United 4 Smart Sustainable Cities

# Case study
# Daegu, Korea (Republic of)
## February 2022


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United 4 Smart Sustainable Cities

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11
SUSTAINABLE CITIES
AND COMMUNITIES

## Acknowledgments

This case study was researched and written by John Smiciklas (Consultant), Natallia Hubskaya (Consultant) and Mythili Menon (ITU).

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## Disclaimer



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## Abstract

This case study outlines the journey of Daegu since 2014, when the city's Smart City Plan was unveiled to the public. As a part of ITU's and Daegu's collaboration, the U4SSC Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals', which are based on Recommendation ITU-T Y.4903, were implemented to support the assessment of the city's existing smart city undertakings, benchmark performance and underscore effective best practices in order to improve the applicability of these KPIs on a global scale. Being one of the pioneering cities in the Asia-Pacific to implement the U4SSC KPIs, the findings from the implementation process will also serve as a touchstone for other cities in the region, which are also commencing their smart and sustainable city journeys.

## Foreword

As the Mayor of Daegu Metropolitan City, it is my honour and pleasure to write a foreword for the publication. I believe it is extremely meaningful to publish this Case Study on ITU-T International Standards to shape Smart Sustainable cities.

As human beings started to form communities, we gradually moved towards urbanization. The establishment of these cities has caused numerous urban problems. To deal with these burgeoning problems and to build smarter and more sustainable cities, tremendous efforts have been made around the world.

The City of Daegu is not an exception. In 2016, we announced the 2030 Future Growth Plan, which has paved the way for the establishment of a smart city with the vision of becoming "A Global Leading City with Industrial Growth and Citizens' Happiness". Accordingly, this city is envisioned as a platform, to solve a variety of urban issues together with the public and private sectors, and revitalize related industry.

We have built a leading model for smart cities by establishing the Suseong Alpha City testbed, and have been exploring smart city services through 13 systems in five fields, including autonomous driving, smart street-lights and underground utilities management. During the first half of 2022, we plan to become a data-centric city capable of integrating and utilizing the whole city's data by building and managing a Smart City Data Hub.

Furthermore, we have introduced the Urban Problem Discovery Team's Living Lab System, where citizens can explore urban issues and discover optimal solutions for existing urban issues. The best-use cases derived from their solutions are further tested and subsequently implemented in the whole city.

In particular, we have formulated the 2021–2025 Smart City Plan and presented our policy direction for a smart city project based on citizens' happiness and for boosting local enterprises' growth. In this context, we will select 35 programmes in six sectors – Smart Transportation, Safety, Environment, Welfare, Economy and Administration – and advance towards the creation of "Smart Daegu" where people will be happy to live and work.

In keeping with the adopted endeavour, we will continue our efforts to pursue the establishment of a smart city, and become an *innovation standard* for initiating a new smart city wave across the globe. Moreover, by inviting citizens to participate in applying emerging smart city technologies, everything in daily life will become smarter and will make people's lives more convenient, more inclusive, safer and cleaner.

In closing, I am very pleased to have this opportunity to verify the city's capacity in establishing a world-class smart city by participating in the Smart Sustainable Cities KPI Project of the U4SSC. I hope that Daegu's case study and the knowledge provided in this Case Study will be of help for many other cities aiming to formulate their own smart city strategies.

I would like to extend my warm appreciation to ITU for putting in every effort to publish this report.

Kwon Young-jin
Mayor of Daegu Metropolitan City

## Foreword

The preparation of Daegu's vision for its future as a Smart Sustainable City began in 2014 with a citizen roundtable followed by an expert roundtable in 2015. Daegu's "Future Vision 2030" established in 2016 highlights the city's resolve to ensure that industrial growth works in service of citizen happiness.

Citizens have always been at the centre of Daegu's smart city strategy. This is exactly the approach advocated for by ITU, and I would like to highlight my appreciation for Daegu's will to share its experience on the international stage.

Learning from experience is one of the main objectives of the United for Smart Sustainable Cities (U4SSC) initiative, experience that provides key guidance to the international standardization work of ITU-T Study Group 20 (Internet of Things and Smart Cities and Communities).

Daegu is the first city in Korea to evaluate its progress towards smart city objectives and the United Nations Sustainable Development Goals (SDGs) with the U4SSC Key Performance Indicators for Smart Sustainable Cities based on the ITU standard Y.4903.

U4SSC is supported by 17 United Nations partners committed to the achievement of SDG11 to "make cities and human settlements inclusive, safe, resilient and sustainable".

The collaboration driven by U4SSC has helped more than 150 cities around the world to adopt Key Performance Indicators that not only support cities' self-evaluations but also provide a common format for cities to share these evaluations with other cities working to accelerate progress towards the SDGs.

Alongside the value of this empirical knowledge to other cities, this reporting also assists cities in soliciting feedback that contributes to their continuous efforts to refine smart city strategies.

I would like to thank all contributors to this Daegu case study for your support to global efforts to accelerate the digital transformation of cities and communities. This case study is certain to serve as a valuable point of reference to other cities around the world, as well as a source of inspiration for people-oriented approaches to the development of Smart Sustainable Cities.

Chaesub Lee
Director, ITU Telecommunication Standardization Bureau

## Executive summary

The International Telecommunication Union (ITU) serves as the UN specialized agency for information and communication technologies (ICTs). Leveraging on its global membership which includes 193 Member States as well as some 900 companies, universities, and international and regional organizations, ITU also functions as an international standard developing organization (SDO) to establish international standards (ITU-T Recommendations) covering the utilization/application of ICTs and digital technologies across various domains. Within the last decade, ITU has also dedicated its standardization efforts to the topic of smart and sustainable cities. These efforts culminated in the development of a set of key performance indicators (KPIs) for smart sustainable cities (SSC) to (i) assist cities in becoming smarter and more sustainable and (ii) provide cities with a tool for monitoring and self-assessment.

In 2021, the city of Daegu (Republic of Korea) initiated a partnership with ITU to implement the United for Smart Sustainable Cities (U4SSC) KPIs on SSC. These KPIs are based on Recommendation ITU-T Y.4903 "Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals". The KPIs are categorized into three key dimensions: Economy, Environment, and Society and Culture. The KPIs are specifically designed to assist in measuring Daegu's progress towards becoming a smart sustainable city and to determine Daegu's advancement in relation to the goals and targets elucidated in the UN Sustainable Development Goals (SDGs).

This case study documents the key findings arising from the implementation of the U4SSC KPIs, and a review of the programmes implemented by Daegu with reference to the same KPI framework. The case study also highlights the activities carried out in line with the Daegu Metropolitan Smart City Plan.

The story of Daegu's smart and sustainable city journey narrated through this case study has been carefully curated to provide an insight into the concept of smart sustainable cities, underline the importance of cities being able to evaluate their smart city action plans and ensure that findings of this study can be shared widely with other aspiring smart sustainable cities to support them on their respective smart sustainable city journeys. Furthermore, Daegu's implementation of the U4SSC KPIs makes it the first city in the Republic of Korea to undertake this process of a smart sustainable city self-assessment based on an ITU-T Recommendation. The observations derived from Daegu's experience are also expected to serve as the basis for other cities to implement the U4SSC KPIs and augment their smart sustainable city plans in alignment with the findings of the exercise.

The case study commences with Section(s) 1, 2 and 3, which introduces the concept of smart sustainable cities, the history of ITU and engagement with smart sustainable cities globally. These sections also highlight the importance of standardization in fostering smart sustainable city transitions. Additionally, the initial sections introduce the U4SSC initiative and its pivotal role in driving the transition of smart sustainable cities worldwide by sharing technical knowledge and providing the platform for the preparation of appropriate guidelines.

This is followed by Section 4, which traces the journey of Daegu as a city and provides details of Daegu's strategy and plans to become a smart sustainable city. Section 5 describes the scope of the U4SSC KPIs for the SSC project in Daegu and underscores the three main phases of implementing the KPIs. This Section also delves into the role of the KPIs as the primary tool with which to measure Daegu's efforts in becoming smarter and more sustainable.

The case study progresses on to Section 6, which explores and links the various smart sustainable city initiatives, activities and projects adopted by Daegu and provides an in-depth understanding of Daegu's initiatives in each of the important areas relating to smart and sustainable cities.

Section 7 reviews and provides a snapshot of Daegu's KPI data. It also elaborates on a series of best practices for aspiring smart sustainable cities based on Daegu's experience in implementing the U4SSC KPIs and the execution of the Daegu Metropolitan Smart City Plan.

The final section sets the stage for presenting certain policy recommendations for Daegu in accordance with existing legislation in the country, along with new areas to be explored. The case study concludes by highlighting the core follow-up activities for Daegu to continue with its smart and sustainable city initiatives successfully.

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**Tables**

## Common terms and abbreviations

| | |
|---|---|
| µg / $m^3$ | Micrograms per Cubic Metre |
| 3-D | Three-Dimensional |
| 3G | Third Generation |
| 4G | Fourth Generation |
| 5G | Fifth Generation |
| ADAS | Advanced Driver-Assistance Systems |
| AI | Artificial Intelligence |
| AMI | Advanced Meter Infrastructure |
| API | Application Programming Interface |
| AQI | Air Quality Index |
| AR | Augmented reality |
| ATMS | Advanced Traffic Management System |
| BcN | Broadband Convergence Network |
| BMS | Bus Operation Management System |
| BOD | Biological Oxygen Demand |
| CCTV | Closed-Circuit Television |
| COVID | Coronavirus Disease |
| DDoS | Distributed Denial-of-Service |
| EMF | Electromagnetic Field |
| EV | Electric Vehicles |
| FG-AI4AD | Focus Group on Artificial Intelligence for Autonomous and Assisted Driving |
| FG-AI4H | Focus Group on Artificial Intelligence for Health |
| FG-AI4NDM | Focus Group on Artificial Intelligence for Natural Disaster Management |
| FG-SSC | Focus Group on Smart Sustainable Cities |
| GDP | Gross Domestic Product |
| GHGs | Greenhouse Gases |
| GJ | Gigajoule |
| GPS | Global Positioning System |
| HDFS | Hadoop Distributed File System |
| HTTP | Hypertext Transfer Protocol |
| ICTs | Information and Communication Technologies |
| IEC | International Electrotechnical Commission |
| IoT | Internet of Things |
| ISO | International Organization for Standardization |
| IT | Information Technology |
| ITS | Intelligent Transportation System |
| ITU | International Telecommunication Union |
| ITU-T | ITU Telecommunication Standardization Sector |

| | |
|---|---|
| km | Kilometres |
| KPIs | Key Performance Indicators |
| kWh | Kilowatt hours |
| L | Litres |
| $m^2$ | Square Metres |
| m2m | Machine to Machine |
| MB | Megabytes |
| MOU | Memorandum of Understanding |
| MQTT | Message Queuing Telemetry Transport |
| NGSI-LD | Next Generation Service Interfaces |
| $NO_2$ | Nitrogen Dioxide |
| $O_3$ | Ozone |
| OECD | Organisation for Economic Co-operation and Development |
| PC | Personal Computer |
| PHEV | Plug-in Hybrid Electric Vehicles |
| PM | Particulate Matter |
| R&D | Research and Development |
| RFP | Request for Proposal |
| SAE | Society of Automotive Engineers |
| SDGs | Sustainable Development Goals |
| SDO | Standards Development Organization |
| SG5 | Study Group 5 |
| SG20 | Study Group 20 |
| SIEM | Security Information and Event Management |
| SMEs | Small and Medium Enterprises |
| SMS | Short Message Service |
| $SO_2$ | Sulphur Dioxide |
| SSC | Smart Sustainable Cities |
| TCP/IP | Transmission Control Protocol/Internet Protocol |
| U4SSC | United for Smart Sustainable Cities |
| UN | United Nations |
| UNECE | United Nations Economic Commission for Europe |
| USB | Universal Serial Bus |
| UTIS | Urban Traffic Information System |
| VR | Virtual Reality |
| VDS | Vehicle Detector Systems |
| WeGo | World e-Governments Organization of Cities and Local Governments |
| WHO | World Health Organization |
| Wi-Fi | Wireless Fidelity |


DAEGU

# 1 Introduction

Global urbanization trends are impacting increasingly on economic, social and environmental conditions worldwide. Based on rural-to-urban migration, coupled with population growth rates, it has been estimated that by 2030, nearly 60 per cent of the world's population will be living in cities. Furthermore, while cities occupy just three per cent of the Earth's land, they account for up to 80 per cent of global energy consumption and 75 per cent of global carbon emissions.[1] Confronted with challenges such as overcrowding, pollution, inadequate infrastructure, resource shortage, health hazards and crime associated with urbanization, governments are exploring alternatives to cater to the requirements of their inhabitants without compromising on the needs of future generations.

It was in this context, in the mid-1980s, that the concept of "smart cities" emerged. This promised to pave the way towards urban agglomerations that are sustainable, inclusive, interconnected, reliable and safe, while providing a data ecosystem predicated on technology integration. Recognizing the importance of intersectoral collaboration between multiple actors – including governments, citizenry, academia and the private sector – in urban transformations towards smartness, it is imperative that civil society is maintained as the fulcrum for the formulation and adoption of digital transformation solutions for the planning and operation phases of smart sustainable cities.

By embracing technologies and applications across verticals, cities can utilize the data streams generated to monitor, assess and improve their operational performance, reduce their environmental impact and become more sustainable. Thus, the two tenets of "smartness" and "sustainability", previously considered mutually exclusive, are now embraced as a part of the global approach to managing urbanization across sectors, including transport, education, energy, environment, waste management and health care, through the implementation of digital technologies.

Figure 1: Daegu panorama

As cities comprise multidimensional interactive systems, city governments are using performance-measurement tools to assess progress towards desired goals. Based on the results, they re-orient their actions to ensure that the needs of their inhabitants are met with respect to sustainability.[2]

> *"How city systems interact, how we interact with these systems, and how we interact with each other are questions of key importance to COVID-19 response and recovery, but also key importance to our ability to contend with challenges of all kinds."*
>
> *Chaesub Lee, Director of the ITU Telecommunication Standardization Bureau*

Such actions conducted on behalf of governments are supported by the Sustainable Development Goals (SDGs) framework, which was adopted universally by the General Assembly of the United Nations. Within this framework, the 17 SDGs encompass 169 targets aimed at monitoring a diverse range of domains, including poverty, food security, health, education, gender equality, water management, clean energy, job security, innovation, effective production systems, climate action, life on land and in water, collaboration for the goals and, last but not least, sustainable cities.

## 2 ITU, smart sustainable cities and Daegu

Stepping into the smart and sustainability city sphere in 2013, the International Telecommunication Union (ITU), the United Nations specialized agency for information and communication technologies (ICTs), in its role as an international standards development organization (SDO), established the Focus Group on Smart Sustainable Cities (FG-SSC). In 2015, the work of this Focus Group concluded with the approval of 21 Technical Specifications and Reports, and the establishment of one of the first international definitions that effectively captured the complementary essence of "smartness" and "sustainability".

Subsequently, together with the United Nations Economic Commission for Europe (UNECE), the definition was revised and agreed upon as follows:

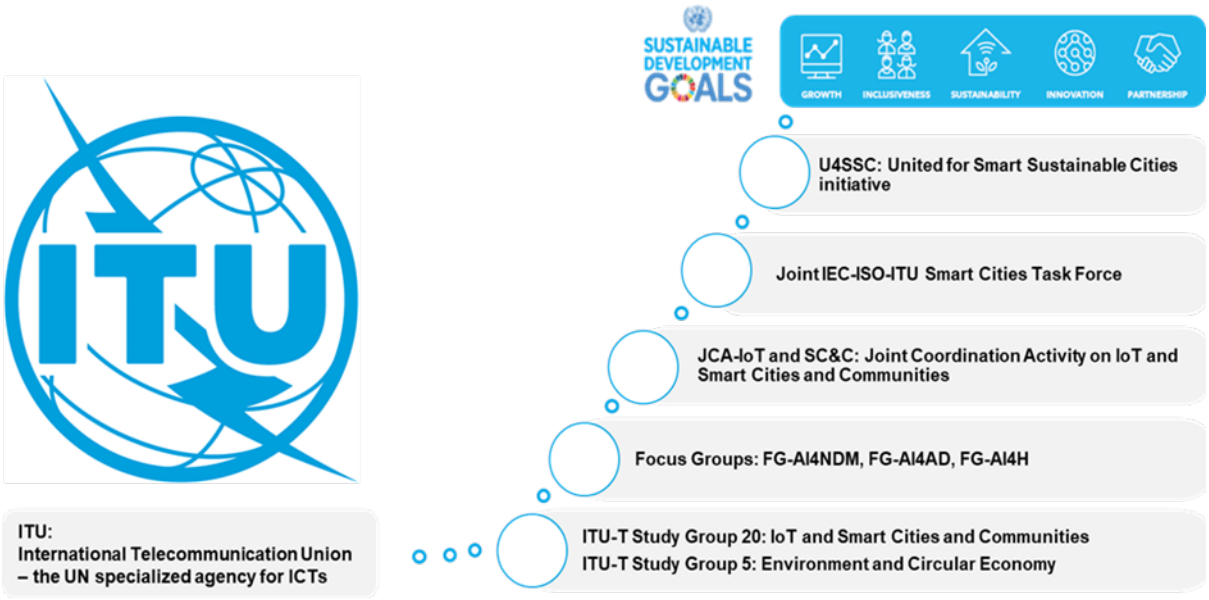
> *"A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects".*
>
> Recommendation ITU-T Y.4900

Since then, ITU has played a leading role in providing a platform where the concepts of smart, sustainable cities are elaborated, discussed, developed and standardized. More information on ITU's activities and roles are discussed at the end of this case study.

ITU leads the new and emerging area of smart sustainable cities through ITU-T **Study Group 20 Internet of Things (IoT) and smart cities and communities (SG20)**, where representatives of the ITU-T membership develop Recommendations (standards) that leverage IoT technologies to address urban-development challenges.[3]

Alternate channels called Focus Groups (FG-AI4AD, FG-AI4H and FG-AI4NDM) are also created in response to immediate ICT standardization demands; these are open to organizations outside ITU's membership and are afforded flexibility in their working methods.[4]

Figure 2: How ITU supports smart cities and communities




To complement this standardization work, initiatives with other UN agencies such as the United for Smart Sustainable Cities (U4SSC), aim to address the needs of cities to become smarter and more sustainable, and to support the attainment of the Sustainable Development Goals (SDGs).


**United for Smart Sustainable Cities**

United for Smart Sustainable Cities (U4SSC) initiative is a United Nations initiative. It is spearheaded by the ITU, UNECE and UN-Habitat and supported by 14 other United Nations agencies and programmes. Since its establishment, the U4SSC has been one of the leading platforms to promote knowledge-sharing and the development of guidelines for supporting aspiring smart sustainable cities.

This global platform was established in 2016 based on the principle underscored in the United Nations Sustainable Development Goal (SDG) 11 which is focused on making "cities and human settlements inclusive, safe, resilient, and sustainable." Participation in U4SSC activities is open to all interested stakeholders and smart, sustainable city experts.

The current active Thematic Groups include:

- City Platforms
- Lessons learned from building urban economic resilience at city level during and after COVID-19
- Compendium of Practices on Innovative Financing for Smart Sustainable Cities Projects
- Guiding principles for artificial intelligence in cities
- Procurement Guidelines for Smart Sustainable Cities
- Digital Transformation for People Oriented Cities

Figure 3: Dalseong Park

**Daegu project**

Based on ITU's leading role in Smart Sustainable Cities, in early 2021, Daegu approached ITU to develop a joint project to implement the U4SSC KPIs and develop this case study. The aim is to highlight, review, analyze and provide feedback on Daegu's Smart, Sustainable City strategy, plan and initiatives. As part of the project, ITU will provide recommendations on how Daegu can expedite its smart sustainable city journey in line with the SDGs. Not only will Daegu focus on implementing the U4SSC KPIs, the city will also provide feedback on its implementation experience and engage with the larger U4SSC community.

The experience of Daegu in implementing the U4SSC KPIs, provides the city with transparency on its internal processes, and helps to visualize the KPIs and analyze the role of digital technologies in making cities smarter and more sustainable.

## 3 Measurement of smart sustainable cities - U4SSC KPIs

Smart sustainable city transformations conducted/initiated on behalf of governments are supported by the Sustainable Development Goals (SDGs) framework (containing 17 overarching goals and 169 targets), which was adopted universally by the General Assembly of the United Nations.

With the understanding that progress towards meeting the goals of the SDGs can be hastened through digital transformation, ITU developed Recommendation ITU-T 4903 Key performance

indicators for smart sustainable cities to assess the achievement of sustainable development goals. This set of KPIs for smart, sustainable cities (SSC) was developed to establish the criteria to evaluate ICTs' contributions in making cities smarter and more sustainable, and to provide cities with the means for self-assessments.

Following this, the U4SSC initiative published the U4SSC KPIs for SSC – based on Recommendation ITU-T Y.4903 – to support cities worldwide in evaluating the role and contribution of ICTs in smart sustainable cities, and to provide cities with the tools for self-assessments to achieve the SDGs.

