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Output Report on ITU-D Question 1/2

Smart sustainable cities and communities

Study period 2022-2025

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This report was prepared in response to Question 1/2: **Smart sustainable cities and communities**, under the overall guidance and coordination of the management team of ITU-D Study Group 2 led by Mr Fadel Digham (Arab Republic of Egypt), as Chair, supported by the following Vice-Chairs: Mr Abdelaziz Alzarooni (United Arab Emirates), Ms Zainab Ardo (Federal Republic of Nigeria), Mr Javokhir Aripov (Republic of Uzbekistan), Ms Carmen-Mădălina Clapon (Romania), Mr Mushfig Guluyev (Republic of Azerbaijan), Mr Hideo Imanaka (Japan), Ms Mina Seonmin Jun (Republic of Korea), Mr Mohamed Lamine Minthe (Republic of Guinea), Mr Víctor Antonio Martínez Sánchez (Republic of Paraguay), Ms Alina Modan (Romania),[1] Mr Diyor Rajabov (Republic of Uzbekistan),[1] Mr Tongning Wu (People's Republic of China), and Mr Dominique Würges (France).

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[1] Stepped down during the study period.

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Executive summary

In view of the importance of the role of information and communication technologies (ICTs) in the functioning of today's society, the World Telecommunication Development Conference 2022 (WTDC-22) approved the continuation of Question 1/2 ("Creating smart cities and society: Harnessing information and communication technologies for sustainable socio-economic development").

In accordance with the resolutions and guidelines of WTDC-22, this output report on the ITU Telecommunication Development Sector (ITU-D), including Question 1/2 for the 2022-2025 study period, reports on experiences and contributions shared by Member States and partners on the issues of connectivity, smart city planning, user equipment and terminals, business rules and business models, and capacity building on ICTs for the development of a sustainable economy and smart society with smart city indicators and mechanisms.

Chapter 1 describes objectives, expected results, sharing experiences and lessons learned, as well as some statistics on smart cities, and discusses artificial intelligence (AI) and Internet of Things (IoT), identifying common core elements of the concept of smartness.

Chapter 2 describes the benefits of connectivity and broadband infrastructure, infrastructure sharing, challenges and approaches to solutions to connect rural areas, and cybersecurity. It also points out the basic considerations for the design of a reliable and robust central telecommunication infrastructure.

Chapter 3 presents policies and business models relevant to smart cities by highlighting examples of legal frameworks to promote the development of smart sustainable cities and communities (SSC), as well as recommended good practices.

Chapter 4 presents the steps and aspects to be considered when planning for a smarter city (architecture, software, etc.).

Chapter 5 introduces smart services, which are systems and applications that make use of cutting-edge technologies such as artificial intelligence (AI), Internet of Things (IoT) and big data, by providing more efficient, customized and automated solutions. Smart services leverage the capabilities of smart devices and terminals, which play a key role in the evolution of smart cities and societies. The different sectors covered by these services are also highlighted. These include, but are not limited to, education, transport, health, etc. Chapter 5 also presents the holistic approach needed with respect to the underlying infrastructure, device standardization, data privacy and citizen participation.

Chapters 6 and 7 introduce intelligence assessment mechanisms and the importance of capacity building. Capacity building for smart sustainable cities and communities (SSC) is a holistic process that focuses on fostering initiatives and acquiring essential knowledge on ICTs.

This output report is the culmination of years of committed work, and multiple contributions from the membership. It follows up on the annual progress reports already produced.

Abbreviations and acronyms

Abbreviation	Term
2G	second generation mobile technology
3G	third generation mobile technology
4G	fourth generation mobile technology
5G	fifth generation mobile technology[2]
AI	artificial intelligence
CIRT	computer incident response team
CO2	carbon dioxide
COVID-19	coronavirus disease 2019
CSO	civil society organization
DBT	direct benefit transfer
DSIT	Department of Science, Innovation and Technology
DTC	digital transformation centre
EG-ATRC	Egyptian African Telecom Regulatory Training Centre
FAO	Food and Agriculture Organization
FG-AI4A	Focus Group on Artificial Intelligence and Internet of Things for Digital Agriculture
GCWC	Greater Cairo Water Company
GDP	gross domestic product
GIS	geographic information systems
HNT	home network transport
HVAC	heating, ventilation, and air conditioning
ICFM	intelligent connected fare meter
ICT	information and communication technology
ILO	International Labour Organization
IoT	Internet of Things

[2] While care was taken in this document to properly use and refer to the official definition of IMT-generations (see Resolution ITU-R 56, "*Naming for International Mobile Telecommunications*"), parts of this document contain material provided by the membership which refers to the frequently used market names "xG". This material cannot necessarily be mapped to a specific IMT-generation, as the underlying criteria from the membership are not known, but in general, IMT-2000, IMT-Advanced, IMT-2020 and IMT-2030 are known as 3G/4G/5G/6G, respectively.

(continued)

Abbreviation	Term
ISM	information security manual
IVS	intelligent video solutions
JCA-IoT and SC&C	joint coordination activity on Internet of Things and smart cities and communities
KPI	key performance indicator
LDC	least developed countries
LPWA	low power wide area
LTE	long-term evolution
NCSC	National Cyber Security Centre
NPSA	National Protective Security Authority
NTRA	National Telecommunications Regulatory Authority
NUCA	New Urban Communities Authority
OCERT	Oman Computer Emergency Response Team
OSEE	open source ecosystem enabler
PAS	publicly available specification
PM-WANI	Pradhan Mantri Wi-Fi access network interface
PUE	power usage effectiveness
R&D	research and development
SDG	sustainable development goal
SOA	service oriented architecture
STEM	science, technology, engineering, and mathematics
TMG	Telecommunications Management Group
U4SSC	United for Smart Sustainable Cities
UAV	unmanned aerial vehicle
UPI	unified payment interface
UXP	unified exchange platform
WTDC	World Telecommunication Development Conference
WWF	World Wide Fund for Nature (formerly World Wildlife Fund)

Chapter 1 – Introduction

Given the rise of a "fourth industrial revolution", that is supported by smart manufacturing and marked by the widespread application of new and emerging technologies, many countries are increasingly investing in projects related to the digitalization of organizations and companies and in technological innovation. In today's interconnected world, digital development is the cornerstone for sustainable growth and for the promotion of digital inclusion. As urban centres often become the focal points for technological advances, the importance of extending digital reach to remote rural areas cannot be overemphasized. Digital infrastructure in rural areas acts as a catalyst for economic growth, giving communities the tools and resources to improve their livelihoods in a sustainable manner. For example, access to digital platforms enables farmers to obtain real-time information on markets, which in turn leads to improved farming practices and so optimizes yields. In addition, digital connectivity opens up opportunities for remote education and healthcare applications, ensuring rural communities have access to quality learning and medical services, thereby reducing the disparity between urban and rural living standards.[3]

In accordance with the resolutions and guidelines of the ITU World Telecommunication Development Conference 2022 (WTDC-22), this output report by the ITU Telecommunication Development Sector (ITU-D), on Question 1/2 for the 2022-2025 study period, reports on experiences and contributions shared by Member States and partners on the issues of connectivity, smart city planning, user equipment and terminals, management rules and business models, as well as capacity building on information and communication technologies (ICTs) for the development of a sustainable economy and smart society with smart city indicators and mechanisms.

In 2022, 57 per cent of the world's population were living in urban areas, and this proportion is expected to reach 68 per cent by 2050. While rapid urbanization has contributed to economic development, it also generates challenges attached to the urban environment. With the increasing scale and complexity of cities, environmental pollution, traffic congestion, resource shortages and other challenges, have negatively impacted on the sustainable development of cities, and on the quality of life of their residents. Traditional urban management strategies have been unable to fully meet the development needs of modern cities. With the current rapid development of smart cities and the promotion of urban management, there is a necessity to widely apply modern scientific and technological means and convert them into practical governance technologies to promote changes in all fields of urban management.

1.1 Objectives

The key objectives of Question 1/2 on smart cities and communities include:

a. Discussion of methods of improving connectivity to support the smart society, including connectivity to support smart grids, smart cities and information and communication technology (ICT) applications in public administration, transport, business, education and training, health, the environment, and agriculture and science.

b. Examination of good practices for fostering and enabling deployment and use of smart devices, including mobile devices, and the importance of the application of such devices.

[3] ITU-D SG2 Document SG2RGQ/208 from ITU BDT.

c. Sharing of experiences and good practices in building smart cities.

1.2 Outputs

The key outputs include:

a. Guidelines on policy approaches to facilitate the development of ICT applications in society, fostering social and economic development and growth.

b. Case studies on the application of Internet of Things (IoT) and ICT applications in building sustainable cities and communities, identifying the trends and good practices implemented by Member States as well as the challenges faced, in order to support sustainable development and foster smart societies in developing countries.

c. Organization of workshops, courses and seminars for the development of capacities allowing improved uptake of ICT applications and IoT.

d. Annual progress reports, which should include case studies, and a detailed final report containing measurement analysis, information and good practices, as well as any practical experience acquired in the areas of use of telecommunications and other means of enabling ICT applications and connecting devices for development of the smart cities and society.

1.3 Methodology

To share experiences and lessons learnt in the process of creating smart cities and society, delegates from ITU Member States and Sector Members have submitted contributions and made presentations on this topic. In addition, a series of workshops has been conducted at which experts and Member States shared their experiences. Finally, activities and studies carried out by the ITU Telecommunication Development Bureau (BDT) in relation to the subject of smart cities and communities have been reflected when applicable.

1.4 Enlarging scope: smart villages and other communities

As urbanization intensifies at an unprecedented rate, more than half of the global population now resides in urban areas, accounting for approximately 4.4 billion individuals worldwide. The economic significance of urban areas is underscored by the fact that they generate over 80 per cent of the global gross domestic product (GDP), thereby contributing substantially to sustainable economic development. The urban population is projected to undergo continued growth, with an estimated 7 out of 10 people worldwide expected to live in cities by 2050, more than doubling the current urban population size.[4]

This rapid urban expansion presents a dual aspect of challenges and opportunities. Cities, while offering prospects for growth and innovation, also face significant hurdles such as ensuring affordable housing, security, effective transportation, accessibility to basic services, and sustainable resource use. Addressing these challenges necessitates a collaborative approach involving policymakers, urban planners, community leaders, and city dwellers.

Urbanization also exerts a significant environmental impact, with cities consuming 78 per cent of the world's energy and producing approximately 60 per cent of global carbon dioxide (CO2)

4 https://www.worldbank.org/en/topic/urbandevelopment/overview.

emissions, along with being responsible for 50 per cent of global waste production. As urban expansion continues, prioritizing environmental considerations becomes essential.

The rise of smart city innovation, responsive to the intersection of social, environmental, and economic challenges, aims to enhance the quality of life, promote sustainability, and foster economic growth. Smart city investments are projected to double from USD 410 billion in 2020 to USD 820 billion by 2050, and the global market for smart city technology is expected to grow beyond USD 300 billion by 2032.[5] This indicates significant opportunities in the technology sphere and the need for substantial investment in smart city solutions.

Several technologies are shaping smart sustainable cities by supporting infrastructure investment, digitisation, and sustainability, often with backing from public funding. Technologies such as IoT for transportation, AI for energy management, digital twins for urban planning, smart sensors for waste management, and big data for water management, highlight the convergence of smart technologies and sustainability.[6]

Buildings play a foundational role in the creation of smart sustainable cities and shape urban sustainability significantly. They contribute to 30-40 per cent of global greenhouse gas emissions due to energy consumption and density.[7] Recognizing the pivotal role of buildings is critical for creating resilient, liveable, and sustainable cities, especially considering that people now spend about 90 per cent of their time indoors.[8] The integration of smart technologies within buildings can lead to transformative changes in urban sustainability.

