SMART CITY PATHWAYS FOR DEVELOPING ASIA

An Analytical Framework and Guidance

*Seok Yong Yoon, Hong Soo Lee, Thilo Zelt,
Ulf Narloch, and Elliot Aguirre*

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ABBREVIATIONS

ADB	–	Asian Development Bank
GIS	–	geographical information system
ICT	–	information and communications technology
IOT	–	internet of things
MDB	–	multilateral development bank
PPP	–	public–private partnership

EXECUTIVE SUMMARY

This working paper aims to provide additional clarity and guidance on smart cities, considering that there is a significant amount of available material that may increase the complexity and confusion for practitioners and decision makers in putting this information to best use.

This paper has been informed by the Asian Development Bank's (ADB) ongoing discussion on smart city opportunities and project activities across sectors and regions. This includes the March 2018 brainstorming session, which brought together representatives from ADB's Digital for Technology Development Unit; Governance Thematic Group; Environment Thematic Group; Climate Change and Disaster Risk Management Thematic Group; Urban Sector Group; Transport Sector Group; South Asia Department's Urban Development and Water Division; and Pacific Department's Urban, Social Development, and Public Management Division.

Smart cities can improve the access and quality of urban services for citizens, businesses, and governments through digital technologies. To understand, structure, and assess smart city programs across different cities in Asia and the Pacific, this publication proposes an analytic framework to guide practitioners and decision makers in assessing the status and devising strategies and actions to implement smart city initiatives.

Indeed, successful smart city initiatives are based on a comprehensive strategy. Yet, there is no one-size-fits-all approach for smart cities, and operational models need to be tailored to individual country and city contexts. Within Asia and the Pacific, the settings, in terms of development status, digital development maturity, and government capacity, vary greatly. Therefore, smart city programs can vary from building basic information and communication technology (ICT) infrastructure to sophisticated big data and artificial intelligence-enhanced applications and platforms.

Based on a desk review of 29 smart city models, most of which have been applied in both developed and developing countries across multiple regions, three commonalities were identified:

- **High-level objectives**, which define the desired outcome to be achieved, such as quality of life, economic growth, sustainability, resilience, and inclusiveness.
- **Enabling factors**, which represent cross-cutting entry points for digital transformation, such as technology, policy, skills, business, and planning.
- **Action fields** in which smart city solutions can be applied.

In order to provide a pragmatic understanding of smart city solutions, several ADB case examples have been identified and are presented along the following action fields, for which application scenarios are briefly described below:

- (i) **ICT infrastructure.** A city-wide network of connectivity, combined with the latest intelligent systems, secures the real-time exchange of data across a city and makes it available to citizens and businesses.
- (ii) **Urban and land use planning.** Combining geographic information system (GIS) data on land, properties, and other assets with data from a variety of tools in a centralized way optimizes urban planning.
- (iii) **Mobility and transport.** Digital technology enables and supports sustainable transport modes and mobility services to efficiently move people and goods, while increasing accessibility and affordability, as well as reducing accidents, congestion, and pollution.
- (iv) **Energy.** Intelligent systems monitor, control, and optimize energy demand and supply in real time, thereby providing affordable, reliable, and clean energy.

- (v) **Environment.** Digital solutions build on database applications to monitor and control environmental quality in air, water, and land, providing early warning and effective management of environmental pollution and degradation.
- (vi) **Water and wastewater management.** Urban water supply and wastewater systems are managed in an intelligent and integrated manner through smart solutions based on real-time data, which decrease system losses, while supporting efficient metering and tariff collection.
- (vii) **Climate resilience and disaster risk management.** Intelligent solutions enhance the coverage, precision, and reliability of information on natural hazards, enabling timely climate change adaptation and disaster risk management responses that reduce damage and loss, and increase the coping capacity of governments, citizens, and businesses.
- (ix) **Food and agriculture.** Digitally connected and enhanced agricultural and food systems allow high-precision and controlled farm production, which increases and diversifies food production; strengthens value chains; and reduces input use, food transport, waste, and imports.
- (x) **Public management and services.** Comprehensive digital services (or e-services) ensure easy access and quick processing of requests for citizens and businesses, while digitized public administration supports accountability, efficiency, and transparency.
- (xi) **Economy and jobs.** Economic growth and employment opportunities are promoted through innovation and skills that transform existing industries and service sectors, and create new digital services and markets as new engines of growth.
- (xii) **Education.** Digitally enhanced learning tools and data-driven educational offerings provide highly personalized opportunities for training and education, while all citizens are taught digital skills relevant to make best use of existing and future applications.
- (xiii) **Health.** Through digital channels, a smart city manages a comprehensive health information system and provides all citizens with tailored health care services, including personalized advice to lower the risk of illnesses and accidents.
- (xiv) **Society and culture.** Digital technologies empower citizens to take part in all aspects of social life and to benefit from the cultural offerings in a city, creating an open, collaborative, and engaged society.
- (xv) **Safety and security.** Police and other agencies apply digital technologies and make cities safer by expanding real-time surveillance of public spaces, improving the prevention of crime and improving the management and response to emergencies.

Informed by this review, a smart city analytical framework is proposed for developing Asia, which reflects the region's context to assess existing smart city programs, develop new smart city portfolios, and provide direct support for the planning and implementation of smart city solutions. The framework thus serves as a high-level analytical guidance, which also provides the necessary flexibility to be tailored to specific country, city, and project contexts, especially concerning digital maturity and local capacities.

The ADB Strategy 2030—Operational Priority 4: Making Cities More Livable put forward ‘Livability’ as the heart of the envisioned transformation of Asian cities. The Operational Priority emphasized that fundamental to Livable Cities is an integrated planning approach to the provision of infrastructure and services, and other public goods based on economic competitiveness, environmentally sustainable growth, social and financial inclusion, and resilience. The smart city analytical framework proposed in this paper can be applied to a variety of cities and urban agglomerations of developing Asia to improve Livability, and does so through a standard five-phase process of assessing, planning, and implementing smart city strategies and actions:

- (i) **City diagnostics**, which identifies key urban challenges, and the extent and potential of digital solutions to address these challenges.
- (ii) **Readiness assessment**, which assesses the city's digital maturity based on existing capacities. Strategy development to formulate strategic goals.

- (iii) **Implementation planning**, which identifies measures, timelines, and assistance needed.
- (iv) **Monitoring and evaluation** to track implementation progress over a longer time span.

The enabling factors that provide the necessary foundations to accelerate the effective transition toward a smart city are discussed and the paper draws out key next steps to support policymakers in implementing pathways to smart cities.

I. INTRODUCTION

1. Rapid urbanization is a defining phenomenon in the Asia and Pacific region. By 2050, Asia's total urban population will rise to 3.5 billion.¹ The growing concentration of people in cities poses fundamental challenges, particularly for urban areas in developing Asia, as they are struggling to provide continuous and adequate basic services, placing them on an unsustainable development path.² In recognition of this challenging setting, the Asian Development Bank (ADB)—aligned with one of the seven operational priorities of the Strategy 2030—aims to make cities in its developing member countries (DMCs) green, competitive, resilient, and inclusive.³

2. This working paper considers smart cities to improve the access to and quality of urban services for citizens, businesses, and governments through the strategic use of digital technologies. Given the variety and complexity of smart city initiatives, an analytic framework to assess, design, and implement a smart city concept in specific contexts in Asia and the Pacific is presented to support the implementation of smart city initiatives by ADB's DMCs.

3. The proposed analytical framework can help professionals to make sense of the abundance of information, define priorities, identify opportunities and implementation barriers, link strategy and actions, and monitor progress. In this working paper, an analytic framework for smart city pathways in developing Asia is developed based on an extensive review of 150 smart city initiatives worldwide and an analysis of 29 international smart city models.

4. This paper has been informed by ADB's ongoing discussions on smart city opportunities and project activities across sectors and regions, including the March 2018 brainstorming session, which brought together representatives from ADB's Digital for Technology Development Unit; Governance Thematic Group; Environment Thematic Group; Climate Change and Disaster Risk Management Thematic Group; Urban Sector Group; Transport Sector Group; South Asia Department's Urban Development and Water Division; and Pacific Department's Urban, Social Development, and Public Management Division.

5. This paper sets out the following objectives:

- Review international smart city initiatives and models to compile common elements and assess their applicability to cities in developing Asia (Chapter 1).
- Present and discuss the main action fields illustrated by a list of ADB and international case examples utilizing smart city solutions (Chapter 2).
- Consider smart city enablers, their role, challenges, and opportunities (Chapter 3).
- Provide guidance on steps for realizing smart city opportunities through an analytical framework, with consideration to the role of multilateral development banks (MDBs) in financing smart city initiatives and supporting knowledge exchange and partnerships (Chapters 4 and 5).
- Propose next steps and recommendations for policy makers to advance smart city solutions in their plans, projects, and programs (Chapter 6).

6. This working paper is designed for smart city practitioners to guide their work, facilitate effective technical advice, inform decision making, and support discussions with stakeholders in DMCs on how to initiate actions that help realize the opportunities of smart city solutions presented in this paper.

¹ United Nations. 2018. *World Urbanization Prospects: The 2018 Revision*.

² "Developing Asia" refers to the ADB's member countries.

³ Excerpted and rephrased some relevant texts to digital technologies on the Operational Priority 4 from the Operational Plans of ADB's Corporate Strategy 2030. <https://www.adb.org/about/strategy-2030-operational-priorities>.

7. Learning from the critical discussions on smart cities over the past 2 decades, there is no one-size-fits-all approach for smart city development. It is not possible to prescribe a universal set of smart city solutions and actions. Further, not all devices are smart devices. “Smartness” arises when data can be used to improve decision making. Throughout Asia and the Pacific, countries possess different urban settings, distinct challenges, and capacities. Within the region, the national and subnational setting varies in terms of development status, digital maturity, and government capacity from highly developed digital leaders to least-developed countries with limited information and communication technology (ICT) infrastructure. A tailored approach will be necessary to reflect the specific urban challenges as well as a city’s capacity to address those challenges, and sustainably implement and manage smart city solutions. As such, this paper acknowledges the diversity of smart city initiatives, models, and implementation modes and, based on these, draws out the potential opportunities and challenges to facilitate the advancement of tailored smart city pathways across Asia and the Pacific to support the development of livable cities (Box 1).

Box 1: Smart City and Making Cities More Livable

This working paper considers how the smart city concept can make cities more livable by reviewing the ADB’s urban sector development strategy of the Operational Plan 4: Making Cities More Livable under the ADB’s Corporate Strategy 2030. The Operational Plan 4 is envisioned as a cross-sector and cross-thematic platform for urban development investments, technical assistance, and knowledge work.

“Livability” is a term often used to describe the quality of life and community well-being, supported by strong governance systems and practices. Although definitions vary, at the heart of the envisioned transformation toward a livable city is an integrated planning approach to the provision of infrastructure and services and other public goods. This is based on economic competitiveness, environmentally sustainable growth, social and financial inclusion, and resilience.

Operational Plan 4 will help ADB and governments in developing member countries adopt a holistic approach to achieve livable cities with the following strategic areas:

- (i) Improve the coverage, quality, efficiency, and reliability of services in urban areas to make them energy-efficient, gender-responsive, inclusive, and sustainable by supporting integrated development, building capacities, and promoting high-level technologies.
- (ii) Strengthen urban planning and financial sustainability of cities by promoting inclusive and participatory processes and supporting cities to develop and efficiently use their financial resources.
- (iii) Improve urban environments, climate resilience, and disaster management through, for example, enhancing resources and building capacity.

Source: ADB 2019. *Strategy 2030 Operational Plan for Priority 4: Making Cities More Livable 2019–2024*. Manila. <https://www.adb.org/documents/strategy-2030-op4-livable-cities>.

II. REVIEW OF SMART CITY INITIATIVES AND MODELS

8. The following chapter lays out a review of international smart city initiatives and models to compile common elements and assess their applicability to cities in developing Asia and the Pacific. These emerge as high-level objectives, key enablers, and specific action fields.

A. Smart City Initiatives by Region and Income Group

9. Smart cities have become a global trend, evolving from the improvement of infrastructure and service delivery by use of sensors and technology to the improvement of city-wide decision making by use of data analytics. Yet, most cities have had difficulties making their smart vision a reality. Cities set ambitious objectives, and the private sector often tries to promote the vision for marketing its solutions. Today, most cities attempting a transformation to become smarter in their planning and management are still at the initial stages of the process.

10. In a desk review, 153 cities with official documents on smart city strategies by city authorities were analyzed.⁴ There was a sharp increase in the number of such publications from 2014 to 2015; today, there are about 40 new official smart city publications per year. This rise indicates a strong momentum toward applying smart city solutions to urban development challenges. Although smart city approaches can be found all around the world, they originated in Europe. The number of smart city strategies in Europe almost equals the number of strategies in Asia and the Pacific and North America combined (Figure 1). In Asia and the Pacific, most strategies come from the People's Republic of China (PRC) and India. Hardly any smart city publications by governments can be found in Africa or South America, and no strategies were identified in low-income countries. This finding suggests that cities in low-income countries lack the means and resources to develop and to implement smart city strategies, or that it may not be their core priority in light of more pressing basic infrastructure and services demands.