These indicators have been developed to provide cities with a consistent and standardized method to collect the necessary data to measure performance and progress regarding:

- achieving the SDGs;
- becoming a smarter city; and
- becoming a more sustainable city.

The U4SSC KPIs have been implemented in more than 150 cities around the world. The U4SSC verification and benchmarking visualization programmes are supporting these cities in evaluating their existing smart sustainable city vision, mission, strategy and implementation projects.

The U4SSC KPIs for Smart Sustainable Cities have been classified into three key dimensions:

1. Economy
2. Environment
3. Society and Culture

Each of the aforementioned dimensions is further divided into seven sub-dimensions, namely:

1. Information and Communication Technologies (ICTs)
2. Productivity
3. Infrastructure
4. Environment
5. Energy
6. Education, Health and Culture
7. Safety, Housing and Social Inclusion

ITU's case studies, developed based on the implementation of the U4SCC KPIs, allows for the showcasing of a diverse range of approaches to creating a smart sustainable city, along with relevant governance mechanisms, investment protocols and coordination processes.

Additionally, the U4SSC KPIs serve as effective tools for self-assessment for cities. The U4SSC KPIs can identify the key areas for improvement and lay the foundation for reviewing city strategies and the basis for measuring and monitoring activities.

# 4 Overview of Daegu

## 4.1 Introduction

Figure 4: Image of the city of Daegu

Situated in the inland south-east of the Korean Peninsula, the Daegu Metropolitan city covers an area of 883 $km^2$ and is home to more than 2.4 million people. Being the third-largest city in the Republic of Korea, Daegu has served as one of the country's cultural centres. The following events are held every year: the Daegu Colorful Festival, the Chimac Festival, the Daegu International Musical Festival and the Daegu International Opera Festival. Daegu has also hosted several leading conferences and events including the World Energy Congress (2013) and the World Athletics Championships (2011).

The city of Daegu has developed machinery/metal, automotive parts and textile manufacturing, and is focusing on new industries such as medical, future automotive, water, energy, robotics and other smart city-related industries to boost the city's sustainable growth trajectory.

Following the inauguration of Mayor Kwon Young-jin, in 2014, a smart sustainable city vision was prepared in 2015 through a process that included an inhabitant roundtable meeting, followed by an expert meeting.

To lead the smart sustainable city initiative, in 2016, the "2030 Future Growth Plan" and smart city industry strategy were established, and various smart city services such as smart parking, smart park, and remote meter reading of water supply have been delivered.

The city's activities are centred on the health and happiness of its inhabitants and on ensuring that their needs are met. Accordingly, the city's main goals are illustrated in Table 1.

### Table 1 - Key objectives of the city of Daegu

| Goal | Objective |
|---|---|
| City of Opportunity | A city that attracts people and corporations and is able to support the dreams and endeavours of its young inhabitants through continuous innovation |
| City of Human Warmth | A warm, tightly-knit community that cares for the socially disadvantaged and is inclusive of all inhabitants |
| Pleasant City | A foundation for inhabitants' lives that provides a safe, clean and pleasant environment, and promotes balanced development |
| Happy City | A city in which culture flows through everyday life "like a river" and learning is not a privilege but a necessity |
| City of Participation | A city in which ownership belongs to the inhabitants and the driving force of development is communication and cooperation with inhabitants |

In keeping with its people-oriented approach to operational urban management, over the years, Daegu has been honoured with several awards and titles, including the Korea Master Brand Award in the Medical City category for seven consecutive years, including 2021. This is also a testament to measures implemented such as social distancing and the vaccination drive adopted by the city when it was faced with the COVID-19 pandemic.

> *"Through smart city planning, we will strive to become a smart city where new smart technologies can be continuously tested and services that inhabitants can experience in the future Daegu smart city blueprint."*
>
> *Kwon Young-jin, Mayor of the Daegu Metropolitan City Government.*

Daegu was also honoured with the Best Smart City Project Award during the Smart City Asia-Pacific Awards 2018 for its work on the Intelligent Counseling system, Dubbot, which serves as a chatbot for the provision of relevant details about Daegu, including tourist information.

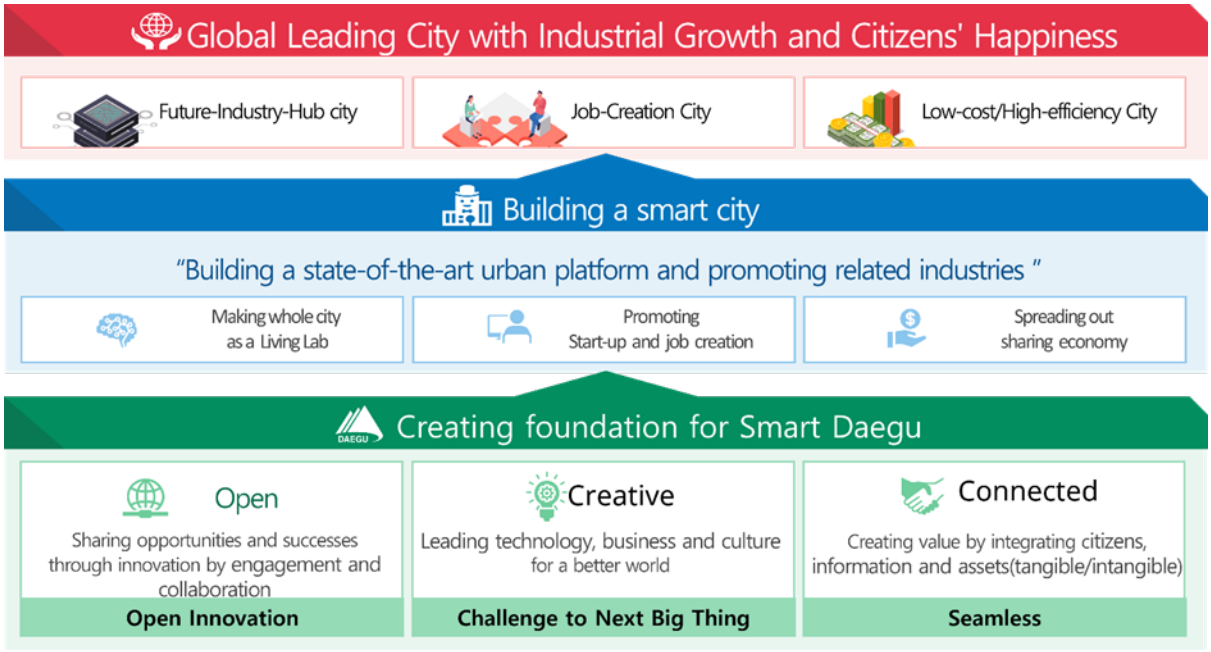
Subsequently, the underground facility management system (in 2019) and the small electric mobility charging and parking station (in 2021) also won the Best Project Award.

Furthermore, in 2018, in line with Daegu's smart city endeavours, the city was selected as a pilot city for the "Smart City Innovative Growth Engine Project".

## 4.2 Smart sustainable city strategy: Daegu's blueprint for its future

The transition of Daegu into a smart sustainable city started in 2016, with the establishment of Future Vision 2030, which laid out a vision on how to transform the city. The vision is illustrated in Figure 5 and contains a final vision for Daegu to be a "Global Leading City with Industrial Growth and Inhabitants' Happiness". A key feature of this vision is that "growth" is linked to "inhabitant happiness".

Figure 5: Daegu's future vision 2030




To further incorporate ICTs as the core of city operations at the national level, in 2018, the Republic of Korea adopted the Act on the Promotion of Smart City Development and Industry. This legislation aims to support national smart city projects to facilitate sustainable urban regeneration, promote innovation, enhance data connectivity and improve the quality of living.

As part of the Republic of Korea's smart city innovation growth engine project, USD 54 million will have been invested in Daegu during the period 2018–2022. The annual smart city budget of Daegu City is USD 17 million.

In 2021, the Daegu Metropolitan City Smart City Plan, an action plan to create a smart sustainable city, was established linking municipal administration goals of Daegu and solutions for urban problems. This Smart City Plan is a legal plan established in accordance with Article 8 of the Smart City Creation and Industry Promotion Act.

**The importance of a master plan**

*"The master plan is to find a direction to move forward based on the current situation and problems. If you find a direction to move forward, you can create areas to focus on. Only then can the city's goals, visions and strategies be established. Therefore, it is most important to establish a master plan."*

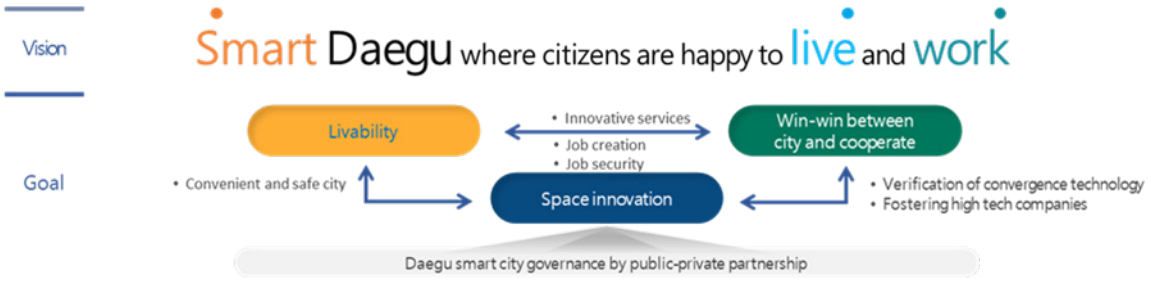
*Daegu Smart City Division Director, Hwang Yoon-Keun*

The Daegu Metropolitan Smart City Plan (2021–2025) aims to resolve various urban problems, securing urban competitiveness and improving the quality of life of its inhabitants. It contains the implementation strategies, discovery of inhabitant-experienced smart city services and the establishment of mid- to long-term comprehensive plans to create a Daegu-type smart city model.[5]

The overall goals of the Smart City Plan are **Liveability**, **Win-win for the corporate sector and the city** and **Space innovation**. (See Figure 6):

- For **Liveability**, Daegu's goal is to provide practical services and expand civic participation.
- For **Win-win for the corporate sector and the city**, Daegu's goal is to create business models that promote high-tech industry.
- For **Space innovation**, Daegu's goal is to pursue opportunities related to digital transformation and regional expansion of smart city services.

Figure 6: Daegu Smart City vision and goals



***"Each city should have a clear direction and plan to become smarter and more sustainable.***

*When establishing the master plan, Daegu City set the direction of creating a smart city where industrial growth and inhabitant happiness are together. We wanted to grow traditional and future industries evenly and develop old and new urban structures together. We are supporting policies that encourage companies to use the entire downtown area as a test bed, and in particular, smart city services must be included in urban regeneration areas. This is to provide business opportunities for companies and to receive convenient services for inhabitants. Therefore, it is necessary to find and include smart city strategies and goals suitable for each city's situation."*

*Daegu Smart City Division Director, Hwang Yoon-Keun*

As illustrated in Figure 7, the plan links the overall city goals of Daegu to city problems to be solved, and then the areas of technical innovation that can be deployed to address these issues. The final piece of the plan, as shown in Figures 7 and 8, links the smart city goals to strategies, action plans and a vision for the future image of Daegu as a smart sustainable city.

Figure 7: Daegu Smart City plan

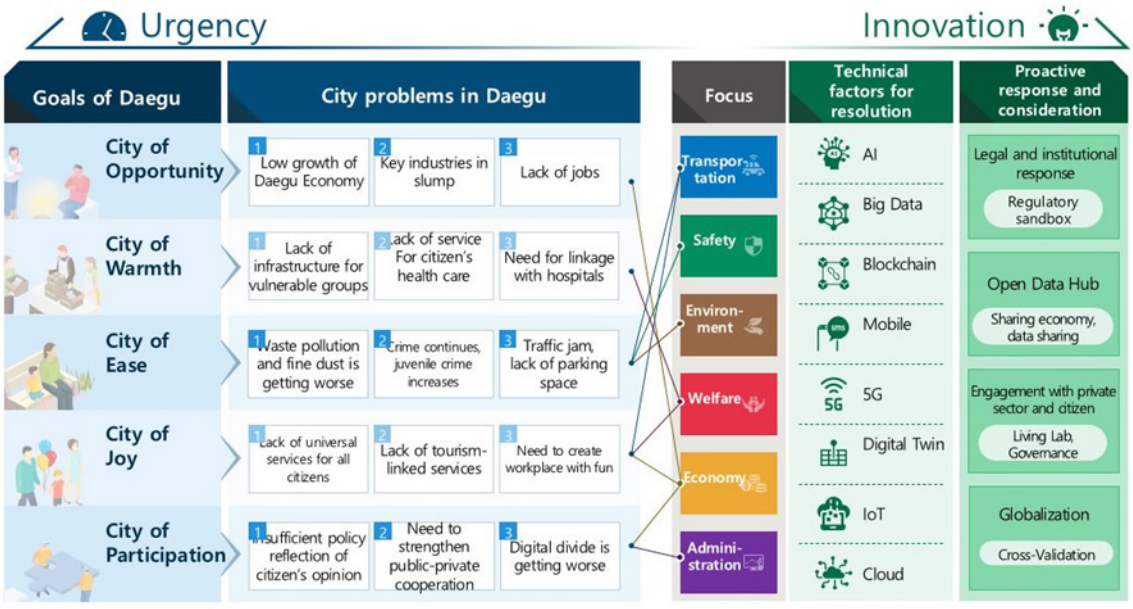
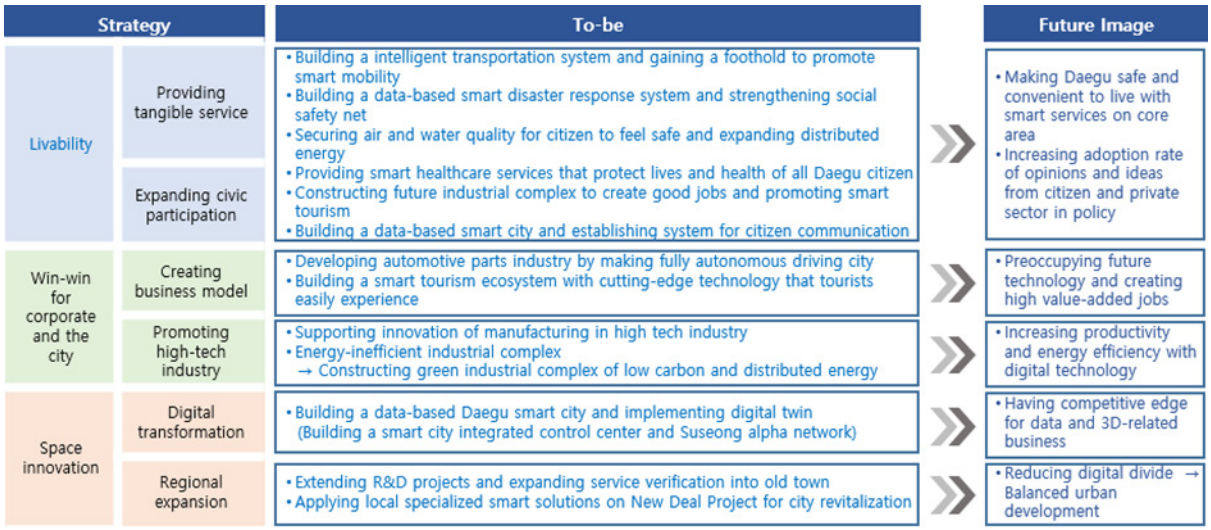


Figure 8: Daegu Smart City strategies and envisioned outcomes




To realize Daegu's Smart City Plan, a Smart City Division was launched as a task force in 2016 and became an official city department under the Innovation Growth Bureau in 2017. The Smart City Division consists of four teams with 22 staff members, including teams for planning, infrastructure, software and the ICT industry, with duties listed below.

***The importance of a dedicated organization, manpower, and the industry-university-institute collaboration governance.***

*"Currently, many of the smart city projects are public-led. To promote public projects, a dedicated organization and dedicated manpower are essential elements within local governments. And industry-university-institute collaboration governance is also essential for inhabitant participation, corporate participation and service discovery. Our city has assigned dedicated manpower to the Smart City Division and has created a Smart City Support Centre with a local university (Gyeongbuk National University). The city oversees policy functions and collaboration between departments within city hall, and the Smart City Support Centre oversees working with inhabitants and businesses. Therefore, it is necessary to have organization, manpower and governance in place to move toward a smart city."*

*Daegu Smart City Division Director, Hwang Yoon-Keun*

a. **Planning Team:** This team conducts smart city research and development, promotes smart city business and applies smart city technology.

b. **Infrastructure Team:** This team supports and fosters the expansion of the smart city system, building and utilizing infrastructure of Suseong Alpha City as a smart city testbed.

c. **Software Team:** This team assists companies related to software, artificial intelligence (AI), virtual reality (VR) augmented reality (AR) / cloud-based services and other ICT convergence

businesses (including providing a testbed, overseas expansion), and trains software engineers in these fields.

d. **ICT Industry Team:** This team assists companies related to the convergence of sports and business and ICTs, drone technologies, laser technologies and 3-D printing, and trains ICT engineers in these fields.

In 2018, to support smart city plans and projects, the Smart City Support Centre was established and has been in operation to support the participation and collaboration of inhabitants and companies, which is the core of the Daegu Smart City Project. The main purpose of this centre is to implement the existing smart city best practices to:

- support the complete smart city cycle (planning, execution and monitoring);
- foster inhabitant participation; and
- gather local expertise and form a variety of networks.

In addition, since 2019, Daegu has been operating a living lab called the *Urban Problem Discovering Community* for facilitating inhabitant participation. Within this living lab, inhabitants pinpoint the city's problems and offer possible solutions. The lab had 151 participants in 2019 and 94 in 2020.

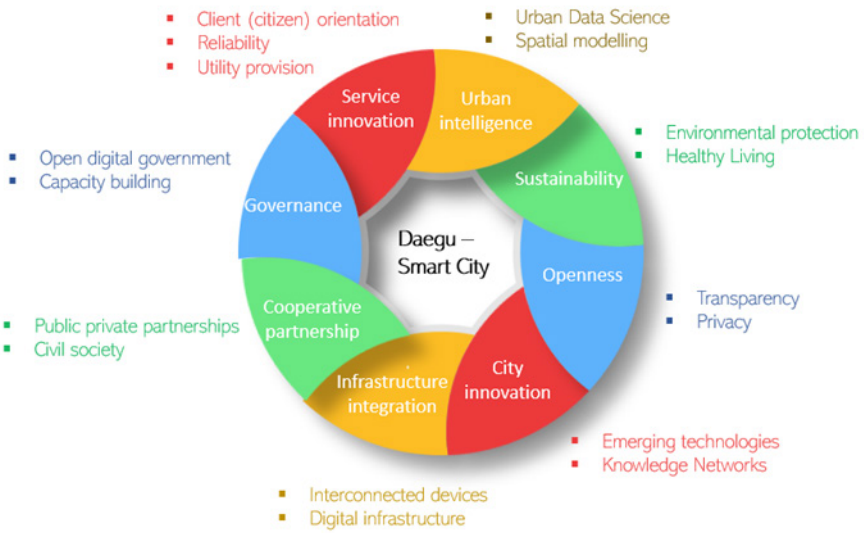
The Daegu Smart City Plan envisions the following:

a. Creation of a refined smart city model directed towards the integration of digital technologies, the adoption of a secure Big Data management system, and the establishment of an index for evaluating progress towards the smart city goals.

b. Driving sustainable growth through the generation of new business models and urban living labs.

The Daegu Smart City Plan is premised on the theme of the "smart economy". In keeping with this, and in accordance with the city's smart city goals, Daegu serves as a testbed for small and medium enterprises (SMEs) working on new and disruptive technologies, and supports companies to grow their business in the city.[6] Daegu expects that its inhabitants will receive benefits from the smart city technology provided by the companies, as the growth and prosperity of these companies is anticipated to foster job creation.

Figure 9: Core areas of focus for Smart City Daegu




***It's about urban data policy.***

*"Establishing policies for city data can be a difficult problem. Our city had many concerns about what data to collect, how to store, process, and how to use it for decision making. We started by creating a data hub and collecting data related to traffic, safety, and city facilities. Afterwards, we challenged ourselves to become a data-based administration by, for example, pursuing the optimization of police patrol points and bus routes. We expect to use data convergence analysis to solve other urban problems in the future. It can be said that it is essential to recognize the importance of urban data and establish a clear direction for the policy."*

*Daegu Smart City Division Director, Hwang Yoon-Keun*

# 5 Daegu - KPI project overview

## 5.1 Background

In 2021, the city of Daegu partnered with ITU to implement the U4SSC KPIs for SSC. The implementation of these U4SSC KPIs in Daegu aimed to quantify the efficacy of the city's smartness and sustainability strategies, while also measuring Daegu's progress in attaining the targets stipulated in the Sustainable Development Goals. Feedback from this project will enable Daegu to assess its performance vis-à-vis its smart sustainable city vision to facilitate better decision making, evaluate the success of new initiatives and set the basis for the refinement of Daegu's Smart City Plan.