In buildings, various technologies are revolutionizing aspects such as energy efficiency, operational maintenance, occupant comfort, and resource management. AI can play a pivotal role in optimizing energy efficiency by analysing data from IoT sensors to dynamically adjust heating, ventilation, and air conditioning (HVAC) systems and lighting, resulting in reduced energy consumption. IoT sensors enable predictive maintenance by monitoring equipment health in real time and enhance occupant comfort by monitoring indoor air quality, temperature, and lighting levels. Digital twins create virtual replicas of buildings, allowing for real-time monitoring and simulation of resource usage, which aids in better resource management, such as optimizing water usage and waste reduction strategies.

1.5 Rural versus urban considerations

Rural and remote locations, such as villages, can face specific challenges in delivering the necessary infrastructure to meet their needs. These challenges can include limited resources, resistance to technology in general, a lack of capacity and digital skills, unfamiliarity with smart city solutions that can address their needs, an aging population, and the inability to attract investment. The experience of Romania with smart villages found that all levels of government (municipal, regional, and national) should coordinate smart city strategies, in combination with community involvement and participation, in order to reduce the digital divide and improve the living conditions of disadvantaged communities.[9]

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5 ITU-D SG2 Document (workshop presentation) Q1/2-2024-06 from BOMA.
6 *Ibid.*
7 *Ibid.*
8 *Ibid.*
9 ITU-D SG2 Document SG2RGQ/31 from Romania.

The collaborative bottom-up approach[10] (between local, county and national levels), developed to achieve the development objectives of the municipality of Ciugurd in Romania, deserves to be highlighted. This implies that smart cities do not exist in a vacuum; they depend on smart territories, which recognize the complementary assets of urban and rural areas, ensure their integration, and foster effective partnerships between cities and villages to ensure positive socio-economic outcomes through an urban-rural continuum. The smart cities principle must also consider approaches that enable, through the strategic use of ICT, the voices of the marginalized and the poor to be heard, and the well-being of the informal sector comprising the dynamism of informal activities, as well as the needs of women, youth and the elderly to be recognized. It is through the social fabric, and not simply by developing economic competitiveness and advanced infrastructure, that resilient and sustainable cities are built.[11]

China, for its part, advocates smart village development based on digital twins by preserving the cultural values of ancient villages threatened by urbanization and lack of awareness among villagers. For this purpose, it was suggested to map representative villages, enriching interactive online and offline tourism experiences, and establishing a self-financing mechanism for protection efforts.[12]

[10] Bottom-up approach therefore consists of taking into consideration local contexts, recognizing local organization and the effective involvement of villagers in the general options of rural development (see also link).
[11] https://habitat3.org/wp-content/uploads/Habitat-III-Issue-Paper-21_Smart-Cities-2.0.pdf.
[12] ITU-D SG2 Document 2/42 from China.

Chapter 2 – Connectivity

2.1 Connectivity and infrastructure

The digital connectivity, infrastructure, and services provided by smart cities and communities facilitate the delivery of government services, contribute to economic growth, help bridge the digital divide, and provide opportunities for greater employment, poverty reduction, and education. As has been seen throughout the study period in various national experiences, emerging technologies can be used in unique ways to enhance participative delivery of government services, increase productivity, reduce waste, support public safety, enable innovative services in fields like cultural tourism, and, in times of crisis, support national resilience and keep people, governments, and businesses connected.

The ITU project "Connect2Recover – Digital infrastructure and ecosystem reinforcement against COVID-19"[13] aims to reinforce digital infrastructure and ecosystems to provide a means of utilizing digital technologies and services such as teleworking, e-commerce, remote learning and telemedicine, to prevent the spread of COVID-19 infections while maintaining socio-economic activities to the maximum extent possible, as well as to support the recovery efforts and preparedness for the 'new normal' (and potential future pandemics). The project seeks to carry out assessments of the current situation of and pressures on telecommunication networks caused by the increased use of digital services during the COVID-19 pandemic. The project also aims to assess the use and provision of digital services during the COVID-19 crisis and beyond, as well as planning and carrying out pilot projects to improve connectivity and emergency services in beneficiary countries.

The ability to deliver government services electronically (i.e., e-government) can result in cost and time savings, improved service quality, increased user satisfaction, and enhanced transparency. At the same time, these same technologies can exacerbate economic and social divides and hasten vulnerabilities. Vulnerabilities can, for example, arise from the potential for cascading effects from the disruption of a single service, leading to potentially significant and distinct consequences for users. Above all, infrastructure deployment is not a 'one-size-fits-all' approach. It is a balancing act between the unique needs of the community and its residents, with the development of tools necessary to deliver government services.

The work of the World Bank emphasizes the need to promote broadband connectivity, through increasing the use of information and communication technology (ICT) services and applications for sustainable and transformative development.[14]

Among other things, due consideration should be taken for the needs of urban cities and rural and remote communities, of existing architecture and new building projects, and of multiple technologies such as 5G, 4G long-term evolution (LTE), optical fibre, and Wi-Fi to facilitate connectivity.

[13] ITU-D. Connect2Recover initiative.
[14] ITU-D SG2 Document 2/74 from the World Bank.

Examples of technologies to facilitate connectivity

- 2G introduced digital voice transmission, replacing analogue. It enabled short message service (SMS) and basic Internet browsing, laying the foundation for modern mobile connectivity. Despite being slower, 2G is still used in some remote areas.
- 3G marked a significant leap, providing faster data transfer for mobile Internet, video calls, and multimedia messaging than previous generations. It introduced high-speed web browsing and facilitated applications such as mobile banking and e-learning.
- 4G-LTE technology has expanded meaningful connectivity across the globe by providing wide coverage for higher speeds compared to earlier generations of wireless communications. The use of an LTE network for the deployment of an intelligent video solution (IVS) by the Government of the Republic of Madagascar proves that this technology can enable meaningful connectivity. To date, 18 LTE sites[15] have been deployed in the area of the capital Antananarivo, each connected to the main fibre-optic network. The deployment of 4G-LTE technology in rural areas can help achieve the Sustainable Development Goals (SDGs), in particular SDG 9, building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation, SDG 10, reducing inequalities within and among countries, and SDG 11, making cities and human settlements inclusive, safe, resilient and sustainable.
- 5G can have a role in facilitating connectivity and infrastructure for smart cities. By mid-August 2021, 176 commercial 5G networks were launched worldwide, with 461 operators in 137 countries investing in 5G technology, including trials, licensing, planning, network deployment, and launches.[16] 5G deployment can play an important part in delivering high-speed broadband connectivity for developing countries, achieving digital equity and the United Nations SDGs, and enhancing people's quality of life.
- Local 5G is a private network designed for specific areas such as factories, campuses, or smart cities. It can offer fast speeds, low latency, and high reliability, supporting its applications for real-time monitoring and IoT. Unlike public 5G, which is operated by telecommunication providers, local 5G is owned and managed by the organization. It can provide enhanced security, control, and customization to meet unique needs.
- LPWA (low power wide area) is a wireless communication technology designed for long-range, low-power transmission, which can help address unique use cases/environmental challenges for some IoT devices. L supports small, infrequent data transfers over large distances with minimal energy consumption. Common LPWA technologies include long range applications (LoRa), narrowband IoT (NB-IoT), and Sigfox low power wide area network (LPWAN), all of which cater to different use cases in IoT, smart cities, and industrial applications.
- Wi-Fi has seen a growing impact on infrastructure and the development of smart cities and presents a business case for connectivity to rural areas given its cost-effectiveness. Intel noted the benefits of using 6 GHz unlicensed spectrum for Wi-Fi and the role of Wi-Fi in facilitating the Internet of Things (IoT), as well as its contribution to increasing energy efficiency, and particularly its facilitation of digital solutions such as video conferencing and smart-building technology which can reduce city congestion and energy consumption.[17] The evolution of Wi-Fi, with its operation in unlicensed frequency bands and lower deployment costs, can be a useful tool to provide affordable Internet access.
- Optical fibre offers many advantages in terms of high connectivity. It represents a means to offer high speeds that support meaningful connectivity, in order to support sustainable development and promote smart societies in developing countries. Referring to the experience of Madagascar cited above, it is noted that optical fibre optics served as the main network technology enabling the connection of the 18 LTE sites deployed in

[15] ITU-D SG2 Document 2/139 from Madagascar.
[16] ITU-D SG2 Document SG2RGQ/10 from Intel Corporation.
[17] ITU-D SG2 Document 2/162 from Intel Corporation.

Antananarivo, the installation of 1 200 intelligent video surveillance (IVS) cameras and the distribution of 1 500 LTE smartphones for use by the municipal police. The success of this solution highlights the importance of optical fibre in providing and promoting effective connectivity for sustainable development and security.

- Cable television (CATV) provides affordable Internet access in suburban and semi-urban areas by utilizing coaxial cables already deployed for television services. This technology can help accelerate connectivity rollout without heavy infrastructure investment where such cables already exist.
- x digital subscriber line (xDSL) leverages twisted pair cable in existing copper telephone lines. xDSL offers an economical option for areas with this pre-existing infrastructure for faster provision of connectivity compared to building new connectivity infrastructure such as fibre-optic cables.
- The use of satellites or other aerial solutions such as high-altitude platform systems (HAPS) or unmanned aerial vehicles (UAV) can be key to connecting communities in rural, remote, and/or geographically dispersed or hard to reach areas. As observed in the *Mi Pueblo Conectado* programme from the Argentine Republic,[18] satellites can be used to advance the digital development of provincial and municipal governments, provide services to users, and reduce the digital divide. One of the key features of the programme is the provision of satellite broadband connectivity.

2.2 Mitigating risk

While greater use of, and reliance on, connected infrastructure and services can present immense benefits to citizens, it can also introduce risks. To mitigate these risks, it is important to understand the extent of the risk, the needs of the government entities and citizens, and to increase cybersecurity awareness and good practices. Successful risk mitigation begins with having plans in place ahead of a cybersecurity incident.

In the case of the United Kingdom of Great Britain and Northern Ireland's Secure Connected Places Playbook, developers ensured that the playbook met the needs of those that would use it, used an iterative testing approach, and developed and tested interventions with a broad sampling of local government authorities. While highlighting the risks associated with increased reliance on connected technologies, such as public safety threats, and community trust if safeguards are not followed, the playbook cites the National Protective Security Authority (NPSA) as the United Kingdom's approach to addressing security issues. In 2017, the NPSA commissioned PAS 185, a specification for establishing and implementing a security-led approach to the development of connected places. Since then, the Department of Science, Innovation and Technology (DSIT), in collaboration with other government agencies,[19] has been working to reduce and mitigate the cybersecurity vulnerabilities inherent in connected place systems.[20] The approach has primarily involved working with local government stakeholders and industry to provide guidance to support the secure implementation of connected place projects. In 2021, the National Cyber Security Centre (NCSC) produced the Connected Places Cyber Security Principles. This guidance, produced primarily for United Kingdom local and national authorities responsible for the design, construction and operation of connected places,

[18] ITU-D SG2 Document 2/144 from Argentina.

[19] DSIT is convening a working group and steering committee to provide input into our approach to cyber security policy in connected places across various UK government departments and agencies, including the NCSC and NPSA.