⁴ Roland Berger. 2019. *The Smart City Breakaway: How a Small Group of Leading Digital Cities Is Outpacing the Rest*. Munich.

B. Smart City Initiatives by Sector Focus

11. The development of smart city strategies takes place in different contexts driven by various policies. In Europe, the concept has arisen mostly in the context of energy efficiency and sustainability, promoted by various funding and support programs of the European Union's Directorate General of Energy.⁵ In the United States (US), many smart city approaches have a strong mobility focus bolstered by a funding challenge of the US Department of Transportation.⁶ In the PRC, the formal announcement of a national smart cities pilot in 2013, led by the Ministry of Housing and Urban–Rural Development, and several related policy and guidance papers, have led to a combined focus on transport, water, energy, and health care.⁷

C. City Initiatives by Comprehensiveness

12. The development of smart city strategies takes place in defective smart city initiatives are all based on a comprehensive strategy that considers relevant action fields within a city and assigns priorities to specific projects that channel scarce municipal resources to core action areas. As such, a comprehensive smart city strategy needs to support financing plans, engagement strategies, stakeholders' roles and responsibilities, and road maps and implementation plans of various associated projects. A comparison of the comprehensiveness of different smart city strategies based on the Smart City Strategy Index⁸ showed that cities in Asia had higher scores than cities in other regions (Figure 2). Little difference in comprehensiveness was observed by income groups, although high-income countries in Europe tend to have more smart city strategies when compared to Asian countries. While many cities are moving ahead with the implementation, not all cities are acting upon their defined strategies.

⁵ R. Ferrara. 2015. *The Smart City and the Green Economy in Europe: A Critical Approach*. *Energies*. 8 (6). pp. 4724–4734.

⁶ Government of the United States, Department of Transportation. 2015. *Smart City Challenge*. Washington, DC.

⁷ EU SME Centre. 2015. *Sector Report: Smart Cities in China*. http://ccilc.pt/wp-content/uploads/2017/07/eu_sme_centre_report_-_smart_cities_in_china_i_edit_-_jan_2016_1_1.pdf.

⁸ The Smart City Strategy Index is presented in Appendix A.

D. Smart City Initiatives by Action Field

13. Smart city action fields are chosen depending on the cities' challenges and priorities. The scores for the different indicators within the action fields of the Smart City Strategy Index represent a proxy of the ambition or level of willingness to achieve set targets for each action field. Comparing these scores among cities grouped by region, income, and population size showcase different priority setting within smart city action fields. In Asia and the Pacific, cities are defining more ambitious approaches for almost all action fields.

14. Further, larger cities have better-developed strategies regarding the smart city action fields. Corresponding to the findings for Asian cities, large cities have higher scores for almost all indicators within the action fields. Aiming to provide solutions for larger populations and to manage limited space and resources, larger cities often seek more ambitious targets for buildings, environmental management, transport, education, health, and e-government than smaller cities. For the income category, however, differences in the actions taken by poorer and wealthier cities are less pronounced. Higher-income cities have higher scores for multimodal transport, while lower-income cities score significantly higher on civil security.

III. SMART CITY MODELS

A. Smart City Model Components

15. This section presents the results from a review of 29 international smart city models, their common elements, and their applicability to cities in developing Asia to identify conceptual guideposts for smart city plans, processes, and action checklists (see Appendix B for methodology).

16. These models, developed by official bodies (e.g., the European Union or MDBs), think tanks, research institutions, foundations, technology providers, and consultancy firms, have been recently developed and offer a varied regional focus. They serve as a practical guideline for cities in their development of smart city plans (Box 2), outline key actions for the development of these plans (Box 3), or assess and compare the status of different cities. While these models serve different purposes, their structural elements are often similar, consisting of high-level objectives, action fields, and enabling factors, in which digital maturity is implicitly reflected.

17. The models identified are composed of various elements, categorized into three building blocks:

- (i) **High-level objectives**, which define the desired outcome to be achieved, such as quality of life, economic growth, sustainability, resilience, and inclusiveness.
- (ii) **Enabling factors**, which represent cross-cutting entry points for digital transformation, such as technology, policy, skills, business, and planning.
- (iii) **Action fields** in which smart city solutions can be applied.

All existing models differ in the coverage of these building blocks and their sub-elements.

Box 2: Association of Southeast Asian Nations Smart Cities Framework

In response to the challenges posed by rapid urbanization and the region's growth, member states of the Association of Southeast Asian Nations (ASEAN) established the ASEAN Smart Cities Framework (2018). It serves as a nonbinding guide for the participating 26 pilot cities, in a manner that is specific to each city's local and cultural context.

The multilevel framework defines strategic outcomes, urban systems and focus areas, and enablers as key elements of a smart city plan. While the framework emphasizes the need for smart city development to be in accordance with each city's given characteristics and potential, it posits three overarching strategic objectives for all cities. The six focus areas are to be combined and adapted to reflect an individual city's needs. These focus areas are underpinned by integrated master planning and development as well as dynamic and adaptive urban governance. In addition, technology and partnerships are promoted as key enablers.

The three-layered model provides a framework in which a smart city can be conceptualized and translated into concrete projects in the pilot cities. Focus areas are selected based on their significance for achieving the three strategic outcomes. For example, the focus of the city of Luang Prabang in Lao People's Democratic Republic is on implementing a smart urban drainage and sewage system to reduce water pollution. Phnom Penh, the capital of Cambodia, is focusing on an urban transport master plan to tackle congestion in the growing capital. Notably, key enablers and relevant urban systems apply to all individual focus areas, and their relevance is universally valid.

Continued on next page

Box 2 continued

Source: ASEAN Smart Cities Framework. Jakarta.

Box 3: Econsult Solution ThoughtLab Smarter Cities 2025

The Smarter Cities in 2025 analysis, by Econsult Solutions, Inc. ThoughtLab, defines characteristics of successful smart cities and lays out the most effective path for becoming a smart city. Based on in-depth benchmarking surveys with government leaders in 136 cities, smart city perspectives, practices, and performance results are channeled into a smart city pyramid and road map.

The report identifies 10 smart city pillars that drive benefits to local stakeholders. In most successful smart city strategies, these pillars can be divided into foundational pillars and technology-enabled pillars. Based on the surveys conducted, their relevance can be arranged according to their priority in smart city development. Their base position in the pyramid reflects the foundational pillars' paramount function as enablers for the levels built on top. The technology-enabled pillars reflect action fields and individual strategic goals that are flexibly addressed based on a city's needs and potential.

The proposed road map for the smart city development in the report illustrates the steps that need to be taken to create ideal conditions for smart city activities. It assesses the current city needs (step 1) and then addresses enablers such as governance, infrastructure, and technological innovation (steps 2–6). Finally, it highlights the need for cooperation with existing digital ecosystems for strategy development and implementation (step 7) and emphasizes the importance of substantial investment to ensure the longevity of the smart city effort (step 8).

Source: Econsult Solutions, Inc. ThoughtLab. 2018. *Smarter Cities in 2025*. <https://econsultsolutions.com/esi-thoughtlab/smarter-cities-2025/>.

18. Most models define high-level objectives to guide smart city programs. Eight high-level objectives were common among the reviewed smart city models: innovation, sustainability, and efficiency are covered by more than 50% of the reviewed models, followed by quality of life, competitiveness, economic growth, and inclusiveness appearing in about one-third of the models. Resilience is the least-mentioned objective mostly limited to models that focus on high-risk contexts (Figure 3).

19. Key enabling factors of a smart city can be found in most of the models. Not surprisingly, most of the models recognize the crucial role of technology and innovation. The crucial role of planning and coordinating the implementation of a smart city approach, however, is recognized by only one-third of the models. To a large extent, digital maturity is covered by the enabling factors that determine the city's readiness for digital transformation.

20. Almost all models include action fields, but the number and segmentation of these areas vary. Across all models, 14 action fields were identified, although the degree to which these are covered in the models differ (Figure 4). E-government and ICT infrastructure are the most defined action fields as they reflect obvious action fields in any smart city utilizing digital solutions. Urban agriculture comes last and seems not to be perceived as a primary concern for many city governments; however, new farming methods are gaining attention due to the challenge of feeding growing urban populations. Most of the models take a variety of action fields into account, but only a few consider the full range of actions to be addressed (Figure 5). More than one-third of the models cover fewer than 10 action fields limiting their focus for the digital transformation of their cities.

B. Smart City Model Comparison by Regions

21. Many of the reviewed smart city models either have a specific European or global (non-region specific) focus (Figure 6). Only three models have been specifically devised for Asia and the Pacific.⁹ In total, 16 of the 29 models have already been used in Asian cities.

22. Regarding smart city objectives, models for Asian cities have a broader coverage of economic and social objectives than other models. Innovation, efficiency, and sustainability come first in both groups, while competitiveness, economic growth, and inclusiveness are considered more in models for Asia (Figure 7). Despite the importance of increasing climate and disaster risks, particularly in Asia and Pacific, resilience is only mentioned in three models.

23. Regarding smart city enablers, fewer differences between Asian and non-Asian models are observed. Yet, Asian models put more emphasis on digital skills and capacities, which rank first with technology and innovation (Figure 8). This finding may reflect that training and capacity building are key for the application of new technologies in the region.

24. Regarding smart city action fields, only minor differences appear. ICT infrastructure and education rank higher among the Asian models, in most of the cases confirming a focus on skill development and technical capacity building (Figure 9). Land use and urban planning are covered, more often reflecting the mounting challenge of limited land availability and urban sprawl in many Asian cities.¹⁰

⁹ Association of Southeast Asian Nations (ASEAN). 2018. *ASEAN Smart Cities Framework*. Jakarta; IESE. 2018. *Cities in Motion*; IESE. 2018. *Cities in Motion Index 2018*. Barcelona; IESE Business School; Indian School of Business and The Shakti Foundation. 2017. *Smart Cities Index: A Tool for Evaluating Cities*. Delhi; and KPMG. 2019. *Connected Cities. Citizen Insights across Asia Pacific*. <https://assets.kpmg/content/dam/kpmg/cn/pdf/en/2019/01/connected-cities-citizen-insights-across-asia-pacific.pdf>.

¹⁰ African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank. 2019. *Creating Livable Cities: Regional Perspectives*.

Figure 3: Smart City Objectives **Figure 4: Smart City Action Fields** **Figure 5: Number of Action Fields by Smart City Model** **Figure 6: Smart City Models by Region** **Figure 7: Smart City Objectives**

Based on review of 15 Smart City models from

Based on review of 14 Smart City models from

Figure 8: Smart City Enablers

Based on review of 15 Smart City models from

Based on review of 14 Smart City models from

Figure 9: Smart City Action Fields

Based on review of 15 Smart City models from

Based on review of 14 Smart City models from

IV. SMART CITY ACTION FIELDS

25. Having defined the common elements of smart city initiatives and models as high-level objectives, enabling factors, and action fields, the following chapter presents and discusses each of these action fields and their role in smart city solutions. Each action field is illustrated by an ADB case example that utilizes smart city solutions.

A. Information and Communication Technology Infrastructure

26. Smart city operations are built upon resilient and accessible ICT infrastructure, in which a city-wide network of connectivity systems exchange and update information in real-time.¹¹ This information can then be provided to the public. ICT connectivity is improving through infrastructure network equipment components such as fixed-line and mobile network infrastructure, satellites, data centers, and corresponding transmission lines. Mobile phone applications also extend ICT connectivity to the end user, increasing accessibility. This infrastructure is supplemented by emerging intelligent systems,¹² including internet of Things (IOT) and artificial intelligence. ICT systems are dependent on broadband internet, public Wi-Fi, and/or long range low-power wide-area networks; IOT networks transfer data from sensors; city control centers monitor data flows in real time; data platforms provide access to these data sets for multiple users; data centers and cloud computing enhance the real-time exchange of data; and ICT security and resilience protocols protect the systems and underlying data.

Box 4: ADB Case Example 1—Affordable Satellite-Based High-Speed Broadband Internet in Asia and the Pacific

ADB approved a \$50 million project with Kacific Broadband Satellites International Limited (Kacific), its first satellite financing.

The project will provide affordable high-speed broadband internet connections to countries in Asia and the Pacific. It will connect the remote areas of small island nations in the Pacific and larger island nations like Indonesia and the Philippines through satellite-based internet.

For further international case examples, see Appendix 1.C.

Source: ADB. 2019. *ADB's First Satellite Financing to Expand Internet Access in Asia and Pacific*. <https://www.adb.org/news/adbs-first-satellite-financing-expand-internet-access-asia-and-pacific>.

Photo credit: ADB

B. Urban and Land Use Planning

27. Rapid growth in many regions of Asia often generates urban sprawl and unregulated development in risk-prone areas such as flood zones (footnote 12). To address these challenges, smart cities can harness a myriad of digital technologies to improve land use planning and decision making through more effective monitoring, mapping, and analysis of urban environments. These technologies include new data from remote sensing earth observation, geographic information systems (GIS), and big data analytics. Remote sensing data from satellites provide real-time earth observation. GIS store, integrate, and display this data alongside other geo-coded information to spatialize key patterns that inform land use planning. Big data

¹¹ ITU-T. 2020. Internet of Thing and Smart Cities and Communities. Study Group 20. <https://www.itu.int/en/ITU-T/ssc/Pages/default.aspx>.