The Daegu Smart City Division spearheads the implementation of the Smart City Plan and has also supported the collection of the data necessary for reporting on the different KPIs.

The following sections highlight the three phases of implementing the U4SSC KPIs for SSC in Daegu.

Figure 10: Phases of the ITU-Daegu project


## 5.2 First phase of the project

The first phase of the project entailed the gathering of data by agencies and related authorities, led by the Smart City Division in accordance with the requirements of the U4SSC KPIs for SSC, which are based on Recommendation ITU-T Y.4903: "Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals". The current KPIs are categorized into the three dimensions: 1) Economy, 2) Environment and 3) Society and Culture, with each dimension containing different sub-dimensions, as shown in Tables 2 to 4.

## Table 2 - U4SSC KPI Dimension – Economy

| Dimension | Sub-Dimension | Description |
|---|---|---|
| **Economy** | **Information & Communication Technologies Infrastructure** | • These KPIs aim to assess the availability and use of ICT infrastructure in cities to facilitate smart sustainable city services.<br>• Cities should demonstrate that they have secure and reliable ICT infrastructure, services, and customer-friendly services and devices.<br>• ICT networks and information platforms should contain effective mitigation of possible risks associated with the use of ICTs (e.g., electromagnetic fields, privacy issues and child online protection). |
| | **Innovation** | • These KPIs aim to assess "innovation" in cities, which refers to the city's ability to adjust to changing needs of its inhabitants.<br>• In this context, innovation is proportional to research and development investments, as well as existing patents. |
| | **Employment** | • The related KPIs in this sub-dimension are linked to the employment rate. |
| | **Trade** | • These KPIs provide an overview of the exports and imports facilitated within the boundaries of the city.<br>• E-commerce is also a good indicator of trade in SSC. |
| | **Productivity** | • These KPIs aim to assess the use and impact of ICTs in the economic development of cities.<br>• They cover innovation, job creation, trade and productivity.<br>• These KPIs are also expected to play a pivotal role in assessing a city's adoption of ICTs to support socio-economic growth. |
| | **Physical Infrastructure** | • These KPIs aim to assess the impact of ICTs on city infrastructure, development and sustainability.<br>• Aspects evaluated by these KPIs include infrastructure for the provision of city services, such as water and waste management, energy, sewage, transport, road infrastructure and buildings. |

Table 3 - U4SSC KPI Dimension – Environment

| Dimension | Sub-dimension | Description |
|---|---|---|
| **Environment** | **Environmental Quality** | • These KPIs aim to assess the use of ICTs in supporting urban environmental services and improving the overall environmental quality in cities. |
| | **Energy** | • These KPIs aim to assess the use of renewable and sustainable sources of energy in a city, as well as its energy-efficiency and energy-reduction measures.<br>• The use of energy from renewable sources, along with efficient uses of energy, can lead to the longer-term sustainability of an urban area, provide for more independence of electricity supply and lead to the reduction of GHG emissions related to electricity generation. |
| | **Biodiversity** | • These KPIs aim to provide an overview of the natural environment in cities along with the presence of different native species.<br>• They also account for the indigenous species found in the city. |
| | **Air Quality** | • These KPIs examine quality of air (including greenhouse gases), as this is a factor impacting public health and air pollution. |
| | **Noise** | • The KPIs within this category considers noise exposure level in the city. |
| | **Water and Sanitation** | • These KPIs focus on water resource availability, water distribution, water saving, wastewater treatment, drainage, sanitation, etc. |

Table 4 - U4SSC KPI Dimension – Society and Culture

| Dimension | Sub-dimension | Description |
|---|---|---|
| **Society and Culture** | **Education, Health and Culture** | • These KPIs aim to assess the impact of ICTs to improve inhabitants' quality of life. They focus on areas such as education, health and city safety, among other aspects related to quality of life within the city. |
| | **Safety, Housing and Social Inclusion** | • These KPIs aim to assess the impact of the use of ICTs to promote urban equity, inhabitant participation, and to enhance social inclusiveness.<br>• They focus on qualities such as equity, governance, city openness and public participation. |

To provide additional guidance to the city on the collection of the data for the KPIs, ITU developed the Collection Methodology for Key Performance Indicators for Smart Sustainable Cities. This provides calculation methodologies, potential data sources, linkages to SDGs, background on

the rationale, among other items, on each of the 91 KPIs. The collection of data for each KPI was organized and facilitated by the Smart City Division. Data were collected and reported for the majority of the KPIs (97 per cent) and could then be used as the focal point for analysis of Daegu for the period 2020–2021.

The data-collection process was coordinated with the departments, agencies and entities listed in Table 5.

### Table 5 - Key entities involved in Daegu's smart sustainable cities (SSC) project

| Entity | Function |
|---|---|
| Planning and Coordination Office | This office is composed of a policy department, a budget department, a digitalization department and a data statistics department.<br>The entity in charge of establishment of major city policies, budgeting and control, data and statistical analysis. |
| Inhabitant Safety Office | This office oversees disaster-related tasks such as disaster response, recovery and prevention, and establishes safety policies for the city. |
| Economic Bureau | This bureau is composed of departments that promote local economy, establish industrial complexes, foster machine/robotics and textile/fashion industries, and manage agricultural and fishery products and oversee the city's economic policy. |
| Job and Investment Bureau | The bureau is composed of departments that support job creation, business attraction, start-up promotion, youth activity support and social economy. |
| Innovative Growth Bureau | This department fosters businesses with high growth potential such as medical care, future car, water, energy, and smart city. There is a Smart City Department in the Innovative Growth Bureau, which oversees the smart city transition of Daegu. |
| Urban Redevelopment Bureau | This bureau consists of departments in charge of urban planning, urban regeneration, urban landscape, construction, architecture, housing and cadastral tasks. This bureau is also in charge of urban planning. |
| Local Government Bureau | The bureau consists of departments that handle communication infrastructure management, civil society cooperation, civil affairs and procurement. |
| Welfare Department | The department oversees welfare for the vulnerable groups such as the elderly and the disabled. It also oversees the welfare of the city. |
| Inhabitants' Health Bureau | This department oversees health, medical care, health promotion and food hygiene. A department dedicated to infectious diseases has been established to deal with COVID-19. |
| Bureau of Women and Youth Education | This bureau is composed of departments in charge of women, youth, childbirth, childcare, and education support. |
| Culture, Sports and Tourism Bureau | This bureau is composed of departments that promote and establish policies for industries related to culture, sports and tourism, and establish policies. |

| Entity | Function |
|---|---|
| Green Environment Bureau | This bureau consists of departments that manage natural ecology, noise, air, waste, recycling, water quality, parks and green areas. It oversees the establishment of city environmental policy. |
| Transportation Bureau | This bureau consists of departments that manage traffic safety, eco-friendly transportation, public transport, automobiles, roads and railroads. It establishes city traffic policy. |
| Fire Safety Headquarters | The headquarters oversee fire prevention and suppression, rescue and first aid. |
| Waterworks Authority | The Waterworks Authority is responsible for providing tap water in Daegu. |
| Daegu Office of Education | This office oversees operation of curriculum, promotion of science and technology education, promotion of social and art education. It supports the operation of schools under its jurisdiction. |
| SK Telecom | SK Telecom is a leading mobile telecommunication service company in the Republic of Korea. |
| Korea Electric Power Corporation | This corporation provides the electricity supply service in the Republic of Korea. |
| Daesung Energy | This company provides natural gas in Daegu. |
| Daegu Metropolitan Police | The Daegu Metropolitan Police is responsible for the overall safety and security of the city. It also supports traffic management and forms a part of the urban emergency services. |
| Daegu Environmental Corporation | This corporation is entrusted with sewage treatment and waste incineration by Daegu. |
| Daegu Infrastructure Corporation | This corporation is entrusted with the management of sports facilities, roads, streetlights, public parking lots, and other infrastructure by Daegu. |
| Daegu Urban Corporation | This corporation implements regional development such as housing site development and industrial complex development, improvement of the residential environment, and supplies rental housing. |
| Daegu Metropolitan Transit Corporation | This corporation operates and maintains Daegu Urban Railway Line 1, 2, and 3. |

This phase concluded with the KPI data submission by Daegu.

## 5.3 Second phase of the project

ITU assigned an independent auditor to verify the data based on the U4SSC KPIs. Following this process, Daegu is also expected to provide feedback on the applicability of the U4SSC-KPIs, as well as further suggestions on how Daegu and other cities could ease the process of data collection during interim reviews of smart city strategies.

The verification process involves the following series of steps:

- Interviewing city stakeholders, including staff of the Smart City division

- A review of the underlying data sources
- An analysis of the veracity of the data submitted (to determine whether the data are primary, secondary or tertiary)
- Verification that the data submitted by Daegu are in conformance with the requirements of the Collection Methodology for Key Performance Indicators for Smart Sustainable Cities.

This phase concluded with the publishing of a city snapshot and verification report, the results of which are highlighted below.

### Verification results

The verification process of Daegu reporting on the U4SSC KPIs disclosed the following findings:

| Total number of KPIs | 91 |
|---|---|
| KPIs verified: | |
| Data presented met the requirements of the KPIs and were verifiable | 88 |
| No data reported | 3 |

The results were provided to Daegu in a formal verification report in 2021.

Table 6 depicts the number of KPIs reported and verified through the verification process in the three dimensions of the U4SSC KPIs.

Table 6 - Number of U4SSC KPIs successfully reported by Daegu

| | Total | Reported | Verified | % KPIs Verified |
|---|---|---|---|---|
| **Economy** | | | | |
| Core KPIs | 23 | 23 | 23 | 100 % |
| Advanced KPIs | 22 | 20 | 20 | 91 % |
| **Environment** | | | | |
| Core KPIs | 12 | 12 | 12 | 100 % |
| Advanced KPIs | 5 | 4 | 4 | 80 % |
| **Society & Culture** | | | | |
| Core KPIs | 19 | 19 | 19 | 100 % |
| Advanced KPIs | 10 | 10 | 10 | 100 % |
| **Overall** | | | | |
| Core KPIs | 54 | 54 | 54 | 100 % |
| Advanced KPIs | 37 | 34 | 34 | 92 % |
| **Total** | 91 | 88 | 88 | 97 % |

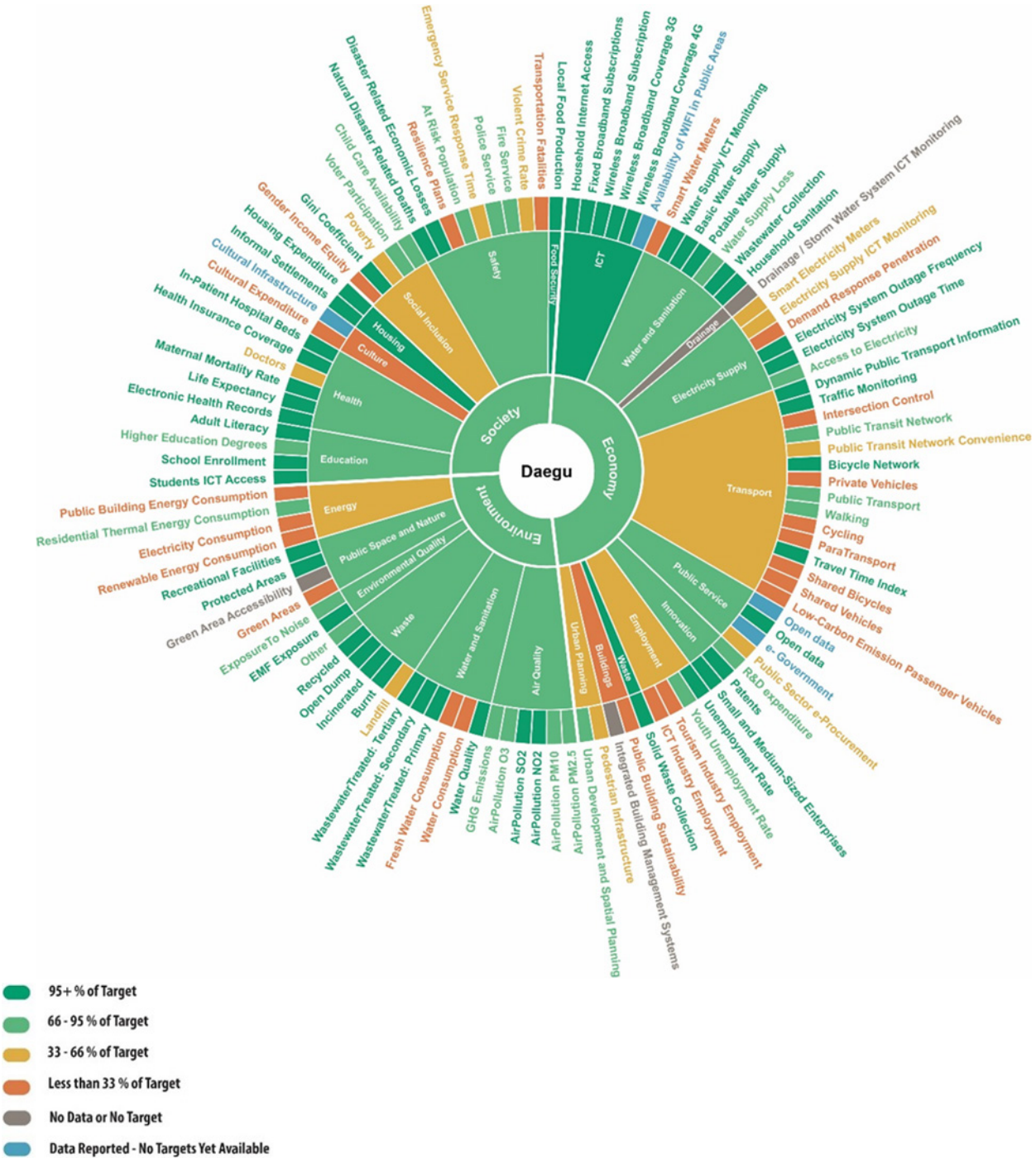
As a key element of the U4SSC KPIs project, benchmarks were developed for most KPIs, followed by a visual benchmarking "wheel" graphic to demonstrate to cities how their performance could be reported.

The benchmarks were set based on several factors:

- Fully meeting the aligned SDG(s)
- Performance compared with other international and transnational targets (e.g., OECD, European Commission)
- Performance against a UN agency's goals (e.g., International Telecommunication Union)
- Evaluation of city performance using UN and other international statistical data
- Performance measured versus leading city performance globally.
- Performance measured versus leading city performance globally.

Presented in the Figure 11 is the benchmarking result for Daegu based on the U4SSC KPI data provided.

Figure 11: U4SSC KPIs - Benchmarking visualization for Daegu (2021)



## 5.4 Third phase of the project

The final phase of the project involved the preparation of this case study.

The objectives of the case study are to:

1. Provide an overview of the project partnership between Daegu and ITU.
2. Underscore the key initiatives and activities relating to Daegu's Smart City Plan.
3. Evaluate the compatibility of the U4SSC-KPIs with Daegu's Smart City Plan.
4. Highlight opportunities for improvement in the city's current initiatives.
5. Provide recommendations to Daegu in relation to its smart city endeavours.
6. Highlight the importance of creating an environment for a business-friendly ecosystem to enhance the value proposition of smart city services.
7. Extend advice to aspiring smart sustainable cities to bridge the knowledge gaps in the implementation of the U4SSC-KPIs and the smart city concept.
8. Offer feedback to help revise the U4SSC KPIs in keeping with technological advancements, demographic changes and the availability of funding.

The Smart City Division has outlined the following expected outcomes from the publication of this case study:

- Understanding the current shortcomings of Daegu's smart strategy
- Sharing best practices with aspiring smart cities to provide them with the required guidance to initiate their own smart city journeys.

The following are the target audiences for this published case study:

- The Republic of Korea Government and local governments of other cities, including Seoul and Busan.
- Megacities in the Asia-Pacific region.
- Civil society in the Republic of Korea.
- Academia and non-profit organizations working on smart cities.

# 6 Daegu Initiatives – A holistic approach to building a smart sustainable city

The Republic of Korea has been a pioneer in the quest for creating smart cities since the mid-1990s. The country transitioned from an economy based on textile and clothing industries in the 1970s to

a nation with progressive heavy and chemical industries such as steel and chemicals in the 1980s. Since the 1990s, the Republic of Korea has achieved structural advancement in terms of capital and technology-intensive industries such as automobiles and semiconductors. This has translated into the country embracing ICTs for enhancing sustainability, liveability and productivity to spur a wave of smart urbanism. Supported by three Ministries, the National Smart City Programme in the Republic of Korea encapsulates a series of initiatives aimed at data-driven decision making, enhanced inhabitant engagement, promoting digital equity, generating economic opportunities, and improved infrastructure for the delivery of services.

As Daegu endorses new initiatives as a part of its Smart City Plan, the city's implementation of the U4SSC-KPIs will provide relevant insights into the following aspects:

- Alignment of the U4SSC-KPIs and the National Smart City Programme, which dictates the future trajectory of Daegu's Smart City Plan.
- Refinement of the KPIs to improve their applicability across various regions, including the Asia-Pacific region.
- Utilizing the U4SSC-KPIs to gauge the progress of specific initiatives under the umbrella of Daegu's Smart City Plan.
- Creation of a business environment to encourage tech-based small and medium enterprises (SMEs) and defining additional KPIs for measuring progress on the front to boost avenues for employment.

The ensuing sections will examine how Daegu's current smart initiatives correspond to each of the three dimensions of the U4SSC KPIs, namely 1) Economy, 2) Environment and 3) Society.

## 6.1 Dimension: Economy

To envision and ensure quality of life for its inhabitants, urban spaces are evolving to integrate ICTs for improved services. Previously, the Republic of Korea championed eco-city initiatives to transform its urban centres into carbon-neutral and sustainable cities. This premise of establishing eco-cities (aimed at protecting the natural environment) was combined with the subsequent National Smart City Programme, which aims to adopt state-of-the-art technologies for overall urban planning, development and management. In keeping with this nationwide Smart City Programme, cost-effective urban services related to transport, manufacturing and education have been introduced (based on the linkage between data and service systems), and supported by a high level of network connectivity, the introduction of 5G and high penetration of mobile devices.

An adequate degree of collaboration between public and private entities offering various services has also enabled the rollout of a secure IT infrastructure, which ensures a high level of personal data protection.

Some of the relevant initiatives within this dimension have been elaborated upon in the following sections.

Figure 12: Daegu smart optical telecommunication centre


### 6.1.1 Intelligent transportation

To facilitate the adoption and commercialization of autonomous vehicles, Daegu launched its first Advanced Driver-Assistance Systems (ADAS) demonstration facility in 2017, as part of the national government's "Digital New Deal Programme". Furthermore, in partnership with car manufacturers, Daegu is working towards the creation of additional testbeds for the implementation of ADAS technologies (and addressing the feasibility of different SAE levels of automated driving), to improve the technological maturity of self-driving car models available on the market.

Daegu's public transport system spans the metro, trains and buses. To promote the use of these public transport channels and foster ease of transport within the city, Daegu has introduced pre-paid smart transportation cards, which can be used in the largest metropolitan cities of the country, including Daegu and Seoul. Available at a reasonable price of USD 2, the card is also embedded with an automatic recharge function if the balance of a traveller runs low on credit.