[20] For example, the confidentiality and integrity of citizen and business data, the delivery and resilience of public services, and citizen security.

aims to raise awareness and understanding of the security considerations needed to manage security risks.[21]

Lessons learned from the example in Australia of mitigating security risks in smart places, including the Internet of Things, supply chain, operational technology, and cloud computing, have resulted in the publication of good practices that implementers can follow to help mitigate the full range of security risks. The efforts of Australia in securing smart places also stressed the importance of operational redundancy. Indeed, it is important to consider the interconnectedness and potential for cascading cybersecurity incidents in smart place technologies. Implementers should ensure that appropriate contingency measures for the manual operation of all critical functions are in place and that staff are trained to implement and operate them in the event of an emergency. These contingency measures should include disconnecting smart place technologies from essential services to allow them to operate independently. Therefore, the Australian Signals Directorate has produced the Information Security Manual (ISM), which is a cybersecurity framework that an organization can apply, using its risk management framework, to protect its information technology and operational technology systems, applications and data from cyber threats. The ISM framework provides priority strategies that organizations and professionals can leverage to mitigate cybersecurity incidents caused by various cyber threats.[22]

2.3 Infrastructure sharing

Infrastructure acts as a silent partner of the city in providing communities and organizations with access to essential services, and ensuring their sustainability and resilience.

One approach to connectivity and infrastructure deployment is to piggyback on already established systems, such as infrastructure for electricity and water. An example of this is Egypt's plans to improve infrastructure in brownfield and rural areas through the installation of optical fibre in water pipes with the aim of enhancing telecommunication infrastructure and water management capabilities by increasing the telecommunication network capacity. The project is a collaboration between the National Telecommunications Regulatory Authority (NTRA), the Egyptian Water and Wastewater Regulatory Agency (EWRA), Telecom Egypt, and the Greater Cairo Water Company (GCWC) to use existing raw water pipelines for fibre-optic deployment using a pipe-in-pipe technique. The project illustrates the benefits of using existing pipelines to overcome right-of-way issues, increasing the telecommunication penetration rate, extending consumer reach, and reducing the cost of installing fibre-optic networks. Such an infrastructure sharing model exemplifies the important collaboration between technology and urban development and how effective collaboration is crucial for the successful planning and implementation of infrastructure buildout and sharing.[23]

2.4 Infrastructure planning

As seen in the multitude of shared experiences, smart cities and communities rely on thoughtful, planned digital transformation and a best-in-class infrastructure to deliver public services, promote connectivity for all, create government transparency, and improve the quality of life and well-being of residents.

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21 ITU-D SG2 Document 2/199 from the United Kingdom.
22 ITU-D SG2 Document SG2RGQ/38 from Australia.
23 ITU-D SG2 Document SG2RGQ/131 from Egypt.

Through planning, smart city governments have a comprehensive view of all city operations, infrastructure, and services. This allows city leaders to anticipate potential issues, quickly address challenges, and improve outcomes. All of this helps improve the experience of residents, visitors, and businesses in the urban area, and shape a brighter future for the smart city or community.

While smart sustainable cities offer opportunities for cities and their residents, the underpinning infrastructure should be designed to meet residents' needs, using a variety of technological innovations, such as artificial intelligence, Internet of Things, 4G-LTE, 5G, optical fibre, Wi-Fi and satellite to foster digital inclusion while also ensuring the security and reliability of government services for empowered, resilient, and connected communities.

Chapter 3 – Policies and business models

The increasing urbanization around the world is accompanied by major economic, environmental, political and technological changes. The development of smart cities is emerging as a solution to respond effectively to the challenges we face. Smart cities can be understood not only as "*urban areas that use different types of electronic methods and sensors to collect data*",[24] but also as an approach that requires policies and regulations, good practices, business models and even public funding in order to meet the challenges of sustainable development for smart cities and their residents.

The concepts of sustainable development and smart cities are closely linked, since both propose a development model to meet the needs of the current population without harming future generations. For smart cities, the question of sustainable development is essential and calls for the involvement of stakeholders as participants. To achieve this result, the smart city and its residents form an inseparable whole within which public participation is encouraged.[25]

To achieve this, countries and/or institutions have proposed, based on their own experiences, a variety of innovative solutions to improve the efficiency, resilience and sustainability of smart cities and communities.

3.1 Policies

Optimizing smart city development policies is one of the main challenges that the various stakeholders are working on for better stakeholder involvement. The smart city equates to a business model where economic growth is compatible with the well-being of citizens and respect for the planet.

As part of its efforts to support digital transformation, the World Bank[26] encourages governments to develop policies focused on the use of ICTs for sustainable social and economic development, through services and advice such as targeted policy guidance, technical assistance and capacity building. Client countries are encouraged to develop policies that focus on:

- connectivity, access and use of broadband;
- ICTs industry and digital jobs;
- digital technology at the service of the climate;
- accelerating the use of digital technology in all sectors;
- digital protection measures.

Thus, the focus has been on key approaches that increase the use of ICT services and applications to promote transformative and sustainable development. For example, in order to improve connectivity and access to digital services in rural areas, and strengthen the fibre optic network in and around the city of Parakou by densifying related infrastructure, Benin received World

[24] https://fastercapital.com/content/Smart-city-development--Building-Sustainable-Business-Models-in-the-Smart-City-Industry.html.
[25] https://www.synox.io/en/smart-city-en/smart-city-development/.
[26] ITU-D SG2 Document 2/74 from the World Bank.

Bank support in 2019 for a project on the digital transformation of rural areas for the period 2018-2025.[27]

Meanwhile, the Centre for Telematics Development in India has proposed government frameworks and policies aimed at digital transformation and inclusion by developing the PM-WANI programme, which is designed to proliferate broadband through a secure and convenient network of public Wi-Fi hotspots.[28]

Egypt aims for collaborative regulation for smart cities, by sharing an ambitious Vision 2030 plan for sustainable development and decarbonization strategy, that requires the collaboration of different government entities, as well as coordinated efforts between government, private sector and civil society.[29]

Argentina recommends the deployment of artificial intelligence, in line with sustainable development policies for smart cities and communities, and a framework was designed for the technological adoption of AI within that country that is based on its unique context, emphasizing ethical principles and human-centric approaches.[30]

An example of a legal framework aimed at promoting the sustainable development of smart cities and communities is the framework put in place by Egypt[31] through collaborative regulation, which has enabled:

- the pooling of smart infrastructure, approval of telecommunication designs and exchange of good practices for the development of smart cities between the National Telecommunications Regulatory Authority (NTRA) and New Urban Community Authority (NUCA);
- pooling efforts between NTRA and NUCA to ensure excellent coverage and sharing of sites between mobile operators;
- the development by NTRA and the National Building and Housing Research Centre of national codes for smart infrastructure based on NTRA guidelines;
- the conclusion of a Memorandum of Understanding/Protocol of Cooperation between NTRA and the Greater Cairo Water Company (GCWC) for "infrastructure sharing" within the framework of a pilot project to connect two large switching centres.

3.2 Legal framework

Smart cities are growing in popularity and represent a potential transformation for the future of our urban societies. This approach is based on the use of ICTs to improve the quality of life of residents, optimize resource management, and promote sustainable development. However, these innovations also raise complex legal issues that require in-depth consideration of regulations adapted to this new context:

- In a smart city, data is the fuel that enables the various technological solutions to function. Among these data are also those that directly concern individuals. The question of the protection of personal data becomes important. The European General Data Protection Regulation (GDPR) is one legal framework for the protection of personal data. Legislation

[27] https://www.worldbank.org/en/news/press-release/2019/07/01/benin-world-bank-provides-100-million-to-promote-digital-solutions-in-rural-communities.
[28] ITU-D SG2 Document (workshop presentation) Q1/2-2023-05 from India.
[29] ITU-D SG2 Document 2/133 from Egypt.
[30] ITU-D SG2 Document 2/149 from Argentina.
[31] ITU-D SG2 Document 2/133 from Egypt.

such as this, where adopted, can impose obligations on the actors involved in the development and implementation of smart city projects such as data minimization, transparency, and security.

– Smart cities are an opportunity for a variety of stakeholders to exchange views and contribute to the sustainable development of their community. Public authorities, businesses, civil society organisations, and individuals all benefit from working together to create transparency and accountability in service delivery, and exchange views on the implications of these technologies within the community.[32]

In view of the above, it is clear that the effective implementation of strategic tools enabling collaboration for the efficient and sustainable development of smart cities requires an appropriate regulatory environment.

Developing a supportive policy and legal framework helps facilitate the growth of smart sustainable cities and communities. Governments can establish regulations that encourage the adoption of smart technologies and address data privacy, public safety, and other concerns associated with digital connectivity. Financial incentives, such as grants, subsidies, and tax benefits, can stimulate private sector investment in sustainable solutions tailored to the needs of both urban and rural settings. Policymakers can also support frameworks that enable the integration of environmentally responsible technologies and sustainable practices into urban planning and development strategies.

Building sustainable smart cities and communities also benefits an enabling legal framework that promotes dialogue and effective collaboration mechanisms across different sectors.

3.3 Inclusive design

Deepening usage of ICTs can affect digital gender equality and digital skilling in rural and remote areas in Africa.[33] To address this digital divide and foster meaningful ICT usage by women for socioeconomic gains, policymakers can prioritize three key policy areas:

1. Ensuring accessible and affordable connectivity: It is imperative to expand broadband infrastructure to reach underserved regions, particularly rural areas and marginalized communities. Additionally, promoting affordable and accessible devices, such as smartphones and tablets, can reduce the cost barrier for women and enable them to participate in the digital world. Furthermore, prioritizing online safety measures can empower women to be cybersecure and instil confidence in using ICTs.
2. Investing in digital skills development: Integrating digital literacy into formal education systems, including STEM subjects, can empower women with the necessary skills to thrive in the digital age. Additionally, establishing mentorship programmes that connect women with experienced professionals can offer valuable guidance, support, and networking opportunities, and foster their professional growth.
3. Promoting digital financial inclusion: Expanding access to digital banking and payment services is crucial to ensure that women can participate more fully through their economic empowerment. This can better enable them to manage their finances efficiently, access credit, and participate in economic activities. Furthermore, implementing policies that reduce transaction costs and make digital financial services affordable for all will reduce barriers that may hinder women's adoption of these services. Additionally, providing financial literacy training will empower women to make informed decisions regarding their finances and utilize digital financial tools effectively.

32 https://www.avocats-emergence.fr/reglementations-pour-les-villes-intelligentes-enjeux-et-perspectives/.
33 ITU-D SG2 Document 2/290 from the *Réseau International Femmes Expertes du Numérique* (RIFEN).

3.4 Environmental impact and sustainability

Smart sustainable cities and communities should be designed with climate-smart strategies, energy-efficient designs, and environmentally conscious policies that promote resilience in the face of environmental challenges. Establishing monitoring and evaluation mechanisms, such as key performance indicators (KPIs), is essential to track progress and ensure continuous improvement. Feedback from stakeholders, including individuals, civil society organisations, rural leaders, and municipal officials, will help refine strategies and help smart solutions evolve to meet changing needs and challenges.

Promoting development of small island communities is of critical importance in fulfilling the SDGs in the Asia Pacific region.[34] Pacific Island countries aim to bring the benefits of the digital transformation to their citizens by adopting a whole-of-government and Smart Islands initiative approach. The project aims to provide assistance for the provision of affordable and sustainable access to digital networks and services to communities on Smart Islands for three Pacific Islands countries (Republic of Fiji, Papua New Guinea, and Republic of Vanuatu).

The objectives of the project, "Green GovStack:[35] Accelerating sustainable government services digitalization and digital transformation", are to help partner governments:

1. become digital frontrunners in enabling green paperless, presence-less, and cashless services, which will maximize their positive environmental and climate impact;
2. use greener technologies, particularly by adopting hardware circular economy models, climate-neutral CPUs/servers, data centres and energy-efficient software development;
3. provide guidance in setting smart policy and regulatory frameworks in order to be a driver for sustainable digitalization that adopts the use of circular economy models and innovates in greener technologies.