¹² Intelligent systems are advanced, internet-connected computers that combine artificial intelligence and machine learning to gather and analyze data and can communicate with other systems.

analytics enables further integrated analysis of this data with other ground data, including user-generated mobile phone data. Parametric modelling software and computational design programs also help visualize different urban planning scenarios. Collating this information on open data platforms further widens the potential of new urban planning solutions and other smart city applications.

Box 5: ADB Case Example 2—Land Registry with Block Chain Technology in Fiji

ADB, together with the iTaukei Land Trust Board (TLTB), has developed a modernized land management system for Fiji. It features a proof-of-concept for a blockchain-based system that seeks to secure customary land records, streamline land lease transaction steps, and ensure transparency of the auditing process. The simple process, fully adopted in 2019, is fast and secure, which significantly improves the user experience. Due to its accuracy and low cost, other countries, including India and Japan, are also rolling out blockchain for land value registration.

For further international case examples see Appendix 1.C.

Source: ADB. 2019. *Distributed Ledger Technology and Digital Assets: Policy and regulatory challenges in Asia*. <https://www.adb.org/sites/default/files/publication/509941/distributed-ledger-technology-digital-assets-asia.pdf>.

C. Mobility and Transport

28. Urban environments face a multitude of challenges related to mobility and transport, including traffic congestion and associated air quality impacts, diffuse urban pollution, and accidents, among others. Smart cities can address these challenges using technologies that link to four transformational trends: the rise of shared mobility, the emergence of autonomous technology and self-driving vehicles, the digital transformation of automotive production processes, and the growth of e-mobility.¹³ For example, an intelligent traffic management system controls traffic flows in real time, smart traffic lights regulate traffic flows to decrease congestion, shared mobility services reduce the number of vehicles on the street, multimodal platforms enable the combination of different transport modes, autonomous vehicles provide safe and convenient transport, electric vehicles double as battery storage or energy generators, and smart parking apps decrease congestion and pollution in city centers. Collectively, these systems allow cities to balance the demand for accessible mobility and transport with the objective of low-carbon and livable cities.¹⁴

¹³ Arup. 2014. *Delivering the Smart City – Governing Cities in the Digital Age*.

¹⁴ See ADB Operational Priority 7—Fostering regional cooperation and integration.

Box 6: ADB Case Example 3—Intelligent Transport System in Guizhou, People's Republic of China

In August 2019, ADB signed a \$200 million loan to develop an innovative intelligent transport system that aims to boost transport safety, lessen air pollution, and lighten traffic congestion in Gui'an, a new city in Guizhou Province, People's Republic of China (PRC). This project will finance real-time traffic and road weather monitoring, a multimodal transportation systems management and operations center, and an integrated traffic operations and safety and emergency management system. The intelligent transport system will also include some sustainable transport infrastructure, such as clean energy buses, bus stations, and electric vehicle charging stations. It will be a pilot for other cities demonstrating integrated smart transport development.

For further international case examples see Appendix 1.C.

Source: ADB. 2019. ADB-Supported Sustainable Transport Project to Reduce Pollution, Improve Mobility in Guizhou, PRC. <https://www.adb.org/news/adb-supported-sustainable-transport-project-reduce-pollution-improve-mobility-guizhou-prc>.

D. Energy

29. The growth of urban populations, combined with rising income levels, places a corresponding increase on per capita energy demand. Moreover, the proliferation of renewables and decentralization of energy networks introduces opportunities and challenges around energy supply and variance. Digital technologies can improve and stabilize energy supply from renewable energy sources across decentralized grids to enhance energy efficiency and optimize supply and demand.¹⁵ While urban energy networks have historically relied on ICT infrastructure, several technologies are driving transformation in the energy sector, including smart meters and grids, sensors, virtual power plants, and distributed energy generators. Smart metering systems and sensors provide utility companies and their customers with information on real-time energy consumption, which allow for more individual energy management and tailored energy supply. Smart grid systems work to stabilize energy supply and demand, while incorporating renewable energy. Virtual power plants connect energy storage systems and power consumption units, and play a crucial role in decentralized energy generation, grid stability, and flexibility.

¹⁵ World Bank. 2017. *Practical Guidance for Defining a Smart Grid Modernization Strategy: The Case of Distribution*. Washington, DC.

Box 7: ADB Case Example 4—Scaling Up Renewable Energy to Reduce Energy Poverty in the Philippines

In August 2019, ADB signed a \$200 million loan to develop an innovative intelligent transport system that aims to boost transport safety, lessen air pollution, and lighten traffic congestion in Gui'an, a new city in Guizhou Province, People's Republic of China (PRC). This project will finance real-time traffic and road weather monitoring, a multimodal transportation systems management and operations center, and an integrated traffic operations and safety and emergency management system. The intelligent transport system will also include some sustainable transport infrastructure, such as clean energy buses, bus stations, and electric vehicle charging stations. It will be a pilot for other cities demonstrating integrated smart transport development.

For further international case examples see Appendix 1.C.

Sources: ADB. *Energy for All Initiative*. <https://www.adb.org/sectors/energy/programs/energy-for-all-initiative>; ADB. 2019. *Pilot Project Brings 24-Hour Solar Power to Improve Life on Small Philippine Island*. <https://www.adb.org/news/pilot-project-brings-24-hour-solar-power-improve-life-small-philippine-island>.

E. Environment

30. Rapid urbanization in developing Asia has contributed to the deterioration of environmental quality, including deteriorating air quality from transport and industrial emissions, and challenges associated with increased waste generation and solid waste disposal practices. As a result, harnessing digital opportunities to reduce air pollution, improve emissions control, and establish sustainable waste management systems is fast becoming a priority in smart city operations.¹⁶ Sensors provide a novel method to monitor and manage air, water, and soil quality in addition to the levels of waste generation. While remote sensing provides satellite data on the quality of environmental resources, sensors on vehicles and other devices such as streetlights provide real-time data on air pollution and emissions levels; thereby providing useful insights around patterns of pollutants that can better inform decision making. Similar solutions are applied to monitor the quality of land and water resources. For example, the health of vegetation—a key component of functioning ecosystem services in urban and peri-urban environments—can be assessed using remote sensing techniques. Finally, smart waste management systems and devices such as smart bins, smart trucks, and robotic sorting can enhance the sustainability of this sector.

¹⁶ T. M. V. Kumar. 2020. *Smart Environment for Smart Cities*. Springer Singapore. <https://www.springerprofessional.de/en/smart-environment-for-smart-cities/16892646?fulltextView=true>

Box 8: ADB Case Example 5—Deploying Circular Economy Practices for Waste in the People’s Republic of China

In August 2019, ADB signed a \$200 million loan to develop an innovative intelligent transport system that aims to boost transport safety, lessen air pollution, and lighten traffic congestion in Gui’an, a new city in Guizhou Province, People’s Republic of China (PRC). This project will finance real-time traffic and road weather monitoring, a multimodal transportation systems management and operations center, and an integrated traffic operations and safety and emergency management system. The intelligent transport system will also include some sustainable transport infrastructure, such as clean energy buses, bus stations, and electric vehicle charging stations. It will be a pilot for other cities demonstrating integrated smart transport development.

For further international case examples see Appendix 1.C.

Sources: ADB. *Energy for All Initiative*. <https://www.adb.org/sectors/energy/programs/energy-for-all-initiative>; ADB. 2019. *Pilot Project Brings 24-Hour Solar Power to Improve Life on Small Philippine Island*. <https://www.adb.org/news/pilot-project-brings-24-hour-solar-power-improve-life-small-philippine-island>.

Photo credit: ADB

F. Water

31. Supply of reliable and potable water to urban residents, alongside wastewater and drainage networks, are a basic service that cities need to provide. In developing Asia, climate change impacts, aging infrastructure, and growing water demand due to urbanization and increasing household incomes are challenges that smart technologies can help to address.¹⁷ These technologies enable smart cities to manage their water resources more efficiently by controlling water quality and consumption in real-time, and enabling improved detection of water leaks, overflows, and damage to water and wastewater infrastructure. Smart meters manage water distribution by controlling valves in targeted areas respondent to water demand. Water-point mapping and monitoring through drones or mobile phones also help control and measure water use. The operation and maintenance of water treatment utilities and sewerage systems can also be aided by smart technologies. Moreover, technologies such as remote sensing enable more precise forecasting of water flows over the broader water catchment to support integrated water resource management.

¹⁷ ADB. 2011. *Smart Water Solutions in Small Packages: Stories from Pilot and Demonstration Activities*. Manila. <https://www.adb.org/publications/smart-water-solutions-small-packages-stories-pilot-and-demonstration-activities>.

Box 9: ADB Case Example 6—Piloting Smart Devices for Drinking Water Management in Dhaka, Bangladesh

As part of ADB's regional capacity development technical assistance Smart Drinking Water Management in South Asian Cities (TA 9048-REG), smart water devices were piloted in key cities such as Dhaka to enhance capacity of water utilities and increase their operational efficiency and financial sustainability. Twelve smart meters, one base station, and one monitoring station were set up during the pilot phase. In Dhaka, this program supplemented a major initiative to upgrade the city's water network and increase the accessibility to all residents. Dhaka achieved this by delineating the city into smaller and more manageable district metering areas, which use smart meters to monitor the network for leaks and to ensure that clean, pressurized water is delivered 24 hours a day to all residents.

For further international case examples, see Appendix 1.C.

Sources: ADB. 2018. *ADB Perspectives on Smart City*. ADB Knowledge Events. <https://events.development.asia/system/files/materials/2018/03/201803-adb-perspectives-smart-city.pdf>.

Project sheet available at <https://www.adb.org/projects/49289-001/main#project-overview>; ADB. 2017. *The Dhaka Water Services Turn-around*. <https://www.adb.org/sites/default/files/publication/384631/dhaka-water-services.pdf>.

G. Climate Resilience and Disaster Risk Management

32. Cities concentrate people and assets and, combined with their specific locations (often along coasts), face a variety of climate and disaster risks including flooding, drought, sea-level rise, severe storms, and earthquakes. To address this, it is key to build urban resilience or strengthen a city's capacity to absorb, anticipate, adapt to, recover from, and transform in the face of acute shocks or chronic stresses.¹⁸ There exists a need across developing Asia to integrate digital technologies into climate and disaster risk management protocols to both minimize risk and increase response capacity. Big data analytics combines earth observation and land-based sensors. It is a powerful tool to monitor and predict weather conditions, extreme events, and possible natural disasters. Satellites provide spatial data on floods, storms surges, and sea-level rise, which can then be combined with on-the-ground observations derived from sensors or mobile phones to establish a rich pool of data. Algorithms and other artificial intelligence-based solutions help detect patterns from historical data to identify risks and to forecast future events that may divert from those patterns. Concurrently, platforms and mobile phone applications help make these data accessible to a wider audience, including with early warning messages. As such, a smart city constitutes a safer, more resilient space in which impacts from climate change and natural disasters are mitigated and better managed.

¹⁸ United Nations Office for Disaster Risk Reduction (UNDRR). 2019. *Global Assessment Report on Disaster Risk Reduction*.

Box 10: ADB Case Example 7—Using Open Source Geospatial Data to Build Urban Resilience

The Urban Climate Change Resilience Trust Fund (UCCRTF), established in 2013 as part of ADB's Livable Cities initiative, aims to support medium-sized and rapidly developing cities to integrate resilience principles into planning and design. Additionally, it aims to reduce climate and disaster risk, particularly among vulnerable populations. The UCCRTF provides planning, investment, and knowledge services.

One of the projects supported by the UCCRTF is the Spatial Data Analysis Explorer (SPADE) which uses open source technology that is hosted on a centralized cloud-based server. SPADE provides accessible, up-to-date information on climate change scenarios using open source data. This information can be spatialized against topography, land use, socioeconomic, and infrastructure data to support planning and development to integrate resilience against climate and disaster risks. SPADE is currently being piloted in Bangladesh and Viet Nam.

For further international case examples, see Appendix 1.C.

Sources: Development Asia. 2018. *Using Spatial Cloud Computing to Build Livable Cities*. <https://development.asia/explainer/using-spatial-cloud-computing-build-livable-cities>; ADB Livable Cities. *Urban Climate Change Resilience Trust Fund*. <https://www.livablecities.info/urban-resilience-fund>.

Photo credit: ADB

H. Food and Agriculture

33. Producing and providing food for urban centers in developing Asia is a critical challenge, particularly considering population growth. Similarly, increasing wealth is shifting demand to high-input products such as meat, which in most cases have a higher ecological footprint than plant-based diets.¹⁹ Supply chains often require travel from rural to urban centers and, more recently, long-distance imports to supply the growing demand for exotic food products in Asia, which bears high costs and emissions. At the same time, local and small-scale food producers in rural Asia often lack tools to more efficiently manage their production and are also highly sensitive to climatic changes. Finally, food waste is a pressing challenge as well. Smart cities can use digital technologies such as drones, robotics, and IOT to enable more precise agricultural production systems, including in urban agriculture.²⁰ Data-driven and IOT-based operations in agriculture as well as laser- and camera-guided robots enable more precision farming. In urban settings, vertical farms use hydraulic systems to produce food with limited space. Further, mobile phone applications can provide up-to-date information and connect different end users to optimize food supply chains. Similarly, zero waste platforms, whether online or as part of a mobile phone applications, can help to minimize food waste by, for example, adjusting food prices based on expiration dates and alerting customers to available products.