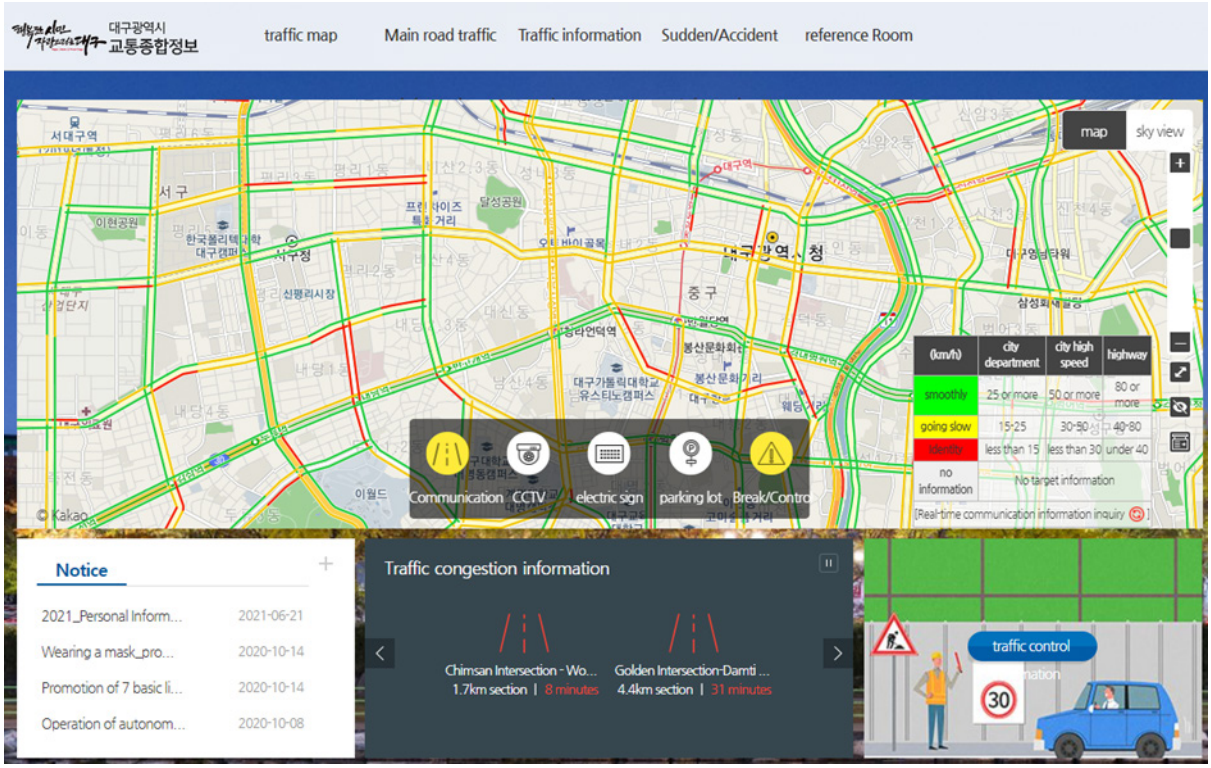
### 6.1.2 Intelligent traffic management based on Artificial Intelligence

Daegu has also implemented an Intelligent Transportation System (ITS) to provide traffic information and direct traffic in congested areas. The ITS provides real-time traffic information and consists of the Advanced Traffic Management System (ATMS) and the Urban Traffic Information System (UTIS).

These systems automatically operate and manage the traffic system to improve efficiency and ensure safety.

Starting in 2009, Daegu has implemented the ATMS in three phases to provide drivers with real-time traffic information (e.g., travel time, speed). ATMS solves and traffic problems such as traffic congestion and longer emergency response times. It also helps to establish efficient traffic policies by analysing accumulated traffic information.

Figure 13: Screenshot of traffic information website http://car.daegu.go.kr/




Traffic information is collected in real time from roadside base stations, vehicle detector systems (VDS) and closed-circuit television (CCTV) installed on major arterial roads. This information can be checked in vehicle terminals, roadside electronic signs, websites, and on mobile devices.

In addition, the Urban Traffic Information System (UTIS) was built between 2013 and 2014 to manage traffic flow efficiently by distributing traffic in congested areas by providing optimal route information to destinations reflecting real-time traffic conditions of roads.

The UTIS collects traffic information (travel route, location, speed, etc.) by road section from on board equipment (OBE) installed in major cities across the country by the National Police Agency, such that drivers can select a driving route to their destination using real-time information including CCTV images transmitted to their navigation system.

Figure 14: Traffic variable message sign


With real-time traffic volume analysis, it will be possible to provide civic-oriented traffic services such as:

- optimal navigation routes;
- remaining time for traffic lights;
- information on the need to bypassing areas for emergencies and school opening and closing times;
- priority signal control for emergency vehicles; and
- pedestrian detection at crosswalks.

Leveraging the potential of Artificial intelligence (AI) in traffic monitoring and management, autonomous public transport systems, autonomous and assisted driving, and road safety management, Daegu intends to build an AI-based (adaptive), smart transportation system, which will encompass a wide range of features, including real-time traffic monitoring and analysis, as well as an intelligent traffic control system by the year 2023.

The anticipated CCTV installations at 250 major intersections will provide the data to support such a system. The envisioned smart transportation system will also allow for emergency vehicle priority, obstacle/accident detection, automated hazard zone warning, signal control, optimal route guidance, and securing pedestrian zones.

The goal is to make it a smart city platform that will be used to improve the quality of life of the inhabitants.

### 6.1.3 Bus Management System (BMS)

Figure 15: BMS signs

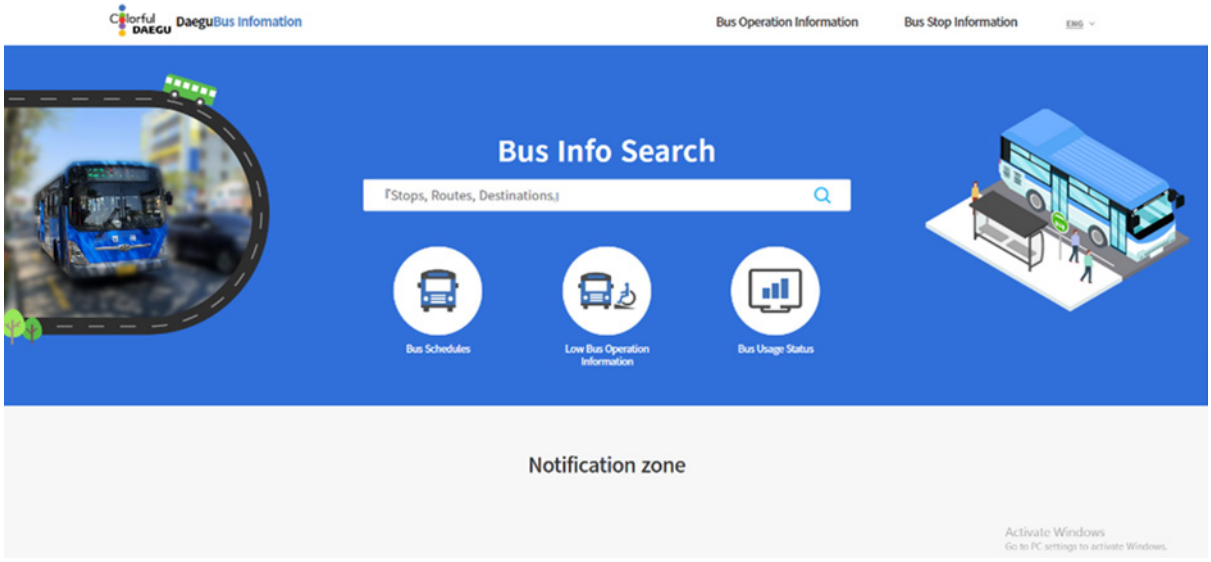

Daegu implemented a Bus Operation Management System (BMS) in August 2006. As of 2020, the Daegu BMS allows for real-time information to be displayed at each of the 3 226 bus stops and individual bus locations to mitigate traffic congestion in the city centre, ensure on-time arrival of buses and comply with dispatch intervals.

Anyone can search for bus information easily by accessing the Daegu City bus information system through their smartphone or PC.

In addition, bus information guides have been installed at major stations since 2012, allowing inhabitants to check bus arrival times, and current time and weather information without additional equipment.

By continuously expanding the installation of bus information guidance devices, Daegu plans to continue to promote an environment in which all inhabitants can receive accurate bus information.

Figure 16: Screenshot - Daegu bus information website



### 6.1.4 Data-driven smart sustainable city

Since 2016, Daegu has been testing and deploying various smart city services such as Smart Park (Public Wi-Fi, Solar Bench, Smart Bin, Smart Lighting), AMI and Smart Energy (Smart Grid, Micro-Grid) services in various city districts. The goal has been to verify the adequacy of these smart sustainable city services and technologies.

After testing these services, if it is determined that the service can improve the quality of life of the inhabitants it will be extended to the entire city of Daegu.

However, these smart city services/solutions were conducted in a silo, which meant that each service platform was built and operated separately for each service and/or solution.

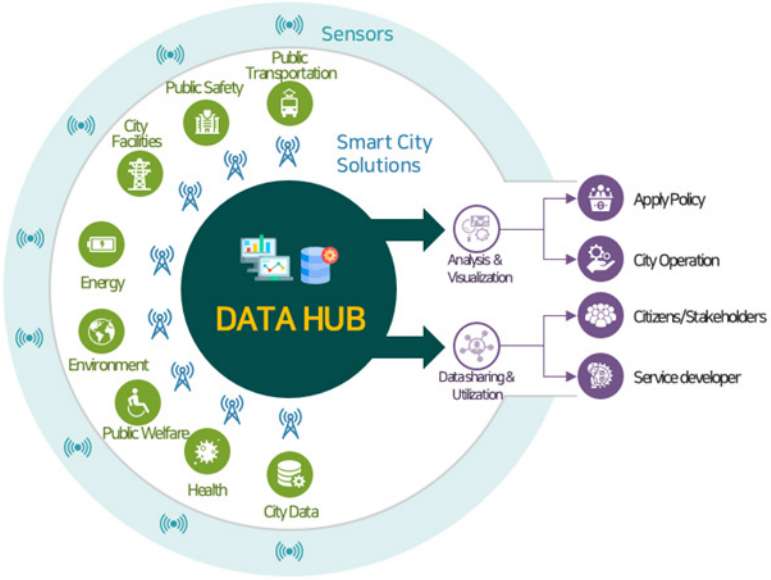
The problem with this silo method is that the service system structures and complexities that exist, and the data collection, are operated by each individual sector/silo and are, therefore, not interconnected.

To address the issue of interconnectivity, Daegu established the Suseong Alpha Test-bed Platform in new city areas for integrated smart city services/solutions and verification. There are currently thirteen services and/or infrastructure deployments in five areas under the Suseong Alpha Test-bed Platform performing integrated collection, storage and management of data. Services include City Management (underground facility management, communication infrastructure), Smart Energy (electric vehicle charger), Smart Mobility (connected car driving road, pedestrian safety information, illegal parking, unmanned parking system), Smart Safety (smart streetlight, living safety CCTV, licence-plate recognition CCTV) and Smart Living (smart media wall, smart working, digital signage).

As more data from the various smart services/solutions are collected, Daegu City has begun to review measures to solve urban problems using the collected data, and to actively promote data utilization by inhabitants and the private sector. Daegu believes that the core value of a smart sustainable city is the utilization of data. This utilization of data is essential for the transformation to a data-driven smart sustainable city that can solve city and inhabitant issues.

Recognizing this necessity, in 2018, the national government selected Daegu as a data hub demonstration city and is building a data hub together with SK Telecom.

Figure 17: Visualization of the Daegu data hub concept




The purpose of the data hub is to support city operators to:

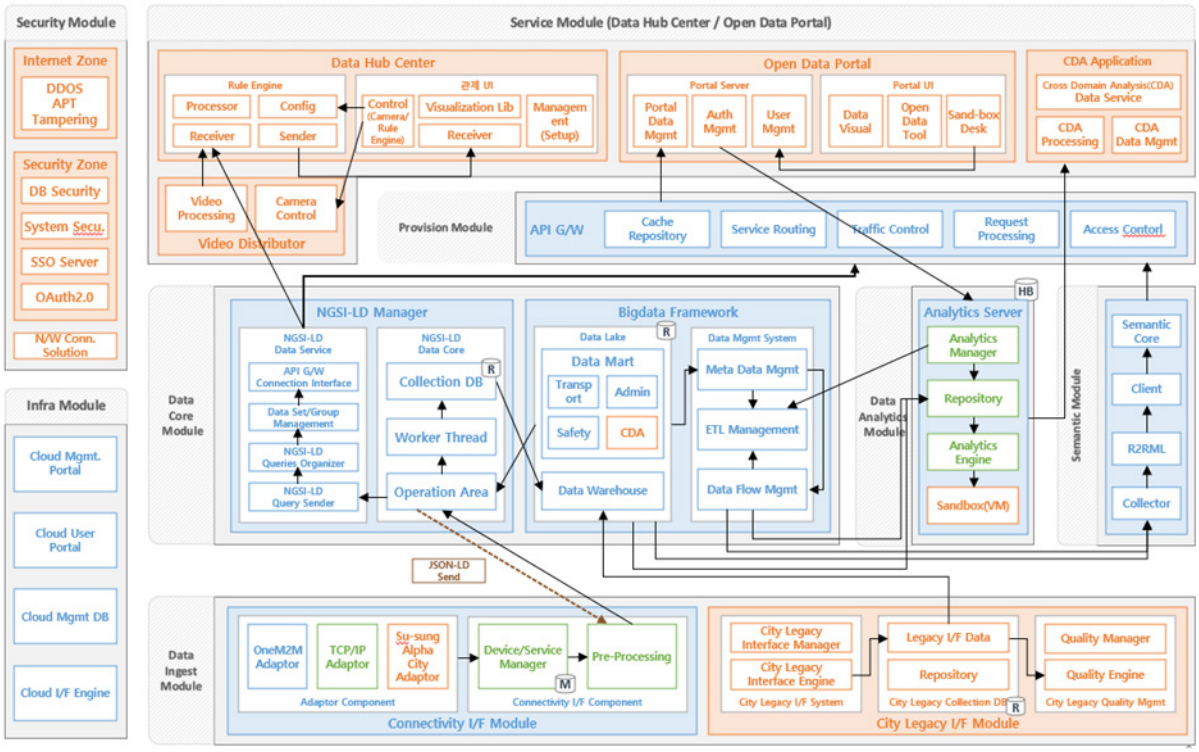
1. Collect, store and manage city data
2. Provide cross-domain analysis
3. Suggest solutions to urban problems
4. Provide the private sector and inhabitants with open data to solve various urban problems

Daegu has decided to use the data hub as a city operations platform for data-driven smart sustainable city operations.

In the first phase, all the data from Daegu will be collected, stored and managed in the data hub. Daegu legacy data will be transmitted directly to the data hub, and various city data streams such as traffic, safety, and urban facilities will be transmitted from current city service platforms to the data hub.

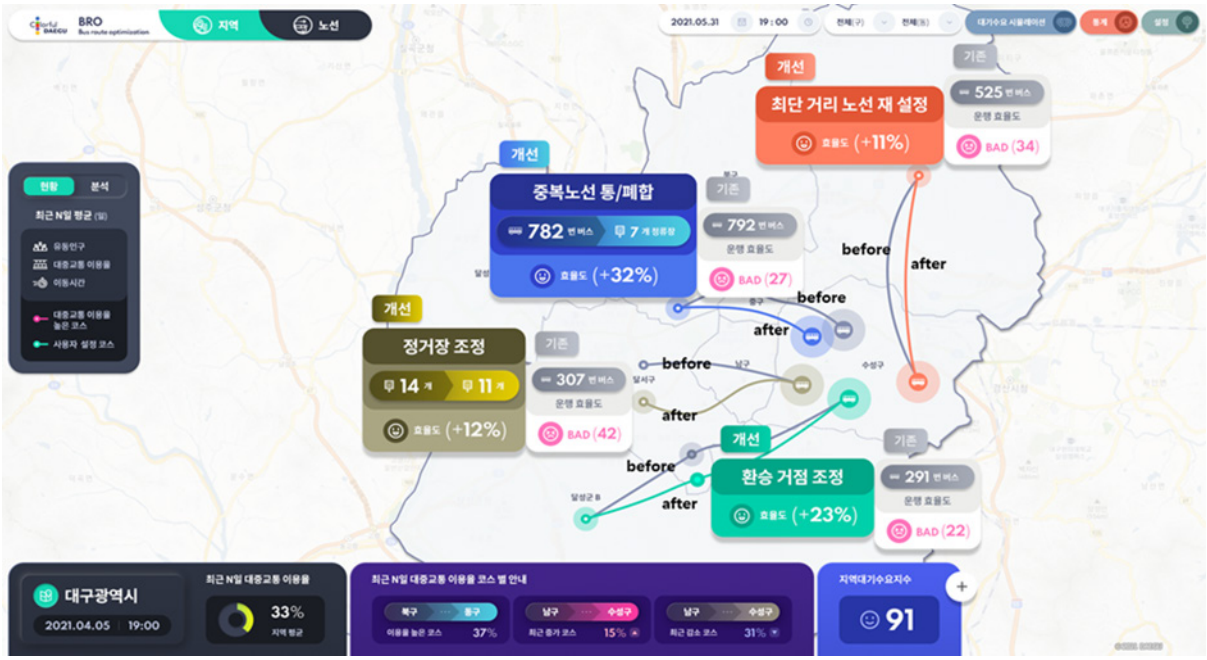
Among the many issues that could potentially be solved through data analysis, bus route optimization and building a city safety infrastructure were selected as the most urgent tasks. A cross-domain analysis algorithm to solve these issues will be developed and city operators will be provided with solutions. In addition, an open data portal will be built and operated so that data can be opened and utilized by private and public institutions. The first phase will be completed in 2021 and is scheduled to become operational in 2022.

Figure 18: Data hub architecture



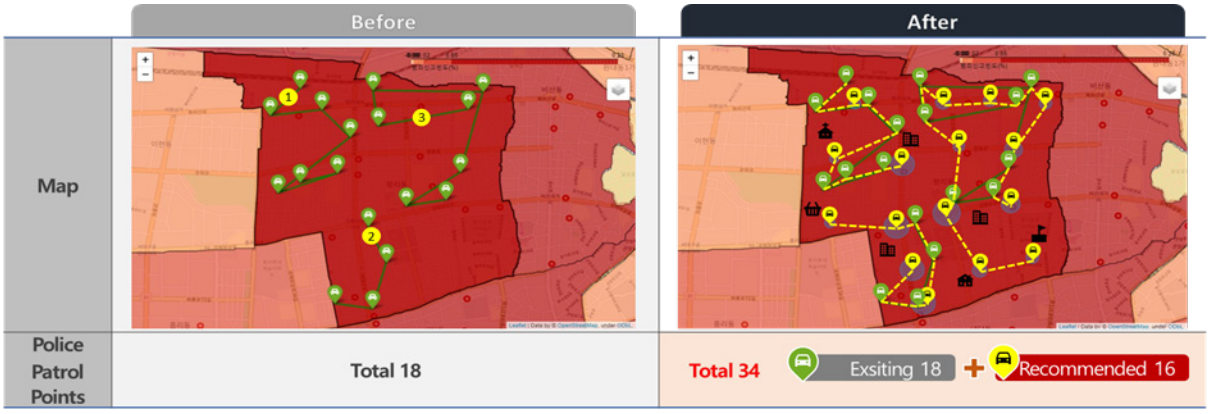

The Data Hub is defined as a total of eight modules: Data Ingest, Data Core, Data Analytics, Semantic, Provision, Service (Monitoring, Open Data Portal, Cross-domain Analysis), Security, and Infra Module. The Data Hub collects data with a OneM2M standard interface and supports protocols such as HTTP, MQTT, TCP/IP, and applies ESB (Enterprise Service Bus) technology in response to the inflow of large amounts of data. Incoming data are stored and managed in a data lake with Big Data (Hadoop, HDFS, etc.) technology applied, and the relationship between data is analyzed by managing it in the NGSI-LD data format adopted as the data standard of the system.

Figure 19: Bus route optimization




Bus routes optimization will provide the most basic methodology for creating a comfortable urban environment through efficient bus operations, energy savings, and a reduction of $CO_2$ and particulate matter. To this end, Daegu city's traffic data (bus, subway, private car), people movement data and housing data will be used to provide city operators with measures to establish, adjust and remove bus routes.

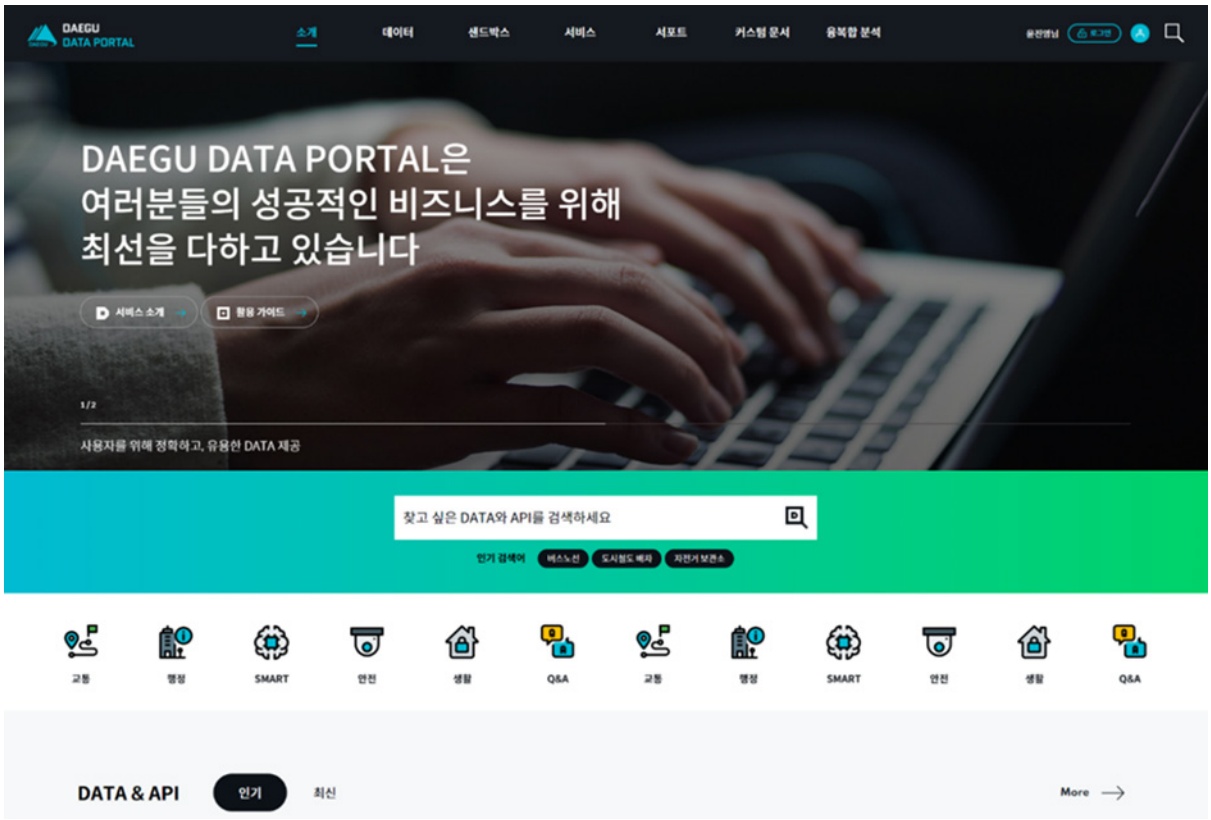
Figure 20: Optimal police patrol routes




The purpose of building a city safety infrastructure is to provide analysis results for optimal CCTV placement and optimal police patrol routes using police data, CCTV data and people movement data. To optimize police patrol routes, a pilot test was conducted in five areas of Daegu from

November 2019 to February 2020. A result of the pilot test was that crime reports decreased by 16.3 per cent and the five major crime rates (murder, robbery, rape, theft and violence) decreased by 18.6 per cent. Based on these positive results, Daegu city plans to extend optimal police patrol routes to the entire city of Daegu.

