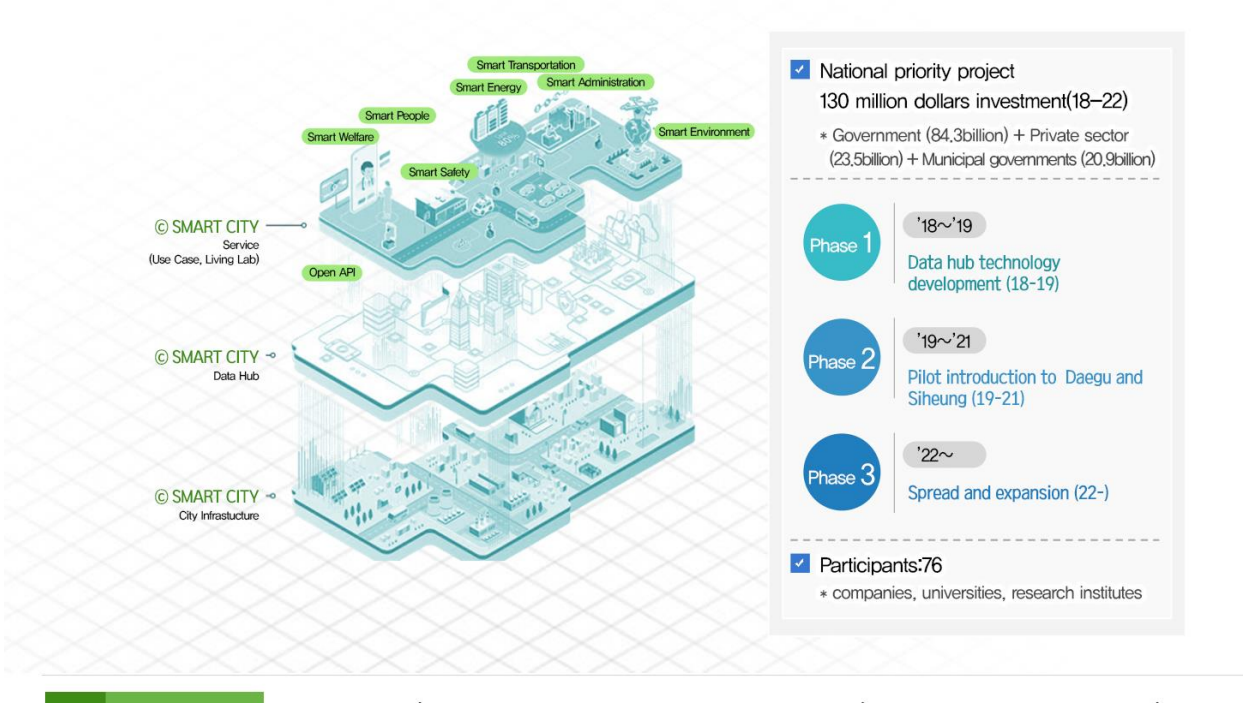
Source: KRIHS (2018[7]), *A Study on Strategic Response to Smart City*, KRIHS, Sejong.

Korea's smart city initiative adopted a top-down approach, mainly led by the public sector through both the central and local governments. Korea established an information platform called the Integrated Operation Control Center (IOCC) encompassing all urban infrastructure. As the existing investment strategy faced

limitations when the new town developments came to a halt in the mid-2010s, the Korean government actively promoted information and system integration projects to maximise the utilisation of established infrastructure. Korea also established a new smart city act (July 2017), a national smart cities strategy (January 2018), and the 3rd Comprehensive Plan (June 2019). Through these national strategic moves, Korea expanded the scope of smart city projects from new towns to existing cities and declining areas, and from the construction phase to maintenance and management phases. The government is now working on promoting more participation from businesses and citizens in smart city projects.

As a result, Korea set up a three-layer smart city model around Infrastructure, Data Hub, and Service (Figure 2.1). This model has been applied via two national pilot projects in the cities of Sejong and Busan, 125 smart challenges in 25 cities, 6 smart urban regenerations projects, and 79 integrated platforms. This model enables systematic pilot testing of various innovative solutions such as the Epidemic Investigation Support System (EISS) and smart parking. It also facilitates the use of smart city infrastructure and data by private sector partners.

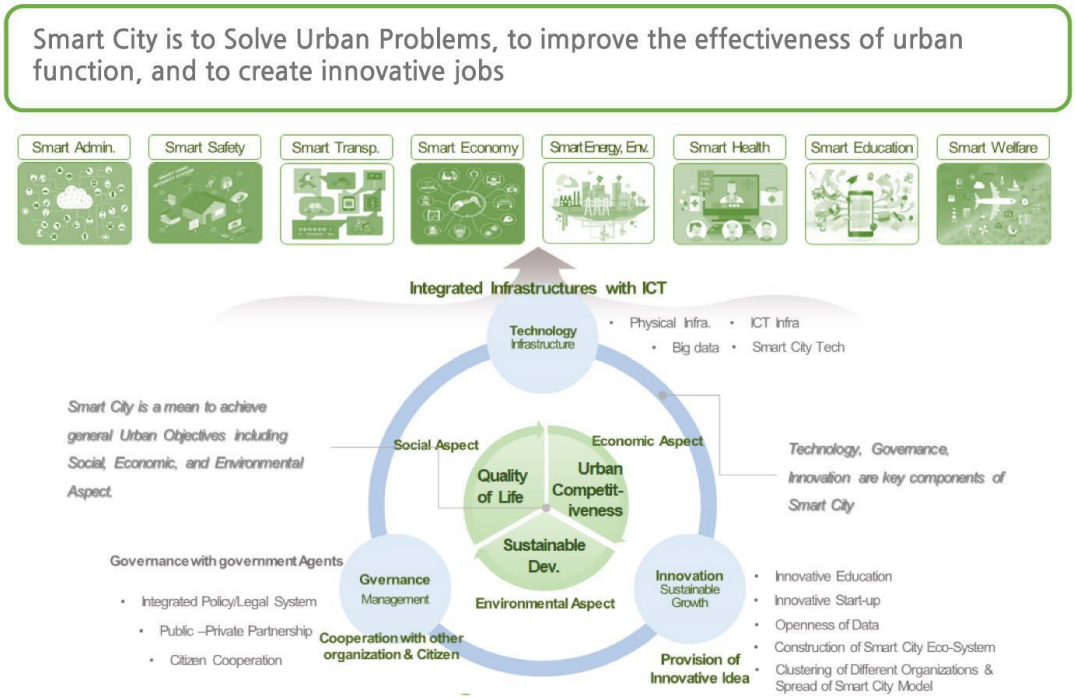
Figure 2.1. Three-layer smart city model in Korea



Source: MOLIT (2019[8]), *Smart city brochure*, https://smartcity.go.kr/wp-content/uploads/2019/08/Smart-city-broschureENGLISH.pdf.

Korea's new smart city concept is very similar in its goals and structure to the OECD's smart city definition presented in Chapter 1 (Box 2.1) and has broadened its scope over time (Box 2.2). KRIHS defined smart cities as “environmentally sustainable cities which improve people's quality of life, urban competitiveness by applying information and communication technology and eco-friendly technology to urban spaces to improve the efficiency of urban functions such as administration, transportation, and logistics, crime prevention and disaster prevention, energy and environment, water management, housing, welfare, etc.” (Figure 2.2). While both definitions from KRIHS and the OECD share well-being and sustainability goals, the main difference is that the OECD emphasises inclusion and resilience, whereas KRIHS emphasises urban competitiveness. The OECD also includes stakeholders' engagement in addition to the level of digitalisation.

Figure 2.2. Korea's smart city concept



Source: Lee and Chang (2019[9]), *The Evolution of Smart City Policy in Korea, Smart City Emergence*.

Box 2.1. Definitions of smart cities by the OECD and the Korean Research Institute for Human Settlements (KRIHS)

OECD (2020[1])

"Cities that leverage digitalisation and engage stakeholders to improve people's well-being and build more inclusive, sustainable and resilient societies."