¹⁹ World Bank. 2018. *The Changing Wealth of Nations—Building A Sustainable Future*. Washington, DC.

²⁰ World Bank. 2019. *Future of Food: Harnessing Digital Technologies to Improve Food System Outcomes*. Washington, DC.

Box 11: ADB Case Example 8—Digital Solutions to Improve Agricultural Value Chains, Regional (Bangladesh, Pakistan, Tajikistan, and Viet Nam)

ADB aims to widen the use of digital technologies in Bangladesh, Pakistan, Tajikistan, and Viet Nam to increase the productivity and efficiency of production and marketing systems along agricultural value chains. The technical assistance project will result in a commercially viable business model that encourages the broad participation of the public and private sectors as well as civil society, and boosts access to location-specific, reliable, and real-time information on (i) weather forecasts and alerts, (ii) irrigation scheduling, (iii) market information and analytics, and (iv) agricultural extension services. Helpline call centers set up in each country will provide information on best practices to improve crop production.

For further international case examples, see Appendix 1.C.

Source: ADB. 2019. *Regional: Digital Solutions to Improve Agricultural Value Chains*. <https://www.adb.org/projects/49054-001/main#project-pds>.

Photo credit: ADB

I. Public Management and Services

34. Government and public authorities can increase accessibility, accountability, and transparency of their services to growing urban populations using digital tools.²¹ Cloud computing and storage expands the quality, reliability, and affordability of services provided and offers new ways to manage and record information and internal processes, as it allows for large amounts of data to be shared between different departments in different locations. Additionally, it provides data storage and management capabilities, and facilitates digital identification and digital payment schemes. Both provide the public easier access to government and nongovernment services. Web portals, mobile phone apps, and digital reality solutions can also present data and information in novel, transparent, and accessible ways.²²

²¹ Z. Mahmood. 2013. *E-Government Implementation and Practice in Developing Countries*. University of Derby.

²² Including augmented and virtual reality.

Box 12: ADB Case Example 9—E-Government Procurement for Increased Transparency in Asia and Pacific

Government institutions have integrated information technology as a means to increase efficiency and transparency of procurement. In 2013, ADB provided technical assistance to build the capacity of Asia and Pacific developing member countries in implementing e-government procurement and strengthen transparency of public procurement tenders. This project included the creation of an e-government procurement handbook to centralize the multitude of options for financing and delivery of e-government systems available to all levels of governments to meet their specific needs with regards to procurement. Implementation of the e-government procurement system in the software-as-a-service model was prepared to support a significant number of participating ADB developing member countries to develop e-procurement systems based on international best practices.

E-Government Procurement Road Maps: Phases and Stages

e-GP = e-government procurement.

For further international case examples, see Appendix 1.C.

Sources: ADB. 2013. *Regional: Asia Pacific Public Electronic Procurement Network*. <https://www.adb.org/projects/47192-001/main#project-pds>; ADB. 2013. *E-Government Procurement Handbook*. <https://www.adb.org/documents/e-government-procurement-handbook>.

J. Economy and Jobs

35. Cities in developing Asia are home to a large share of the region's population, provide economic opportunities, and are often the base of many industries and service sectors, acting as a key component of the regional economy (footnote 12). Digital technologies provide an opportunity for new products and services that can transform existing business models and processes, and create new economic activities and employment. This occurs both through the direct development of digital technologies, which can attract investment into cities and thereby drive further economic development, and through improving the range

and accessibility of opportunities to the public. For example, innovation labs bring together individuals and start-ups to develop new products and services that can be prototyped and tested before being introduced to markets and made available to a wider audience. These products and services also transform traditional sectors through the digitization of existing processes, as realized in e-commerce or industry 4.0.²³ Job-matching platforms can also bring together employers and prospective employees with the requisite skills. Finally, digital skills can be consistently developed through smart education (see Section V).

Box 13: ADB Case Example 10—The Transformative Role of ICT in the Kyrgyz Republic

ADB and the Kyrgyz Republic established a 5-year country partnership strategy in 2018 to promote sustainable economic growth for the country. This includes encouraging digital transformation as information and communication technology (ICT) implementation and uptake has significant potential to overcome the barriers facing the country given its double landlocked nature and its historical dependence on gold as its major trading commodity. Specifically, the Country Partnership Strategy launched the Taza Zoom digital transformation program which aims to improve internet connectivity and access to government services. The intended impact will be to attract greater private sector investment in the ICT industry as a whole.

UN E-Government Index. Source: UN DESA. UN E-Government Knowledge base. <https://publicadministration.un.org/egovkb/enus/Data/Country-Information/id/91-Kyrgyzstan> (accessed 16 October 2018).

For further international case examples, see Appendix 1.C

a. Kyrgyz Republic E-Government Rank

b. Online Service Index, 2018

Sources: ADB. 2018. *ADB Approves New Partnership Strategy for Kyrgyz Republic*. <https://www.adb.org/news/adb-approves-new-partnership-strategy-kyrgyz-republic>; ADB. 2019. *Kyrgyz Republic – Improving Growth Potential*. <https://www.adb.org/sites/default/files/publication/527161/kyrgyz-republic-growth-potential.pdf>.

K. Education

36. Education is key to an inclusive city in which all residents can participate in and benefit from available and emerging opportunities. While significant progress has been made in recent years, cities in developing Asia can continue to expand education services and vocational training across all ages. As digitization accelerates, education services should work to promote digital skills to ensure that citizens are well-equipped to participate in the digital economy.²⁴ Digital technologies enable broader access to a variety of personalized and international education services, while changing the ways in which education is provided. In schools, digital equipment like tablets, smartboards, and interactive whiteboards enhance the learning experience because they support a variety of learning styles. E-learning apps also provide free or lower-cost education at distance, increasing the accessibility to a wider audience. However, it should be noted that the up-front costs of digital equipment can present an inappropriate hurdle to those that are lower income to access e-learning opportunities.

²³ African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank. 2018. *The Future of Work – Regional Perspectives*.

²⁴ ADB. 2015. *Innovative strategies in technical and vocational education and training for accelerated human resource development in South Asia*. <https://www.adb.org/sites/default/files/publication/176571/tvet-hrd-south-asia-sri-lanka.pdf>.

Box 14: ADB Case Example 11—Digital Skills Program in Sri Lanka

ADB and the Government of Sri Lanka partnered on the Skills Sector Enhancement Program beginning in 2018. The program aims to improve teacher training and the government's quality assurance mechanisms for technical training. Additionally, the program sought to identify the greatest gaps in Sri Lanka's labor market. The project improved industry partnership for technical and vocational education and training (TVET) planning and provision, and prepared skills forecasting reports for information and communication technology (ICT).

Enhancing Work Skills of Young People in Sri Lanka. <https://development.asia/case-study/enhancing-work-skills-young-people-sri-lanka>

For further international case examples, see Appendix 1.C

Sources: ADB. 2015. *Innovative strategies in technical and vocational education and training for accelerated human resource development in South Asia*.

<https://www.adb.org/sites/default/files/publication/176571/tvet-hrd-south-asia-sri-lanka.pdf>; ADB. 2018. *Sri Lanka: Skills Sector Enhancement Program*. <https://www.adb.org/projects/42251-018/main#project-pds>.

Photo credit: ADB

L. Health

37. Affordable health care is a basic service to which cities must work to ensure all residents have access. Smart cities, including those cities with aging populations, can support the health of its residents, lower the incidence of chronic health issues, and decrease the risks posed by acute health crises, using digital means through administering comprehensive health information.²⁵ Specific technologies include cloud computing, mobile phone apps, robotics, and big data analytics. Cloud computing infrastructure enables new health information systems that create an interconnected information base for patients, doctors, and other actors in the health care system. This infrastructure can be diversely applied, from individual-specific health measures up to a nationwide health insurance program. Mobile phone applications can disseminate medical information and, when connected to wearable gadgets like smart watches, can improve user knowledge through up-to-date provision and sharing health-related data (Box 4). Telemedicine connects patients and doctors remotely, increasing the accessibility of health care services. Robotics are especially useful in cities with aging populations to supplement nursing staff or enable the elderly to live independently for longer through ambient assisted living. Finally, the application of big data analytics helps identify personal health risks and early prediction of potential epidemics.

²⁵ ADB. 2018. *Transforming Health Systems Through Good Digital Health Governance*. ADB Sustainable Development Working Paper Series. Manila.

Box 15: Digital Systems to Support the COVID-19 Response in Republic of Korea

The Government of the Republic Korea, under the National Strategic Smart City Research and Development Program, has powered an urban big data integrative platform, the coronavirus disease (COVID-19) Data Platform. It is a cloud-based open data hub used to collect, store, process, analyze, and publish cross-function data in a holistic way. The COVID-19 Data Platform is designed to support epidemiological surveys to quickly identify the transmission routes that infected patients have visited by using real-time data analysis including global positioning system, mobile information, and credit card transaction history. The platform supports health officials by comparing the data with the interview results of patient transmission routes. Big data analysis allows officials to use real-time data on COVID-19 patients, including their whereabouts and the time spent at each location. From these multiple data points, the system can detect incidents of cluster infection and identify the source of transmission. Other mobile applications have been developed including a Self-Diagnostic App and a Self-Quarantine Safety Protection App. The applications allow users to monitor their health conditions and conduct regular self-diagnosis. They further ensure that self-quarantine measures are respected by setting off an alarm when a user ventures out of their designated quarantine area.

COVID-19 Epidemiological Investigation Support

Source: The Government of the Republic of Korea. 2020. *Flattening the curve on COVID-19: How Korea responded to a pandemic using ICT*. http://overseas.mofa.go.kr/gr-en/brd/m_6940/view.do?seq=761548.

Box 16: ADB Case Example 12: Digital Health and E-Governance in Tonga

In July 2019, ADB approved a digital health and e-governance project for Tonga. Improved internet connectivity via the fiber optic cable promotes an e-governance environment for improved health system response. The project will create the information technology infrastructure and establish systems to transition from the fragmented paper-based system to a modernized digital health information system. The project comprises software and hardware, policy advisory and legislative support, as well as capacity development. It will incorporate the existing health pilot into broader digital health system interventions supporting the Tonga National Health Strategic Plan 2015–2020, resulting to optimized resources and decision-making.

How Unique Health IDs are Supporting Improved Health Care. <https://development.asia/explainer/how-unique-health-ids-are-supporting-improved-health-care>.

For further international case examples, see Appendix 1.C

Source: ADB. 2019. *Tonga: Introducing eGovernment through Digital Health*. <https://www.adb.org/projects/50281-001/main#project-pds>. Photo credit: ADB

M. Society and Culture

38. Digital technologies are broadly transforming the ways in which people engage with each other and their environments. In Asia and Pacific, the number of mobile phone users and apps has increased from 2.34 billion users in 2014 to 2.8 billion users in 2018, with an anticipated growth of another 370 million by 2025.²⁶

²⁶ GSMA Association. 2019. *The Mobile Economy Asia Pacific 2019*. https://www.gsma.com/mobileeconomy/wp-content/uploads/2020/03/GSMA_MobileEconomy2020_APAC.pdf.

These technologies create new opportunities to bring people together with similar needs and interests. Thus, cities can strive to harness these tools to promote social cohesion and cultural belonging, while simultaneously working to mediate potential negative impacts. Digital platforms and new communication tools support public–social partnerships, providing new opportunities for civic engagement and access to cultural activities. Citizens can take part in local problem solving and public participation, providing them with an improved sense of belonging. App-based social services help people connect, collaborate, and stay safe in daily life. This is particularly useful for new migrants and visitors to the city, who can be assisted by these services for cultural integration. It can be useful as well for new residents to orient themselves in their new context. Similarly, these apps can support gender equality, whether by providing specific tools that allow everyone to move safely in the city or by increasing access to opportunities online. Additionally, digital reality tools increase access to cultural programs such as concerts, museums, and sports matches. Social and cultural engagement opportunities will become more accessible as well to those with disabilities.

Box 17: ADB Case Example 13—Innovating Tourism Business Models in the Greater Mekong Subregion

Tourism destinations across the Greater Mekong Subregion face a wide range of constraints that hamper tourism growth. These include insufficient transport infrastructure, weak business-enabling environment, slow distribution of digital marketing tools, and inadequate market linkages between tourism and other sectors. Recognizing that innovative tourism business models could promote inclusive and sustainable tourism growth, ADB, in partnership with the Greater Mekong Subregion, Tourism Working Group, and the Government of Australia, launched the Mekong Innovative Startup in Tourism (MIST) acceleration program.

The first MIST program successfully incubated 12 early-stage ASEAN-4 tourism start-ups, and facilitated market access and technology transfer for another 12 mature tourism technology companies with proven intermodal transport, destination marketing, and hospitality service solutions. The program was well received by relevant industry stakeholders. It has generated more than 100 applications to the program, 360 positive media stories, and 1.5 million social shares.