Figure 21: Open data portal




The Data Hub provides a data portal for inhabitants to provide public data according to the city's data governance structure. Inhabitants can receive data visualization, Open API and Data Analysis sand-box services according to their level of expertise in data utilization. The city data within the data hub can be visualized for easy understanding by inhabitants and can be checked freely in a web environment. Inhabitants with higher professional knowledge can access the Big Data environment and receive an analysis environment in which they can perform actual data analysis.

The Data Hub applies the S/W system for blocking poor data inflow through a quality-control function for input data. The S/W system is also used for overall data management, authentication management for output data, and for data-traffic management. Security and safety are ensured by physically dividing the area where configuration and data are stored and utilized, and by the configuration of security equipment such as APT, DDoS and SIEM.

The city of Daegu plans to operate the Data Hub in 2022, develop algorithms for long-term and continuous solution to urban problems, and upgrade the Data hub by securing new data to utilize it as an urban operations platform.

### 6.1.5 Daegu smart city operation model

Daegu recognizes that in order to realize a data-driven smart sustainable city, the existing urban operation system must be converted into a smart sustainable city operations system. Accordingly, Daegu is reviewing smart sustainable city strategies, inhabitant-centred smart sustainable city operations, and systematic management and evaluation guidelines to make this happen. The intention is to convert the existing city operations model based on departments or tasks into an integrated city operation model suitable for a data-driven smart sustainable city. As a first step, SK Telecom's smart city operations model was applied to Daegu.

#### 1. City operation framework

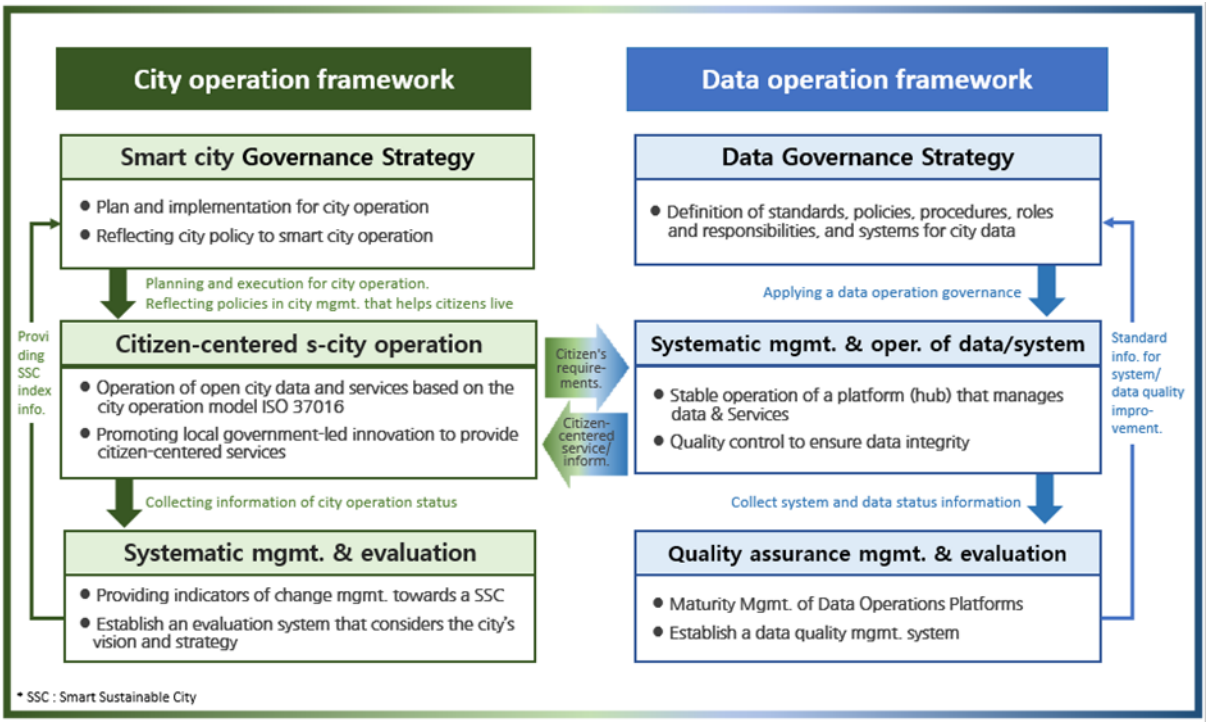
Daegu aims to implement a smarter and more sustainable city through the formulation of a smart sustainable city strategy based on an inhabitant-centred city operations, systematic management and evaluation through the conversion of the existing city operations model into a city operations framework. Globally, the standards and operational directions that smart sustainable cities have in common is their aim to attain SDG17 – *Strengthen the means of implementation and revitalize the global partnership for sustainable development* – which is expected comprehensively to lead to the happiness of inhabitants' lives in urban areas.

#### 2. Data operation framework

To enable data-driven city operations, Daegu will collect, store, manage and analyse all city data beyond the existing smart city service-oriented silo form, and share data with various city stakeholders such as inhabitants, local governments and private companies. Daegu aims to establish and operate a data management/operation framework that can be utilized for smart and more sustainable city operations.

The smart city operation model is as follows:

Figure 22: Daegu smart city operation model




The two frameworks will become one ecosystem, which implements a system that realizes a sustainable smart city. In other words, the data collected, stored, managed, analyzed, shared and utilized through the data operation framework will be leveraged as a base material for city operation and create a mechanism for realizing a more Smart Sustainable City.

Daegu City built the governance system in 2021 and collected indicators for an evaluation system for the city, including the U4SSC KPIs. The city will customize and implement them step by step from 2022.

This focuses on the success of sustainable cities in the future by generating more data, and by how well they utilize it to create value added data and services that improve inhabitants' lives.

### 6.1.6 Smart manufacturing and business ecosystem

Smart manufacturing systems are driven by the utilization of technologies derived from areas of emerging research, including robotics, machine learning and the Internet of Things (IoT) to monitor real-time production rates to meet changing demands. In this context, Daegu is promoting the expansion of smart factories, which is predicted to facilitate a 30 per cent process improvement

and a 40 per cent quality improvement. In due course, the city aims to convert 50 per cent of the general factories into smart factories, based on the needs of the manufacturing industry.

Daegu also plans to improve the competitiveness of local manufacturing companies by suggesting a regional-specific strategy and providing continuous management support.

### 6.1.7 Telecommunication infrastructure

To reduce the annual rental cost of telecommunication lines and respond to the new demand for telecommunication, Daegu established its own network. Starting in 2016, the project involved three phases of deployment.

In the first phase of the Daegu communication network, 125 km of the backbone network was constructed. In the second and third phases, an additional 605 km of sub-networks and access networks were laid out.

Daegu now has an optical cable network of 730 km to connect the 354 administrative agencies in the city.

Daegu has also now secured its own communication infrastructure that handles all online administrative tasks such as telephone, Internet, civil service, CCTV, transportation, disaster management, firefighting and the environment.

In addition, Daegu is planning to construct an IoT wireless network across the city leveraging its own optic communication network, with connection to wired networks, public and shared Wi-Fi networks, and its own IoT network by 2023, to ensure that it will have the "Daegu One Network".

The IoT network will be used for expanding the remote metering of the water supply and will be linked to the IoT services such as streetlights, street parking lots and environmental sensors.

## 6.2 Dimension: Environment

The prospect of leveraging new technologies for community-based environmental monitoring has opened new avenues for real-time monitoring of various environmental variables, which can have a positive impact on the quality of life in the city through communication and knowledge sharing. The second dimension of the U4SSC KPIs related to environmental aspects is dedicated to various aspects of sustainability and monitoring of environmental conditions (including air and water quality), liveability (e.g., accessibility to adequate green space).

The recent key environmental smart sustainable initiatives in Daegu are explored below.

### 6.2.1 Air quality information system and fine particulates reduction

Air pollution monitoring stations have been installed at 18 locations across Daegu to provide air quality information on particulate matter ($PM_{2.5}$ and $PM_{10}$) and ozone concentrations in real time.

Inhabitants can check the air quality readings through a website, as shown below in Figure 23.

In addition, information is provided through air pollution alerts and air information forecasting notification services to minimize damage caused by respiratory diseases, particularly to the elderly and children.

Figure 23: Screenshot of Daegu air quality website https://air.daegu.go.kr/open_content/ko/index.do

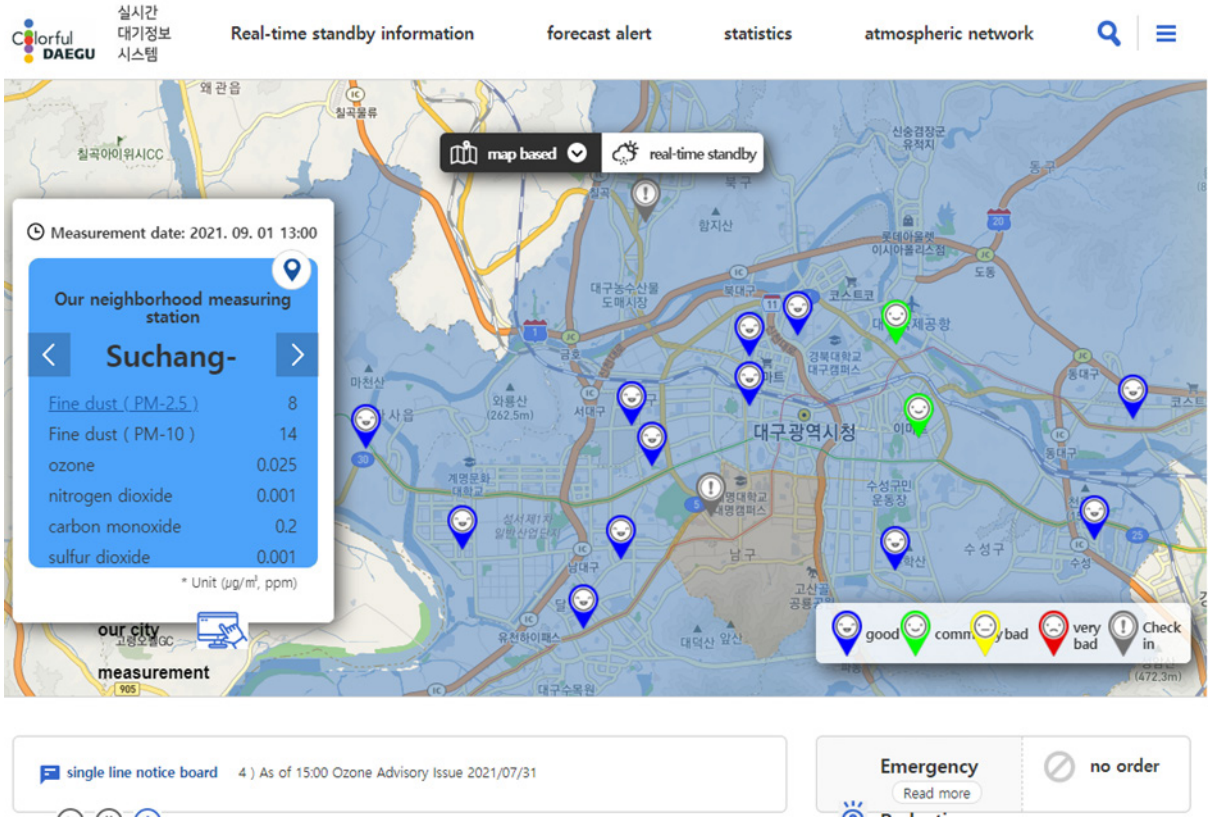


Figure 24: Daegu air quality traffic lights

In addition, fine particulate matter traffic lights are installed to display colours (blue, green, yellow and red) according to the concentration of fine particulates through real-time atmospheric information such that the concentration of fine particulates can be checked by inhabitants and commuters.

To reduce fine particulate re-scattering from the roads, a demonstration was carried out by installing a dampening wall at Dong-il Elementary School in Daegu.

By installing 30 dampening walls at a distance of 60m, fine particulates are collected and discharged automatically to the sewer using the vehicle wind and a gravity particulate collection method generated when a vehicle passes by. This new pilot system is 5.6 times more efficient at collecting fine particulate matter than current systems (based on daily collection of particulates of $PM_{10}$ - 289 mg/m2 vs 51.4 mg/$m^2$). This has the same effect as creating a forest of about 70 m in length by planting trees 5 m apart between the driveway and the sidewalk.

### 6.2.2 Urban greening policy promotion (Green Daegu)

To create a more beautiful and pleasant urban landscape, Daegu has been promoting the Green Daegu Planting Project since 1996. Daegu has planted 44.4 million trees as follows:

1st Planting:

10.93 million trees from 1996 to 2006

2nd Planting:

12.08 million trees from 2007 to 2011

3rd Planting:

11.64 million trees from 2012 to 2016

4th Planting:

9.75 million trees from 2017 to 2020

Figure 25: Daegu Arboretum

Through this project, more green areas and parks are available and can be enjoyed by residents for recreational activities. Other benefits include the reduction in airborne particle matter and the mitigation of the urban heat island phenomenon.

### 6.2.3 Carbon neutrality

To enable the city to deal with climate change, Daegu is taking the lead in promoting carbon neutrality in the region. As carbon neutrality is a task that can alter societal needs, systematic communication and collaboration are required in a wide range of fields. In this context, the Daegu Metropolitan City Carbon Neutral Citizens' Council was formed recently as a community governance mechanism that encompasses carbon neutrality in general. In this consultative body, the government plans to establish and implement policies in eight areas by promoting strategies for 2050 carbon neutrality implementation, annual greenhouse gas reduction, carbon neutrality demonstration and commercialization projects, along with raising awareness on the importance of carbon neutrality within the smart city domain.

| Field | Major related departments | Policy tasks |
|---|---|---|
| Climate Environment | Department of Climate Atmosphere | • Establishment of policy foundations such as core institutions and finances<br>• Management and evaluation of greenhouse gas reduction implementation |
| | Environmental Policy Department | • Ecological restoration and management<br>• Environmental education and industry development |
| Civil Life | Department of Climate Atmosphere | • Discover and foster carbon-neutral activities with inhabitant participation<br>• Establishment and activation of carbon-neutral community network |
| | Youth Policy Department | • Fostering future generations of carbon-neutral talent and activities |
| | Department of Social Economy | • Vitalization of local communities such as cooperatives |
| Circular Economy | Resource Circulation Department | • Improvement and advancement of recycling system<br>• Fostering the remanufacturing industry |
| | Department of Water Energy Industry | • Reinforcement of circulation in the manufacturing process and conversion of carbon resources |
| Forest, Agriculture and Livestock | Department of Forestry & Greenery; Department of Park Development | • Expansion of carbon absorption function in the forest sector<br>• Reinforcement of the downtown ecological axis such as urban redevelopment and the creation of inhabitant parks |
| | Agriculture & Distribution Department | • Expansion of low carbon production base in agricultural and livestock industries |

| Field | Major related departments | Policy tasks |
|---|---|---|
| Economic Industry | Economic Policy Department, Industrial Development Department, Textile Fashion Department | • Conversion of high-emission industries to low-carbon industries<br>• Smart Green Industrial Complex Creation<br>• Fostering a local economy related to carbon neutrality |
| Energy Conversion | Department of Water Energy Industry | • Decarbonization Energy Conversion<br>• Spread of Smart Grid networks |
| Green Transportation | Transportation Policy Department, Bus Operation Department, Taxi Logistics Department, Railway Facilities Department, Road Department | • Establishment of eco-friendly transportation system (walking, bicycle, public transportation)<br>• Conversion of internal combustion engine vehicles to eco-friendly vehicles |
| | Department of Future Automotive | • Expand green mobility such as electric and hydrogen vehicles |
| Building and City | Building & Housing Department | • Zero-energy building and green re-modelling spread |
| | Urban Planning Department | • Low carbon of urban and building energy sources |
| | Department of Urban Design | • Conservation and expansion of green infrastructure in urban space |
| | Smart City Department | • Creating an IoT-centric smart city |

### 6.2.4 Smart energy

As part of the blocked micro-grid project, Daegu has built the following:

- An energy-saving system with the embedded function of integrated distribution in the national industrial complex
- An integrated operation centre for public institution and energy heavy consuming companies as part of the smart grid expansion project

### 6.2.5 Environmental monitoring and conservation

The city has implemented a real-time water quality monitoring system to enable inhabitants to assess the quality of tap water to ensure that it is potable. Furthermore, air-monitoring systems are also available to evaluate ozone, particulate and methane concentrations near industrial areas. To

ensure the sanctity of its rivers, sensors to monitor and manage the influx of pollutants have also been implemented.

Another initiative directed at preserving the natural environment includes judicious waste collection. To circumvent the utilization of waste burning and indiscriminate landfill dumping, Daegu conducts separate garbage collection, supported by segregation of waste for recycling and regulation on the use of purely disposable products.

## 6.3 Dimension: Society and Culture

The third dimension of the U4SSC KPIs delves into the impact of ICTs in improving equity, governance, information flow and public participation. ICTs can provide a convenient platform for large-scale inhabitant engagement, and ICT applications are the key to delivering information on government services and performance to the public. This section also examines Daegu's actions in using technologies when the city was on the brink of facing the adverse effects of the COVID-19 pandemic in the first quarter of 2020.

### 6.3.1 Urban problem discovery team

Since 2019, the urban problem discovery team has been operating as a living lab activity, which is called a "laboratory of daily life" as inhabitants find out which urban problems Daegu is facing and cooperate to develop solutions.

A total of 393 inhabitants participated in the operations over the course of three years (2019–2021), to uncover and tackle 36 urban problems. The number of participants each year has been denoted in the table on the next page.

Figure 26: Urban problem discovery team - 2nd generation

The programme also involves the dissemination of knowledge on: accessing urban services; solving urban problems; and defining urban problems by gathering and researching materials, conducting field visits, and organizing problem-solving seminars with experts.

| Category | Operating Period | Participants | Performance |
|---|---|---|---|
| 1st Gen | 2019.04.16–2019.06.26 | 209 inhabitants participated<br>81 civil scientists | Derived 15 urban problems |
| 2nd Gen | 2020.08.06–2020.11.12 | 101 inhabitants participated<br>51 civil scientists | Derived 12 urban problems |
| 3rd Gen | 2021.05.18–2021.07.29 | 83 Inhabitants participated<br>34 civil scientists | Derived 9 urban problems |

Among the 15 problems in the first generation of operation, three were selected for problem solving: (i) particulate matter; (ii) safe return home of youth; and (iii) unauthorized dumping.