By emphasizing the promotion of capacity building and knowledge acquisition in ICTs, both urban and rural communities can be transformed into smart sustainable cities and communities, where technology, governance, and sustainability are seamlessly integrated to improve quality of life, drive economic growth, and safeguard the environment for future generations.

3.5 Business models

The Digital Investment Framework for the SDGs supports governments and their partners opting to take a whole-of-government approach to investing in shared digital infrastructure to strengthen SDGs programming across sectors.[36] In this regard, international cooperation is beneficial in the development of financing mechanisms linked to policies and business models for smart sustainable cities.[37]

Additionally, smart city projects and services seek to improve the quality of life, efficiency, sustainability, and resilience of urban areas by leveraging ICTs. However, these projects and services also face significant challenges in terms of financing, governance, scalability, and value

[34] ITU-D. Smart Islands.
[35] ITU-D. Global (Green) GovStack.
[36] ITU-D SG2 Document 2/209 from ITU BDT.
[37] ITU-D SG2 Document 2/127 from RIFEN.

creation. It is therefore essential to adopt appropriate business models that can address these challenges and ensure the viability and long-term impact of smart city solutions.[38]

To achieve the goals of viability, sustainability, and profitability, companies develop self-sustaining business models in the form of innovation in order to create, deliver, and capture value for their stakeholders.[39] It is within this framework that the World Bank has recommended the deployment of economic models[40] and digital data to mitigate greenhouse gas emissions and support the development of smart cities and communities.

For example, the World Wide Fund for Nature (WWF) has teamed up with Swisscom and Impact Hub to reduce the environmental footprint of the ICTs sector by offering smart home as a service (SHaaS) aimed at realising the potential to reduce greenhouse gases through digital solutions in the field of smart buildings.[41]

In the area of public financing, within the framework of policies and business models that guarantee the participation of the various stakeholders and sustainable development, China in its contribution[42] recommended the participation of various stakeholders, in particular that of the public, in order to create an environment of co-construction and shared governance between governments, businesses and the public.

Examples of public-private partnerships for smart city projects and services include the Republic of Singapore's Smart Nation Sensor Platform and Microsoft's CityNext initiative, where the company works with city governments and other partners to provide cloud-based solutions in various areas such as education, healthcare, energy and transport.

The Telecommunications Management Group (TMG) Inc. encouraged regulators and the private sector to work on developing future deployment scenarios for wireless power transfer (WPT) technology to support smart sustainable cities and communities. This proposal illustrates a use case in the integration of a specific technology to respond to needs of a smart city.

A smart city is first and foremost developed by, and for, its inhabitants. To meet their different needs, the smart city uses the latest technologies in the management of its different sectors (governance, environment, energy, transport) to make existing infrastructures more efficient. Transparency of its governance, and active participation of the different actors, aides the success of this approach. The emergence of smart cities is an innovation that has given rise to the development of new forms of businesses whose processes are multi-sectoral and interactive.[43]

Smart cities are urban areas that use ICTs to improve the quality of life, service efficiency and environmental sustainability of their residents. The development of a smart city is a complex and dynamic process that requires a holistic and collaborative approach, constant learning and adaptation.

38 https://fastercapital.com/content/Smart-city-development--Building-Sustainable-Business-Models-in-the-Smart-City-Industry.html#What-are-the-different-types-of-business-models-that-can-be-applied-to-smart-city-projects-and-services-.
39 https://www.one-planet-lab-fr.ch/post/mod%C3%A8les-d-affaires-durables-et-circulaires.
40 ITU-D SG2 Document 2/74 from the World Bank.
41 https://www.wwf.ch/sites/default/files/doc-2018-11/2018_11_Busniness_Model_Innovation.pdf.
42 ITU-D SG2 Document 2/169 from China.
43 https://www.synox.io/cat-smart-city/smart-city-users/.

By applying the recommendations and good practices, taking into account national circumstances, it is hoped that the sustainable development goals of smart cities and communities will be achieved.

Overall, smart city projects also raise significant governance issues. Conducting a smart city project involves rethinking the decision-making and collaboration methods between the various public and private, as well as individual, stakeholders. In this context, it is essential to establish appropriate governance that is transparent, inclusive and respectful of democratic principles. Specific bodies can be created to ensure effective monitoring and control of the development of smart city projects. Furthermore, it is valuable to encourage public participation in these projects, in particular by promoting access to information and by developing consultation and co-construction tools.

Chapter 4 – Smart city planning

Smart city planning is an approach that uses the strengths of new knowledge and tools to promote urban planning and development that responds to the evolving needs and challenges of urbanization.[44]

Policymakers might struggle to prioritize the steps and aspects to be considered when planning a smart city. Smart city planning benefits from incorporating the following:

- a strategy that clearly sets out a vision for the future;
- a list of desired programmes and first-generation results;
- an organizational structure, which distributes different roles to people to achieve targeted results;
- a timeline that establishes implementation timelines and sequential dependencies;
- an operating and capital budget for implementation initiatives;
- sources of funding through, e.g., public, private and blended financing.[45]

Resident participation, a key element when planning a smart city, includes informing and involving residents in decision-making and giving residents the opportunity to be proactive contributors within the smart city process.

4.1 Project design and features

Smart cities respond to a variety of needs, use cases, and populations and, as such, have been designed with a range of technologies and network designs to best match these needs and prospective solutions. The following sub-sections provide an overview of some of the main networking and design elements of smart cities.

4.1.1 Layers of networking and ICTs

Some of the greatest benefits of the smart city approach come from the interaction of different layers of ICTs, each with a specific role:

- Sensor layer: IoT sensors and devices collect data on various aspects such as traffic, air quality, energy consumption, etc.
- Network layer: Collected data is transmitted via telecommunication networks to servers.
- Processing layer: Data is stored and analysed, using technologies including artificial intelligence and machine learning, to extract useful insights and build a composite picture on environmental conditions or service delivery.
- Application layer: Applications are developed to use the data collected and its analysis to enable smart city projects, such as energy management, waste management, etc.

[44] https://habitat3.org/wp-content/uploads/Habitat-III-Issue-Paper-21_Smart-Cities-2.0.pdf.
[45] https://www.bdo.ca/getmedia/daebf299-c58f-4a2d-9814-fa15fa8e01ad/PS_07June19_Smart-Cities-Report-V6.pdf.

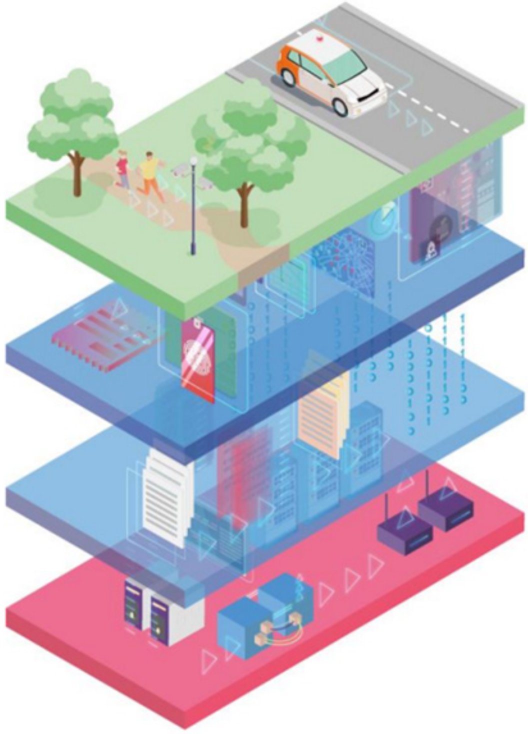
4.1.2 Elements of application design

No singular application or project will be universally applicable. Good smart city design relies on implementation being adapted to local needs and context. Even with this challenge, some principles of application design emerge as positive practices for policymakers aiming to maximise impact in resource-constrained contexts.

- **Interoperability**, including implementations such as open data portals, can enable different public and private developers, to iterate improvements on smart city projects and facilitate better integration of different solutions.
- **Scalability** of a singular project can expand its potential impact by offering similar benefits to different communities and users.
- **Reusability** emphasises that the design of services can have relevance for other, new applications with a view to reducing development time and costs.
- **Integrity** of datasets stresses the importance of adequate data protection and management procedures to better ensure that smart city projects are correctly informed and implemented.
- **Evidence-based design and decision-making** leverages access to reliable data to improve planning, policy and project decisions based on their impact.
- **Real-time access** to datasets can help ongoing project management and service delivery as well as aiding emergency response.
- **Spatial analysis** underlines the importance of geographically-relevant data to enable advanced analytics for urban planning, infrastructure management, and public safety.

An example of architecture implementation from a smart city project in Moscow is illustrated in Figure 1.

Figure 1: Architecture example of a smart city[46]



4.2 Open-source software

The adoption and development of open-source software is influenced by a variety of factors that can either help or hinder its preparedness and implementation. The following sub-sections provide a study of the main factors that increase the level of preparedness for the use and development of open-source software.

4.2.1 Education and awareness

- Technical training: Strengthen the teaching of programming and open-source software skills in educational systems, including universities and technical schools.
- Workshops and seminars: Organize events to raise awareness of the benefits of free open-source software, as well as its use, development and maintenance.
- Online resources: Ensure that online courses, tutorials, and documentation are available locally to help developers learn skills on open-source software.

4.2.2 Access to technology and infrastructure

- Internet connectivity: Improve high-speed, low-cost Internet access to facilitate access to online resources and development tools.
- Adequate equipment: Ensure that users have computer hardware that is compatible with open-source software, particularly in rural areas.
- Resource sharing initiatives: Promote the establishment of community resource centres where open-source hardware and software are available for public use.

[46] ITU-D SG2 Document SG2RGQ/167 from the Russian Federation

4.2.3 Institutional and policy support

- Enabling public policies: Develop government policies that encourage the use of free open-source software in public administrations and educational institutions.
- Public-private partnerships: Foster collaborations between the public sector, the private sector and civil society organizations to promote the open-source software ecosystem.
- Funding and grants: Provide financial support for open-source projects and initiatives.

4.2.4 Entrepreneurial climate and innovation

- Incubators and coworking spaces: Establish technology incubators and co-working spaces for startups focused on open-source software development.
- Market access: Help open-source software companies access local and international markets through networking platforms.
- Encourage innovation: Organize hackathons, development competitions, or artistic residencies to stimulate creativity around free open-source software.

4.2.5 Local communities and developer networks

- Community building: Promote the creation and support of local communities around free open-source software (meetups, online forums, user groups).
- Knowledge sharing: Encourage the sharing of experiences and good practices between developers, enabling them to overcome common challenges.
- International collaboration: Establish links with open-source developer communities globally to benefit from shared expertise and resources.

4.2.6 Economic and social benefits

- Cost savings: Educate businesses and governments on the savings that can be made through the use of open-source software, including the avoidance of application licence costs.
- Sustainable development: Raise awareness of how the use of free open-source software can contribute to sustainable development and technological autonomy.
- Valuing local talent: Promote the successes of local developers in the field of open-source software to inspire others to follow the same path.

To increase the level of preparedness for the use and development of open-source software, it is essential to adopt a multifaceted approach. Efforts must focus on education, institutional support, infrastructure, the entrepreneurial climate, and the creation of vibrant communities. Multi-sectoral collaboration, involving governments, businesses, non-governmental organizations (NGOs) and citizens, is crucial to building a productive ecosystem for free open-source software.

Chapter 5 – Smart services and smart devices

The digital world already permeates many aspects of our daily lives. Basic digital skills are a crucial step towards immersion in the 'smart city'. A smart city or community aims to improve the well-being of its inhabitants, businesses, visitors, organizations and administrators by providing smart services that contribute to a better quality of life. These smart services can help to better manage resources such as energy or water, and to enhance the operational efficiency of management tasks such as monitoring and reducing local traffic and pollution or finding greener ways to light and heat buildings.