KRIHS (2016[10])

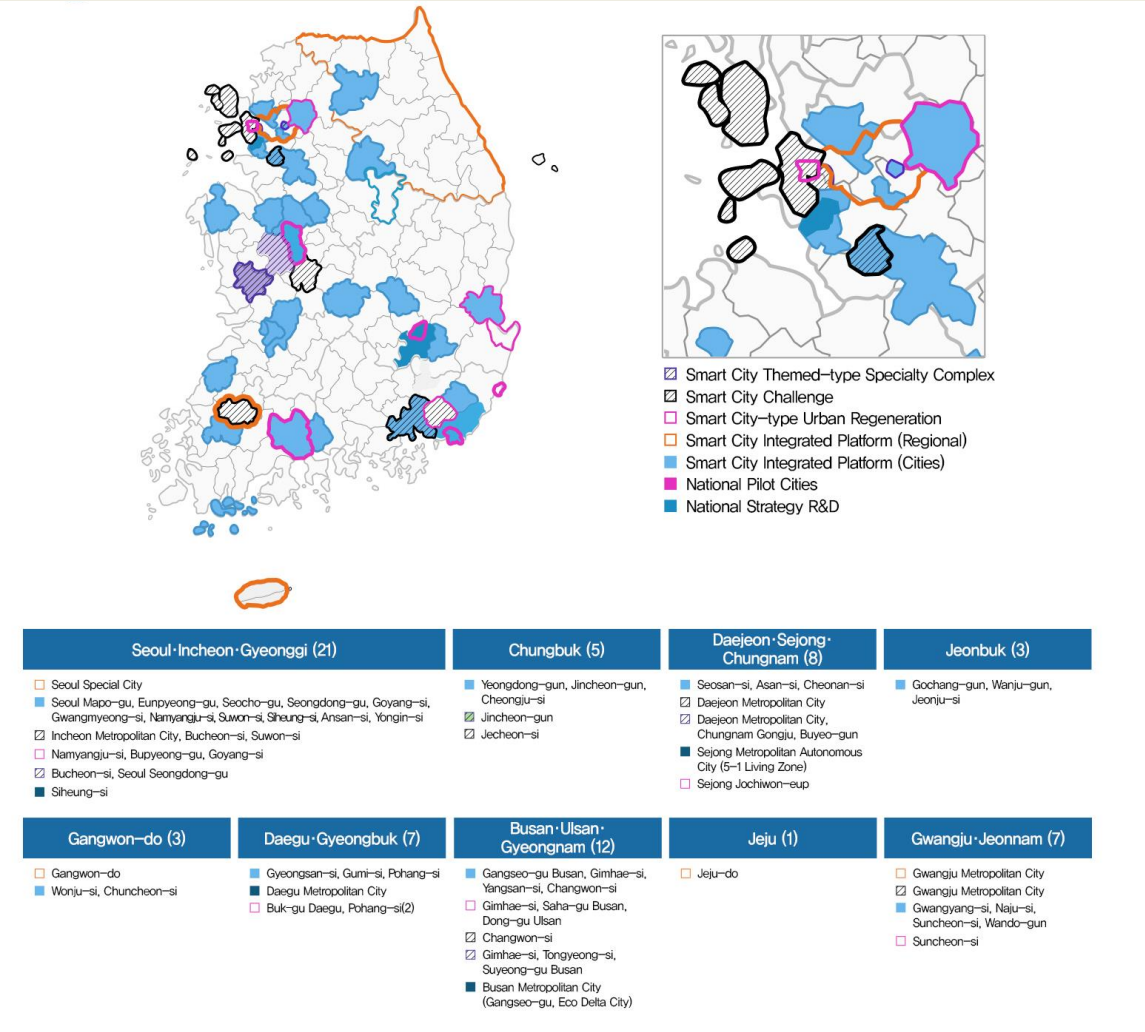
"Environmentally sustainable cities which improve people's quality of life, urban competitiveness by applying information and communication technology and eco-friendly technology to urban spaces to improve the efficiency of urban functions such as administration, transportation and logistics, crime prevention and disaster prevention, energy and environment, water management, housing, welfare, etc."

Box 2.2. Smart cities in Korea at a glance

According to Korea's 3rd Smart City Comprehensive Plan, 78 local governments (17 metropolitan governments and 61 local governments) out of 162 local governments across the country have created dedicated organisations such as smart cities divisions or teams, and this number is increasing rapidly (10 in 2014, 34 in 2018, 78 in 2019). Following the government's various policies and efforts to create and spread smart cities, 67 local governments are currently carrying out smart city government-supported projects.

The scope of smart city services has also increasingly diversified. In 2014, the two top sectors, crime and disaster prevention (35%) and transport (32%), accounted for 67% of smart city services, whereas in October 2018, smart city services covered a range of sectors, from crime prevention (24%) to traffic (22%), administration (15%), environment and energy and water resources (15%), and health and welfare (7%). The type of business is also increasingly shifting from building infrastructures to providing innovative spaces linked to creating new industries and building data-driven platforms (KRIHS, 2018[7]).

Status of smart city projects by local governments in Korea



Source: MOLIT (2019[8]), *Smart city brochure,* https://smartcity.go.kr/wp-content/uploads/2019/08/Smart-city-broschureENGLISH.pdf.

Evolution of the smart city indicator framework in Korea over time

Before the 2010s, smart cities' measurement mainly focused on the performance of individual smart city projects set by local governments. It was therefore difficult to grasp the status of smart city projects conducted by various ministries, including the Ministry of Land, Infrastructure and Transportation (MOLIT), the Ministry of Commerce, Industry and Energy (MOCIE), and the Ministry of Future (MOF), let alone the performance of these projects. Despite significant government investment, it is also estimated that Korean smart cities projects were undervalued internationally due to the lack of comprehensive objective data (Jang, Lim and Lee, 2015[11]). As a result, it became clear that there was a need for smart city standardisation and certification through comparative analysis of smart city infrastructure and service delivery levels. At the same time, some local governments in Korea participated recently in international evaluations such as the Asia-Pacific Smart City Awards and the Barcelona World Smart City Awards, and were recognised for their strong performance (Table 2.2).

Table 2.2. International awards and standard certification of Korean smart cities

Year	Awards or certification
2017	IDC Public Safety (Daejeon, 119 Rescue), IDC Urban administration (Incheon, IOCC)
2018	IDC Civil Participation (Daegu, AI civil complaint chatbot), Barcelona SCEWC (Busan, Transportation)
2019	IDC Public Administration (Daegu, Utility lines management System), IDC Smart Water (Busan, Eco-delta smart city), Barcelona SCEWC (Seoul, Data-driven smart city/ Jinju, platform city)
2020	ISO 37106 (Daegu, Sejong, Goyang, Whaseong)

Sources: MOLIT (2019[12]), *3rd Smart City Comprehensive Plan,* https://smartcity.go.kr/en.

In the 2010s, the Korean government and private sector attempted to develop smart city measurement frameworks. In particular, the U-City R&D team (2013-2018) promoted the development of indicators to measure U-City components such as policies, services, and infrastructure presented by the U-City Act based on U-City features such as effectiveness, sustainability, and connectivity. This framework was composed of quantitative measurement indicators, so that local governments could directly evaluate whether U-City projects were being carried out properly. However, due to the limited scope of the U-City Act, the framework could not encompass all the relevant aspects of smart cities (Lee et al., 2016[10]). Following the revision of the Smart City Act, the related contents were absorbed into the measurement framework of the Smart City Certification System.

In the private sector, the Korea Ubiquitous City Association developed a demo trial of U-city certification in 2014. The U-city certification aimed to diagnose the status and results of ongoing and completed ubiquitous projects and to analyse their adequacy and applicability. The Korea Ubiquitous City Association carried out its assessment based on MOLIT's U-city survey data (2012) for indicators on U-city plans, infrastructure, and services (which are stated in the U-City Construction Act), as well as the operation and management of IOCCs, and the quality of life of residents. The assessment was conducted at three levels: metropolitan city level, city/county/district level, and project level. Cities that scored more than 100 points could get the certification. According to the results, Seongnam scored 123 out of 200 points, followed by Hwaseong (121), Paju (117), Wonju (117), Yongin (108), and Suwon (105). However, this certification system remained at the trial stage and has not been implemented further since then (Lee et al., 2016[10]).

Recent initiatives for better performance measurement of smart cities in Korea

Key performance indicators in Korea's "Smart Challenge" initiative

Key performance indicators (KPIs) at the city level and service level are actively used in Korea's smart city challenge projects. Korea's "Smart Challenge" is an initiative that reflects the main characteristics of the US Smart City Challenge and the European Horizon 2020 programme. It is currently promoted in 2021 and is subdivided into four types ("City Challenge", "Town Challenge", "Campus Challenge", and "Smart Solution Spread Project"). Due to the nature of the smart challenge initiative, which aims to solve urban problems with innovative ideas through public-private co-operation, it is thoroughly implemented as competition-based through step-by-step support from preliminary projects to main projects, and outcome indicators are actively used to measure service performance. Since 2019, 125 projects have been conducted in 25 local governments.

Table 2.3. KPIs in Korea's smart challenge projects: examples of City Challenge projects

Cities	Participating companies	Contents	KPIs
Daejeon	LG CNS, KT, 10 companies	Smart parking, fire surveillance and related services	parking lot utilization rate, reduced traffic, parking revenue, user satisfaction, paid subscriber ratio, reduced fire alarm, ratio of responses in 2 minutes, real time monitoring ratio
Incheon	Hyundai motor, 3 companies	Demand-responsive transportation demonstration	public transport share, satisfaction, intermodality, # of subscribers, # of local partners
Bucheon	KE KDN, 10 companies	e-mobility & smart parking	reduced traffic flow, employment, parking lot supply/demand ratio, illegal parking, citizen satisfaction, shared parking spaces per day, new village enterprises

Source: www.smartcity.go.kr.