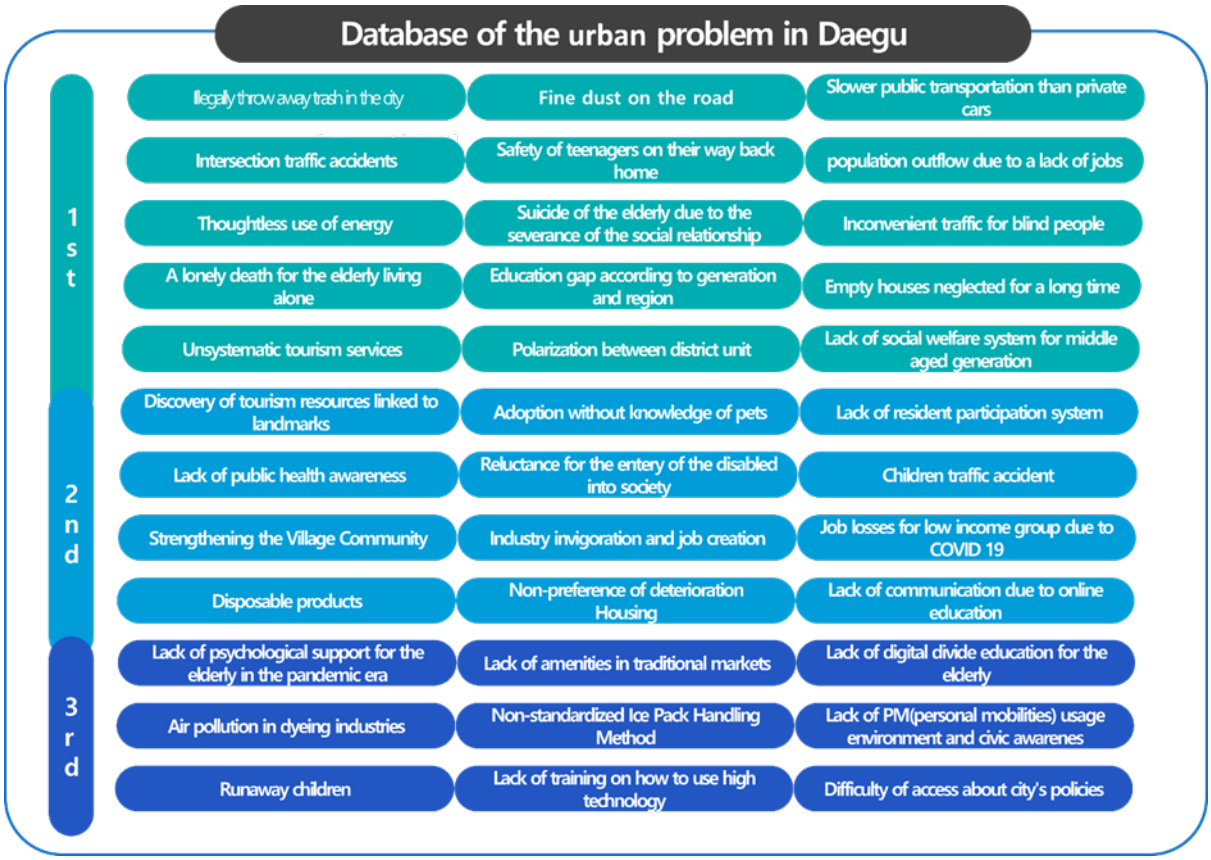
The following solutions were generated:

- Reduction of fine particulate matter generated from roads by installing a dampening wall in front of Dong-il Elementary School in Suseong-gu
- Development of a safe management platform for teenagers on their way home through Big Data analysis of moving routes around Gosan-dong, Suseong-gu
- Eco-bin installation to solve the problem of unauthorized garbage in Dong-gu's Safe Creation Valley, etc. For this, a small-scale demonstration has been completed.

From the 12 problems uncovered during the second generation of operation, traffic safety and resource recovery were selected as research tasks, and R&D demonstration is being carried out.

In this way, Daegu is promoting the creation of a smart city based on inhabitant participation where inhabitants comprehend urban problems directly, come up with solutions using novel ideas, and implement them throughout the city after small-scale R&D demonstrations. In this process, local businesses can participate and grow, thereby nurturing a smart city ecosystem where the well-being of inhabitants is looked after and businesses can thrive.

Figure 27: Database of city problems



### 6.3.2 Police patrol base optimization

As the need for smart security that reflects data analysis using Big Data emerged, Daegu Metropolitan City, Daegu Police Agency and SK Telecom signed a memorandum of understanding (MOU) to create a safe society, and jointly promoted research to optimize response efficiency through Daegu Police data analysis. Through the analysis of the 112 emergency call reports, along with dispatch and the data population, optimized patrol points were piloted through the correlation between the report occurrence and the response required time and the report occurrence prediction.

The main examples of pilot operations are elaborated upon in the following paragraphs.

A total of 34 new changes have been made at 18 existing patrol locations by adding patrol points in keeping with frequent reports in Pyeongri-dong, Seo-gu, and by changing the intermittent reports to new patrol lines.

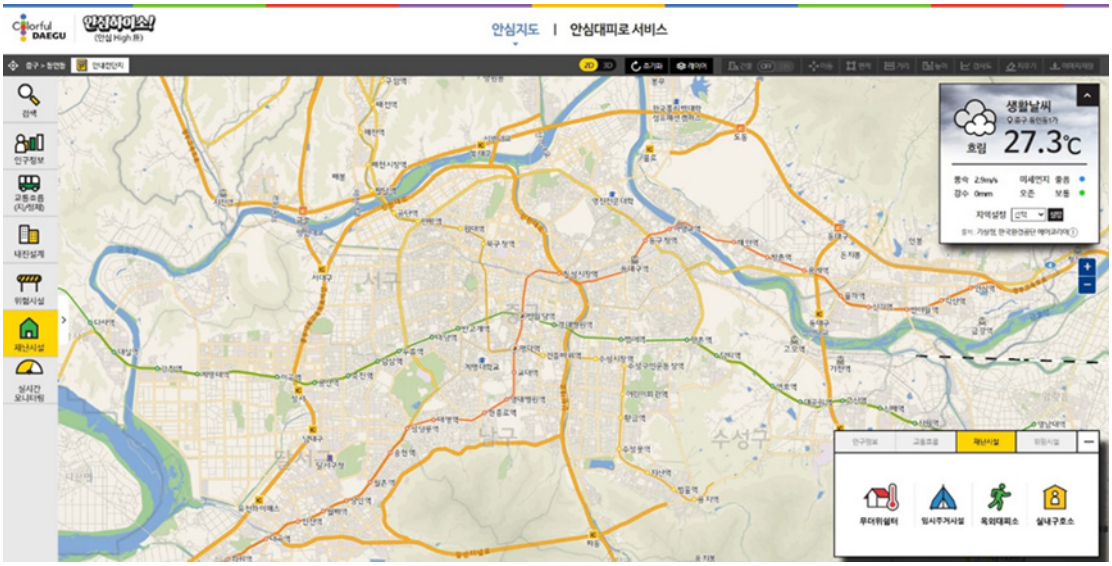
The pilot programme, in operation for three months, showed a seven per cent reduction in 112 reports and a 3 per cent reduction in five major crime types.

To further enhance safety services for the establishment of social safety systems, Daegu is looking to develop and establish a safety 2.0 Tool Kit SW. This would provide a social safety analysis and prediction service using machine-learning techniques for urban Big Data such as 112 reporting, floating population, aging of buildings and CCTV. Through data analysis, services such as predicting urban safety and recommending key monitoring areas and patrol stations can be provided.

### 6.3.3 Smart disaster response system

Daegu has established a disaster-management system that enables three-dimensional, spatial, information-based policy guidance, disaster/risk/escape facility management and earthquake/windstorm/flood damage information management. In addition, a disaster information system was established to provide information on safe evacuation for inhabitants, real-time disaster information and customized information for users in general.

Figure 28: Screenshot - disaster information system




"Anshim-Haiso" is a disaster information system for inhabitants that provides web and mobile app services. The name of this system translates to "Don't Worry" in Daegu's dialect and true to its name it provides GPS-based user locations or general and optimal routes to areas of interest. In particular, offline relief services are provided in case of data communication disconnection.

### 6.3.4 Inhabitant participation and feedback

Daegu understands that inhabitant participation in its smart city plan is vital for success. Accordingly, there are several feedback mechanisms in Daegu.

Each smart city service has its own feedback system. System managers collect customer feedback to determine improvements to process, policies among other things.

The city has a city-wide, integrated feedback mechanism for handling complaints for all services. This system, named "Dudeuriso", which translates to "Please knock" in Daegu's dialect, immediately receives all complaints from the Internet/mobile/phone/SMS and delivers them quickly to the department in charge of the service, and corrective action is taken within a certain period (on average five days). The method of providing resolution of the complaint is also delivered in a way that inhabitants choose, such as Internet, SMS or phone calls. After providing the results, the department in charge will normally follow up with a thorough satisfaction survey.

In addition, a system called "Talk Daegu" allows inhabitants to ensure that their opinions are reflected in city policies through proposals or discussions.

The department in charge analyses the inhabitant's feedback from Dudeuriso and Talk Daegu, and reports the analysis to decision makers to ensure that they can make the necessary changes quickly.

There is yet another programme designed to understand an inhabitant's needs, called the "Citizen-Centric Smart Communication Programme". This programme assists inhabitants to pinpoint urban problems, discover solutions and put these solutions into practice.

### 6.3.5 Support for vulnerable people

Daegu is in the process of verifying a smart home service for about 300 households where seniors live alone. The service analyses the life patterns of these vulnerable people with information collected from various sensors in the house and identifies any unusual signs to prevent accidents in advance.

Daegu is also building a non-face-to-face payment platform that connects public supply and consumer data for private food delivery services to ensure food support for vulnerable people. This platform continues to operate even if schools and free meal sites are closed in the face of national disasters such as the spread of infectious diseases.

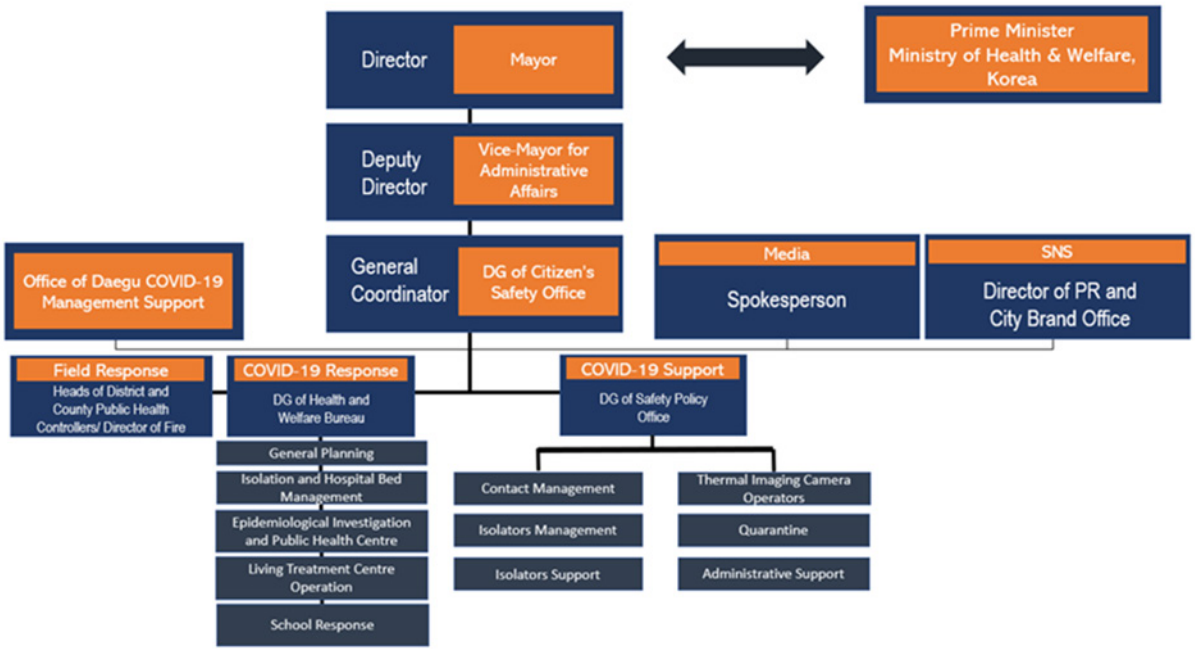
### 6.3.6 Crisis management in the advent of COVID-19

In Daegu, the COVID-19 outbreak started due to a collective infection in Shincheonji in February 2020. The result was that Daegu received negative publicity within the Republic of Korea and around the world. However, due to the successful measures implemented, Daegu is now considered to be an exemplary city that has mitigated and controlled COVID-19 successfully.

On 18 February 2020, a "Disaster Safety Countermeasure Headquarters" was established immediately after the first confirmed case of COVID-19.

With the Mayor at the centre, experts in civil safety, disaster management, emergency life- safety support, medicine and immunology, quarantine, disaster recovery and supply management were established as a single team to address all COVID-19-related issues and responses.

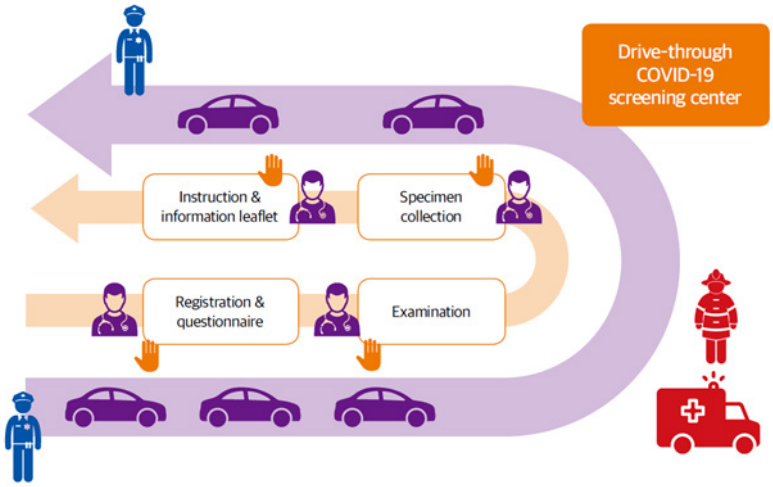
Figure 29: Structure of the Daegu disaster safety countermeasures HQ




Daily briefings were held, at a set time, to resolve public anxiety and implement transparent policies through quick and accurate sharing of information on the unprecedented COVID-19 situation. During the peak of the COVID-19 pandemic in the city, the local government initiated the use of mobile phones to foster contact tracing and curb the spread of the virus, as well as to deter community transmission within the region. Relevant information was disclosed on the Daegu municipal website, and SMS alerts and alerts for foreign patients were provided through mobile phone monitoring.

Rapid and pre-emptive diagnostic tests and full investigation of high-risk groups were conducted for early detection of confirmed cases, in order to isolate them from ordinary inhabitants and provide appropriate treatment.

Figure 30: Daegu drive through COVID testing




Daegu also introduced innovative ideas such as drive-through and walk-through locations to collect samples for diagnostic tests and introduced the world's first "residential treatment centre" to address the shortage of beds caused by the surge in confirmed cases and thus prevent the collapse of the medical system.

Implementation of the seven coronavirus regulations helped to prevent the spread, and these policies succeeded because of the voluntary participation by inhabitants.

Figure 31: Guidelines on COVID-19

In view of the ongoing COVID-19 pandemic, Daegu City has adopted healthcare policies to:

- cover the medical expense of low-income households;
- provide health support for pregnant women and infants; and
- ensure vaccinations for the high-risk and vulnerable sections of the population.

# 7 Daegu KPI data analysis

## 7.1 Introduction

*"Daegu City has been given an opportunity to become the centre of the IT industry in Korea. We will be providing full administrative and financial support so that we can emerge as the new incubator for start-up businesses."*

*Kwon Young-jin, Mayor of the Daegu Metropolitan City Government.*

A smart sustainable city is one in which technology is integrated into the city's operations. Such a city is able to provide information to inhabitants and decision makers to enhance the lives of its inhabitants[7]. Most smart city ventures are initiated through a feasible implementation plan[8] that defines problems to be solved with realistic expectations, in keeping with the needs of inhabitants. Daegu has made exemplary progress to becoming smarter and more sustainable, with a realistic plan and significant commitment from government, industry and its inhabitants.

Showing a deep commitment at the national level to implement ICTs as the basis for a new economy and to overcome the digital divide between urban and rural areas of the country, in 2004, the Republic of Korea's politicians decided to roll out the Broadband Convergence Network (BcN) and the country was subsequently considered a pioneer in connecting even the most remote areas.[9]

The government's support for ICT development began as early as the 1990s, with the advent of the Internet era. By the late 1990s, the Korea Agency for Digital Opportunity & Promotion (KADO) was set up to increase access to the Internet and provide digital literacy training to more than 10 million inhabitants to make them Internet ready.[10]

The Daegu Smart City plan defines strategies, problems and solutions and integrates several inhabitant-led programmes to meet urban needs, while ensuring sustainability.

A key to implementing a strategy, plan or project is to use a system to gather feedback to determine progress and what needs to be updated or changed if project goals are not being met.

The following Figures (32 and 33) show the general profile of Daegu and the population distribution by age groups.

Figure 32: General highlight of Daegu

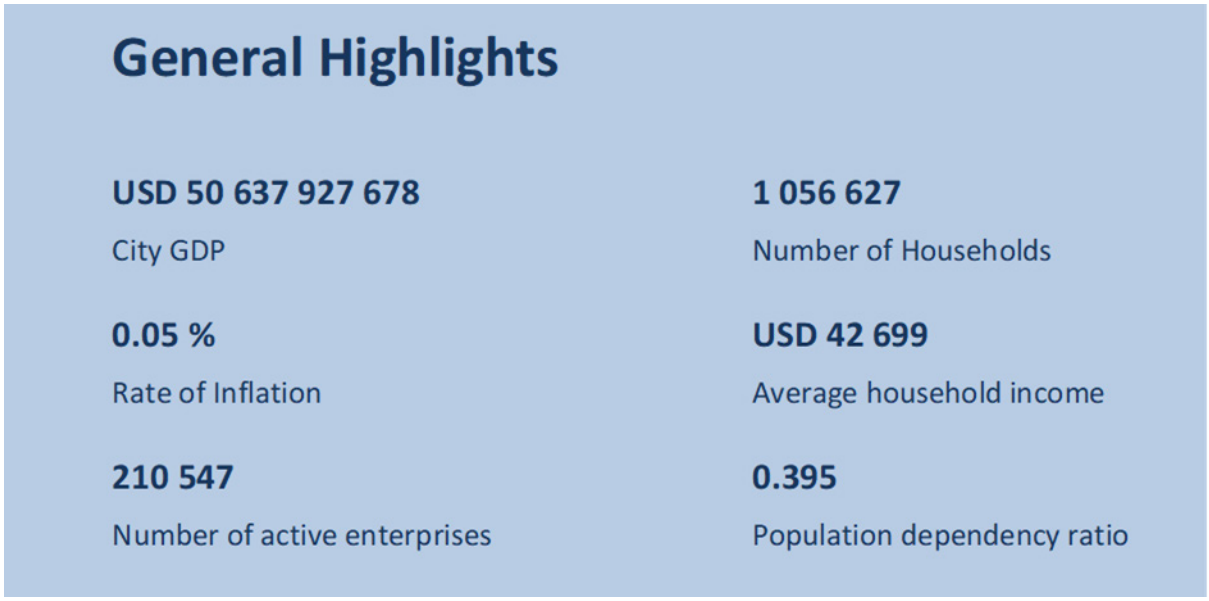
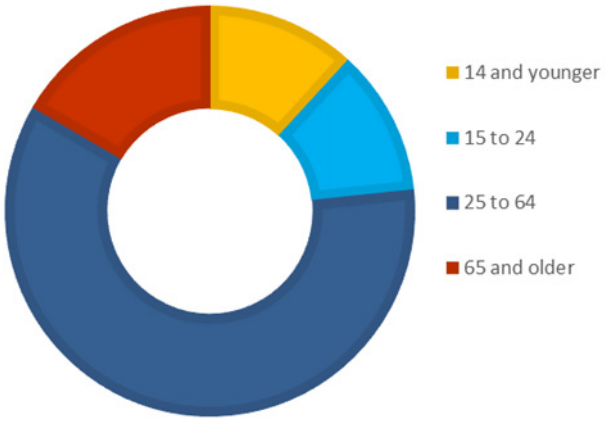



Figure 33: Daegu age distribution



## 7.2 Daegu performance and considerations: Economy dimension

**99.30 %**

Percentage of the city served by wireless broadband (4G)

**100.00 %**

Percentage of households with Internet access

**100.00 %**

Percentage of major streets monitored by ICT

The key theme assessed by these KPIs is the level of implementation of ICTs. A smart sustainable city requires fixed as well as mobile ICT infrastructures to allow for the deployment of applications that will:

1) facilitate the development of smart sustainable cities;

2) promote civic engagement; and

3) foster improvements in sustainability (gained through efficiencies in operations).

There are also KPIs within this dimension that are meant to help to analyse the general economic well-being and innovation of a city and measure the support from ICTs in the process.

Data collected and reported by Daegu show that there is an integrated plan between the city and the private sector to further the development of the city through the Daegu Smart City Vision.