Smart services make use of new and emerging technologies, such as artificial intelligence (AI), machine learning (ML), and Internet of Things (IoT) to provide more efficient, personalized and/or automated solutions. The successful delivery of smart services is influenced by a variety of factors comprising technological, organizational, and societal dimensions. Smart services leverage capabilities of smart devices and terminals which are pivotal in the evolution of smart cities and societies. Smart services enhance urban services, improve quality of life, and promote sustainable development. These services span various sectors, including education, transportation, health, government services, and smart villages/cities aiming to create more responsive, efficient, and sustainable urban environments.

This part of the report explores examples of the deployment of smart services, and the factors fostering smart devices and good practices adopted by different countries and organizations in their deployment and usage, for providing smart services in cities/societies. The good practices considered cut across various sectors with overlapping features and benefits.

5.1 Holistic approach to enabling deployment of smart services

The role of smart devices within a smart city approach emphasises the benefits of a holistic approach with respect to infrastructure, standards, and public engagement and education.

- **Robust infrastructure** is the cornerstone of any smart city initiative. A strong and resilient network infrastructure, including 5G and fibre optic networks, is essential to ensure seamless communication between devices and cloud servers. Adequate and reliable power supply, especially for devices deployed in outdoor environments, is crucial. Smart grid technologies can help optimize energy distribution and consumption. Furthermore, robust cybersecurity measures, such as encryption, access controls, and regular security audits, can help protect devices and data from cyber threats.
- **Standardization and interoperability** are key factors in ensuring the smooth integration of different devices and systems. Adopting standardized protocols that are supported with pre-existing use by industry and service providers helps facilitate seamless communication between devices. Promoting open data standards enables data sharing and innovation, supporting the development of new and innovative applications.
- **Public engagement and education** are crucial for successful smart cities. Educating the public about the benefits of smart devices and how they are used can support widespread use and spread the potential benefits of new projects and applications. Involving individuals and civil society in the design and deployment of smart city solutions, including devices, through public consultations, surveys, transparency measures, and other means can foster a sense of engagement and encourage active participation.

Establishing feedback mechanisms allows individuals as service users, to provide input on smart services and device performance. Human-centric design supports the widespread adoption of smart devices and services. Devices and services should be designed to be accessible to the widest number possible and have intuitive user interfaces. For example, people with disabilities and people with lower or no literacy might have specific needs or benefit from adaptations that enable their participation based on the devices they have access to. Personalization is just one example of how to enhance user experience by tailoring services to individual needs and preferences.

- **Data-driven decision-making** is a key component of smart city initiatives. Leveraging data analytics to identify trends, optimize operations, and improve service delivery can lead to significant benefits. Predictive maintenance, which uses data to predict equipment failures and schedule maintenance proactively, can help reduce costs and improve service reliability.

By carefully considering these factors, cities can effectively deploy smart devices and terminals for delivery of smart services to improve the quality of life for their residents.

5.2 Smart services application areas

Smart services offer a host of benefits in terms of operational efficiency, personalization, decision-making, security, innovation, health, education, sustainable development, mobility and inclusion. Smart services can play a crucial role in process improvement, value creation and the overall well-being of society. This section details use cases highlighting the usefulness and efficiency of smart services in a number of distinct sectors.

5.2.1 Transport

The Rwanda Utilities Regulatory Authority and the Government of Republic of Rwanda[47] have introduced various ICT initiatives to address transport challenges in Kigali. These initiatives include automated fare collection systems, speed-governor devices in vehicles, and an intelligent connected fare meter (ICFM) for motorcycle taxis to track fares and improve revenue collection. Additional measures, such as the driver vocational card system for public transport drivers, road speed cameras, and CCTV cameras, aim to enhance road safety and reduce traffic congestion. These technologies are being leveraged to create a smarter and more efficient transport system in Kigali.

In India, Nayan Technologies[48] has been actively deploying solutions, such as installing dashcams in buses to monitor both driver and passenger safety. The company is committed to vehicular safety, focusing on monitoring driver behaviour and implementing advanced driver-assistance systems to improve road safety. It emphasizes the importance of compliance with traffic rules, such as the wearing of public transport uniforms, prohibiting the use of mobile phones while driving, or driving with an unfastened seat belt.

In the United States, the Smart Parking System[49] from Evanston, monitors parking space occupancy in real-time using sensors installed in parking spaces. This system helps drivers find available parking more efficiently, reducing traffic congestion and enhancing the overall parking experience.

[47] ITU-D SG2 Document SG2RGQ/24 from Rwanda.
[48] ITU-D SG2 Document (workshop presentation) Q1/2-2024-01 from Nayan Technologies.
[49] ITU-D SG2 Document (workshop presentation) Q1/2-2024-05 from the Illinois Smart City & Region Association.

In Mexico, a one-stop platform[50] consolidates 34 000 databases from 250 government institutions and 5 400 public services. This portal allows citizens to access services like obtaining birth certificates online within minutes. Additionally, Mexico City uses an advanced traffic management system that employs IoT sensors and AI algorithms to monitor and control traffic flow in real-time, thereby reducing congestion and emissions.

In the Syrian Arab Republic, the Electronic Government Data Bus Project[51] aims to create an integrated structure for exchanging shared government data. This project enhances the efficiency and quality of electronic government services by providing a central platform for data exchange between public agencies. The project includes components such as identity management, electronic payment, and data exchange services, saving time and effort, and reducing costs while improving citizen satisfaction. Capacity building initiatives supported by EuropeAid provide training for civil society organizations (CSOs) to improve their ability to deliver services and support community development and resilience.

5.2.2 Education and capacity building

In India, an example of smart services in the field of education is the Digital Infrastructure of Knowledge Sharing (DIKSHA)[52] digital learning platform, supporting multiple languages and regional educational boards. DIKSHA provides a variety of educational content and has achieved significant reach and usage among students and teachers.

In Egypt, the Egyptian African Telecom Regulatory Training Centre (EG-ATRC)[53] focuses on building local expertise in African countries for managing and deploying smart solutions. It offers training programmes and workshops to develop technical skills and knowledge, creating a sustainable ecosystem for smart technology deployment and fostering innovation and local development.

The Open-Source Ecosystem Enabler (OSEE) training framework[54] supports the deployment of smart technologies through comprehensive training and capacity building. It provides a structured framework for developing local expertise in managing and deploying smart solutions, enhancing the skills and knowledge of local communities to effectively utilize and maintain smart technologies.

5.2.3 Government services

The Digital India Mission,[55] launched by the Government of India, envisions providing digital infrastructure as a utility to every citizen, empowering citizens digitally, and ensuring governance and services on demand. The Digital India Mission is built on foundations including broadband highways, universal access to mobile connectivity, a public Internet access programme, and e-governance (reforming government through technology).

India's use of digital public infrastructure (DPI),[56] through the "India Stack," which comprises Aadhaar (the world's largest biometric ID system) for digital identity, unified payment interface

50 https://www.gob.mx/.
51 ITU-D SG2 Document SG2RGQ/129 from the Syrian Arab Republic.
52 ITU-D SG2 Document SG2RGQ/63 from ITU BDT.
53 ITU-D SG2 Document 2/329 from Egypt.
54 ITU-D SG2 Document 2/331 from ITU BDT.
55 ITU-D SG2 Document (workshop presentation) Q1/2-2023-05 from India.
56 ITU-D SG2 Document SG2RGQ/63 from ITU BDT.

(UPI) for digital payments, and data exchange platforms such as DigiLocker and Account Aggregator are examples of smart services improving quality of life for citizens, as well as enhancing efficiency of delivery. DPIs support various public and private services and have enabled significant savings for the government through direct benefit transfer (DBT) schemes.

In the Kingdom of Bhutan, the National Digital Strategy[57] creates a unified digital framework for improving public services. It develops a cohesive strategy for digital transformation, including infrastructure development and capacity building, which improves the delivery and accessibility of government services and enhances the quality of life for citizens.

In Madagascar, the National Interoperability Framework[58] aims to improve quality of life for citizens through digital health, education, and public security services. The framework promotes interoperability and integration of digital services across various sectors, ensuring seamless and efficient service delivery and fostering a more connected and responsive government.

In the State of Palestine,[59] the unified exchange platform (UXP)[60] is an example of a technical platform that enables secure data exchange between government and non-government databases. The platform facilitates government-to-government (G2G), government-to-business (G2B), and government-to-citizen (G2C) services, providing basic services to citizens through a unified government service portal. The platform enables seamless data exchange and integration across government systems, and implements an interoperability framework to facilitate data sharing and collaboration, enhancing the efficiency and transparency of government operations and improving service delivery.

In the Syrian Arab Republic, the Digital Government Procurement System[61] enhances transparency and efficiency in government procurement by implementing a digital procurement system to streamline processes and reduce corruption. This increases accountability and efficiency in government spending, fostering trust and transparency.

The GovStack Building Block Approach[62] provides a modular and scalable framework for digital transformation based on sustainable development goals. This approach facilitates the adoption of digital technologies in government, improving service delivery and popular engagement.

The Democratic Republic of the Congo[63] is addressing the challenges and progress in digital transformation for e-government services by identifying key barriers and opportunities for digital transformation. This enhances the capacity of government institutions to deliver efficient and effective services.

In Egypt, a strategy of collaborative regulation for telecommunication infrastructure[64] enhances the efficiency and reach of telecommunication services by using water pipelines for telecommunication infrastructure. This improves the accessibility and reliability of telecommunication services, supporting smart city initiatives. Egypt's approach to developing smart cities involves collaborative regulation between various governmental entities. The

57 ITU-D SG2 Document 2/248 from Bhutan.
58 ITU-D SG2 Document 2/243 from Madagascar.
59 The State of Palestine is not an ITU Member State; the status of the State of Palestine in ITU is the subject of Resolution 99 (Rev. Dubai, 2018) of the ITU Plenipotentiary Conference.
60 ITU-D SG2 Document 2/132 from the State of Palestine.
61 ITU-D SG2 Document 2/261 from the Syrian Arab Republic.
62 ITU-D SG2 Document 2/209 from ITU BDT.
63 ITU-D SG2 Document 2/147 from the Democratic Republic of the Congo.
64 ITU-D SG2 Document SG2RGQ/131 from Egypt.

National Telecommunications Regulatory Authority (NTRA) and the New Urban Communities Authority (NUCA) work together to ensure smart-ready infrastructure. This collaboration includes developing national codes for smart telecommunication infrastructure in various building types, and ensuring new city constructions are equipped with smart infrastructure from the outset. Additionally, the National Initiative for Smart Green Projects drives smart climate solutions and sustainable development strategies across Egypt's 27 governorates.

5.2.4 Energy

In Canada, the Building Owners and Managers Association[65] has highlighted how various technologies are revolutionizing aspects such as energy efficiency, operational maintenance, occupant comfort, and resource management in buildings. AI can play a role in optimizing energy efficiency by analysing data from IoT sensors to dynamically adjust heating, ventilation, and air conditioning (HVAC) systems and lighting, which reduces energy consumption. IoT sensors also facilitate predictive maintenance by monitoring equipment health in real time and enhance occupant comfort by tracking indoor air quality, temperature, and lighting levels.

5.2.5 Health

In Madagascar, the National Interoperability Framework[66] aims to improve the quality of life of citizens through digital healthcare services. The framework helps to promote interoperability and integration of healthcare services across various platforms, enhancing the accessibility and efficiency of healthcare delivery and improving health outcomes for citizens.