Five International Tourism SMEs qualify for the MIST Market Access Program 2018. <https://mist.asia/5-international-tourism-smes-qualify-mist-market-access-program-2018/>.

Source: ADB. 2018. *Mekong Tourism Innovation*. <https://www.adb.org/sites/default/files/project-documents/52108/52108-001-tcr-en.pdf>.

Photo credit: ADB

N. Safety and Security

39. The safety and security of citizens is a key priority for governing authorities and urban service providers. With increasing urban populations and the complexities of rapidly growing informal areas, the demand on central city authorities is increasing. Evolving digital solutions may provide support for urban monitoring, crime prevention, terrorist attacks, first aid and emergency response, integrating crime prediction and prevention into a wider concept of smart public safety.²⁷ Real-time data can facilitate decision making around the control and forecasting of crime and emergency situations. Surveillance cameras, drones, and sensors may help identify threats in real-time and notify security forces and first responders. Other digital tools such as facial recognition or electronic fingerprint may facilitate the identification of offenders. Mobile

²⁷ The Economist. 2019. *Safe Cities Index: Urban Security and Resilience in an Interconnected World*.

phone apps provide an additional means to report and monitor crime, inform on emergency procedures (first aid) or guidance (evacuation), and provide a channel to communicate with security forces for direct assistance. The application of smart surveillance and alarm systems may detect crime in real-time and trigger necessary measures, such as the deployment of nearby police officers, crucially important when requiring rapid response such as for terrorist attacks. Lastly, econometric forecasting models may predict crime so that necessary prevention measures can be taken to keep high-risk areas safe such as public transport systems and energy distribution systems.

Box 18: ADB CaBse Example 14—Mainstreaming Gender into Planning in Bandung, Indonesia

Gender mainstreaming across local governments and planning promotes inclusive cities. In rapidly urbanizing Indonesia, the government has formalized an initiative to mainstream gender in national and local planning and budgeting. The Future Cities Laboratory (FCL) is undertaking the ADB-funded project Future Cities, Future Women: Urban Data, Gender, and Planning in Bandung. This project, under the ADB framework Promoting Gender Equality and Women's Empowerment, aims to improve gender sensitivity in planning. To do so, the project is using ur-scape, a geospatial-based planning support tool developed by FCL's Urban-Rural Systems team. This project aims to ensure that the infrastructure network, basic provision, and public facilities are gender inclusive, integrating safety into these considerations.

For further international case examples, see Appendix 1.C.

Sources (including photo credit): Future Cities Laboratory. Urban Data, Gender and Planning in Bandung. <https://fcl.ethz.ch/research/research-to-application/urban-data-gender-and-planning-in-bandung.html>; Future Cities Laboratory. Ur-scape planning support tool. <https://fcl.ethz.ch/research/research-to-application/urscape.html>;

Future Cities Laboratory. Future Cities – Future Women kicks off. <https://fcl.ethz.ch/news/news/2019/08/future-cities---future-women-kicks-off.html>.

Photo credit: ADB

Box 19: International Case Example 1—Household CCTV Subsidies for Improved Women's Security in New Delhi, India

The Delhi city government has offered subsidies to households wanting to install closed circuit television or CCTV cameras outside their homes. The project is set to install 140,000 cameras across the city with the aim to improve women's safety. Powered by artificial intelligence technology, the cameras will be able to observe, predict, and react to people who display unusual behavior. The government subsidy will extend to the electricity consumption of the devices, upon submission of details by the users. Along with Delhi, other cities have been increasing the numbers of CCTV cameras as part of the 'safe city' plan focusing on women's security. These include Bengaluru, Mumbai, Chennai, Hyderabad, Ahmedabad, and Lucknow.

For further international case examples, see Appendix 1.C.

Source: OnManorama News. 2019. *Women's Safety: Free CCTV outside you house but with a rider*. 11 June.

Photo credit: ADB

V. SMART CITY ENABLERS

40. Having presented and discussed smart city action fields, illustrated with pragmatic ADB case examples, this chapter considers smart city enablers, their role, challenges, and opportunities. Smart city enablers are key components that provide the necessary foundation and tools to accelerate the effective transition toward a smart city. In this chapter, enablers are generally grouped into themes, but will differ from city to city depending on the context and the desired smart solutions.

A. Policy and Institutions

41. Strong policies and institutions are essential to promote the uptake of smart city initiatives. They are crucial in supporting the implementation of modern technologies and infrastructure to improve the use of data and mitigate the potential disruptive impact of technology on society.

42. Due to restrictions of their national frameworks, local governments may lack the necessary policy competencies to manage and coordinate local infrastructure. Some municipalities are restricted, for instance, from efficiently managing overall traffic flows and mobility, if major roads or other parts of the transport system (e.g., metro or ferry systems) are managed by regional authorities. Municipalities may also face challenges with the incompatibility of smart city initiatives with their public procurement policies. Therefore, city governments and local stakeholders should be empowered to drive their city's smart agenda and ensure that technology is used appropriately. Aligning clear governance structures, regulatory frameworks, and urban policies behind a coherent vision or strategy for the city can provide better buy-in and oversight of the use and direction of smart technology and initiatives.

43. ICT availability and the provision of stable high-quality communications network are essential to supporting the functioning of digital technologies necessary for smart cities. Smart city applications run on ICT infrastructure and are generally built to manage the flows of urban data. ICT in the context of the smart city can improve quality, effectiveness, and efficiencies of urban services. It may reduce costs and other resource consumption, improve collaboration between services; and improve communication between citizens, businesses, and government. Management, operation, and maintenance of ICT and digital technologies is, therefore, required to support smart city initiatives. Such considerations of the associated costs should be considered from the planning stage onward as a factor on city finances. Clear oversight of existing capacities and available resources to ensure the sustainable management and maintenance of ICT for future smart city tools is essential.

44. Besides those technical considerations, security and data privacy have emerged as intertwined challenges within the smart city context, warning of the potential personal privacy threats posed by smart city initiatives to citizens' personal, financial, and global positioning system data.²⁸ Citizens are often given little clarification to provide meaningful consent to the processing of personal data, the collection of private data from public interactions, the privatization or ownership of data (as well as the infrastructure), the safety of stored data (cloud or other systems), and the repurposing of big data for profit.²⁹ Ensuring strong security and privacy measures are embedded in policy and regulations, as well as related smart city infrastructure and processes, is paramount to ensure trust and engagement of various stakeholders in the planning, implementation, and management of smart city strategies and actions.

²⁸ World Bank. 2017. *Internet of Things. The New Government to Business Platform: A Review of Opportunities, Practices, and Challenges*. <http://documents.worldbank.org/curated/en/610081509689089303/pdf/120876-REVISED-WP-PUBLIC-Internet-of-Things-Report.pdf>.

²⁹ L. Edwards. *Privacy, Security and Data Protection in Smart Cities: a Critical EU Law Perspective. Create working papers*. <https://www.create.ac.uk/publications/privacy-security-and-data-protection-in-smart-cities-a-critical-eu-law-perspective/>.

45. Another area of concern is gender. Smart city initiatives have been criticized for techno-centric visions of innovation and using gender-blind policies. However, gender inequality and discrimination against women can be increased by the technological systems that are synonymous with the development of smart cities. Gender responsive policies are needed to ensure urban policies work for all citizens, as gender differences are apparent in socioeconomic conditions such as education, employment, and income. As urban innovation increasingly relies on urban open data analytics, it is crucial that sex disaggregation are built into data collection and analysis processes in order to look at gender-specific needs, as well as gendered outcomes and consequences of smart city initiatives. Forgoing such disaggregation risks leading to gender-blind smart city policies and initiatives, aggravating existing inequalities, and safety risks to women.³⁰ Smart city initiatives must consider the implications on gender equality and inclusivity more broadly throughout design, implementation and monitoring stages.³¹ Smart city solutions are to benefit all members of society ranging from informal citizens, businesses, visitors, residents, and civil society groups, and should be as inclusive as possible.

B. Technology and Innovation

46. Access to technology and innovation can support a city toward developing smart technologies, infrastructure systems, utilities, and intelligent approaches to providing urban infrastructure and social services by tailoring and increasing the reach of smart city solutions.

47. Hackathons are comparatively simple and creative ways of harnessing public, private, and academic expertise to design innovative and tailored solutions. These can be led by city governments, civil society organizations, or multilateral development banks (MDBs), as for instance ADB and the Asian Institute of Management's Hackathons in 2019 illustrates, which focused on solutions for the digital skills gap for today's workforce and improving digital payments.³² Fablabs (fabrication laboratory) small-scale workshops that offer personalized digital fabrication using technology-enabled products may also support skill development and local entrepreneurship. Many of these operate in Asia under the Fablab Asia Network, combining information technology skills and manufacturing in an open setting.³³

C. Business and Finance

48. With urban development needs becoming more complex, financing is one of the top challenges for cities across Asia and the Pacific. Very few cities are able to self-fund infrastructure and urban development projects,³⁴ and public and private capital is often scarce or difficult to mobilize.³⁵

49. Multi-layered and integrated public-private partnerships (PPPs) are becoming essential avenues to explore. The private sector can provide funding, technical expertise, and innovation that compliments and strengthens public sector efforts. However, several countries and local authorities remain poorly equipped to address the needs of such arrangements and would benefit from transaction advisory services on PPPs. Although public grants are limited, MDB financial instruments and national development banks both offer

³⁰ M. Sangiuliano. 2017. *Smart Cities and Gender: Main arguments and dimensions for a promising research and policy development area*.

³¹ See example at ADB's ASEAN Australia Smart Cities Trust Fund has put gender equality and women's empowerment at the core of the fund's digital solutions alongside social inclusiveness and climate change. ADB. 2019. *ASEAN Australia Smart Cities Trust Fund*. <https://www.adb.org/site/funds/funds/asean-australia-smart-cities-fund>.

³² ADB. 2019. ADB-AIM Hackathon 2019. <https://digital.adb.org/challenges>

³³ Fablab. No Date. Fablab Asia Network. <https://www.fablabs.io/organizations/fablab-asia-network-15b88e56-0c55-4329-b68a-bdc0b14a06b0>.

³⁴ ADB. Forthcoming. *Contemporary Issues for Livable Asian Cities*. Manila.

³⁵ European Commission. 2017. The making of a smart city: policy recommendations. https://smartcities-infosystem.eu/sites/default/files/document/the_making_of_a_smart_city_-_policy_recommendations.pdf.

services that can be harnessed.³⁶ Successful examples can be found in ADB's support to New Clark City with PPP negotiations for water and energy distribution systems and ICT infrastructure, both geared toward the development of a smart, green, and inclusive city.³⁷

50. Partnerships with universities and nonprofit organizations can equally be explored (see Asian Institute of Technology and training on drones, satellite imagery, and GIS in agriculture).³⁸ Making urban data open and accessible to researchers and the private sector to facilitate innovation and solutions may be explored. Equally, telecommunications and transit companies may make their data available to support better management (see Grab/MDEC/World Bank partnership for OpenTraffic Platform in Malaysia).³⁹ As stated, a clear policy framework is essential to attract investors and provide the stability required.

D. Digital Skills and Capacity

51. Local governments are usually not sufficiently well equipped in terms of ICT capacities. Digital skills and capacities at the local government level are needed to collect, process, and analyze large amounts of data about the urban environment and the services within it. Without these, the flow of information needed for effective planning and decision making may be restricted, which can cascade down to inefficient use of resource services to citizens.

52. For many city administrations attracting the right skills and talent can be difficult, particularly in cities that cannot offer the employment conditions of the private sector. Furthermore, the digital divide within and between local governments propagates an unequal playing field for data capturing, management, and application, whereby government capacity to effectively capitalize on the benefits of various smart tools and systems is uneven. This is of particular concern for secondary cities and smaller towns that are not as easily able to realize opportunities in smart city opportunities due to their disadvantage of having fewer resources and smaller city governments, while typically attracting fewer talented personnel than capital cities and economic hubs.⁴⁰

53. Several solutions can be explored to address this shortfall such as upskilling of staff, twinning arrangements with more experienced or capacitated cities, or partnerships with technology providers and academic centers of excellence. From a policy perspective, cities should make use of managerial training programs and exchange of good practices with more advanced cities. The investment into smart city initiatives would benefit from being coupled with investment into digital skills training.

³⁶ ADB. 2008. Public-Private Partnership Handbook. *Business Guide*. <https://www.adb.org/documents/public-private-partnership-ppp-handbook>.

³⁷ ADB. 2019. *How Public-Private Partnership is building a new smart city in the Philippines*. <https://www.adb.org/news/videos/how-public-private-partnership-building-new-smart-city-philippines>.

³⁸ Asian Institute of Technology. 2018. Regional Training on drones. <https://www.ait.ac.th/event/regional-training-drones-satellite-imagery-gis-agriculture/>.

³⁹ Grab. 2017. Grab and MDEC together with the World Bank Group Launch OpenTraffic Platform in Malaysia to Combat Local Traffic Woes. grab.com/my/press/business/grab-mdec-together-world-bank-group-launch-openttraffic-platform-malaysia-combat-local-traffic-woes/.