### 7.2.1 Internet access

The analysis of Daegu's reporting starts with connectivity. Connectivity is at the heart of an SSC and the basis for the Daegu Smart City Plan. With 100 per cent Internet access, this puts Daegu and the Republic of Korea at the top of the list of OECD countries.[11] With more than one mobile broadband subscription per person, this sets the basis for inhabitants that can engage with the initiatives within the Daegu Smart City Plan. One of the most important factors is that the Republic of Korea and, therefore, Daegu, is near the top of the list globally with a fixed Internet average connection speed of 48.12 Mbit/s[12] and an average mobile Internet speed of 192.58 Mbps.[13] Daegu has also built its own optical network such that the city has enough capacity for new communication demands to process online administrative works and smart city services. With this impressive Internet infrastructure, Daegu is well positioned from an infrastructure perspective to execute its smart sustainable city vision.

### 7.2.2 Innovation

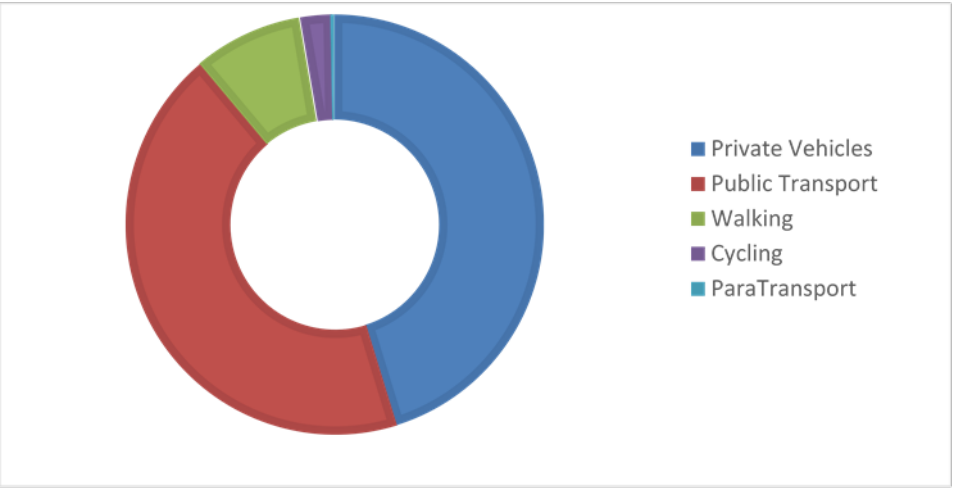
R&D spending in Daegu is a credible 2.26 per cent of city GDP and the rate of new patents (115/100 000 inhabitants) indicates that innovation has taken hold within the city, which bodes well for the future transition to a more digital-based economy. Daegu has provided various incentives to local software companies with excellent technology and innovative ideas. The city supports many activities such as participation in domestic and foreign exhibitions, overseas collaboration, prototype production, consulting and human resource development.

### 7.2.3 Transport

Transport is a key infrastructure in any city and one that can be improved significantly through the application of ICT systems. In keeping with the trends in other smart-related KPIs, Daegu's major arterial roads are monitored 100 per cent by ICT systems. While few intersections are currently controlled adaptively (1.98 %), Daegu plans to install CCTV at about 250 major intersections by 2023 and develop an AI-based smart transportation system that gathers information and uses it to optimize and control traffic signals in real time.

There is a good public transport network consisting mainly of the Daegu Metro, with three lines – one of which is a monorail – and an extensive bus network. Consistent with data reported on other smart KPIs, 100 per cent of Daegu's public transport stops have dynamic information available. The Daegu Bus Management System allows for real-time information to be displayed at each of the 3226 bus stops in the city and online. There are areas for improvement and the most impactful could be to reduce the 45.20 per cent transportation mode share for private vehicles (see Figure 34), even though the time travel index value of 1.37 indicates that congestion is not a serious problem. More emphasis on programmes and policies to reduce private vehicle use is strongly encouraged.

Figure 34: Daegu transport mode share



### 7.2.4 Water, wastewater and waste collection

These components of a city's infrastructure are key to the quality of life, the health of a city and its inhabitants, and the reduction of pollution. In each of these categories, the infrastructure is in place, with 99.97 per cent access to potable water, 98.67 per cent of wastewater collected to 97.60 per cent for waste collection. What is outstanding is the performance for the KPI for water loss. In Europe, the average water loss is 26 per cent, but some major cities there and in North America have reported leakage rates of 30 per cent and more.[14] Daegu's reported data of only 3.94 per cent water loss is easily a value that most cities would be aspiring to achieve.

### 7.2.5 Employment

Daegu has reported a low level of unemployment (3.78 %) and youth unemployment (7.47 %). ICT sector employment is at a credible 2.17 per cent and this should increase with the implementation activities related to the Smart City Plan. Daegu currently has a low age- dependency ratio of 39.5, indicating overall a low level of dependency for each worker. However, demographically most of the dependents are seniors, which indicates a society that is aging, with Korea as a whole expected to have more than 20 per cent of its population aged 65 years and older in 2026.[15]

### 7.2.6 Public services

Providing public services through smart means is where Daegu's commitment to smartness and sustainability is best exemplified. With 13 805 services provided through electronic means and more than 8 000 open data sets available, public services are where inhabitants interact with smart sustainable city initiatives on a regular basis. Daegu's focus on the inhabitant as the true customer and receiver of benefits of their Smart City Plan is presented by these statistics.

| Measures adopted by Daegu | Suggested action(s) for Daegu and other aspiring smart cities |
|---|---|
| Daegu has implemented its smart sustainable city through a well-defined and communicated Smart City Plan. The plan starts with a clear vision, clear strategies and clear plans, and is based around the needs and involvement of inhabitants. Daegu has kept inhabitants' needs at the centre of its smart city strategy, and this has enabled the city to convert the creation of a smart city into a "co-creation process", which is supported by transparency, online feedback platforms and assurance of quality of life for its residents.<br><br>This was supported at the national level through the Act on the Promotion of Smart City Development and Industry, which was adopted by the Republic of Korea in 2018. | Other cities can learn from the systematic approach applied by Daegu in developing its Smart City Plan. These aspiring smart cities can learn from the clear pathway developed and the focus on the inhabitant, and not merely the deployment of technology, which forms the basis of the overall plan.<br><br>Inhabitant feedback loops are an important part of any smart sustainable city plan and should implemented by aspiring cities to gather the required information to evaluate, update and change strategies and plans<br><br>Cities should receive support and clear direction from national governments so that smart city plans, programmes and projects can be replicated more easily throughout a country and ensure interoperability of city ICT systems on a national level.<br><br>The establishment of smart and sustainable cities can also promote regional economic development if actions are taken to connect cities, innovation hubs and the surrounding rural areas.<br><br>Cities, including Daegu, may also wish to refer to ITU-T Y.4000 series Supplements to the Y-series Recommendations related to IoT and SC&C–Smart sustainable cities, which provide guidance to city leaders on strategy and planning. |

| Measures adopted by Daegu | Suggested action(s) for Daegu and other aspiring smart cities |
|---|---|
| Daegu, and the Republic of Korea, are world leaders in Internet connectivity and fixed and mobile broadband speeds. The Republic of Korea is also leading the development of next generation wireless broadband technologies and aims to deploy 5G earlier than any other country. 5G is expected to become the infrastructural backbone for the 4th Industrial Revolution.<br><br>Daegu has also deployed more than 3 600 public Wi-Fi zones throughout the city to ensure public Wi-Fi is ubiquitous. | Aspiring smart cities can learn from the commitments made by the Republic of Korea and then follow through to connect their respective countries with the Broadband Convergence Network (BcN).<br><br>Clear polices and goals related to the connectivity and the digital divide can be the basis for mitigating any urban connectivity issues.<br><br>For those areas where connectivity is lacking because of lack of funding, Recommendation ITU-T L.1700: "Requirements and framework for low-cost sustainable telecommunications infrastructure for rural communications in developing countries" is applicable for any situation where the urban–rural divide exists.<br><br>It is also essential that other cities learn from Daegu that a robust ICT infrastructure, including public Wi-Fi, is needed as the basis for digital transformation to become smarter and more sustainable.<br><br>As the city of Daegu has itself achieved 100 per cent connectivity, it should strive to strengthen its IoT framework in keeping with the ITU-T Y Series Recommendations dedicated to infrastructure connectivity and networks (Y.4250-Y.4399), along with framework architecture and protocols (Y.4400-Y.4549). |
| Since 2009, Daegu has been implementing an intelligent transportation system and has plans to increase the capacity of the system, implement AI capabilities and achieve greater intersection control.<br><br>On the public transport side, there is an existing bus management system to provide inhabitants with the required information to schedule their trips. | Other cities can learn from Daegu's phased approach to intelligent traffic management. Cities are recommended to follow an approach of phased implementation to initially solve larger issues and then add to management capacity to increase efficiency of traffic stream.<br><br>Also, it is key to follow the example of Daegu and ensure that there are ways to communicate traffic issues to all users of the transportation network. This helps ensure that the users are duly informed and can minimize their travel times. |

| Measures adopted by Daegu | Suggested action(s) for Daegu and other aspiring smart cities |
|---|---|
| Daegu has a dedicated Smart City Division team which supports companies involved in the development of new technologies and business. For the Smart City Plan, a Smart City Support Centre was established and has been in operation to support the participation and collaboration of inhabitants and companies.<br><br>An Urban Problem Discovery Team has been set up to gather and engage inhabitants in the overall project. | Other cities should, when possible, emulate the clear definition of responsibilities to support their journey towards becoming smarter and more sustainable. It is also key for any city embarking on this journey to engage and capture the knowledge of current inhabitants to help define problems and provide feedback on locally based solutions.<br><br>Following on from the establishment of its smart city plan, the city should aim to set up an evaluation framework based on the U4SSC KPIs to ensure that the guidelines depicted in its city's plan are implemented adequately, and to strive for the collective attainment of SDG11 and SDG17. |
| The growing volume and variety of data streams generated in the urban sphere are pertinent for obtaining the city's insights and formulating knowledge-based solutions for supporting sustainable development. Realizing this, the Republic of Korea launched its Open Data Portal, which is complemented by Daegu's own regional city portal. | Other cities and countries can learn from Daegu and the Republic of Korea by establishing national, regional and city-level data hubs that are coordinated and can exchange data easily. Accordingly, aspiring smart cities are encouraged to view open data as a vital enabler for the generation of actionable data and contextual analysis for managing and planning for the future city.<br><br>Lack of coordination of the data hubs can result in data collected at the local level not being able to be shared at the national level or between cities. A lack of interoperability can hinder the ability to translate actionable information based on the raw data feeds. In this context, Daegu and other aspiring smart cities should aim to ensure data interoperability across the data value chain. |

| Measures adopted by Daegu | Suggested action(s) for Daegu and other aspiring smart cities |
|---|---|
| Like many other cities, Daegu has reported a low level of public buildings that have undertaken sustainability certifications. | It is a recommended that Daegu and other aspiring smart sustainable cities implement Recommendation ITU-T L.1371: "A methodology for assessing and scoring the sustainability performance of office buildings" as the basis for improving the sustainability of its public (and possibly private) buildings. This Recommendation provides a framework to critically assess and score ten key areas of environmental performance and management: Energy, Water, Air, Comfort, Health and Wellness, Purchasing, Custodial, Waste, Site and Stakeholders. Use of this standard will allow Daegu and other aspiring smart sustainable cities to develop baseline measures of building sustainability, a plan for improving building performance, and to measure the effects of improvements on building performance. |

## 7.3 Daegu performance and considerations: Environment dimension

**45.40 %**

Percentage of city area protected as natural sites

**313.76 litres / day / capita**

Water consumption

**6 482 kWh / yr / capita**

Electricity consumption

This dimension examines the level of ICT integration in supporting the city's environmental sustainability and energy efficiency. Another area of focus is long-term sustainability as the KPIs measure key resource consumption metrics. These KPIs also provide a baseline for future comparisons.

The data collected and Daegu's Smart Sustainable City initiatives show that Daegu has developed a comprehensive system for the monitoring of environmental quality and resource consumption. Daegu is using ICTs to monitor air, water and wastewater quality indicators. It will be an ongoing challenge for Daegu to balance the increasing level of unitization of ICTs with its sustainable procurement and operation.

### 7.3.1 Recreation, green spaces and air quality

The review of Daegu's performance starts with its efforts to green the city. With 45.40 per cent of the city protected, Daegu has made great strides in ensuring that there is a balance between the urban and natural spheres. Recreational facilities at almost $3m^2$ / person are at the top range of the benchmark and this shows that Daegu's inhabitants are well served in this area. Air quality considerations are a top priority for Daegu and its inhabitants, and air pollution is the largest single environmental risk for health.[16] Fine particulate matter of 2.5 micrometres or less in diameter ($PM_{2.5}$) is the most dangerous pollutant because it can penetrate the lung barrier and enter the blood system, causing cardiovascular and respiratory disease and cancers. By reducing air pollution levels, countries can reduce the burden of disease, and long- and short-term illnesses.[17] As such, Daegu has implemented a significant programme of ICT-based air quality monitoring and reporting. While Daegu's reported $PM_{2.5}$ of 20 ug/$m^3$ is above the WHO guideline of 10 ug/m,[18] it does lie within the WHO interim target of 25 ug/$m^3$. In addition, Daegu supports the early scrapping of old diesel vehicles and provides subsidies when inhabitants purchase electric vehicles. Daegu's programmes and emphasis on $PM_{2.5}$ air quality, the implementation of $PM_{2.5}$ traffic lights and projects to capture fine particulates show that the city is on the path to ensuring a healthy urban environment.

### 7.3.2 Wastewater treatment and waste disposal

Daegu reported water consumption of 313.76 ℓ / day / capita, which is at the lower level of performance to the benchmarks. Water quality testing reports that 100 per cent of samples tested comply with regulations, and an extensive wastewater treatment regime that treats 100 per cent of water through primary (screening and sedimentation), secondary (biological oxygen demand (BOD) reduction) and tertiary processes (disinfection) is also reported. Daegu has implemented separate collection services for waste and recycling and a deposit programme for bottles. With 72.9 per cent of waste diverted to recycling, Daegu is making progress on transforming into a circular economy.

### 7.3.3 Energy usage

Daegu has reported electricity consumption of 6 482 kWh per year per capita and also reports that renewables currently account for only 1.03 per cent of that consumption. While this is below the country average of 10 900 kWh per year per capita for the Republic of Korea, it is significantly above the Asia-Pacific average of 2 800 kWh per year per capita.[19] It is of concern that coal still plays a significant role in the electricity supply mix. Hence, while Daegu gives carbon points and incentives according to energy reduction, more attention needs to be paid to reducing electricity use (based on fossil fuels) in order to assist with meeting the goals of the Paris Agreement.

| Measures adopted by Daegu | Suggested action(s) for Daegu other aspiring smart cities |
|---|---|
| As part of its urban greening strategy, Daegu planted 44.4 million trees between 1996 and 2020. The Republic of Korea has an existing legislation for the protection of biodiversity known as the National Biodiversity Strategies and Action Plans (NBSAP). | A major biodiversity threat on the Korean Peninsula is habitat loss from rapid urbanization and industrialization, causing the number of endangered flora and fauna to increase at a rapid rate.[20]<br><br>While Daegu's initiative is commendable and is making an impact, other cities can and should replicate and implement similar programmes. Where the resources for a large programme are not available, cities can start with small-scale local projects at the neighbourhood levels that integrate inhabitants into the effort. Greening efforts can also be encouraged through local regulations that ensure that the current tree cover is maintained and that permits would be required to remove trees.<br><br>Daegu and other cities should review the guidance and knowledge provided by the Convention on Biological Diversity to determine steps to that can be taken to maintain and increase biodiversity. |
| Daegu has made it a key feature of its smart sustainable city journey to implement air quality and water quality monitoring systems. Additionally, these monitoring systems are used to provide inhabitants with actionable information. | Aspiring cities should follow the example of Daegu and develop a robust, ICT-based system for monitoring air and water quality. Other cities can learn from the experience of Daegu by creating the infrastructure needed and the effective methods used to communicate with inhabitants.<br><br>Daegu, and other cities, may wish to expand the monitoring system to other attributes related to the environment such as waste, noise, EMF exposure and CO2 emissions.<br><br>Cities may also wish to use Y Suppl. 36: ITU-T Y.4550-Y.4699: "Smart water management in cities", which provides municipalities, decision-makers and interested stakeholders with an overview of the main technical aspects that need to be considered to design and implement smart water management effectively in cities. |

| Measures adopted by Daegu | Suggested action(s) for Daegu other aspiring smart cities |
|---|---|
| Renewables currently account for about one per cent of the electricity consumption in Daegu. The Smart City Plan has as a key component the promotion of new industries based on digital transformation and ICTs. | Daegu should consider investing in renewable energy. The energy derived from these sources will help limit the contribution to greenhouse gas emissions, while ensuring that the core energy needs of the city are met.<br><br>The investment in renewable energy-based technologies will allow Daegu, and other aspiring cites, to develop and promote new, clean technologies and industries that can form the backbone for a low-carbon economy and reduce the environmental impact of a city.<br><br>All cities should be prepared to move away from carbon-intensive energy sources to ensure they and their countries can meet their commitments in the Paris Agreement, and limit global warming and the resulting severe weather events. |

## 7.4 Daegu performance and considerations: Society and Culture dimension

**90 %**

Percentage of local food production

**0 %**

Percentage of inhabitants living in informal settlements

The KPIs within this dimension focus on the themes of openness, public participation and transparency in governance. KPIs that measure the quality of life of inhabitants and the extent of ICT implementation in the education, health and safety sectors are also included.

As reviewed in the preceding sections, Daegu has made significant progress in implementing smart, sustainable city projects and is executing its overall vision.

These projects lay the basis for the development of electronic services for health, welfare and education that meet the needs of inhabitants.

### 7.4.1 Education

**20 558**

Higher level education degrees per 100 000 inhabitants

**100 %**

Percentage of Students with classroom access to ICTs

Daegu's performance in the education category is exemplary. This is to be expected, as schools have integrated ICTs at all levels of the school system to foster 21st Century learners. The goal is to strengthen the 21st Century learner's capacity, and in this context, there is a focus on the 4Cs: Critical thinking and problem-solving; Collaboration; Character; and Communication.[21] Daegu reports 100 per cent ICT access for students, and a commendable 20 558 higher-level degrees per 100 000 inhabitants. Adult literacy is at 99.84 per cent.

Due to a cluster outbreak in Daegu and Gyeongsangbuk-do in 2020, the school year was delayed initially and online learning was launched for all elementary, middle- and high-school students from April 2020. To further this, while students performed problem solving through gamification, AI was used to diagnose the student's level and provide customized learning for weak areas.

### 7.4.2 Health care

The reported data for health care are excellent, with almost all KPIs being reported at the highest benchmark levels. Electronic health records are in place for 96.64 per cent of inhabitants, in-patient hospital beds are an impressive 1 530.59 per 100 000 inhabitants and there is almost universal health coverage, at 96.72 per cent. The response to the COVID-19 pandemic has shown the benefit of having a sound healthcare system.

### 7.4.3 Housing

The data submitted by Daegu show that the cost of housing is within a reasonable range for inhabitants as the expenditure is at 19.10 per cent and there are no informal settlements within the city.