5.2.6 Agriculture

The ITU-T Focus Group on artificial intelligence (AI) and Internet of Things (IoT) for digital agriculture[67] (FG-AI4A) was established in collaboration with the Food and Agriculture Organization (FAO) to explore the use of emerging technologies, such as AI and IoT, in data acquisition and management, with the goal of enhancing agricultural modelling and optimizing production processes. Key concepts such as decision agriculture and digital agriculture were introduced. Decision agriculture is an approach that emphasizes the optimization of crop production and waste reduction by addressing soil, water, and crop variability. Decision agriculture incorporates technologies such as global positioning system (GPS), sensors, and information systems to gather data on environmental factors fundamental to managing agricultural systems.

5.2.7 Other smart services and applications

In China, the 'AI for Good, bridge the AI divide'[68] initiative leverages AI for smart city applications, ensuring equitable access and benefits. It promotes the use of AI to address urban challenges and improve service delivery, enhancing the efficiency and effectiveness of urban services and fostering inclusive and sustainable development.

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[65] ITU-D SG2 Document (workshop presentation) Q1/2-2024-06 from BOMA.
[66] ITU-D SG2 Document 2/243 from Madagascar.
[67] https://www.itu.int/en/ITU-T/focusgroups/ai4a/Pages/default.aspx.
[68] ITU-D SG2 Document 2/295 from China.

Through the application of AI large models in smart cities[69] China enhances smart city functionalities utilizing AI for predictive analytics, automated services, and improved decision-making processes. This improves the responsiveness and adaptability of urban services, enhancing the quality of life for residents.

The Shenzhen Art Museum in China[70] has implemented a digital art museum information system that leverages cutting-edge technologies such as mobile Internet, IoT, cloud computing, big data, and AI. This system enhances the visitor experience through features such as 3D virtual galleries, augmented reality (AR) mobile navigation, and WeChat public services. The Smart Museum Project, launched in 2014, integrates these technologies to create dynamic perceptual systems for visitors and staff, improving the management, interpretation, and representation of cultural heritage.

Green smart city construction, from China Unicom,[71] integrates sustainability into smart city planning by utilizing green technologies and sustainable practices in urban development. This reduces the environmental footprint of cities, promoting sustainable and resilient urban growth.

Smart city models for developing countries, from *Réseau International Femmes Expertes du Numérique* (RIFEN),[72] has promoted tailored smart city solutions to the specific needs and contexts of developing nations, by developing adaptable and scalable smart city models that address local challenges. This enables smart technologies that are accessible and beneficial to all, promoting equitable development.

IoT cloud platform and remote private booth, from the KDDI Corporation,[73] showcases innovative IoT solutions for smart services by implementing remote monitoring, smart grids, and connected healthcare solutions. This enhances the efficiency and reliability of urban services, improving the quality of life for residents.

Emergency restoration of communication services, from the KDDI Corporation,[74] highlights the role of smart technologies in disaster response and resilience by ensuring that critical services remain operational during emergencies. This enhances the resilience and responsiveness of urban services, protecting lives and property.

Wireless power transmission via radiofrequency beam (beam WPT), from TMG Inc.,[75] explores advanced connectivity solutions for smart cities by utilizing wireless power transmission to enable efficient and reliable power distribution. This supports the deployment of smart devices and terminals, enhancing the connectivity and functionality of urban services.

Building local capacity for secure connected places (United Kingdom):[76] The United Kingdom developed local capacity to adopt secure connected place technology by utilizing the Secure Connected Places Playbook to provide guidance and good practices. This enhances the security and resilience of smart city infrastructure, protecting against cyber threats.

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69 ITU-D SG2 Document 2/294 from China.
70 ITU-D SG2 Document 2/175 from China.
71 ITU-D SG2 Document SG2RGQ/198 from China Unicom.
72 ITU-D SG2 Document 2/270 from RIFEN.
73 ITU-D SG2 Document 2/177 from KDDI Corporation.
74 ITU-D SG2 Document SG2RGQ/148 from KDDI Corporation.
75 ITU-D SG2 Document 2/192 from TMG Inc.
76 ITU-D SG2 Document 2/199 from the United Kingdom.

Madagascar has implemented a digital public infrastructure modernization[77] programme and upgraded digital infrastructure in Antananarivo to support smart services by including the installation of intelligent video solutions (IVS) and other smart technologies. The system includes LTE and fibre-optic networks that support real-time video surveillance. High-definition (HD) cameras and multimedia handsets are used for real-time monitoring and dispatch, allowing for effective surveillance from key locations and tracking of police service vehicles. The implementation of advanced access control mechanisms ensures system performance by controlling maximum and minimum speeds, transmission delay, and packet loss rate. Additionally, the Orinasa Digital Platform streamlines business registration processes, reducing the time required to register a company from weeks to hours. This has improved the efficiency and reliability of public services, enhancing the quality of life for citizens.

The practices highlighted in this chapter emphasize the importance of capacity building, strategic planning, interoperability, sustainability, and innovative technologies, in fostering and enabling the deployment of smart devices and terminals. These practices provide valuable insights and models for other regions looking to implement similar solutions, ultimately contributing to the development of smart, sustainable, and resilient cities and societies.

77 ITU-D SG2 Document 2/139 from Madagascar.

Chapter 6 – Benchmarks and assessment mechanisms for smartness

6.1 How to define smartness

Due to the complexity of smart cities, it can be difficult to qualify whether or not a city is smart, so the smart city assessment system is usually used for relatively scientific assessment. The assessment analyses and evaluates the effectiveness of city construction and operation based on predetermined evaluation indicators, with different dimensions and weights attributed according to the smart city assessment indicator system. Using this system, factors such as the competitiveness of the city can be scientifically measured, problems or weaknesses in the construction and operation of the city can be identified, and stakeholders can be assisted in making decisions and in taking further measures.

6.2 Smart city assessment in practice

In China, the national standard "Assessment indicators for new smart cities", was first released in 2016 and revised in 2022, to include smart city concepts such as people-oriented, effectiveness-guided, objective and standardized, mature and measurable, and time-efficient. The standard comprises an assessment indicator system that considers beneficiary services, precise governance, ecological liveability, information infrastructure, information resources, industrial development, information security, innovation development, and citizen experience, and uses these indicators to assess city smartness. Some developed cities such as Shanghai have also proposed their own city smartness assessment systems.[78]

ITU-T SG20 released the "ITU-T Y.4900-Y.4999 series of Recommendations on Internet of things and smart cities and communities – Evaluation and assessment".[79]

In the Russian Federation, the Smart City project has been implemented since the end of 2018. The project is aimed at forming an effective urban management system, creating safe and comfortable living conditions for citizens and increasing the competitiveness of cities. In addition, the contribution describes the special IQ index of cities, created within the framework of the Smart City project, which indicates the basic level of implementation of digital technologies in urban management, and the effectiveness of solutions performed by regions and cities.[80]

Each of the above assessment systems has its own characteristics. China's assessment system focuses more on intelligent capabilities, while ITU-T assessment system focuses more on infrastructure capabilities. The Russian Federation's assessment system emphasizes the integration of digital services in urban management and the effectiveness of solutions implemented to enhance the quality of urban life.

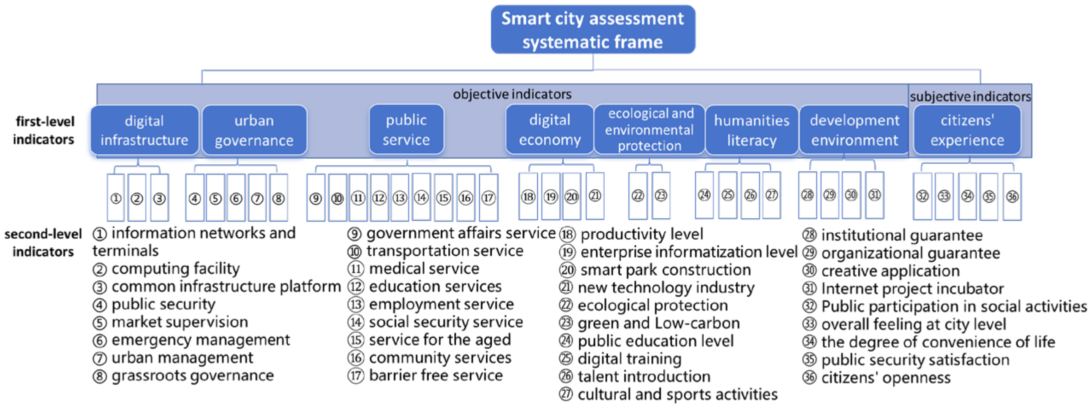
78 ITU-D SG2 Documents 2/169, SG2RGQ/67 and SG2RGQ/200 from China.
79 https://www.itu.int/ITU-T/recommendations/index.aspx?ser=Y.
80 ITU-D SG2 Document SG2RGQ/167 from the Russian Federation.

6.3 Method examples

6.3.1 Framework for a smart city assessment system with subjective and objective indicators (China)[81]

Based on the smart city construction goals, categories, target audience and evaluation objectives, and with reference to China's experience, an example of a framework of a smart city assessment system is shown in Figure 2.

Figure 2: Schematic example of a smart city assessment system



Source: China[82]

The assessment system can include subjective indicators and objective indicators.

The following subjective indicators can be used to evaluate the smartness of a city, including: overall feelings about the level of city planning, construction and operation; the public's participation in social activities; the citizens' satisfaction with the intelligent and convenient aspects of daily life, such as transportation, medical care, education and shopping; the citizens' satisfaction with public security, ecological safety, food and drug safety; and the citizens' openness and awareness of learning, among others. Sample data can be obtained in the form of survey questionnaires for subjective assessment.

The objective evaluation of city smartness can be carried out according to aspects such as: digital infrastructure, urban governance, public service, industrial economy, ecological and environmental protection, humanities literacy, and development environment. The indicators are usually calculated based on the objective data obtained.

This assessment system strives to cover as much as possible, both in terms of the city infrastructure and in terms of the smart applications, including institutional mechanisms, the equipment and facilities environment, the information system platform, and intelligent application, and also increases the consideration of the concept of a green and low-carbon city.

[81] ITU-D SG2 Document 2/169 from China.
[82] *Ibid*.

6.3.2 IQ rating of cities (Russian Federation)[83]

As part of the "Smart City" project, the Russian Federation developed the IQ index to assess the implementation and effectiveness of digital services in urban management. This index aims to evaluate and monitor the progress of digital transformation within cities. It is an integral rating composed of ten sub-indexes, each representing a critical area of digital development:

- innovations in the urban environment;
- intelligent public safety systems;
- smart housing and communal services;
- intelligent social service systems;
- economic conditions and investment climate;
- city administration;
- intelligent environmental safety systems;
- communication network infrastructure;
- tourism and service;
- smart urban transport.

This comprehensive index provides a framework for cities to identify their strengths as well as areas needing improvement, guiding them toward achieving the goals of the "Smart City" project.

6.4 Some other suggestions

The development of smart cities should always be "people-oriented", and the construction and operation of smart cities should always focus on how to better serve the public and improve living standards. Public perception will therefore always be an important indicator of smart city assessment, but attention should also be paid to the balance between subjective and objective indicators.

With the emergence of all kinds of new information and communication technologies, the effective integration of technology and demand has become more and more obvious in their application in smart city scenario innovations and services, which also provide cities with more intelligent capabilities. Therefore, the application of new technologies, the development of new technology industries, and public awareness and acceptance of new technologies have also become new evaluation points in smart cities assessment.

Green development has been a strategic requirement for more countries and cities, especially with the vigorous development of new infrastructure, more mobile Internet applications and mobile payment scenarios, the more important demand for green and low carbon technology. Indicators such as data centre power usage effectiveness (PUE), communication facility sharing, mobile Internet application, green factories, etc., have also become focus points for smart cities assessment.