Development and implementation of a smart city certification framework

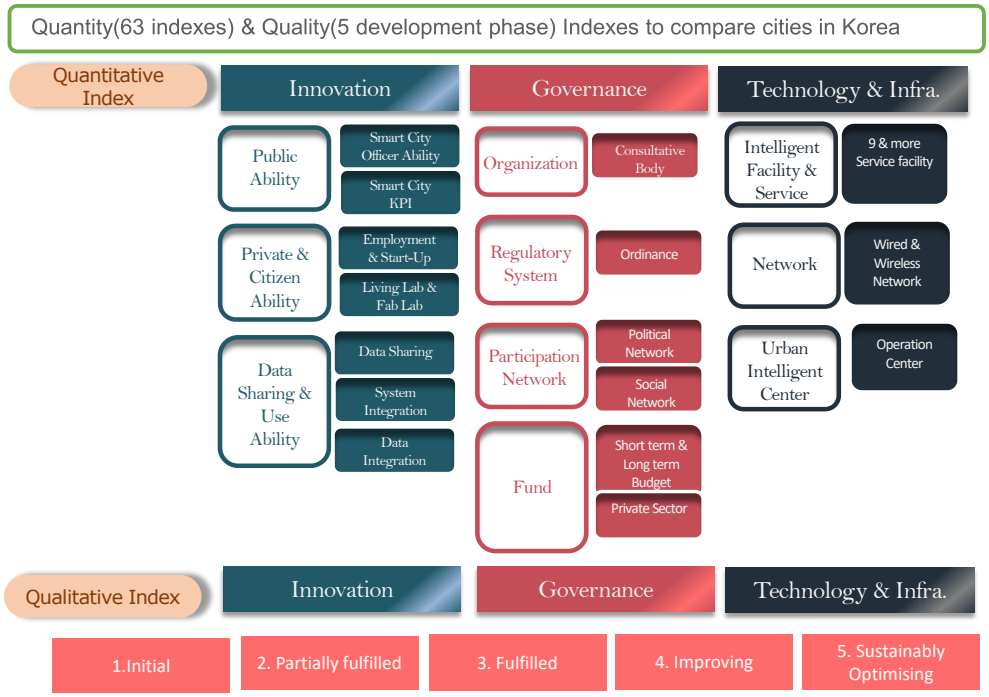
The Korean Research Institute for Human Settlements (KRIHS) promoted the development of an objective smart city diagnostic model. According to Lee (2016[10]), the objectives of the measurement were to:

- **Measure smart cities in line with the new definition in the revised Smart City Act:** The framework should encompass governance, service delivery, and participation from citizens and businesses besides infrastructure, in line with the expanded scope of smart city projects (from new towns to existing cities, and from establishing infrastructure to operation and management).
- **Diagnose the level of smart city development:** Both the current level of smart cities and potential for future development should be measured and compared between cities.
- **Provide evidence to support resource allocation through comparisons between cities, and provide information to the policy-making process**
- **Use objective measurement results in smart city promotion both domestically and abroad:** The framework should be at least partially in line with the main directions on standardisation as discussed internationally (e.g. via ISO)

The government also prepared a legal basis for certification in the Law for Smart City Creation and Promotion of Industries, which expanded and reorganised the previous U-City Act in September 2017.

Along with legal revisions, the Korean government is planning to introduce a smart city certification system to promote actively smart city best practices starting from 2021. The expectation is that if the extent and the potential of smart cities can be objectively identified and analysed through a certification system, resources can be allocated in a more efficient way throughout the policy-making process, and the results from the evaluation can be used to disseminate successful smart city initiatives. In the process of preparing the certification system, the concept of smart city was re-visited by analysing international trends in smart city promotion, for example in the EU and the US. As a result, KRIHS carefully reviewed 400 indicators of 16 major domestic and foreign measurement frameworks and narrowed them down to 233 indicators, by applying seven principles to guide its selection of indicators: policy representativeness, appropriateness, specificity, measurability, timeliness, comparability. The approach focused on indicators that are comparable, achievable, annually obtainable, and continuously monitors local smart cities' development. As a result, KRIHS selected 63 quantitative indicators in three categories (innovation; governance; technology and infrastructure) and added five qualitative levels of evaluation (initial, partially fulfilled, fulfilled, improving, and sustainably optimising) (Figure 2.3).

Figure 2.3. Smart city indicators chosen by KRIHS



Source: Lee (2020[13]) *Presentation to 2nd OECD Roundtable on Smart Cities and Inclusive Growth* (December 2020).

Based on these indicators, KRIHS conducted a survey on the status of smart city services and solutions of 14 local governments, including Seoul, Busan, Osan, Gimhae, Daegu, Bucheon, Hwaseong, Gimpo, Wonju, Anyang, and Paju (July 2017), and obtained some meaningful results (Han et al., 2018[14]):

- There was no significant difference in the policy sectors promoted by each local government. Most of them prioritised crime and disaster prevention, and transportation.
- There was a clear difference between newly created local governments and local governments that have long promoted smart cities in the number of services and solutions, organisational structure, and integration between urban response solutions, etc.

- However, new local governments excelled in providing services combining infrastructure, citizens' participation, and public data platforms, and they could learn from the experience of other local governments.
- Besides, public-private partnerships were incomplete in most cases.

Finally, the “innovation” category is gaining traction to create a smart city industry ecosystem. Although local governments gradually recognise the importance of public capacity, information use and data, private sector capabilities are still weak. Korea also needs to lay the foundation for promoting smart cities from a consumer perspective, following the example of other approaches that value reflecting private sector ideas such as Living Labs.

In 2019, KRIHS has carried out a trial certification of smart cities by test-certifying 10 local governments (Koyang, Gimhae, Daegu, Daejeon, Bucheon, Seoul, Sejong, Suwon, Ulsan, Changwon), and the government will roll out the nation-wide smart city certification system in 2021, with plans to continuously monitor and upgrade it.

Lessons from the Korean smart city measurement framework

Korea’s smart city certification system aims to objectively assess the current progress and future potential of smart cities in the three areas of urban innovation, governance and systems, and technology and infrastructure. The strength of this approach lies in the extensive and systematic analysis of domestic and international experiences, reviewing more than 400 indicators. This framework offers a solid basis for policymakers to identify areas where policy capabilities should be concentrated through objective measurement results (Han et al., 2018[14]). It also allows for diagnosis of best practices and benchmarking of smart city practices. Local governments that receive the certification can save time and efforts for other certification processes for international standards, such as ISO, because the Korean certification framework partially shares indicators and qualitative evaluation phases with such international certification processes.

At the same time, the Korean approach is still process-centred and oriented towards physical facilities. More could be done to better reflect specific local characteristics (such as population size) and improve compatibility with other standards and evaluations (Jang and Kim, 2020[15]). The Korean government should also pursue its efforts to establish a sustainable certification system by encouraging local governments to participate and improve smart cities' overall performance by actively reflecting the certification results in the national smart city policy.