⁴⁰ ADB. 2015. Regional Balanced Urbanization for Inclusive Cities Development: Urban-Rural Poverty Linkages in Secondary Cities Development in Southeast Asia. *ADB Southeast Asia Working Paper Series*. <https://www.adb.org/sites/default/files/publication/161353/sewp-11.pdf>.

54. Closing the digital divide does not concern government staff alone, but also is of importance for citizens.⁴¹ This can be done by extending access to networks and devices as a critical first step in setting the foundations for a smart city and a digitally smarter society. Technologies must serve everyone, even those on the margins of connectivity, regardless of income or status. There is a growing risk that inequality will deepen unless local governments recognize that technology-driven solutions are just as important for the poor as for the affluent.

E. Planning and Coordination

55. A high level of collaboration is essential in implementing complex smart city projects between interdependent stakeholders with varying backgrounds, roles, and interests. Strong planning and coordination and thorough management and operation are required. Coordination, planning, management, and operation can be between ministries (e.g., when planning budgets), but equally also between ministries and implementing partners while the project is live. Well-structured management along with open information flows are crucial to ensure transparency and accountability.

56. At a political level, implementing smart city initiatives can be faced with insufficient political will as such initiatives are perceived as risky or complex. As planning remains inherently political, challenges may be imposed on the implementation of a smart city initiative, especially if additional municipal support or staff, resources, or policy change are required. Thus, strategies are not always implemented. Accurate and abundant information can help evidence-based decision making and increase transparency and accountability. However, political buy-in is also required to support, implement, and deliver on smart city solutions. Further reforms are needed to capitalize on the various opportunities smart city solutions may offer.

57. Further, as local governments generally work in sector silos, the coordination of smart initiatives between government departments can be delicate. Even without the addition of smart city systems, local governments are tested when encouraging their sector experts to work across departmental boundaries in order to increase operating efficiency. The required planning for holistic smart city solutions is often contrasted by the divided institutional features of a city government where the sharing of information between departments can be restricted.⁴² Smart city projects by nature involve multiple disciplines and stakeholders collaborating in an interdisciplinary fashion. Such integrated projects need a variety of representatives from different disciplines with the right level of political support to plan, coordinate, and implement an initiative and its projects.

58. At the citizen level, **stakeholder engagement** is central for planning and coordinating smart city projects, yet meaningful collaboration is difficult to get right. The active participation of city stakeholders in the governance of the city can be facilitated by using online communication tools such as web pages, mobile apps, and social network platforms, among others. Issues of the digital divide and uneven access to such platforms and tools must be considered.

59. Lastly, smart city projects are characterized by a **high level of experimentation**, resulting in rounds of trial-and-error. Having planning and coordination processes that allow for such flexibility is essential.⁴³ Cities can ensure that requirements across city departments are aligned with modern technical options, and delays for bureaucratic procedures are avoided or streamlined.

⁴¹ World Bank. 2016. *World Development Report: Digital Dividends*. Washington, DC.

⁴² IGLUS. 2018. *Smart City Concepts*. <https://fsr.eui.eu/iglus-quarterly-vol-4-no-1-critical-and-practical-views-of-the-smart-city-concept/>.

⁴³ J. Borsboom-van Beurden et al. 2017. *Smart City Guidance Package for Integrated Planning and Management*. <https://eu-smartcities.eu/sites/default/files/2017-09/SCGP%20Intermediate%20version%20June%202017.pdf>.

VI. STEPS FOR REALIZING SMART CITY OPPORTUNITIES: AN ANALYTICAL FRAMEWORK

60. Following the review of international smart city initiatives and models which identified common elements, the presentation of each action field illustrated through pragmatic case examples, and the consideration of smart city enablers needed to support smart city solutions, this chapter proposes an analytical framework for smart cities in developing Asia. The analytic framework, tying into a wider project management lens, may guide practitioners and decision makers in assessing and devising strategies and actions to implement smart city initiatives, and to understand, structure, and assess smart city programs. It is a high-level analytical framework that provides the necessary flexibility for the specific contexts of targeted countries and cities.

A. A Conceptual Basis for the Smart City Analytical Framework⁴⁴

61. This paper understands smart cities as places where digital technology solutions are applied to address urban challenges to the benefit of citizens, businesses, and government. Digital technology solutions are not the end goal but a means for higher-level development objectives. The application of digital technology solutions is underpinned by enablers that strengthen a city's ability to plan and to implement smart city projects, as discussed in the previous chapter. The proposed smart city analytical framework can serve as a general framework that is applicable to a city but can also be scaled to the provincial or national level.

62. Using the smart city analytical framework, policy and institutions, technology and innovation, skills and capacity, business and finance, and planning and coordination can be captured as enablers. Policy and institutions need to provide clear laws and rules for the digital transformation of a city. Technology and innovation measures must develop new digital solutions within the context of the city. Skills and capacity determine a city's digital ability to implement these solutions. Business and finance refer to a city's ability to mobilize the private sector and to generate financial resources for the rollout of digital solutions. Finally, planning and coordination increase the organizational capacity to manage and to implement the digital transformation of a city.

63. Based on the common building blocks from existing smart city models, three key dimensions are proposed (Figure 10):

- (i) **High-level objectives**, such as being green, competitive, resilient, and inclusive, which together contribute to making cities more livable.
- (ii) **Action fields** where digital solutions can be applied.
- (iii) **Enabling factors** that determine the city's readiness to apply digital solutions and set the foundations for these to take place.

⁴⁴ ADB. 2019. *Procurement Plans: India, Tamil Nadu Urban Flagship Investment Program, Tranche 1*. Manila.

64. Global examples of smart city strategies show the need for high-level objectives to operationalize smart city efforts. Vienna, as a leading smart city, has set three main principles: quality of life (i.e., social inclusion, participation, and health); resource efficiency (i.e., energy, mobility, and infrastructure); and innovation (i.e., education, economy, and technology).⁴⁵ On the other hand, the 2018 Act on the Promotion of Smart City Development and Industry of South Korea, also known as the Smart City Act, defines smart city more broadly. A smart city consists of interconnected services and facilities that improve competitiveness and quality of life to provide significant power to individual cities and projects.⁴⁶ In developing Asia, while strategic objectives will naturally differ based on their context, the high-level objectives are universal enough to provide a meaningful common ground for potential collaboration.

65. Extracted from the existing smart city models across the globe, the smart city action fields—where smart city solutions can play a pivotal role in tackling the development challenges of cities in developing Asia—are proposed along three areas:

- (i) **Cross-cutting smart city solutions**, such as urban and land use planning and ICT infrastructure that constitute the foundation for different sector solutions.
- (ii) **Smart city solutions for infrastructure and environment**, such as mobility and transport, energy, environment, water, climate and disaster risk management, and food and agriculture.
- (iii) **Smart city solutions for social and governance sectors**, such as government, economy and jobs, education, health, society and culture, and safety.

66. Cities should prioritize these action fields according to their challenges and needs, as the example of Smart Astana illustrates, selecting only six of the 14 fields (Box 5). Individual projects can be defined within these action fields. For example, smart society encompasses projects such as Smart School, Smart Clinic, and the Smart Astana Chatbot that are all employed with the goal of improving citizens' quality of life and advancing society. Notably, the 14 action fields offer guidance for identifying smart city solutions without being exhaustive.

⁴⁵ Example for smart traffic lights from Smart City Wien: <https://smartcity.wien.gv.at/site/smart-ampeln/>.

⁴⁶ Intralink, 2019, Smart Cities South Korea Market Intelligence Report. https://www.intralinkgroup.com/getmedia/9e2bf792-458f-41f8-9a79-d11d284f4116/Korea_Smart-Cities-full-report_v2.

Box 20: Smart Astana

An ADB mission was fielded to Nur-Sultan, Kazakhstan, in October 2019 to assess the city's smart city status and development potential using the proposed smart city analytical framework. The focus was set on city diagnostics and readiness assessment with a preliminary exploration of strategy development. An exhaustive analysis including implementation and evaluation phases is planned for the next stage. The objective of the mission was to understand, structure, and assess ongoing and planned smart city operations in Nur-Sultan. To this end, developed templates were used to collect the needed information. Based on this information, a systematic evaluation of current smart city needs, objectives, and efforts was prepared, and recommendations for next steps were formulated.

Rapid urban growth and resulting strains on the environment and urban infrastructure were pointed out as main challenges for the city. Although the institutionalization of a central smart city coordination agency indicated a high digital readiness for planning and coordination, there is considerable room for improvement in technology and innovation. Based on an evaluation of the existing project portfolio, several opportunities for collaboration were identified in support of the city's smart city programs.

Overall, the mission proved the proposed smart city analytical framework to be useful in assessing the smart city readiness and identifying potential areas of collaboration for the city's smart city programs. The analytical framework and templates developed for the mission can be used for a high-level overview of where cities stand and how to develop a smart city approach.

Source: Authors.

B. Application of the Smart City Analytical Framework

67. The smart city analytical framework can be applied throughout the whole life cycle of smart city implementation: city diagnostics, readiness assessment, strategy development, implementation planning, and monitoring and Evaluation (Figure 11). While these phases are common standard for development programs and projects, specific smart city considerations and assessments need to be tailored to the city and country context in which they are applied (Box 6 p.33).

68. Phase 1. In this phase, urban challenges are diagnosed, and key prioritized areas are proposed based on the potential of digital solutions to address the identified key urban challenges (Figure 12).

Figure 12: Phase 1 - Smart City Diagnostics Identifies Key Priorities

69. Phase 2. In this phase, the city's capacity in terms of policies and institutions, technology and innovation, business and finance, and planning and coordination are assessed (Figure 13). The higher the detected maturity level, the more sophisticated smart city solutions can be considered.

Figure 13: Phase 2 - Smart City Readiness Assessment Identifies Key Interventions

70. Phase 3. Building on the definition of a detailed target picture, potential solutions are identified, assessed, and then prioritized as quick-win or core strategic solutions (Figure 14).

72. Phase 4. In this phase, detailed implementation plans, including specific road maps, actions, and timelines are developed (Figure 15). As part of the implementation planning, cost estimates and financing plans are also developed.

73. Phase 5. Within this assessment, performance indicators for outcomes and outputs are identified (Figure 16). Such an assessment enables continuous monitoring of the progress made and a rigorous impact evaluation of the changes induced by the implementation over a longer time span (i.e. 3–5 years).

74. To operationalize a smart city vision, these five phases should go hand-in-hand and present a circular process that leads to constant review and update of the city's priorities and operations. Monitoring and evaluation provide findings on the progress toward building readiness and tackling key development challenges of the city, will also evolve given new economic, environmental, social, political, and technological trends.

Box 21: Smart Nation Singapore

Smart Nation Singapore is supported by three key pillars reflecting the overarching vision for the country's development, i.e., serving citizens and businesses better through technology: digital economy, digital government, and digital society. For each pillar, an individual framework reflecting specific enablers and action areas within the strategic goals, is outlined.

The three pillars are underpinned by six core strategic national projects, which act as key action fields in the Smart Nation drive. They are concrete digitization projects that facilitate the three strategic pillars throughout: (i) national digital identity; (ii) e-payments; (iii) smart nation sensor platform; (iv) smart urban mobility; (v) moments of life; and (vi) core operations, development, environment, and exchange.

Conceptual enablers are individually defined for the strategic pillars. Digital economy is facilitated by talent acquisition, research, policy, and infrastructure. Digital government is based on raising digital capabilities and instituting secure systems. Finally, digital society is supported by digital access, literacy, and participation, which provide the path for every citizen to benefit from projects. Further, specific action fields can also be tailored within individual objectives.

Smart Nation Singapore exemplifies that the proposed smart city framework can also be applied on varying levels under an overarching plan.

Source: Smart Nation Singapore. Smart Nation Sensor Platform. <https://www.smartnation.sg/what-is-smart-nation/initiatives/Strategic-National-Projects/smart-nation-sensor-platform>.

VII. THE ROLE OF MULTILATERAL DEVELOPMENT BANKS IN SUPPORTING SMART CITY INITIATIVES

75. Following the presentation of the analytical framework for smart cities in developing Asia and a step by step discussion, this chapter will consider the financing needs to support smart city initiatives and the role of MDBs, and specifically ADB, in meeting them.

A. Multilateral Development Banks' Strategic View on Smartness

76. In line with Sustainable Development Goal 11, MDBs support the concept of livable cities as part of the urban development objectives.⁴⁷ The development community broadly agrees on the significance of urban development, as cities provide a nexus between poverty and economic opportunity. Cities are also a catalyst for economic growth with dense labor markets that accelerate skills training, creativity, and innovation.⁴⁸ However, the aspiration of a better life has lured millions of people into populated urban environments, where it has become increasingly challenging to provide a full range of services for all citizens in a sustainable manner. For these ambitious undertakings, digital technologies can play an important role. Currently, almost all MDBs recognize the transformative nature of digital technologies for urban development programs (Table 1).