### 7.4.4 Safety, preparedness and resilience

Disaster and emergency response are keys to the long-term sustainability and resilience of a city. Overall, Daegu reports a minor loss of life due to natural disasters (0.12 per 100 000 inhabitants) and no economic losses. As the COVID-19 pandemic has shown, disasters can transcend natural weather events such as flooding. However, there is also the need to have an infrastructure in place to ensure that public safety is a priority. Daegu reports a police service (228.71 FTE per 100 000

inhabitants) and a fire service (96.18 FTE per 100 000 inhabitants) that indicate a well-developed infrastructure for public safety. An area of potential concern is the level of traffic fatalities, which is reported at 4.59 per 100 000 inhabitants.

| Measures adopted by Daegu | Suggested action(s) for Daegu other aspiring smart cities |
|---|---|
| As the COVID-19 pandemic interrupted schooling, Daegu was able to transition all students into an online learning environment. This was also made possible due to the investments made at the local and national level to ensure Internet connectivity and high-speed connections. | Other cities can learn from the experience of Daegu when its education system was shocked by the impact of the COVID-19 pandemic. The investment made in digital connectivity paid dividends in allowing the education system to continue to operate remotely.<br><br>Other cities and national governments can learn from this experience and prioritize ICT infrastructure development to make their cities and countries more resilient. |
| To enhance public safety, Daegu implemented a project to optimize police response. Data are collected from the 112 emergency systems and analysed by AI, leading to a 3 per cent reduction in major crimes. | Daegu, as it implements its optimization programme, will need to ensure that inhabitant data are secure, and that patrol optimization does not impact negatively on vulnerable communities.[22] |
| The response to COVID-19 in Daegu was quick and efficient. Daegu was able to manage the surge in confirmed cases and prevent the collapse of the medical system | A key element of the response to Daegu was that its inhabitants were kept well informed, and that information was provided quickly and transparently. Inhabitants trusted the information and acted accordingly. The trust that had been built up among inhabitants partly through their involvement in the Smart City Plan and the benefits inhabitants have received from the results, coupled with the open-data policies of Daegu, could be seen as laying the groundwork for the COVID-19 response.<br><br>Other cities can learn from Daegu that a history of openness and transparency can bring positive dividends when voluntary inhabitant actions are needed to further the goals of a city – and when responding to emergencies.<br><br>In the context of the pandemic, Daegu and other cities should aim to ensure that an adequate number of beds are available to enable hospitalization in case of a resurgence of COVID-19 cases or other related health emergencies in the future. |

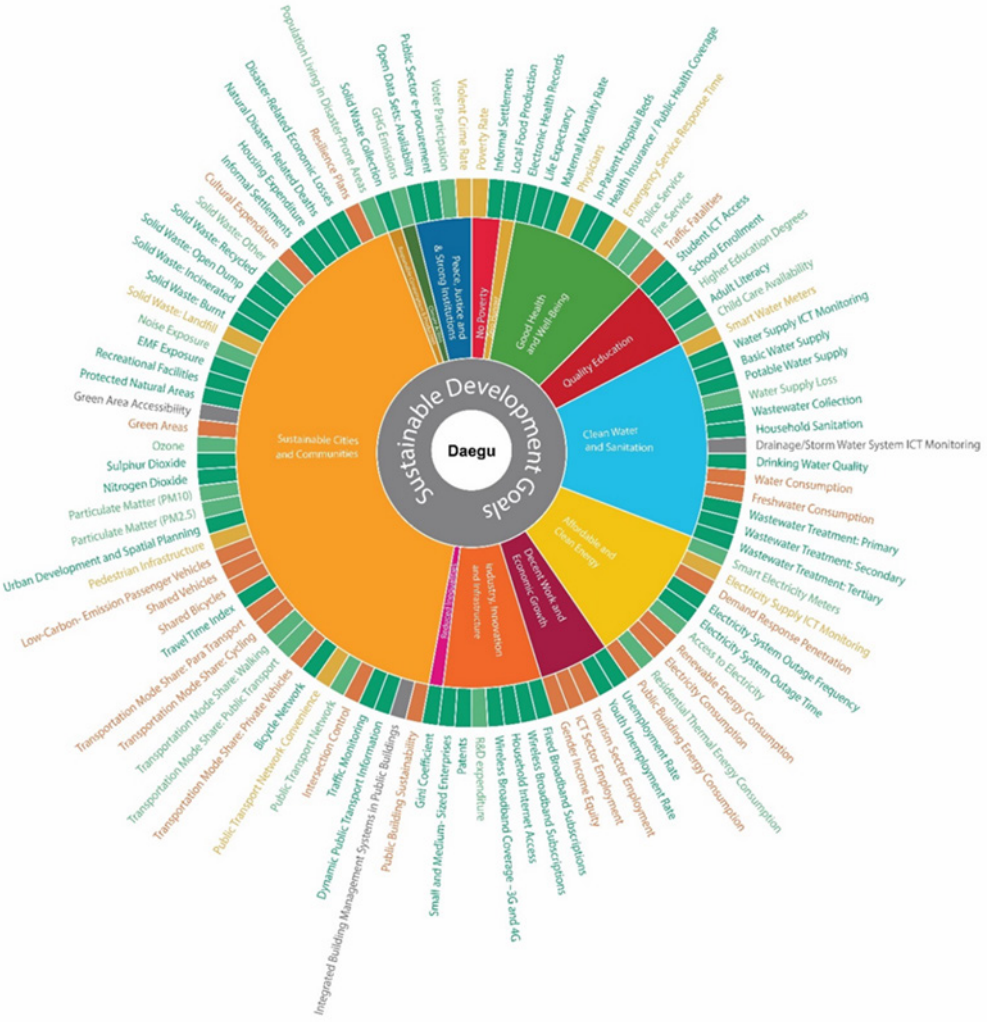
## 7.5 Daegu – progress to SDGs

One of the key benefits for a city in implementing the U4SSC KPIs is that in the process of developing the KPIs, the relationship to the SDGs was considered a primary requirement.

Each KPI bears a direct or indirect relationship to one or more SDG and the total set of KPIs correlate to the various targets contained in all 17 SDGs.

Leveraging this relationship, U4SSC developed a unique benchmarking methodology that provides not a direct relationship, but overall guidance on how a city is localizing the intent of attaining each SDG.

Figure 35: U4SSC KPI - SDG Benchmarking



Using this benchmarking analysis, it is possible to provide the following analysis of progress to the SDGs and the overall performance of the city in this context:

| | |
|---|---|
|  | Poverty rate is low and with no informal settlements, progress on this SDG is, therefore, on track. |
|  | Local food production is significant such that progress on this SDG is well on track. |
|  | Life expectancy, maternal mortality rate and good public health coverage show that progress on this SDG is adequate, with the notable exception of traffic fatalities, which may hamper progress in relation to this SDG. |
|  | Based on the data reported, with high literacy, school enrolment and child-care, progress on this SDG is well on track. |
|  | Based on the data reported, water is clean and available. Consumption is higher than ideal, but water loss is low. Therefore, progress on this SDG is on track. |
|  | Based on the data reported, the electrical distribution infrastructure is excellent. Consumption is higher than ideal, and renewables are not yet a part of the energy mix. In this regard, progress to this SDG requires additional work. |
|  | Based on the data reported, income equality needs improvement, but unemployment is low. Progress to this SDG is on track. |
|  | ICT infrastructure and innovation are excellent. Progress to this SDG is well on track. |
|  | Based on the data reported for the GINI coefficient, progress to this SDG is well on track. |
|  | Public transport use is high, air quality is good, natural areas and recreational areas are plentiful, smart city plans are in place or in construction to mitigate traffic issues and waste is well managed. Progress to this SDG is on track. |
|  | Waste collection is universal in the city. Progress to this SDG is on track. |
|  | Based on the data reported, GHG emissions are not close to the required levels. Progress to this SDG needs additional work. |

| | |
|---|---|
|  | Based on the data reported for voter turnout and open data, there is progress towards this SDG, with only the violent crime rate being an area for further improvement. |

## 8 Policy recommendations

Daegu's pursuit of its smart city goals is supported by various existing legislative instruments implemented by the Republic of Korea. This legislation can be used as the cornerstone for Daegu's overarching implementation policies for the large-scale adoption of emerging technologies, including AI and IoT, with the aim of making the city one of the growth engines in the country. These policy-based recommendations will also allow Daegu's smart city incentives to be linked with national-level regulatory and legislative frameworks.

| Policy recommendation 1 |
|---|
| **Topic** |
| Renewable Energy |
| **Rationale** |
| The provision of utilities in smart cities would benefit from embracing renewable energy as it would help the city reach price and performance parity in terms of electricity use along with carbon emission reduction, cost-effective energy storage and the implementation of new technologies. If deployed using energy derived from renewable energy sources, the use of autonomous networks and connected technologies could become environmentally sustainable, in accordance with international climate targets and the SDGs. |
| **Existing Legislation (if any)** |
| *KOREAN ELECTRICITY UTILITY ACT* |
| **Recommendation** |
| In line with the amendment to Korean Electricity Utility Act favouring renewable energy sources, Daegu could consider investing in solar panels and windmills. The energy derived from these sources would help limit the contribution to greenhouse gas emissions, while ensuring that the core energy needs of the city are met. Smart grid technology is enabling the effective management and distribution of renewable energy sources such as solar, wind and hydrogen.<br><br>The existing smart grid system can be used to connect a variety of distributed energy resource assets by leveraging IoT to collect data, detect and resolve energy- and utility-consumption-related issues through continuous self-assessments, and report outages to enable self-healing capability through the adoption of autonomous networks.<br><br>The penetration of renewable energy-based technologies will fit into Daegu's smart city plan under various scales and allow for the quick transition to a low-carbon economy. |

| Policy recommendation 2 |
|---|
| **Topic** |
| Health |
| **Rationale** |
| The COVID-19 pandemic is a public health emergency occurring on an unprecedented scale. During the first wave of the pandemic, governments across the world introduced new digital contact tracing systems to detect and contain the spread of the virus.<br>The Republic of Korea has also faced a wave of infections related to COVID-19. However, the country has managed to keep the number of severely ill cases under control through contract tracing and steadily rising vaccination rates. |
| **Existing Legislation (if any)** |
| *INFECTIOUS DISEASE CONTROL AND PREVENTION ACT (AMENDED)* |
| **Recommendation** |
| The city could consider including privacy-compatible proximity tracing apps to utilize collected data beyond proximity tracing alone, in order to offer users more granular information about risks in specific locations and to collect data relating to isolation measures, available hospital beds and COVID-19 treatment, along with precautions and the appropriate oversight of individuals breaking quarantine rules.<br>With the vaccination drive in the city, Daegu can also include a feature for digital vaccination certificates in existing contact tracing apps to ensure that all COVID-management-related information is available on one platform for easy access by its inhabitants. |

| Policy recommendation 3 |
|---|
| **Topic** |
| Finance |
| **Rationale** |
| Digital finance systems can play an important role in supporting SMEs in the Republic of Korea. The country already has a rich history of bolstering technological advancements through the work of its local businesses. Having a sound digital finance system can provide the local businesses with access to financing and electronic payment systems, and secure financial products.<br>Additionally, delivering financial services through digital platforms, including via cryptocurrencies, can serve as a catalyst for the provision of credit, insurance and financial education. Such a system can also pave the way for phasing out unreported transactions, recognizing non-performing assets and setting the basis for the launch of regulated digital currencies in the country. |
| **Existing Legislation (if any)** |
| *ACT ON REPORTING AND USING SPECIFIED FINANCIAL TRANSACTION INFORMATION* |

| Policy recommendation 3 |
| --- |
| **Recommendation** |
| Currently, in the Republic of Korea, the financial systems continue to be managed by the national government. Decentralisation of these systems will allow local governments to experiment more with cryptocurrencies and blockchain, which could allow for an added layer of security for financial transactions. This could be a beneficial proposition as the results of such fintech pilots could lay the foundation for the first blockchain-regulatory framework in the country.<br><br>Additionally, to support the Bank of Korea's pilot programme to support the transition to a cashless economy, Daegu could consider being one of the testbeds to examine the feasibility of the central bank digital currency. |

| Policy recommendation 4 |
| --- |
| **Topic** |
| Deforestation and Forest Conservation |
| **Rationale** |
| Forests provide socio-economic benefits to any country's economy. These benefits encompass employment, forest products (wood, paper, fruits, etc.), as well as energy. Often forest areas are known to have recreational value for inhabitants residing in nearby cities. This makes it essential to maintain and enhance the forest areas as a part of a city sustainable forest management.<br><br>It was estimated that in 2010, Daegu had 37.0 kha of natural forest, which extended more than 47 per cent of its land area. As of 2020, the city has been deemed to have lost approximately 4.45 ha of natural forest. With the city's transition to becoming a smart and sustainable city, appropriate technological interventions can be put into place to impede the current deforestation rates. |
| **Existing Legislation (if any)** |
| *FOREST PROTECTION ACTION* |
| **Recommendation** |
| The City of Daegu could explore the potential digitization of its forest area using technologies including the Internet of Things and Wireless Sensor Networks Deep Learning. The data collected from IoT sensors deployed in forest areas can be analysed to facilitate asset registration systems, forest research, hazard assessment and specialized forestry consultation. This departure from the traditional methods of forest protection will prevent illegal logging, encroachment and poaching of native species.<br><br>Another concept that Daegu could explore for its forest regions is that of the "Internet of Trees", which is an early-warning system based on environmental sensors that protects assets, monitors forests, and prevents any potential forest fires from spreading in the region, including into nearby residential areas. |

| Policy recommendation 5 |
|---|
| **Topic** |
| Circular Food Systems |
| **Rationale** |
| Sustainable food systems form an integral part of circular economies. In this context, it would be essential to trace the nutrient flow and assess the circularity of export-oriented agricultural and livestock-based systems. The concept of circular systems is linked intrinsically to smart cities; consequently, any city aspiring to be smart and sustainable must also aim to transition to a circular economy. |
| **Existing Legislation (if any)** |
| FRAMEWORK ACT ON RESOURCES CIRCULATION |
| **Recommendation** |
| The KPIs associated with local food production could not be verified. This KPI is vital for Daegu to be able to support the paradigm shift associated with the transformation of the existing food system into a circular one in order to generate edible organic products, reduce food wastage, improve the recycling of biodegradable waste and promote an overall healthy diet. Such an action point could be directly in line with Korea's Framework Act on Resources Circulation, which aims to overcome resource scarcity and bolster the waste hierarchy. |

| Policy recommendation 6 |
|---|
| **Topic** |
| Biodiversity |
| **Rationale** |
| Protecting biological resources, including flora and fauna, is essential to maintain the ecological balance, which contributes positively to overall environmental management. |
| **Existing Legislation (if any)** |
| NATIONAL BIODIVERSITY STRATEGIES AND ACTION PLANS (NBSAP) |
| **Recommendation** |
| The Republic of Korea has an existing legislation for the protection of biodiversity known as the National Biodiversity Strategies and Action Plans (NBSAP). Given the immediate dangers of the built-up urban environment inadvertently encroaching into protected natural zones, the importance of biodiversity, conservation and preservation of native species should be enshrined adequately in the city's city plan in order to avoid disrupting ecosystems. Monitoring systems could also be put in place to prevent exploitation of biological resources and culling of native species, which may disrupt the natural food chains and the overall habitat. |

# 9 Improvements for implementing the U4SSC KPIs in Daegu

As Daegu is one of the first cities to pilot the U4SSC KPIs in the Asia-Pacific region, it is prudent for it to offer a constructive critique of its experience in applying the KPIs, while highlighting areas that can be explored further, within the remit of its Smart City Plan.

In order to provide a better reflection of data that can be analysed between cities, Daegu has proposed that the current KPI - **SC : SH : SA : 8C Violent Crime Rate** be updated to **Homicide Rate**. The definition for violent crimes can vary between jurisdictions; however, there is greater consistency with the definition of homicide and related crimes such as manslaughter.

## 9.1 Potential areas for exploration: Bridging the gaps to establish smart and sustainable cities

In keeping with the findings of the project, Daegu could also explore the following areas in the context of its existing smart city vision:

### 9.1.1 E-waste collection

- Since ITU's expertise in e-waste management is evident through the various ITU-T Recommendations and Supplements on the topic, Daegu could consider implementing the related ITU standards within this domain. Cities undertaking smart city ventures are likely to be faced with the issue of e-waste and, therefore, it would be prudent for Daegu and other aspiring smart cities to implement the existing ITU standards regarding the management of Waste Electrical and Electronic Equipment (WEEE), which is also anticipated to help facilitate the city's transformation into a circular economy.

### 9.1.2 Detection of invasive species

- The introduction of invasive species into a protected environment can have devastating effects on the food chain and the survival of local species. To ensure that urban stakeholders are aware of this, it is suggested that Daegu could examine the presence or absence of any invasive species and monitor any changes that could impact the ecosystem.

### 9.1.3 Protection of culture and heritage sites

- By leveraging the existing technologies available for monitoring, Daegu should aim to preserve heritage sites and reduce their exposure to pollution and vandalism. For this city, the local government could call upon the expertise of the United Nations Educational, Scientific and Cultural Organization (UNESCO) to:

- provide additional guidance on improving accessibility of heritage sites for persons with disability; and
- formulate a "rule-book" for the maintenance of the area.

## 10 Follow-up activities

Daegu has been a frontrunner in the adoption of digital technologies for its smart city venture. Additionally, the city's management of the COVID-19 pandemic, despite it being at the epicentre of the disease in the country during the initial phase of the outbreak, has been no ordinary feat as it was able to contain the virus soon after its outset. Considering the findings gleaned from the results of the U4SSC-KPI pilot project, the following action points have been suggested for Daegu:

- *Continuance of internal U4SSC-KPI implementation at the city level*: It is important to acknowledge that the transition to a smart and sustainable city cannot be achieved overnight. Therefore, it is vital that Daegu continues with ongoing reporting of the U4SSC KPIs and updates the data on a regular basis to gain an overarching view of the progress achieved. This update of the U4SSC KPI data can form the basis for a regular benchmarking programme for the city to be able to visualize and quantify its annual progress.
- *Implementation of other ITU-T Recommendations:* To supplement the indicators in Recommendation ITU-T Y.4903, along with the policy recommendations showcased in Section 5, Daegu should also consider applying other ITU-T Recommendations on the following topics:
  - *Energy Management:* Recommendation ITU-T L.1383 "Smart energy solutions for cities and home applications"
  - *Environmental Sustainability:* Supplement ITU-T L.44 "A Guideline on best practices and environment friendly policies for effective ICT deployment methods"
  - *Building Sustainability:* Recommendation ITU-T L.1371: "A methodology for assessing and scoring the sustainability performance of office buildings"
  - *ICT Sustainability:* Recommendation ITU-T L.1440: "Methodology for environmental impact assessment of information and communication technologies at city level"
  - *Blockchain integration:* Recommendation ITU-T Y.4907: "Reference architecture of blockchain-based unified KPI data management for smart sustainable cities"
- *Support cities in the Asia-Pacific with their smart city expeditions*: With Asia having eight of the world's megacities – most of which are in developing countries – it would be beneficial if Daegu were to provide these cities with additional guidance for their smart sustainable city journeys. Daegu's well-defined strategy and planning processes, which are aligned with its inhabitants' needs and are dedicated to solving real city problems, are an excellent template that could be used by other cities.

# 11 Conclusions

This case study is the stepping stone for cooperation between ITU and the city of Daegu.

Figure 36: National Debt Redemption Movement Park - Daegu

Daegu has proved to be an ideal partner to implement the U4SSC KPIs, with its region leading smart sustainable city vision and plans and enjoying the support of various governments working in different domains, along with the support of local telecom operators.

The following conclusions are based on the experience of Daegu in implementing the U4SSC KPIs and the Daegu smart sustainable city strategies, plans and initiatives. These findings will serve as a "knowledge hub" for other aspiring smart cities in the Asia-Pacific region and provide them with an insight into making their smart city dreams a reality:

- Daegu has developed a world-class smart sustainable city programme, including clear vision and strategy, defined plans and initiatives, which is having a significant impact on the quality of life of its inhabitants. The city has also been following closely the best practices elaborated in Supplements ITU-T Y.4400 series – Smart Sustainable Cities. Other cities are, therefore, encouraged to use the guidance found within these ITU-T Supplements to assist them in developing their own smart sustainable city initiatives and master plans.

- The focus that Daegu has put on implementing new and emerging technologies to solve city problems and to make the lives of its inhabitants better is another best practice that other aspiring smart sustainable cities should emulate. Another factor which can be considered by aspiring smart sustainable cities is determining the success of technology-based pilot projects though the measurement of defined benefits to inhabitants.
- While Daegu understands that technology needs to be a supportive factor in becoming smarter and more sustainable, the U4SSC KPI analysis does show that Daegu has world-leading ICT infrastructure.
- The strides made by Daegu in engaging with its inhabitants through the smart sustainable city programme set the table to make the response to the COVID-19 pandemic more effective. The trust and engagement built through the development of the city strategy and planning process, and programmes like the Urban Problem Discovery Team, are important factors for ensuring public health. Other cities are invited to consider similar mechanisms to facilitate inhabitant engagement and build trust prior to the onset of emergencies.
- The lessons learned by Daegu on its journey to becoming smarter and more sustainable should be shared with other cities within the Republic of Korea, within the region and globally. Daegu should consider partnering with other cities, in particular cities in lesser-developed regions, to share positive and negative experiences of this journey and best practices.
- With the knowledge gained in the last few years in the realm of smart sustainable cities, Daegu is encouraged to engage further with ITU and the U4SSC initiative to broaden the knowledge base related to smart sustainable cities and provide real-world feedback on the feasibility of projects in other cities.
- The benchmarking exercise undertaken as part of the U4SSC KPI verification demonstrates that more work can be done in the KPI categories of transport, buildings and energy. In this context, a transport system that is less dependent on private vehicles and more focused on less-carbon-intensive modes should be strived for. Additionally, a better understanding of the sustainability performance of public buildings, and a reduction in fossil-fuel-based energy sources and energy use are key areas on which to focus in the future to enhance environmental sustainability, reduce greenhouse gas emissions and improve air quality.
- The reporting of the U4SSC KPIs should continue at regular intervals, or in real time, to determine the trends in performance and the improvement in KPI benchmarks. The U4SSC KPIs can provide a method to determine and visualize the impact of Daegu's initiatives on the city and its inhabitants.
- Following the first-year of the U4SSC KPI implementation in Daegu, the city has achieved the milestone of becoming the first city in the Republic of Korea to utilize the existing U4SSC KPI framework. In addition to the findings provided by the city, it will further serve as the beacon of successful smart sustainable city endeavours for other cities in the region by engaging them and to guide them on equally triumphant smart city ventures.

- Finally, the city of Daegu is encouraged to implement Recommendation ITU-T Y.4904, which provides a maturity model for smart sustainable cities. This maturity model can help to identify the goals, levels and key measures that are recommended for cities to examine their current situation effectively and determine critical capabilities needed to progress toward the long-term goal of becoming smart sustainable cities (SSCs).

## Endnotes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