3 Towards an OECD smart city measurement framework

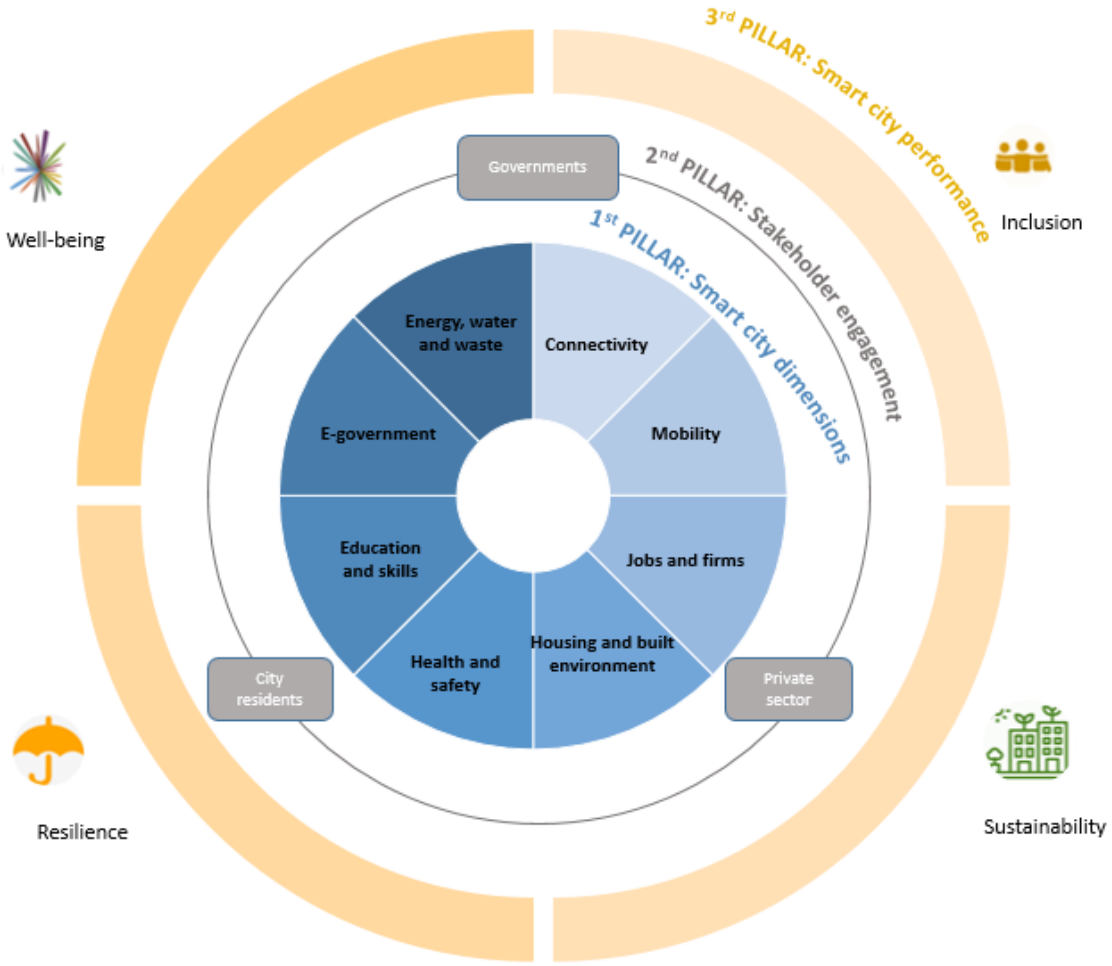
Although smart city performance is a very complex task, an ideal, harmonised measurement framework for smart cities would need to (OECD, 2020[1]):

- capture the impact of digital innovation in cities on outcomes for residents across multiple sectors, i.e. measure not only inputs and outputs of smart cities (i.e. what "goes into" a smart city), but also outcomes in terms of well-being, inclusion, sustainability and resilience;
- assess whether smart city initiatives benefit everyone rather than selected population groups;
- take into account stakeholders' engagement in building smart cities;
- be usable by national and local governments alike; and
- monitor progress over time and across places in a comparable way.

With the objective to assess the extent to which smart cities leverage digitalisation, engage stakeholders and improve people's well-being and to build more inclusive, sustainable and resilient societies; the proposed OECD Smart City Measurement Framework was built around three pillars (Figure 3.1) (OECD, 2020[1]):

- **Pillar 1:** Indicators of the degree of digitalisation and digital innovation at the city level (input and output indicators)
- **Pillar 2:** Indicators of the engagement of various stakeholders in building the smart city
- **Pillar 3:** Indicators of the four core objectives of the smart city (mainly outcome indicators), namely well-being, inclusiveness, sustainability and resilience that are shaped by the smart city dimensions and stakeholder engagement (from Pillar 1 and Pillar 2).

Figure 3.1. OECD Smart City Measurement Framework



Source: OECD (2020[1]), *Measuring smart cities' performance: Do smart cities benefit everyone?*, https://www.oecd.org/cfe/cities/Smart-cities-measurement-framework-scoping.pdf.

Bringing these three pillars together, the proposed OECD Smart City Measurement focuses on people and consider urban residents not only as recipients or users of smart cities, but also as designers of smart cities; encompass not only digitalisation in cities, but also how digital innovation can improve well-being outcomes, inclusion, sustainability and resilience to address local and global urban challenges through digital innovation; enable benchmarking of cities across countries; and allow monitoring over time.

The OECD Smart City Measurement Framework and its three pillars garnered strong support from participants of the Roundtable. The three pillars are briefly outlined in the sections below, together with preliminary sets of indicators, and the main takeaways from the Roundtable's discussions for each pillar.

Pillar 1: Smart city dimensions

The first pillar of the OECD Smart City Measurement Framework addresses the first component of the definition of smart cities, i.e. **the degree of digitalisation and digital innovation implemented at the city level**. As shown in the analysis of existing measurement frameworks of smart cities (see chapter 1), a wide range of indicators already exists on the degree of digitalisation in a city, covering a variety of areas.

The first step in the definition of Pillar 1 consists in identifying the needs of urban residents and what matters most to people in cities. Digital technologies are radically transforming the way people communicate, move around in cities, work, live in their homes, get healthcare and education, vote, and consume energy and water, among many other aspects of their lives. The proposed dimensions for the classification of the indicators therefore include: connectivity; mobility; jobs and firms; built environment; health and safety; education and skills; e-government; energy, water and waste.

The second step is the selection of indicators for each of these dimensions. Importantly, these indicators can be input or output indicators of digitalisation. Table 3.1 proposes a preliminary set of possible indicators for smart city dimensions. This selection of indicators will need to be further discussed and refined, particularly regarding their availability at the city level.

Table 3.1. Suggested indicators for smart city dimensions

Dimensions	Indicators
Connectivity	% households equipped with (high-speed) internet, wireless broadband coverage; % of households who use digital apps or platforms to connect to local community
Mobility	% of smart traffic lights; % of public transport equipped with real-time information; number of users of sharing economy transportation per 100 000 population; % of public parking spaces equipped with e-payment systems
Jobs and firms	% of job seekers who have access to e-career centres; expenditure in R&D
Housing and built environment	Open-source cadastral data; digital land-use and building permits
Health and safety	% of medical appointments conducted remotely; % of population registered with public alert systems for air and water quality; % of population with online access to their unified health file; % population equipped with real-time alert systems
Education and skills	% of children who have access to e-learning platforms; number of computers, laptops, tablets, or other digital learning devices available per 1 000 primary school students; % of adults undergoing reskilling
E-government	% of city services available online; number of municipal smart stations installed per 100 000 population; % of payments to the city that are paid electronically; high-speed connectivity in the public sector
Energy, water and waste	% of households equipped with smart energy meters; % of buildings with smart electricity meters; % of smart street lights; % of households equipped with smart water meters; % drinking water under water quality monitoring by real-time water quality monitoring station; % of buildings equipped with smart waste systems

Source: OECD (2020[1]), *Measuring smart cities' performance: Do smart cities benefit everyone?*, https://www.oecd.org/cfe/cities/Smart-cities-measurement-framework-scoping.pdf.

Discussions during the Roundtable highlighted that, while this first pillar is important to understand the digital advancement of cities, digitalisation and digital innovations are not an end in itself, and participants welcomed the fact that this is only one part of the overall OECD Smart City Measurement Framework. Furthermore, there were proposals to include additional indicators in this first pillar, including indicators on public sector digital infrastructure and reskilling. Future iterations of the framework may therefore consider adding a specific dimension on digital infrastructure and capability.

Pillar 2: Stakeholder engagement for smart cities

The level of stakeholder engagement as an *input* to the process of shaping a smart city is also central to the OECD smart city definition. Key stakeholders of a smart city include the city/local government (including co-operation with all levels of government); the city's residents (including NGOs and knowledge institutions such as universities); and the private sector (firms and entrepreneurs). Stakeholder engagement and partnerships to boost civic engagement and leverage the role of the private sector in decision-making at the city level play a critical role in building smart cities. Stakeholder engagement can take place in different ways, ranging from basic communication and stakeholders' participation and feedback, to full co-production, co-delivery and co-evaluation, which implies a balanced sharing of powers among stakeholders. Digital innovation and technologies can also facilitate new forms of engagement with a broader range of urban residents and other stakeholders, and co-production throughout the policy design and implementation process (OECD, 2020[1]).

Evaluating stakeholder engagement can have several benefits (OECD, 2015[16]), notably because it can help to strengthen the accountability of decision makers by measuring whether public and institutional resources, including stakeholders' time and efforts, are properly used. It can also help to determine whether the engagement process was successful and to inventory lessons learnt to improve practice in the future. This evaluation contributes to anticipating and managing some risks and to map out the different views held by different stakeholders at the start of a process and identify potential challenges that the process may face. Table 3.2 below outlines a set of indicators that can help gauge stakeholder engagement based on previous OECD work on Stakeholder Engagement for Inclusive Water Governance (OECD, 2015[16]). Moving forward, a survey to collect data from cities could also be envisaged, considering that stakeholder engagement is often difficult to measure and compare across countries.