The development of smart cities is a continuous evolving process, and the assessment of smart cities requires continuous revision of the indicator system to reach a reasonable conclusion.

[83] ITU-D SG2 Document SG2RGQ/167 from the Russian Federation.

Chapter 7 – Capacity building

7.1 Capacity building of city planners and administrators

Capacity building for smart sustainable cities and communities is a comprehensive process focused on fostering initiatives and acquiring essential knowledge on information and communication technologies (ICTs). This approach empowers individuals, institutions, and organizations with the resources, knowledge, and competencies necessary to effectively adopt, implement, and manage smart sustainable cities and communities. These efforts are fundamental for driving urban and rural development that is technologically advanced and socially inclusive. By integrating technology and sustainability across diverse landscapes, smart societies can be created that benefit both cities and villages alike.

A critical component of this effort is the development of robust ICT infrastructure. Smart sustainable cities and communities require advanced and resilient infrastructure, such as high-speed Internet, 5G networks, data centres, and IoT platforms, that enables real-time data collection, monitoring, and communication. This infrastructure serves as the backbone for efficiently managing urban services and promoting smart solutions in rural areas.

Promoting digital literacy and skills development is a key focus area, extending to both urban and rural populations. Comprehensive ICT training programmes should be offered to citizens, local authorities, and city employees to equip them with the skills needed to effectively use digital tools and contribute to the management and evolution of smart sustainable cities and villages. In this context, emphasizing science, technology, engineering, and mathematics (STEM) education is crucial for nurturing the next generation of professionals who will drive future innovations and lead sustainable projects. Schools and universities should prepare youth in both urban and rural settings for careers in smart technology development.

The ITU project Digital Skills Badges[84] offers girls and young women access, free of charge, to a high-quality, universally recognized digital skills training and certification programme, through online training, via ITU Academy, and offline hands-on STEM workshops to reach girls and women in underserved areas, with the dual objective of encouraging girls' and women's further pursuit of technical studies and careers and facilitating girls' and women' access to formal employment and entrepreneurship, including in technical sectors. The project also connects girls and young women with role models and mentors. The end goal is to scale up the project globally to promote the digital (and social and economic) inclusion of millions of girls and women around the world.

The programme "Boosting decent jobs and enhancing skills for youth in Africa's digital economy"[85] aims to increase the number of young Africans in every country who access decent work in the digital economy. For the implementation of the programme, ITU and the International Labour Organization (ILO) aim to raise funds for sub-projects in six selected countries in Africa (Republic of Côte d'Ivoire, Republic of Kenya, Nigeria, Rwanda, Senegal, and Republic of South Africa). The programme provides the opportunity to engage ITU and ILO with partners from governments, social partners, the private sector, civil society, academia, and other multilateral

[84] ITU-D. Her Digital Skills: EQUALS Badge.
[85] ITU-D. Digital Transformation Centres Initiative.

institutions and development banks. Interventions in the project will build on programmes that these organizations already have in place to complement and further enhance the delivery scope and capacity of the programme.

The project "Boosting digital skills through digital transformation centres (DTCs)", supports the activities implemented under the DTC Initiative. In particular, it supports activities aimed at scaling the delivery of digital skills training, and hence digital literacy, in local communities and among marginalized groups. While a major focus of the project is to support the DTC activities in Ghana, it will also support the rolling out of the initiative during its pilot phase (covering nine countries) and leading into the second phase (expanding the number of countries). At the end of the project, in the beneficiary countries, there will be a substantial increase in the number of people trained on basic and intermediate digital skills, equipping them with job-ready skills that help them progress in their professional lives, as well as young entrepreneurs trained with digital and entrepreneurship skills.

Institutional strengthening is also vital. Local governments and city planners need training in data-driven decision-making and the management of smart technologies to ensure effective governance of smart sustainable cities. Empowering government officials to understand and leverage technology in their planning and decision-making processes is essential. Public-private partnerships facilitate collaboration between governments, businesses, and technology firms, enabling the pooling of resources and expertise to develop and implement smart infrastructure and services that benefit both urban and rural areas. By providing local governments with the necessary tools for policy formulation and project management, the successful implementation of smart solutions tailored to the unique needs of different environments can be ensured.

Promoting the development of smart villages is of critical importance in accelerating the achievement of the SDGs in the Islamic Republic of Pakistan.[86] Pakistan aims to bring the benefits of digital transformation to its citizens, adopting a whole-of-government and smart village approach in accordance with the vision of the Digital Pakistan project. This project supports the Smart Village project in Pakistan in cooperation with the Ministry of Information Technology and Telecommunication and the universal service fund (Pakistan), and Huawei Technologies Co., Ltd.

Public engagement and awareness-building are essential to fostering inclusivity and understanding in smart sustainable cities and communities. Educating the public about the advantages of smart technologies and sustainability initiatives is critical for fostering a sense of engagement and participation. Digital inclusion should be prioritized to ensure that marginalized and underserved populations, particularly in rural areas, have access to the necessary digital technologies and resources. Addressing barriers to technology adoption, such as low literacy rates or inadequate infrastructure, will promote the benefits of smart living for all members of society.

Training in data management and cybersecurity is also crucial for local officials, urban planners, and rural leaders. The ability to collect, analyse, and interpret data is vital for making informed decisions that enhance the sustainability and resilience of cities and villages. Safeguarding smart systems from cyber threats is essential to protecting the integrity of digital infrastructure in both urban and rural regions. Ensuring the privacy and security of data is paramount to the successful and sustainable growth of smart societies.

[86] ITU-D. Gokina Smart Village in Pakistan: Digital transformation at the community level.

The main goal of the project "Establishment of a cybersecurity innovation centre for the Arab Region",[87] was to setup a Cybersecurity Innovation Centre for the Arab Region, with the support of the Information Technology Authority (ITA) of Sultanate of Oman represented by Oman CERT (OCERT). This setup provided a better reach for ITU cybersecurity related initiatives in the region, as well as enhancing capacity, capability, readiness, skills, and knowledge in the areas of cybersecurity, critical infrastructure protection, and human capacity building for the Arab region.

The main goal of the project "CIRT establishment in Bahamas"[88] is to assist the Commonwealth of the Bahamas to assess their current cybersecurity capabilities, to develop the national cybersecurity strategy and to establish a "National computer incident response team (BS-CIRT)", to serve as a trusted, central coordination point of contact for cybersecurity, aimed at identifying, defending, responding, and managing cyber threats. By extension, this project is expected to increase the national cybersecurity capacity while moving forward on enhancing regional and international collaboration.

Promoting innovation ecosystems is another important dimension of capacity building for smart sustainable cities and communities. Establishing research and development (R&D) centres that focus on cutting-edge technologies such as AI, IoT, and machine learning (ML), in collaboration with universities, industries, and local startups, will drive innovation in smart solutions that address regional needs. Encouraging entrepreneurship within rural areas and supporting startups focused on smart technologies will stimulate local economies while advancing technological innovation. Additionally, participating in global knowledge exchange through international forums, partnerships, and networks will allow cities and villages to learn from good practices and successful initiatives from around the world.

The project, "Enhancing the digital ecosystem and digital skills for the economic empowerment of women in LDCs",[89] enables local women in the Republic of Haiti, Republic of Burundi, and Federal Democratic Republic of Ethiopia to benefit from the digital avenues for development. In close cooperation with the EQUALS Global Partnership, the project works with key public and private stakeholders to address systemic issues that are preventing women from accessing and using digital technologies and from being the drivers of positive change that they can be. Some of the activities planned under this component include linking working-age women with employment opportunities and other income generation opportunities where digital skills are required, while promoting the inclusion of on-the-job training and leveraging opportunities from EQUALS partners to access microfinance for development using ICTs.

Egypt launched the Egyptian African Telecom Regulatory Training Centre (EG-ATRC)[90] in July 2021, to help build African human competencies capable of dealing with emerging challenges in the ICT sector, and relevant skills for the goal of achieving a smart and digital Africa. More than 50 African countries participate in the EG-ATRC activities through physical or virtual sessions in addition to high-level round tables. Both theoretical and practical training is offered reflecting Egypt's expertise at both national and international levels.

[87] ITU-D. Establishment of a Cybersecurity Innovation Centre for the Arab Region.
[88] ITU-D. CIRT Establishment in Bahamas.
[89] ITU-D. Tech as a driver of Women's Economic Opportunity.
[90] ITU-D SG2 Document 2/329 from Egypt.

In summary, the path toward smart sustainable cities and communities is paved with comprehensive training, robust infrastructure, and inclusivity. By prioritizing capacity building, individuals and communities are empowered to embrace digital transformation, ensuring sustainable growth that benefits all sectors of society. The collaborative efforts of governments, private sectors, and civil society will be essential in realizing the vision of equitable and innovative smart societies globally.

Conclusion

The holistic approach to the design and implementation of smart cities and societies emphasizes the importance of leveraging ICTs to enable sustainable socio-economic development by highlighting good practices and the challenges faced by ITU Member States.

The outcomes of the World Telecommunication Development Conference 2022 (WTDC-22) confirm that meaningful connectivity, smart planning and innovative policies are key to meeting the challenges of urbanization and improving the quality of life for all citizens. The integration of cutting-edge technologies such as artificial intelligence (AI) and Internet of Things (IoT) is crucial to optimizing city services and fostering resilience in both urban and rural settings. From improving urban infrastructure, boosting digital culture, and fostering effective governance, to promoting inclusive policies and business models, each chapter highlights the collective efforts of Member States and international organizations to advance smart city initiatives.

By integrating robust ICT infrastructure and smart services, the gap between urban and rural areas can be narrowed, while improving individuals' quality of life, and supporting economic growth. Shared good practices and benchmarks for intelligence assessment offer a roadmap for cities that aspire to digitally transform.

The report highlights various good practices and successful case studies from Member States, showing how collaborative approaches, robust infrastructure and capacity building initiatives can lead to the successful implementation of smart solutions. The focus on citizen engagement, data privacy, and cybersecurity further reinforces the need for a holistic approach that prioritizes inclusion and sustainability. As the world's population shifts more and more to urban life, it is imperative that governments, businesses, and communities work together to create smart and sustainable environments that not only meet the needs of today but also protect the interests of future generations. The insights and recommendations provided in this report serve as a valuable framework for stakeholders to navigate the complexities of smart city development, thereby contributing to a more equitable and prosperous society. By fostering innovation, improving digital literacy, and ensuring effective governance, the full potential of smart cities and communities is highlighted, paving the way for a better and more sustainable future.

Finally, the vision of smart cities and societies is not only technological progress, but sustainable, inclusive and resilient communities that improve the quality of life for all. The report encompasses progress, and potential future advances, reaffirming the commitment to build a smarter and more sustainable future on a global scale.