Table 1: Urban Development Attributes in Multilateral Development Banks

MDB	Urban Development Attributes	Source Document
ADB	Green, competitive, inclusive, and resilient	ADB. 2019. <i>Strategy 2030: Operational Plan for Priority 4: Making Cities More Livable, 2019–2024</i> . Manila.
AfDB	Competitive and bankable with a strong development base, healthy environments for citizens to live and work, well governed	AfDB. 2010. <i>The Bank Group's Urban Development Strategy: Transforming Africa's Cities and Towns into Engines of Economic Growth and Social Development</i> . Tunis.
AIIB	Accessible, efficient, green, resilient, sustainable, thriving	AIIB. 2018. <i>Sustainable Cities Strategy: Financing Solutions for Developing Sustainable Cities in Asia</i> . Beijing.
EBRD	Environmental, resilient to climate change, green, economic and social co-benefits	EBRD. 2016. <i>Green Cities Programme Methodology</i> . London
EIB	Smart, sustainable, inclusive growth	European Commission. 2010. <i>Europe 2020: A Strategy for Smart, Sustainable and Inclusive Growth</i> . Brussels.
IADB	Quality infrastructure and urban services, quality housing, resilience, strong governance and capacity, local economic development	EIB. 2016. <i>The EU Urban Agenda Toolbox</i> . Brussels. IDB. 2019. <i>Urban Development and Housing Sector</i> . Washington, DC.
World Bank	Inclusive, livable, low-carbon, productive, resilient, sustainable	World Bank. Overview. <i>Urban Development</i> . https://www.worldbank.org/en/topic/urbandevelopment/overview

ADB = Asian Development Bank, AfDB = African Development Bank, AIIB = Asian Infrastructure Investment Bank, EBRD = European Bank for Reconstruction and Development, EIB = European Investment Bank, IADB = Inter-American Development Bank. Source: Authors.

⁴⁷ United Nations. 2015. *Transforming our world: the 2030 Agenda for Sustainable Development*.

⁴⁸ ADB. 2019. *Asian Development Outlook 2019: Strengthening Disaster Resilience*. Manila.

77. ADB recognizes digital technology as a key driver for urban development to advance access, quality, inclusiveness, and reliability of urban services. As cities in Asia and the Pacific have different priorities and capacities to adopt technologies, ADB will tailor its support to the demands of cities according to their priority and capacity. As for the capacity development, ADB will help cities participate in twinning initiatives to share best practices and explore technology options in developing their smart city plans through an integrated planning process covering spatial, land use, urban mobility, specific infrastructure, and master plans. In the PRC, for example, capacity building is a focus so that managers and policy makers at the city level can have a better appreciation of the key issues and the role technology plays in becoming a smart city.

B. Financing for Smartness

78. As smart city initiatives gain traction and governments look to replace and upgrade infrastructure networks and services across Asia and the Pacific, a need for innovative funding solutions arises to bridge common funding gaps found in urban infrastructure provision.⁴⁹

79. Several main challenges to financing smart city solutions⁵⁰ arise due to:

- the ‘perceived’ risk and complexity of smart city solutions,
- uncertain return on investment,
- complexity of multi-sector interventions versus single-sector focus,
- preference for long-term projects, and
- benefits not directly linked to financial value.

80. To overcome these challenges, clarity on the revenue model for smart city solutions is needed. This can include savings from improved efficiency in infrastructure and services, tapping new revenue sources, or greater effectiveness in existing revenue streams.⁵¹ Several sources of financing and funding may apply to bridge the infrastructure gap with new and innovative approaches to enable smart infrastructure projects.⁵² Among them is the involvement of the private sector, which brings in additional technical skills and avenues for joint financing and risk sharing.

81. Besides private sector service providers, MDBs are well placed to support financing and provide advice on smart city solutions. Further, they are positioned to provide additional knowledge and capacity support, using digital solutions to improve the livelihoods of all people, and source seed financing to pilot solutions.

82. ADB’s Finance++ aims to offer a combination of ADB’s own finance plus leveraging resources through partnership and provide knowledge to DMCs to maximize and accelerate development effectiveness.⁵³ ADB Knowledge Partners can provide a level of expertise and efficiency to deliver smart city projects.⁵⁴

83. Financing smart solutions depends on the level of preparation and quality of project design to access downstream funding. Support from MDBs through technical assistance and grant funding may help in the planning and piloting of a smart city initiative to facilitate government implementation. ADB’s example in Suva, Fiji, supporting the Digital Land Registry with blockchain technology project illustrates this (see Appendix B).

⁴⁹ ADB. 2017. *Meeting Asia’s Infrastructure Needs*. <https://www.adb.org/sites/default/files/publication/227496/special-report-infrastructure.pdf>.

⁵⁰ ADB. 2018. *Financing Smart City Solutions. Urban Sector Group Meeting Notes*. <https://www.unescap.org/sites/default/files/ADB%20-%20Financing%20Smart%20City%20Solutions.pdf>.

⁵¹ ADB. Forthcoming. *Contemporary Issues for Livable Asian Cities. Chapter on Municipal Financial Sustainability*. Manila.

⁵² ADB Urban Sector Group. 2018. *Financing Smart City Solutions*. Manila. <https://www.unescap.org/sites/default/files/ADB%20-%20Financing%20Smart%20City%20Solutions.pdf>

⁵³ ADB. 2013. *Knowledge Management Directions and Action Plan (2013–2015): Supporting “Finance ++” at the Asian Development Bank*. Manila.

⁵⁴ This was incorporated in the ADB–Future Cities Laboratory partnership in Bandung, for details refer to case example above under Action Field Safety and Security. Project sheet details TA-8797 REG: Promoting Gender Equality and Women’s Empowerment Subproject: Future Cities, Future Women Initiative, Phase I. Bandung.

84. Key questions around how to make these financing streams sustainable remain and it is crucial that governments have the capacity to cover any additional financing needs from new smart city solutions. Special consideration is required to avoid the purchase of costly technology applications which require extensive maintenance and operations, and which cannot be used or maintained without external support.

VIII. NEXT STEPS—RECOMMENDATIONS FOR POLICY AND DECISION MAKERS

85. This working paper serves two specific purposes. First, practitioners and decision makers in developing Asia can use the analytical framework and guidance steps, based on the international review of smart city initiatives and models, to assess and structure approaches to smart city initiatives. Second, the discussion of enablers, action fields, and the role of MDBs in financing smartness, supported by pragmatic case examples, can inform dialogue on smart city pathways between development organizations and DMCs.

86. Application of the smart city analytical framework should depend on the specific context of the target country and city. Available financial, time, and human resources determine smart city programs and actions along the five phases of the framework. The output from the pre-assessment can be used to design more focused technical assistance in high-priority areas.

87. Building from the five enablers, and with the support of the analytical framework, the following key recommendation for policy makers to advance smart city pathways are proposed:

- (i) **Review, assess, and develop a comprehensive policy and regulatory framework** on data governance including data acquisition, processing, sharing, and ownership. As data is key for smart cities, a clear regulatory framework is needed to help implement smart city initiatives, support the control and coordination around data security and privacy issues, and foster innovation and investments in smart city solutions.
- (ii) **Identify and support innovation.** Many examples of smart city initiatives are appearing internationally. These may present innovative ideas relevant to cities in Asia and Pacific. Innovation labs and hackathons can be used for citizens and businesses to participate and experiment with new smart city solutions and increase their digital skills. Assessing existing cases and their feasibility studies can provide the first step toward developing a comprehensive smart city solution.
- (iii) **Consider multiple financing mechanisms.** Policy makers may consider tapping into government budgets as well as financial support from external donors to leverage private sector financing for smart city initiatives. Public–private partnerships may equally build on private sector for funding, technical expertise, and innovation that compliment and strengthen public sector efforts.
- (iv) **Attract and upskill digital capacities by mobilizing external players.** Knowledge sharing within and between cities; twinning arrangements with more capacitated cities; or partnerships with technology providers, academia or nongovernment organizations can be explored to increase digital skills and capacities needed to develop inclusive smart solutions for the benefit of all members of society.

- (vi) **Implement a program management unit** with sufficient capacity for planning, coordination, and implementation of a smart city initiative. Bringing together multiple actors and departments into such unit can facilitate well-coordinated and effective delivery, results monitoring, and learning.

88. Moving beyond the many debates around smart cities (marketed strategies, risk to personal data, among others) there are clear applications of digital solutions that allow for realizing urban development opportunities with better resource use, wider access, and improved management of urban services. In the right context and supported by enablers, smart city solutions can improve access, quality, and reliability of urban services; strengthen urban planning and financial sustainability of cities; and reinforce environmental, climate change, and disaster management, overall making cities more livable. Smart city solutions may help achieve various cities' visions, their countries' development strategies, and eventually the Sustainable Development Goals.

APPENDIX 1: METHODOLOGY, DETAILED RESULTS, AND REFERENCES

A. Assessment of Smart City Initiatives

1. This appendix outlines the assessment of the smart city initiatives, for which the Smart City Strategy Index was used. It was developed by Roland Berger to evaluate the comprehensiveness of urban strategies regarding digital solutions.
2. The selection of strategies was based on a two-step selection approach. First, all cities with smart city activities were identified. Second, the cities with officially published and accessible smart city-related strategy documents were selected for an in-depth assessment. This assessment was based on a three-layer analysis. At the first level, the index differentiated between strategic planning and information and communication technology (ICT) infrastructure and policy as key enablers for a smart city as well as action fields in which solutions are being implemented.
3. The planning dimension covers four criteria: budget, planning, coordination, and stakeholder management. ICT infrastructure and policy are based on ICT policy and legal frameworks and ICT infrastructure. The action fields cover six topics: buildings, energy and the environment, mobility, education, health, and government. Each of these criteria consists of a number of sub-criteria, which were assigned different weights. These sub-criteria are based on a scale from 10 (i.e., no mention) to 100 (i.e., fully detailed). Based on the sub-criteria scores and weighting, the subtotal and total scores were calculated for each city.

B. Smart City Strategy Index

4. Berger's Smart City Strategy Index measures the comprehensiveness and ambition of cities worldwide against the key criteria of a smart city. This index allows for systematic comparison of smart city strategies with different structures and formats and to measure progress over time. As such, it identified and assessed 153 smart city strategies worldwide in 2019. It also provides a clear structure and criteria for the development of a smart city strategy. The assessment framework is based on three smart city dimensions: planning criteria, policy, and infrastructure as enablers.⁵⁵ Six action fields establish areas in which solutions are implemented in smart cities worldwide: buildings, energy and environment, mobility, education, health, and government.
5. Planning capacity assesses practical considerations for the implementation of the strategy, such as budget, coordination, and timeline. Policy and infrastructure focus on the regulative and infrastructure requirements for the implementation of smart city projects. Within each of these dimensions, a set of 12 criteria including 31 sub-criteria is defined that cities should take into account in their smart city plans.

⁵⁵ Based on an assessment measuring implementation progress as implementation capacity (20%), scope (40%), status (20%), and results (20%), a maximum of 100 points can be reached.

Figure A1.1: Roland Berger City Scores

Average of all cities' scores for each of the criteria [max. 100]

Number of cities:
153 Source: Roland Berger. 2019. *The Smart City Breakaway: How a Small Group of Leading Digital Cities Is Outpacing the Rest*. Munich.

6. The 12 criteria were developed to measure the comprehensiveness of smart city strategy. Six are related to the action fields and the other six criteria are on the enablers. The 12 criteria are split into a total of 31 sub-criteria, each with a separate weighting depending on its overall importance. Based on this methodology, the comprehensiveness of the 153 Smart City strategies was measured. Strategic approaches earning a score of 60 points or more out of a maximum of 100 are considered comprehensive, meaning a city has detailed activities and targets of at least moderate ambition for key aspects of a smart city across the 12 criteria.

C. Implementation Status of Comprehensive Smart City Strategies

Figure A1.2: Roland Berger Smart City Strategy Implementation Status

	Implementation progress ¹	Implementation attributes	Example cities	Selected flagship projects
1. Advanced 3 cities		High capability Broad project scope Completed or active status Full results tracking	Vienna Singapore London	E-Health, Open Public Data, Virtual Office Digital & Sensor Platforms, National Digital Identity Open City Data Ecosystem, Sensor Infrastructure
2. Good progress 5 cities		High-medium capability Selected project scope Completed or active status Only project tracking	Chicago Shanghai Birmingham Seoul Guangzhou	Open Grid, Data Platform, Smart Health Centers Data Center, Health Big Data, Government Information System Big Data Corridor, Smart Routing App Open Data Plaza, Open e-Gov Digital ID Card, AI-Based Weather Forecasts
3. Implementation followers 7 cities		Low-medium capability Limited project scope Active or concept status No tracking	St. Albert Chongqing Paris Shenzhen Dalian Santander Davanagere	Public E-Services, Building and Lighting Control Intelligent Community Management, Traffic Support System Open Data, Routing App, Public Feedback Platform City Operations Platform, Early Warning System Industrial Cloud Computing, Traffic Guidance System Cloud City Center, Traffic Monitoring Digital Waste Management, Intelligent Traffic Management

Source: Roland Berger. 2019. *The Smart City Breakaway: How a Small Group of Leading Digital Cities Is Outpacing the Rest*. Munich.