The Roundtable underlined the importance of stakeholder engagement as a fundamental component of smart cities and there was strong consensus that this pillar brings an innovative angle to smart city measurement. Some participants also highlighted the importance of including digital engagement in all dimensions in this pillar.

Table 3.2. Examples of indicators on stakeholder engagement

Dimension	Indicators
Inclusiveness and equity	Informed and transparent identification and selection of stakeholders to be involved in the engagement process
	Broad outreach to inform individuals and organisations
	Stakeholders' motivations and expectations have been clearly identified (e.g. survey)
	Equitable share of representation among categories of stakeholders (local, national and intermediate governments, academia and knowledge institutions, private sector, civil society, citizens
Clarity of goals, transparency and accountability	Clear understanding of the framework of the engagement process in terms of line authority, proposed timeline, targeted objectives, expected outcomes, etc.
	Development of a master schedule
	Consistent and appropriate communication between promoters of the engagement process and the stakeholders involved
	Dissemination of concise summaries of stakeholder meetings, including digitally
Capacity and information	Establishment of a website to educate stakeholders about how they can contribute
	Number of training sessions
	Summary reports are prepared using non-technical language and disseminated, including digitally

	Existence of mediation mechanisms
Efficiency and effectiveness	Regular monitoring throughout the engagement process
	Definition of performance measures to gauge the extent of stakeholder engagement
	Successful use of the inputs from the engagement process to achieve the desired outcomes agreed by stakeholders
	Fulfilment of the agreed-upon purpose of the engagement process
Institutionalisation, structuring and integration	Requirements for stakeholder engagement are in place within the organisation
	Charters and the rules of the game are clearly established
Adaptiveness	Outcomes of engagement processes cover short- and long-term issues
	Regular reassessment and establishment of new methods to address gaps where the engagement process is not meeting expectations

Source: OECD (2015[17]), *Stakeholder Engagement for Inclusive Water Governance*, https://dx.doi.org/10.1787/9789264231122-en.

Pillar 3: Smart city performance

As discussed in previous sections, the degree of digitalisation of a city does not make a city "smart" in itself. What is central to the smart city definition is how digitalisation helps achieve four core objectives, i.e. improve people's well-being and foster more inclusive, sustainable and resilient societies. However, at the city level, measuring the impact of digital innovation on well-being, inclusion, sustainability and resilience may face conceptual and practical limitations, in particular:

- Impacts of digital innovation are difficult to isolate (i.e. there is no clear counter-factual), as technologies are evolving rapidly over time and digital transformation coincides with many other economic and social changes that affect well-being, inclusion, sustainability and resilience at the same time.
- The introduction of one smart city tool can have an effect on several outcome indicators at the same time. For example, public transit apps can improve people's mobility and reduce commuting times, while also decreasing pollution if it fosters more use of public transportation modes. Smart energy meters can help optimise energy consumption, thereby decreasing greenhouse gas emissions and helping people save money on their energy bills at the same time.
- Smart city tools can have both positive and negative impacts at the same time. For example, the installation of surveillance cameras can increase safety, but may also raise privacy concerns.

Despite the difficulty of measuring the impact of digital technologies on well-being, inclusion, sustainability and resilience, evidence of the impact of smart city tools does exist, such as: telemedicine and remote patient monitoring on health outcomes; car-pooling and bike-sharing applications on air quality; smart surveillance on crime rate; water leakage smart detection on water consumption; job e-platforms on job market efficiency; real-time transport applications on commuting times, etc. (OECD, 2020[1]). The preliminary indicators suggested for smart city performance (Table 3.3) aim to reflect the four smart city objectives mentioned above, i.e. well-being, inclusion, sustainability and resilience. These indicators will determine what effect, if any, smart city initiatives in a given city have had on multiple dimensions of residents' lives.

Table 3.3. Suggested indicators for smart city performance

Smart city objectives	Dimensions	Indicators
Well-being	Jobs	Employment rate (%)
		People satisfied with their job (%)
	Income	People with enough money to cover their needs (%)
	Housing	Overcrowding conditions (rooms per inhabitant)
		People satisfied with affordability of housing (%)
	Access to services	Performance of public transport network (ratio between accessibility and proximity to amenities or people)
		People satisfied with public transport (%)
		Average commuting time to place of work (minutes)
	Education	People from 25 to 64 years old with at least tertiary education (%)
	Political participation and community	Voter turnout (voters in the last national election as a % of the number of persons with voting rights)
		Social connectedness
	Health	Life expectancy at birth (years)
		People declaring good or very good health (%)
	Environmental quality	Exposure to PM2.5 in µg/m³, population weighted (micrograms per cubic metre)
	Personal safety	Percentage of population that feel safe walking alone at night around the area they live
		Transport-related mortality rates (deaths per 100 000 people)
		Percentage of population that have been assaulted or mugged in the previous 12 months
	Community	People satisfied with their city (%)
		People with someone to rely on in case of need (%)
	Life satisfaction	Satisfaction with life as a whole (from 0 to 10)
Inclusion	Economic	Gini index of disposable income (after taxes and transfers) (from 0 to 1)
		Ratio between average disposable income of top and bottom quintiles
	Gender and LGBT+	Gender gap in employment rate (male-female, percentage points)
		Female research and development personnel as a percentage of total research and development employment
		People that believes their place of residence is a good place to live for gay or lesbian people (%)
	Migrant and ethnic	Migrant gap in employment rate (native-foreign, percentage points)
		People that believes their place of residence is a good place to live for migrants (%)
		People that believes their place of residence is a good place to live for racial and ethnic minorities (%)
	Inter-generational	Children poverty rate (%)
		Elderly poverty rate (%)
		Youth unemployment rate (%)
		Young population (from 18 to 24 years old) not in education, employment or training (NEET) (%)
	Disability	Population with a disability at risk of poverty or social exclusion (%)
Sustainability	Energy	Energy consumption per capita (kgoe per person)
		Electricity consumption from renewable sources (%)
	Climate	CO_2 emissions per electricity production (in tons of CO_2 equivalent per gigawatt hours)
		People satisfied with efforts to preserve the environment (%)
	Biodiversity	Change in tree cover (percentage points)
	Material footprint	Municipal waste rate (kilos per capita)
		Municipal waste that is recycled (%)
		Number of motor road vehicles per 100 people

		Change in land consumption per capita (square metre per capita)
Resilience	Health and social	Active physicians rate (active physicians per 1 000 people)
		People with jobs that can be performed remotely (%)
		Deaths due to emergencies/ natural disasters
	Institutions	Population without access to health care (%)
		People with confidence in the national government (%)
		People with confidence in judicial system and courts (%)
		People with confidence in the local police force (%)
		People that believe corruption is spread throughout the government in the country (%)
		SME bankruptcies (%)

Source: OECD (2020[1]), *Measuring smart cities' performance: Do smart cities benefit everyone?*, https://www.oecd.org/cfe/cities/Smart-cities-measurement-framework-scoping.pdf.

Several important inputs for this pillar were gathered during the Roundtable. In particular, it was highlighted that some indicators should be added, such as indicators on disability in the "inclusion" section. It was also suggested that the well-being and inclusion metrics could be merged, or inclusion could be mainstreamed into the other objectives. This would mean developing an average assessment of the city's performance in each metric, along with a cohort-specific assessment in order to see any gaps between cohorts.

Next steps and ways to foster peer-to-peer dialogue and mutual co-operation

Moving forward, discussions at the Roundtable highlighted that:

- A measurement framework needs to allow for some distinction between different city contexts (e.g. in terms of size, culture, etc.) and the various degrees of "smartness" as starting points
- The OECD measurement framework should not only allow for horizontal comparison whereby cities can only compare their performance against each other, but should also foster a longitudinal assessment so that cities can measure and improve their performance over time
- A measurement framework needs to be flexible and adaptable, especially given the complex and multi-faceted context with technologies constantly evolving

Drawing on the discussions of the 2nd Roundtable of Smart Cities and Inclusive Growth, the next steps in the development and implementation of the OECD Smart City Measurement Framework will include:

- selecting the specific indicators for each pillar
- identifying the right scale of analysis (e.g. municipality or FUA), considering that many smart city policy interventions are more relevant at a metropolitan scale (FUA) rather than a local scale
- defining the sources of data that can be used
- collecting the data and exploring ways to fill data gaps, for example through surveys and other tools to be defined.

Several questions raised around the implementation of the framework merit further research and discussion, notably issues related to:

- Standardisation and comparability. A smart city measurement framework should ideally allow for comparisons across cities. However, not all cities are starting with the same resources, framework conditions, or capacity; some differentiation is therefore needed.
- Data availability. Gaps in data exist, as the same data is not collected in every city. Several local, national and international data initiatives can help populate databases and implement the

framework, but co-operation and engagement from local and national governments are needed to bridge these gaps.