Annex – List of contributions and liaison statements received on Question 1/2

Contributions on Question 1/2

Web	Received	Source	Title
2/399	2025-04-22	United Kingdom	UK comments on draft Q1/2 final report
2/391	2025-04-22	RIFEN	Smart city models in Africa: dream or reality?
2/386	2025-04-14	China Mobile Communications Co. Ltd.	Study on the pathways of artificial intelligence and its applications to promote inclusive agricultural growth
2/358	2025-03-20	Co-Rapporteurs for Question 1/2	Draft Output Report on Question 1/2
2/354	2025-03-11	Democratic Republic of the Congo	Request for funds for digital transformation in the Democratic Republic of the Congo
2/351	2025-02-27	Burundi	Automation of agriculture: a hope for the development of Burundi in 2060
2/337	2024-11-08	BDT	Extracted lessons learned from contributions to ITU-D Study Group 2 Questions (third meeting of ITU-D Study Group 2)
2/331	2024-10-29	BDT Focal Point for Question 1/2	Open-Source Ecosystem Enabler (OSEE) training framework
2/329	2024-10-29	Egypt	Egypt capacity building centre for African countries (EG-ATRC)
2/295 (Rev.1) +Ann.1	2024-10-22	China	AI for Good, bridge the AI divide
2/294	2024-10-22	China	The application of artificial intelligence large models in the field of smart cities
2/289	2024-10-17	RIFEN	India's AI Mission
2/277	2024-10-30	Rapporteur for Question 1/2	Draft Output Report on ITU-D Question 1/2
2/270	2024-09-29	RIFEN	Smart city models adapted to developing countries
2/261	2024-09-23	Syrian Arab Republic	Digital government procurement system in the Syrian Arab Republic
2/248	2024-09-17	Bhutan	National digital strategy Intelligent Bhutan

(continued)

Web	Received	Source	Title
2/243	2024-09-13	Madagascar	National interoperability framework for a unified, effective e-government system: Improving the quality of life of the Malagasy public through digital health, education and public security services
2/238	2024-09-04	Democratic Republic of the Congo	Progress on the e-government contribution
2/227	2024-10-25	Rapporteur for Question 1/2	Annual progress report for Question 1/2 for November 2024 meeting
RGQ2/213	2024-04-18	China Mobile Communications Co. Ltd.	Case study of digital technology in enhancing consumer experience and upgrading demands in cultural tourism
RGQ2/208	2024-04-16	BDT Focal Point for Question 1/2	Smart Villages and Smart Islands - a gateway to digital rural transformation and meaningful connectivity: an update on implementation and impact
RGQ2/200	2024-04-16	China	Research on key indicators of city smartness assessment
RGQ2/198	2024-04-16	China Unicom	Thinking and prospect of green smart city construction
RGQ2/197	2024-04-16	China Unicom	Exploration and research of digital transformation for urban governance
RGQ2/167	2024-04-04	Russian Federation	Implementation of the "Smart City" project in the Russian Federation
RGQ2/163	2024-03-26	Syrian Arab Republic	A paper on digital development in Syria and the current reality
RGQ2/159	2024-03-26	RIFEN	The concept of smart and sustainable cities and communities, an opportunity for Côte d'Ivoire
RGQ2/148	2024-03-13	KDDI Corporation	Emergency restoration of communication services in Noto Peninsula earthquake (two weeks after the earthquake occurred)
RGQ2/147	2024-03-14	Democratic Republic of the Congo	Digital transformation and challenges of e-government in the Democratic Republic of Congo
RGQ2/144	2024-03-14	State of Palestine	Inventorying government services and setting priorities
RGQ2/141	2024-03-11	RIFEN	Smart sustainable cities and communities
RGQ2/131	2024-02-29	Egypt	Collaborative regulation for telecommunication infrastructure using water pipelines

(continued)

Web	Received	Source	Title
RGQ2/129 +Ann.1	2024-02-29	Syrian Arab Republic	Electronic government data bus project
RGQ2/127	2024-02-29	RIFEN	Smart sustainable cities: innovations for developing countries
2/209	2023-10-26	BDT Focal Point for Question 1/2	A step-by-step approach on implementing the GovStack Building Block approach that is based on Sustainable Development Goals Digital Investment Framework
2/199	2023-10-17	United Kingdom	Building local capacity to adopt secure connected place technology: the UK's Secure Connected Places Playbook
2/192	2023-10-16	Telecommunications Management Group Inc.	Enabling smart sustainable cities and communities through wireless power transmission via radiofrequency beam (beam WPT)
2/177	2023-10-12	KDDI Corporation	IoT cloud platform and remote private booth
2/175	2023-10-12	China	Introduction and experience sharing of using ICT technology to transform Shenzhen Art Museum
2/169	2023-10-11	China	Value of city smartness assessment and suggested assessment framework based on indicators
2/162	2023-10-09	Intel Corporation	Updated Information on Wi-Fi Technology
2/161	2023-10-09	Vice-Chairs, ITU-D Study Group 1; Vice-Chair, ITU-D Study Group 2; Co-Rapporteur for Question 7/2	Implementation of Resolution 9 across ITU-D Study Groups' Questions
2/149 +Ann.1	2023-09-29	Argentina	Recommendations for a trustworthy artificial intelligence
2/144	2023-09-29	Argentina	Mi Pueblo Conectado Programme
2/139	2023-09-22	Madagascar	Modernization of digital public infrastructure and installation of intelligent video solutions (IVS) in the capital of Madagascar
2/133	2023-09-14	Egypt	Collaborative regulation for smart cities
2/132	2023-09-14	State of Palestine	National data exchange - Unified eXchange Platform (UXP)
2/121	2023-09-14	Interim Rapporteur for Question 1/2	Annual progress report for Question 1/2 for October-November 2023 meeting
RGQ2/86	2023-05-21	Vice-Rapporteur for Question 1/2	Proposed draft liaison statement to United for Smart Sustainable Cities (U4SSC)

(continued)

Web	Received	Source	Title
RGQ2/67	2023-05-08	China	The practise of City Smartness Assessment in China
RGQ2/63	2023-05-05	BDT Focal Point for Question 1/2	Digital Public Infrastructure to accelerate digital transformation of government services
RGQ2/51	2023-04-25	Mexico	Internet of Things (IoT) devices catalogue
RGQ2/50 +Ann.1	2023-04-25	Intel Corporation	WBA Whitepaper on Rural Wi-Fi Connectivity
RGQ2/45	2023-04-02	Kenya, ATDI	Resolution 9 (Rev. Kigali, 2022) implementation, ITU-R and ITU-D collaboration - Participation of countries, particularly developing countries, in spectrum management
RGQ2/38	2023-04-13	Australia	Sharing advice from Australia on securing smart places
RGQ2/31	2023-04-04	Romania	Overview of the development of smart villages in Romania
RGQ2/24	2023-03-27	Rwanda	Unlocking the potential of smart transport in African cities through data analytics and AI - a case study of Kigali
RGQ2/11	2023-03-16	Intel Corporation	Updated information on global status of Wi-Fi 6
RGQ2/10	2023-03-16	Intel Corporation	Updated information on the Global status of 5G
2/TD/1	2022-12-05	Vice-Rapporteurs for Question 1/2	Proposed table of contents for Question 1/2
2/83	2022-12-02	Benin	Draft workplan and table of contents for Question 1/2
2/75 +Ann.1	2022-11-21	Telecommunication Development Bureau	Accelerating the digital transformation of government services
2/74	2022-11-18	World Bank	World Bank Study Group 2 Submission: Digital transformation
2/46	2022-10-17	Inter-Sector Coordination Group	Mapping of ITU-D Questions to ITU-T Questions and ITU-R Working Parties
2/42	2022-10-20	China	Actively use digital technology to strengthen the protection of ancient villages and the construction of smart villages

Incoming liaison statements for Question 1/2

Web	Received	Source	Title
2/376	2025-04-16	ITU-T Study Group 15	Liaison statement from ITU-T Study Group 15 to ITU-D Study Groups 1 and 2 on contributions from developing countries
2/345	2025-02-03	ITU-T Study Group 20	Liaison statement form ITU-T Study Group 20 to ITU-D Study Group 2 Question 1/2 on JCA-IoT SC&C Liaison Rapporteur to ITU-D Study Group 2
2/105	2023-07-31	ITU-T Study Group 5	Liaison statement from ITU-T Study Group 5 to ITU-D Study Group 2 Question 1/2 on new Question 1/2 and collaboration
2/97	2023-07-18	ITU-T Study Group 5	Liaison statement from ITU-T Study Group 5 to ITU-D Study Group 2 Question 1/2 on new Question 1/2 and collaboration of ITU-D SG2
2/95	2023-07-03	ITU-R Working Party 5D	Liaison statement from ITU-R Working Party 5D to ITU-R Working Parties 5A, 5C and 6A, ITU-D Study Group 2 and ITU-T Study Group 20 on draft new Report ITU-R M.[IMT.APPLICATIONS]: Applications of the terrestrial component of IMT for specific societal, industrial and other usages
RGQ2/60 +Ann.1	2023-05-03	ITU-T Study Group 15	Liaison statement from ITU-T Study Group 15 to ITU-D Study Group 2 on new Question 1/2 and collaboration
RGQ2/16 +Ann.1	2023-03-14	ITU-T Study Group 3	Liaison statement from ITU-T Study Group 3 to ITU-D Study Group 2 Question 1/2 on the impact of IoT/M2M on the development of emerging economies
RGQ2/8 +Ann.1	2023-05-15	ITU-T Study Group 20	Liaison statement from ITU-T Study Group 20 to ITU-D Study Group 2 on the consent of draft Recommendation ITU-T Y.4218 (ex Y.SRC) "IoT and ICT requirements for deployment of smart services in rural communities"
RGQ2/5	2023-02-17	ITU-T Study Group 20	Liaison statement from ITU-T Study Group 20 to ITU-D Study Group 2 Question 1/2 on new Question 1/2 and collaboration (reply to ITU-D Q1/2-2/86)
RGQ2/3	2023-02-13	ITU-R Working Party 5D	Liaison statement from ITU-R Working Party 5D to ITU-D Study Group 2 Question 1/2 on new Question 1/2 and collaboration: Workshop on smart sustainable cities and communities
2/55 +Ann.1	2022-11-14	ITU-T Study Group 3	Liaison statement from ITU-T Study Group 3 to ITU-D Study Groups 1 and 2 on draft new Technical Report on roaming aspects of IoT and M2M

(continued)

Web	Received	Source	Title
2/44	2022-10-20	Focus Group on Artificial Intelligence and Internet of Things for Digital Agriculture (FG-AI4A)	Liaison statement from ITU-T FG-AI4A to ITU-D Study Group 2 Question 1/2 on invitation to provide inputs to the roadmap of AI and IoT activities for digital agriculture
2/37	2022-10-12	ITU-T Study Group 15	Liaison statement from ITU-T Study Group 15 to ITU-D Study Groups 1 and 2 on the new version of the Access Network Transport (ANT) and Home Network Transport (HNT) Standards Overviews and Work Plans
2/28 +Ann.1	2022-08-01	ITU-T Study Group 20	Liaison statement from ITU-T Study Group 20 to ITU-D Study Groups 1 and 2 on guidelines on developing ICT services for accessible smart cities
2/27	2022-08-01	Joint Coordination Activity on Internet of Things and Smart Cities and Communities (JCA-IoT and SC&C)	Liaison statement from JCA-IoT and SC&C to ITU-D Study Group 2 Question 1/2 on JCA-IoT SC&C Liaison Rapporteur to ITU-D SG2
2/22	2022-06-29	FG-AI4A	Liaison statement from FG-AI4A to ITU-D Study Group 2 Question 1/2 on current activities of FG-AI4A
2/18 +Ann.1-7	2022-05-31	ITU-T Study Group 3	Liaison statement from ITU-T Study Group 3 to ITU-D Study Groups 1 and 2 on SG3 representative to ITU-D and topics of common interest
2/11	2021-12-23	ITU-T Study Group 15	Liaison statement from ITU-T Study Group 15 to ITU-D Study Groups 1 and 2 on the new version of the Access Network Transport (ANT) and Home Network Transport (HNT) Standards Overviews and Work Plans
2/3	2021-10-22	ITU-T Study Group 20	Liaison statement from ITU-T Study Group 20 to ITU-D Study Group Question 1/2 on establishment of a new ITU-T Focus Group on "Artificial Intelligence (AI) and Internet of Things (IoT) for Digital Agriculture" (FG-AI4A)

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