- Data privacy and accessibility. While a smart city measurement framework must not harm data privacy in any way, the OECD can play a strong role in overcoming privacy concerns through its work on data governance, privacy and digital security.

The 2nd OECD Roundtable on Smart Cities and Inclusive Growth highlighted the importance of co-operation between all stakeholders involved in the design, implementation and monitoring of smart city initiatives in order to measure their impact on the well-being of urban residents. The event also showcased various initiatives which could serve as a basis for continued co-operation and dialogue at all levels, and may serve as inspiration for avenues of implementation of the OECD Smart City Measurement Framework: at the city, national and international level.

Major think tanks as the **HUB Institute** emphasised that measurement is crucial but should be kept simple. Their smart city scorecard can help cities benchmark themselves, especially in terms of the impact of projects on the lives of citizens. **McKinsey** provided valuable comments on the proposed framework, including raising the issue of merging well-being and inclusion metrics and the importance of measuring performance and progress over time. The current context can also bring opportunities to foster more innovation. One example is the six dimensions of the **Bilbao** Smart City Plan 2019-2023, which identified several challenges and opportunities such as simplifying procedures for citizens, facilitating communication between different actors, advancing data analytics and ensuring cybersecurity.

A number of organisations and associations are keen to foster more peer-to-peer dialogue in order to enhance digitalisation for the smart cities of the future. The **Organisation for Promoting Urban Development (MINTO)** in Japan, for instance, has formed its mission as a partner for urban development projects, especially in promoting smart cities through new financial support mechanisms for smart buildings. Measurement of smart city performance is crucial to help the organisation evaluate which smart city projects it will support. The **European Digital SME Alliance** is another successful initiative that encourages smart city policy to unleash the potential of local innovators, and especially SMEs, in order to create a virtuous innovation circle and constantly find new ways to innovate. In their view, three elements are key to reach this objective: public procurement, open standards and skill development.

The OECD is committed to facilitating co-operation and dialogue with regards to smart cities, in the form of policy dialogues with local and national governments, continuing to provide a forum for dialogue through the OECD Roundtables on Smart Cities and Inclusive Growth, and through building a consortium of cities to foster inclusive growth through smart cities at the local level.

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Annex A. Smart cities indicators in Korea

Measurement process

- 162 local governments are assessed in 5 classes (A~E).
- Certification is granted for class C or higher, and the valid period is limited to two years in consideration of the fast technology change.
- 63 indicators in three categories are measured: innovation, governance and institution, technology and infrastructure.
- The score by category was determined on a 3:3:4 basis for innovation, governance and institution, technology and infrastructure, respectively, and on a 5:5 basis for qualitative and quantitative indicators.

Concept of quantitative and qualitative indicators

Source: Lee (2020[13]) *Presentation to 2nd OECD Roundtable on Smart Cities and Inclusive Growth* (December 2020).

Category 1: Innovation (300 points)

Table 3.4. Quantitative indicators (Innovation)

Classification		Indicators	
Public Capacity	Public officials dedicated to Smart City	Professionality	Existence of designated department dedicated to smart city
			Number of commendations related to smart cities over two years(# of institutions + # of individuals)
			Whether to manage service performance(KPIs, etc.) of Smart city
Private sector capabilities	Corporates	Employment	Number of employees in the smart city-related businesses

		Innovation	Number of patent applications by local businesses
			Number of start-ups and sales revenue of venture businesses over two years
	Living labs and Fablabs	Living labs (for 2 years)	Living lab operations status
		Collaboration (for 2 years)	Number of citizen collaboration training programs and participants
		Fablabs (for 2 years)	Fablabs(Makerspace) operations status
Information disclosure and utilization	Data link	Level of data link	Whether to prepare or implement standards, plans, etc. for linking and integrating urban information
	Information disclosure	Level of information disclosure	Number of data open APIs provided by local governments
			Number of data provided by local governments except APIs
			Disclosure of DB list managed by integrated operation centres
			Number of private use services for open public information
	Connectivity between systems	Level of connectivity	Number of platforms for system connectivity and integrations
			Type and number of services by sector
			Number of system connections and integrations by service sector

Table 3.5. Qualitative indicators (Innovation)

stages	Initial	Partially met	Fully met	Developing	Optimised
1. Public Capacity					
1.1 Public officials dedicated to Smart City	Dedicated official exists	Long-term dedicated official exists	designated department dedicated to smart city is organised and operating	Utilization of private capabilities for smart city operation	Organisation and operation of a smart city management and operation organisation based on public and private cooperation
2.1 Corporates 2.2 Living labs/Fablabs	Absence of programs for civilian capabilities	programs for civilian capabilities exist	Private sector operating platform and data-driven business engagement programs	Creating a public platform and data-driven business ecosystem	a public platform and data-driven business ecosystem exists
3. Information disclosure and utilisation					
3.1 Data link	Independent data and systems exist between	Some data and systems are linked across	Linked public data and system	Open and reuse public data	Full link and utilisation of public and private data

	sectors	sectors			
	Undisclosed public data	Partial data link between public institutions	Partial opening of public and private data	Improve data quality and scope based on external feedback on data utilisation	

Category 2: Governance and Institution (300 points)

Table 3.6. Quantitative indicators (Governance and Institution)

Classification			Indicators	
Propulsion system		Consultative bodies for smart city	Organisation of Consultative bodies	Organisation and operation of Consultative bodies
Institutional base		Institution	Smart city plans	Whether to establish a mid- to long-term smart city plans within five years
			Smart city ordinances	Whether to establish Smart city ordinances
			Policies for information security	Whether to establish plans for information security
				Number of experts for information security
Cooperation Network		Policy network	Policy network	Number of Smart cities MOUs with domestic and foreign institutions within two years
		Social network	Social network(within one year)	Number of media promotions
				Number of cases of public relations for citizens, such as education, seminars, and symposiums, etc.
Financing		Budget	Annual Budget	Percentage of budget related to smart city compared to the previous year's total budget (%)
		Mid- to long-term budget	Mid- to long-term budget	Percentage of budget related to smart cities over the next two years (%)
		Private investment	Private investment	Number and amount of attracted private investments related to smart cities for two years

Table 3.7. Qualitative indicators (Governance and Institution)

Stages	Initial	Partially met	Fully met	Developing	Optimized
1. Propulsion system					
1.1 Consultative bodies for smart city	Consultative bodies for smart city have been organized	Consultative bodies for smart city are operating	Specified scope of authority and decision-making procedures of consultative bodies for smart city	Operation of a policy-sharing program to support decision-making by the consultative bodies for smart city	Playing a leading role in smart city decision making
2. Institutional base					
2.1 Institutional base	Smart city Visions are established	Specific measures to realize those visions are presented	Measures to secure finance for the realization	Regularization and formalization of performance evaluation in implementing smart city visions and plans	Same as level 4
	Smart city Plans are established	Some of the smart city projects are implemented based on plans	Specific procedures for reflecting citizen opinions and participation in implementing smart city plans are presented	Reflecting citizen opinions in identifying the performance of smart city plans	Full periodic release and collection of opinions in the formulation and implementation of smart city plans
	Some Smart city guidelines are established	Smart city guidelines are in place	Smart city guidelines are in place	Reflecting citizen opinions for smart city guidelines	
3. Cooperation network					
3.1 Policy network 3.2 Social network	Communication and participation programs exist only in individual projects	Communication and engagement programs officially exist on an urban level	Participants can access policy information to enhance understanding of communication and participation programs	Digital technology support so that interested citizens can participate in the policy-making process and receive feedback	Development of a complete virtual model so that all citizens of the city can participate in the policy-making process
4. Financing					
4.1 Budget	Only budget plans for individual projects exist	Mid- to long-term budget plans for each project exist	An integrated budget plan for the whole city exists	External financing measures such as private investment exist	Specified Integrated public and private financing

Category 3: Technology and Infrastructure (400 points)

Table 3.8. Quantitative indicators (Technology and Infrastructure)

Classification			Indicators	
Intelligent Facilities and Services	Required Sectors	Transportation	ICT-based public transportation	Whether BIS(BUS Information System) is introduced
				Public transportation information API application status

			ICT-based traffic flows	Traffic volume API application status
				Number of traffic CCTVs per 1km of road length(wider than 4m)
			ICT-based transport safety	Number of prevention and response activities of the centre compared to the total number of traffic accidents (for 2 years)
				Whether to introduce real-time road hazard information service
				Percentage of ICT-based safety devices operating in school children protection zones
			ICT-based parking	Smart parking spaces information API application status
				Percentage of parking spaces in smart public parking lots compared to the total number of parking spaces in public parking lots
		Safety	ICT-based crime prevention	Number of crime prevention CCTVs per 1,000 people
				Crime response performance using integrated operation centre(IOC)
				Intelligent crime prevention CCTVs operation status
			ICT-based disaster prevention	Disaster(fire, heavy rain, forest fires, landslides, etc.) management services introduced at the IOC
				Presence of disaster alarm systems for citizens
	Optional sectors (3 sectors)	Transportation	Transportation	Indicators set by local governments
		Safety	Safety	Indicators set by local governments
		Administration	ICT-based administration	Presence of citizen participation systems (Current standard)
				Number of policy-making cases using urban data (last 2 years)
				Indicators set by local governments
		Housing	Smart home	Number of households introduced remote inspection system compared to the total number of households
				Whether to operate emergency safety management services linked to smart homes for the vulnerable
				Indicators set by local governments
		Education	e-Learning	Number of e-Learning benefits per 1,000 people (School remote education + Civil remote education)
				Whether to operate a smart schools
				Indicators set by local governments
		Culture and Tourism	ICT-based culture and tourism	Number of cases of providing information related to culture and tourism online (Current standard)
				Vital utilization of smart city technology in culture and tourism (Current standard)
				Indicators set by local governments
		Economy	ICT-based economy	Whether to provide ICT-based commercial activity analysis service to the public (Current standard)
				Smart factory penetration rate
				Indicators set by local governments
				Number of cases of introduction of ICT-based

		Health and welfare	ICT-based health and welfare	hospital information system (HIS)
				Number of beneficiaries of ICT-based social services for the vulnerable
				Indicators set by local governments
		Environment and energy	Environment and energy	Green building certification ratio to total buildings (Current standard)
				Greenhouse gas emission reduction ratio compared to the previous year (Current standard)
				Indicators set by local governments
Information and communication network		Wired network	Status of wired communication network	Whether to manage trouble records for wired communication
				Communication network extension managed by centre compared to local government area
		Wireless network	Status of wireless communication network	The range of public Wi-Fi provision compared to the area of the local government
Urban Integrated Operation Centre		Urban Integrated Operation Centre	Organization	Members of the integrated urban operation centre
				Number of collaboration projects between departments or external organizations among tasks of the integrated operation centre
			Scale	Number of services provided by the integrated operation centre
				Number of individual centres linked and integrated

Table 3.9. Qualitative indicators (Technology and Infrastructure)

Stages	Initial	Partially met	Fully met	Developing	Optimized
1. Intelligent Facilities and Services					
1.1 Transportation	Establish and operate individual services separately	Promote some convergence and integration within individual services	Promote some convergence and integration between individual services	Promote full convergence and integration among all services	Accomplish full convergence and integration among all services
1.2 Safety					
1.3 Administration					
1.4 Housing					
1.5. Education	Absence of integrated service management plan	Partial review of service integrated management plan	Partial review of service integrated management plan	Full review of service integrated management plan	Perfect sharing of convergence services
1.6 Culture and tourism					
1.7 Economy					
1.8 Health and welfare		Irregular Review of integration plans	Review of integration plans if necessary	Present formal and periodic integration measures	Present formal and periodic integration measures
1.9 Environment and energy					
2. Information and communication network					
2.1 Wired network	Development of some wired networks for city management	Partial linkage with urban intelligent facilities	Linked with major urban intelligent facilities	Linked with all urban intelligent facilities	Promote network linkage to link services with neighbouring local governments
2.2 Wireless network	Establishment of plan for wireless network development	Partial promotion of wireless services in public places	Expansion of network connection in major places	Network connection in all areas	Wireless service provision throughout the city
3. Urban Integrated Operation Centre					
3.1 Urban Integrated Operation Centre	Establishment and operation of an integrated operation centre	Individual service management and operation of the integrated operation centre	Functional linkage between individual services of the integrated operation centre	Partial linkage of public and private services of the integrated operation centre	Complete linkage of public and private services of the integrated operation centre
		Partial provision of the local government-wide services	Existence of integrated platforms	Existence of data open type platforms	Operation of data open platforms

Annex B. List of participants of the 2nd OECD Roundtable on Smart Cities and Inclusive Growth

Table A B.1. Annex A. List of participants of 2nd OECD Roundtable on Smart Cities and Inclusive Growth

SPEAKERS			
Organisation	**Name**	**First name**	**Position**
Bilbao TIK, Spain	Ibanez Zugazaga	Ane Miren	Managing Director
European Digital SME Alliance	Toffaletti	Sebastiano	Secretary General
HUB Institute	Ducrey	Vincent	CEO and Co-founder
International Telecommunication Union (ITU)	Lee	Chaesub	Director of the Telecommunication Standardisation Bureau
Korea (MOLIT)	Choi	Im-Rak	Director General for Urban Policy, Ministry of Land, Infrastructure and Transport
Korea Agency for Infrastructure Technology Advancement (KAIA)	Cho	Dae-Yeon	Chief Director of National Strategic Smart Program
Korean Research Institute for Human Settlements (KRIHS)	Lee	Jae-Yong	Director of Smart Green City Research Centre
McKinsey Global Institute	Woetzel	Jonathan	Director and Senior Partner
Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan	Ito	Masahiro	Director of International Affairs Office, City Bureau
OECD	Kamal-Chaoui	Lamia	Director, Centre for Entrepreneurship, SMEs, Regions and Cities (CFE)
OECD	Ahmad	Nadim	Deputy Director, Centre for Entrepreneurship, SMEs, Regions and Cities (CFE)
OECD	Akhmouch	Aziza	Head of the Cities, Urban Policies and Sustainable Development Division
OECD	Kim	Soo-Jin	Deputy Head of the Cities, Urban Policies and Sustainable Development Division
OECD	Paunov	Caroline	Senior Economist
OECD	Viros	Camille	Economist/Policy Analyst
OECD	Diaz Ramirez	Marcos	Junior Economist
Organisation for Promoting Urban Development (MINTO), Japan	Nakamura	Yuria	Director of Research and Planning Department
University of North Texas	Cowley	Jennifer	Provost and Vice President for Academic Affairs
Urban Innovation Vienna, Smart City Agency	Summer	Nikolaus	Senior Expert
Viable Cities (Swedish National Strategic Innovation Program for Smart and Sustainable Cities)	Kordas	Olga	Director
PARTICIPANTS			
Organisation	**Name**	**First name**	**Position**
2THINKNOW	Hire	Christopher	Director Data
42Group	Mangelus	Carl Johan	CEO
Academy of Economic Studies of Moldova	Eugenia	Busmachiu	Dr. Associate Professor

ADR SV Oltenia	Burada	Gabriel	Expert
AEF info	Monier	Julien	Journalist
AIT Austrian Institute of Technology GmbH	Etminan	Ghazal	Business Manager
City of Bogotá	Garcia	Andrea	Contractor
City of Bogotá	Guzman	Felipe	District Counsellor TIC
City of Bogotá	Saenz	Ronald	Advisor
Alcaldía Mayor de Bogotá - Alta Consejería TIC	Santofimio Camacho	Nubia	Policy Consultant Bogotá Smart Territory
Alcaldía Mayor de Bogotá - Consejería TIC	Barbosa	Diego	Consultant
Alta Consejería TIC	Parada	Juan	Advisor
Architects CFS (Pty) Ltd	Bongerize	Rubi Antoinnette	Candidate Architect
Art Cross Foundation	Paitchadze	Ketevan	Founder / CEO
Art Cross Foundation	Tbileli	Nicoloz	Communication Manager
Art Cross Foundation	Tbileli	Mikheil	President/COO
Asian Institute of Technology	Kumar	Sivanappan	Professor
Association of Estonian Cities and Rural Municipalities	Käärmann-Liive	Kaimo	Advisor (on local e-services)
Bangladesh Bank	Karim	Mahmudul	Joint Director
Bilbao City Council	Rojo	Gemma	International Coordinator
Bilbao City Council	Zugazaga Rossi	Alazne	Bilbao International
Blackburn United	Maccallum	Neil	Director
Cbus	Boudarel	Alexandra	Procurement Category Manager
Centrale	Centrale	Tom	CEO
Centre des Recherches et des Technologies des Eaux	Kallali	Hamadi	Researcher
City of Bonn	Nolden	Susanne	International Officer
City of Bradford MDC	Bilous	Jane	Growth & Innovation Programmes Officer
CleanTech Region Impact Group	Ling	Lars	CEO & Founder
Coalition for Urban Transitions (CUT)	Batra	Pandora	Strategic Engagement and Partnerships Manager
Collectivité Territoriale	Weiss	Sylvain	Directeur général adjoint qualité et promotion de la ville
Committee of the Regions	Lopez Cutillas	Gustavo	Administrator
Cork Smart Gateway	Pulgarin	Vanessa	Coordinator
CPCS	Bocoum	Mamoudou	Principal Consultant
DBI	Preston	Rebecca	R&D Associate
Deloitte Tohmatsu Financial Advisory LLC	Hatano	Hiroko	Senior Analyst
Deloitte Tohmatsu Financial Advisory LLC	Motooka	Ryo	Vice President
Edison Electric Institute	Jones	Lawrence	Vice President
EPRA	Pekdemir	Dilek	Research Manager
ERIA	Venkatachalam	Anbumozhi	Senior Economist
ERSAR	Lobo	Filomena	Expert technician
Estonian Association of Cities and Municipalities	Lehtla	Reigo	Environmental Adviser
Eurocities	Iafisco	Anna	Intern
Eurocities	Noordzij	Lodewijk	Policy Officer
European Commission	Dékány	Eniko	Trainee
European Commission	Novaretti	Serge	Policy Officer - Smart Cities
European Commission	Subramaniam	Sumathi	Policy Officer
European Committee of the Regions	Rocha Trindade	Paulo	Policy Officer
European DIGITAL SME Alliance	Zimmermann	Moritz	Communications Officer
Faculty of Economics and Business Univeritas Indonesia	Muzayanah	Irfani Fithria	Lecturer

Federal Economic Development Agency for Southern Ontario	Bozzano-Bae	Isis	Economic, Policy and Planning Analyst
Fondazione per l'Ambiente	Valerio	Stefano	Researcher
Foundation for Social Welfare Services	Ikechi	Mariella	Community Development Worker
Framos	Tyagi	Vivek	Biz Dev Manager
Furban Foundation	Borthagaray	Andrés	President
G3ict	Sarviro	Yulia	Senior Project Manager
Gemeente Balen	De Saedeleer	Lut	Global Cooperation Service
Girne American University	Bayulken, Phd	Bogachan	Head of Architecture Department / Assistant Professor.
IBD-World - Smart Cities Solutions	Yemini	Ohad	CEO
IBM	Sajhau	Philippe	VP Metropole
ICONS	Lusuan	Angelique	Communication Manager
IDSAA	Baulraj	Agastin	Fellow
IDSAA	Jacinth	Bernice	IT Expert
IEA	Kieffer	Ghislaine	Policy Analyst
IMEC	Borghys	Koen	Researcher
INFC	Ha	Jacqueline	Analyst
Infrastructure Canada	Frank	Natalie	Director, Policy and Innovation
Institute for Forecasting, Slovak Academy of Sciences	Polackova	Zuzana	Researcher
International Water Resources Association	Garcia Quesada	Monica	Project Officer
Istanbul Technical University	Özmen	Ece	PhD student
ITF	Ito	Asuka	Policy Analyst
ITF	Sakurai	Nori	Policy Analyst
Kennis Law Office	Kennis	Ioannis	Lawyer
Korean Delegation to the OECD	Shin	Song Bum	Minister
KTH	Lyne	Bruce	Professor
LACROIX Group	Gervais	Stephane	VP Strategic Innovation
Lille University	Esmaeilpour Zanjani	Nastaran	Student
Lumoin	Eeva	Veikko	CEO
MCLedger	Haimet	Susan	Blockchain Program Manager
Minerva Water Governance for Climate Resilience	Bastemeijer	Teun	Founding Partner/Programme Director
Ministère des Affaires Municipales et de l'Habitation du Québec	Martin	Nadine	Conseillère en relations canadiennes et affaires internationales
Ministry of Development and Investments	Kostopoulou	Maria	Director
Ministry of Development Funds and Regional Policy	Zimny	Marta	Chief specialist
Ministry of Economic Cooperation and Development	Kleibrink	Alexander	Senior Policy Officer
Ministry of Energy and Spatial Planning	Richters	Frederick¨-Christoph	Policy Advisor
Ministry of Environmental Protection and Regional Development	Vecozola	Alise	Senior Consultant
Ministry of Finance	Sepp	Eedi	Adviser
Ministry of Transport	Miki	Arisa	Director
MLIT	Umeda	Eijiro	Chief Official
MOLIT	Choi	Huijeong	Deputy Director
NA	Rubasundram	Geetha	Consultant
National and Kapodistrian University of Athens	Tsipouri	Lena	Professor
National Digital Transformation Unit	Alzahrani	Moath	Business Development Lead
NEC Corporation	Yasunaga	Akifumi	Expert

New York University	Murai	Kana	Student
Nishi-Nippon Railroad Co., Ltd.	Fukasawa	Yoshinobu	Director, Overseas Business Department
OiEau	Haener	Paul	Director of Projects
Özyegin University	Ertugal	Ebru	Associate Professor
Paris School of Economics	Risnoveanu	Renee	Master Student
Permanent Delegation of Canada to the OECD	Chouinard	Marie-France	Programme Officer
Permanent Delegation of Korea to the OECD	Ahn	Kwang Youl	First Secretary
Permanent Delegation of Portugal to the OECD	Figueirôa	Ana	Intern
Prime Minister's Office	Schön	Orsolya	Civil Servant
Province Vabk of Turkey	Sari	Volkan Idris	Urban Development Specialist
PwC	Hajjam	Amal	Manager
RACF & Consultant	Falcon	Rosa Amelia	Director
RCE Middle Albania	Shulla	Kalterina	Chair
Ruddi Vaes International Development Consultancies	Vaes	Ruddi	Owner / Senior Consultant
SDG Action Strategy Center	Agouzoul	Hassan	Senior Expert Sustainable Development and Climate Finance
SEAK s.r.o.	Macko	Heliodor	CEO
Shimizu Corporation	Akiyama	Yuri	Senior Associate
SIM-GE	David	Dharish	Faculty
Smart Cities Klub	Jurík	Miloslav	Chairman
Smart Cities Network	Tay	Kc	Chairman
SmartCity.institute	Etezadzadeh	Prof. H.C. Dr. Chirine	President
Sogang University	Kim	Kyung-Hwan	Professor of Economics
Soundwines	Kjellström	Olof	Owner
Subdere	Ravest	Maximiliano	Lawyer, Division of Public Policies and Territorial Development
SUEZ	Alabergère	Sabrina	Institutional Relations Officer
SUEZ	Leclerc	Joannie	Dialogue & Societal Impact Manager
Technopolis Group	Terrier	Apolline	Public Policy Consultant
The City of Bratislava	Dzurovcinova	Petra	Chief Innovation Officer
The Economy Research Institute of the Ministry of Economy	Saltykou	Kiryl	Head of the Department of Environmental Management and Green Economy Development
Ministry of Land, Infrastructure, Transport, and Tourism	Oshida	Akira	Advisor
The Resilience Shift	Bachrach	Theodore	Communications Manager
Tokyu Fudosan Holdings Corporation	Kusakabe	Taizo	General Manager
TrustBlock Solutions Ltd.	Farias-Soto	Lorena	Director
UCLG Africa	Byukusenge	Jerome	Programme officer
UFGC	Forsthuber	Cornelia	Project Leader
Umea Municipality	Gustafsson	Elsa	Intern
UN-ESCWA	Sabbidin Dimassi	Hania	Researcher - 2030 Agenda
United Nations Economic Commission for Europe	Roll	Gulnara	Secretary to Committee on Urban Development
United Way Worldwide	Berzonsky	Gregory	Vice President and Adviser to the President and CEO
Universidade Comunitária da Região de Chapecó - UNOCHAPECÓ	Jacoski	Claudio	Rector/President
Università di Ferrara	Negri	Marco	PhD student
University of Chieti-Pescara	Cialfi	Daniela	Postdoc Researcher
University of Hertfordshire	Kamtam	Prakash	Doctoral Research Scholar

University of Twente	Knight	Louise	Professor of Public Sector and Healthcare Procurement
University of Twente	Stek	Klaas	Research
University of Twente	Araujo Soares	Vera	Professor of Health Psychology and Planetary Health
UR	Ura	Masayuki	Director
U.S. Department of Housing and Urban Development	Mcfarlane	Alastair	Director, Public Finance and Regulatory Analysis
U.S. Department of Housing and Urban Development	Usowski	Kurt	Deputy Assistant Secretary for Economic Affairs
U.S. Department of Housing and Urban Development	Weaver	Bradley	Program Analyst
UTP Malaysia & FFU FU Berlin Germany	Hasan	Azhan	Lecturer and Researcher
Vertemis	Davidson	Diana	Founder, Managing Director
Viable Cities	Minoz	Åsa	Innovation strategist
Vigeo Eiris	Yanez	Jorge	Sustainability Analyst and Team Manager
VVV Media	Westregård	Henrik	Chief Analyst
Wcycle Institute Maribor, Institute for Circular Economy	Kos	Igor	Consultant
World Bank	Turskaya	Anna	Innovation and Entrepreneurship Consultant
Zarzad Morskiego Portu Gdynia S.A. - Port of Gdynia Authority S.A.	Szymanska	Maria	Manager of Spatial Development Section
Zeleznicna spolocnost Slovensko	Zajkova	Ludmila	Management Support Manager