7. To evaluate the implementation status of the smart city strategy, official city information and other online sources were used measuring four factors: capability (Has the city assigned implementation responsibilities?); scope (How many action fields do the city's flagship projects cover?); status (What is the progress of the flagship projects?); and results tracking (Is a monitoring framework in place?).

D. Comparison of Smart City Models

8. The following is an overview of the smart city models that were used for the analyses. Models were defined as planning frameworks or reference structures that help understand, structure, and assess smart city operations across different cities, areas, and countries. Practically, these were mostly conceptual guideposts for smart city plans, processes, and action checklists for developing such plans or indexes to assess and to compare existing plans.

9. A total of 29 different smart city models were identified as concepts, planning frameworks, and indexes. These models were divided into four categories according to the publishing institutions: 10 models from official bodies, such as the Association of Southeast Asian Nations (ASEAN), European Union, and multilateral development banks; 7 models from research institutions, foundations, and think tanks; 9 models from consulting firms, such as KPMG, McKinsey, and Roland Berger; and 4 models from technology providers, such as ATIS and Huawei.

10. Three steps were used to identify and select these models. First, for official bodies, their online publications for smart city models and frameworks were reviewed. Second, a keyword online search was conducted to identify any smart city-relevant reports from other organizations. Third, the identified publications from all publisher categories were analyzed in detail to derive any conceptual frameworks that were used to assess, design, and prioritize smart city approaches.

Table A1: Smart City Models

No.	Model Name	Publisher	Year	Regions Covered				
				Asia	Europe	North America	South America	Africa
Official Bodies								
1	Smart City Framework: Real-Time IOT Stream Processing and Large-Scale Data Analytics for Smart City Applications	EU	2015		•			
2	Mapping Smart Cities in the EU	EU, European Parliament Committee on Industry, Research and Energy	2014		•			
3	ASEAN Smart Cities Framework	ASEAN	2018	•				
4	ASCIMER (Assessing Smart City Initiatives for the Mediterranean Region)	EIB	2018	•				
5	Smart Cities, Smart Investment in Central, Eastern and Southeastern Europe	EBRD	2018	•				
6	The Road toward Smart Cities	IADB	2016			•		
7	The E-Government Survey 2018: Gearing E-Government to Support Transformation toward Sustainable and Resilient Societies.	United Nations (UN), Department of Economics and Social Affairs	2018	•	•	•	•	•
8	Smart City Concept	UN Habitat	2018				•	
9	Smart Cities Study: International Study on the Situation of ICT, Innovation and Knowledge in Cities	United Cities and Local Governments	2017	•	•		•	•
Research Institutions, Think Tanks, Foundations								
10	Morgenstadt City Index	City of Morgenstadt	2016		•			
11	Cities in Motion Index 2018	Cities in Motion, IESE Business School	2018	•	•	•	•	•
12	European Smart Cities 4.0	Vienna University of Technology	2015	•				

continued on next page

Table A1 *continued*

No.	Model Name	Publisher	Year	Regions Covered				
				Asia	Europe	North America	South America	Africa
13	Smart Cities Index: A Tool for Evaluating Cities	Indian School of Business and the Shakti Foundation	2017	•				
14	Smart City: Six Steps to Successfully Transform Your City	IRENA	2017					
15	Smarter Cities in 2025	ESI Thought Lab	2018	•	•	•	•	•
16	EDCI European Digital Index 2016	Nesta	2016		•			
Consultancies								
17	Smart City Governments	Eden Strategy Institute	2018	•	•	•	•	
18	The Smart City Breakaway: How a Small Group of Leading Digital Cities Is Outpacing the Rest	Roland Berger	2019	•	•	•	•	•
19	Smart Cities—What's in It for Citizens?	Juniper Research	2017	•	•	•	•	
20	Smart Cities: Digital Solutions for a More Livable Future	McKinsey Global Institute	2018	•	•	•	•	•
21	Connected Cities. Citizen Insights across Asia Pacific	KPMG	2019	•				
22	WSP Global Cities Index: A Tale of Our Cities	WSP Global	2018	•	•	•	•	
23	Citizen-Centric Cities	Arcadis	2018	•	•	•		•
24	Smart Cities: How Rapid Advances in Technology Are Reshaping Our Economy and Society	Deloitte	2015					
25	PAS 181: Smart City Framework—Guide to Establishing Strategies for Smart Cities and Communities	bsi	2014					
Technology Providers								
26	Smart City Index 2019	Easy park	2019	•	•	•	•	
27	UK Smart Cities Index	Huawei	2017		•			
28	Gulf States Smart Cities Index: Assessment of Strategy and Execution for 10 Cities	Navigant Consulting	2016	•			•	•
29	The Smart Cities Data Exchange	ATIS	2018					

ASEAN = Association of Southeast Asian Nations, EBRD = European Bank for Reconstruction and Development, EIB = European Investment Bank, IADB = Inter-American Development Bank, IRENA = International Renewable Energy Agency, EU = European Union, ICT = information and communication technology, IOT = internet of things,

Source: Roland Berger. 2019. *The Smart City Breakaway: How a Small Group of Leading Digital Cities Is Outpacing the Rest*. Munich.

E. Smart City Initiatives and Model Analysis References (Chapter II):

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Huawei. 2017. *UK Smart Cities Index*. https://e.huawei.com/uk/special_topic/solution/smart_cities_index_2017.

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United Nations. 2016. *The New Urban Agenda*. Nairobi.

UN-Habitat and IHS-Erasmus University Rotterdam. 2018. *European Smart Cities 4.0*. <http://www.smart-cities.eu/index.php?cid=2&ver=4>;

Woods, E., Omara, H., Ravens, S., and Citron, R. 2016. *Gulf States Smart Cities Index: Assessment of Strategy and Execution for 10 Cities*. Chicago: Navigant Consulting.

Wade, M., Pfäffli, M., Rollier, R., and Vonlanthen, B. 2017. *Smart City: Six Steps to Successfully Transform Your City*. <https://www.imd.org/research-knowledge/reports/SmartCity2/>.

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APPENDIX 2: CASE EXAMPLES

In this section, cases are presented in which the digital opportunities of a smart city can be realized in the main action fields. To be relevant for developing member countries, those selected must be (i) technically feasible, (ii) financially feasible, (iii) innovative, (iv) scalable, and (v) of high socioeconomic value. While many more cases and practical examples can be identified, this list provides a starting point.

A. Case Examples Overview

Intervention Area	Case Examples
Information and Communication Technology (ICT) Infrastructure	<ol style="list-style-type: none"> 1. Broadband connectivity infrastructure – introduction of 5G (Republic of Korea) 2. Introduction of public Wi-Fi spots throughout the city (Shanghai, People's Republic of China) 3. Installation of a LoRAWAN network (Mumbai, India) 4. Introduction of open data platform to collect data provided by various institutions and individuals (Paraguay) 5. Provision of multiple, connected big data centers and clouds (Ningbo, People's Republic of China) 6. Cryptographic Information Technology Security and Resiliency Systems (Estonia)
Urban and Land use Planning	<ol style="list-style-type: none"> 7. Implementation of a fully digitized, 3D land-recording system (Kuala Lumpur, Malaysia) 8. Visualization of geographic data coupled with impact simulations to plan and to design urban areas (Honolulu, United States)
Smart Mobility and Transport	<ol style="list-style-type: none"> 9. Intelligent Traffic Management (Hong Kong, China) 10. Multimodal platform – Physical and digital integration of transport modes, travel information, and fare payment systems into one platform (Hong Kong, China) 11. Smart Traffic Lights (Vienna, Austria) 12. Shared Mobility—Sharing motorcycle rides by connecting owners with passengers over a website (Bangladesh) 13. Installation of IOT-connected, bookable charging stations with flexible charging speeds (Amsterdam, Netherlands) 14. Autonomous Vehicles—Connection of urban areas through self-driving taxis that pick-up customers along fixed routes (New Jersey, United States) 15. Mobile smart parking systems (Los Angeles, United States)

Intervention Area	Case Examples
Energy	16. Real-Time Grid Monitoring and Control (Amritsar, India) 17. Automated Energy Management in Buildings (Songdo City, Republic of Korea) 18. Connected streetlight system (Guadalajara, Spain)
Environment	19. Introduction of a mobile sensor network, carried by vehicles, to monitor air pollution (Glasgow, UK) 20. Installation of a demand-based waste collection system using sensors and IOT (San Francisco, United States)
Water	21. Intelligent Water Management (Handan City, People's Republic of China) 22. Forecasting sewage levels and managing sewage flows by integrating data and IOT-connected sensors (Paris, France)
Climate and Disaster Risk Management	23. Development of a climate information database and online portal (Provinces of Newfoundland and Labrador) 24. Early warning of citizens via short text messages (SMS) about forecasted natural disasters (Manila, Philippines)
Food and Agriculture	25. Vertical farming (Singapore) 26. Zero Food Waste Platform (Zurich, Switzerland)
Government	27. Citizen E-Services (Singapore) 28. Cloud-based Digital Public Filing Systems (Heidelberg, Germany)
Economy and Jobs	29. Innovation labs (Berlin, Germany) 30. Job Matching Platform (United States)
Education	31. Digital Skills Program (Australia) 32. Online Education Platform (Seoul, Republic of Korea)
Health	33. Health Information System (Pakistan) 34. Telemedicine (Furness, United Kingdom)
Society and Culture	35. Digital Portal for Citizen Feedback and Participation (Paris, France) 36. Neighborhood Assistance App (United States)
Safety	37. Smart Surveillance and Alarm Systems (Namyangju, Republic of Korea) 38. Intelligent Crime Prediction and Prevention (Wellington, New Zealand)

B. Information and Communication Technology Infrastructure

A1	Broadband Connectivity Infrastructure		
Summary	Introduction of 5G broadband internet		
Challenge addressed			
Target user	City authorities, companies, and residents relying on fast internet for data transmission and controlling		
Service feature	5G internet broadband		
Results	Increased internet speed, reliable access to high bandwidth content like high definition videos and large		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging	Medium, High	N/A
City example	Nationwide project in the Republic of Korea		
Source	TRTWorld. 2019. South Korea Launches First National 5G Networks. 5 April. https://www.trtworld.com/business/south-korea-launches-first-national-5g-networks-25563 https://bit.ly/2KaW2Fh

A2	Public Wi-Fi		
Summary	Introduction of public Wi-Fi spots throughout the city		
Challenge addressed	No access to information for many low-income individuals who cannot afford, for example, smartphones with 3G data		
Target user	Residents without mobile internet or wireless local area network (WLAN) at home, tourists		
Service feature	Wi-Fi		
Results	Free access to fast, reliable, and consistent internet; simple access to information and educational offers; well-informed society including low-income persons		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging, developed	Low	Low-quality or expensive mobile networks
City example	Shanghai, People's Republic of China		
Source	M. Wang, et al. 2016. The Making of a Sustainable Wireless City? Mapping Public Wi-Fi Access in Shanghai. <i>MDPI. Open Access Journal</i> . 8 (2). pp. 1–15. https://bit.ly/2YS6Aze

A3	LoRaWAN		
Summary	Installation of a LoRAWAN network		
Challenge addressed	Low deployment of IOT due to the unavailability or prohibitive costs of internet access		
Target user	City authorities, companies, and residents using IOT-based applications		
Service feature	Low-power internet, IOT access		
Results	Increased use of IOT-based applications, particularly for environmental topics such as air quality monitoring, landslide detection, and meteorological data, through introduction of reliable LoRAWAN network		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging, developed	Medium	Unavailable or expensive internet access
City example	Mumbai, India		
Source	S. Fadia. 2018. This is Determination: SenRa Reaches 30 City Milestone in India with LoRa Network Roll-Out. IoT Technology. 3 December. https://www.iotevolutionworld.com/m2m/articles/440504-this-determination-senra-reaches-30-city-milestone-india.htm . https://bit.ly/2YXNLqp

A4	(Open) Data Platforms	
Summary	Introduction of open data platform to collect data provided by various institutions and individuals	
Challenge addressed	Low amount of publicly available data	
Target user	City authorities, research institutions, companies developing products based on urban data	
Service feature	Open information	
Results	Continuous collection of data provided by various individuals/institutions, free access to data for various stakeholders, ongoing development and improvement of data analysis tools and applications such as early-warning systems	
Regional (city/country) context	Development status	Maturity level
	Developing, emerging, developed	Medium, high
City example	Nationwide project in Paraguay	
Source	J. McMurren, A. Young, and S. Verhulst. 2017. Paraguay Dengue Prediction: Forecasting Outbreaks with Open Data. http://odim pact.org/case-paraguays-dengue-prediction.html https://bit.ly/2Tjnu4h

A5	Data Centers and Clouds		
Summary	Provision of multiple, connected big data centers and clouds		
Challenge addressed	Limited access and sharing of collected real-time urban data within government institutions or with private solution providers		
Target user	City authorities and companies that offer real-time information-based services		
Service feature	Data clouds		
Results	Continuous storage of urban data, provision of real-time information for urban management or mobile/web-based applications and other intelligent systems		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	High	n/a
City example	Ningbo, People's Republic of China		
Source	DBS Group Research. 2018. China Data Centre Sector. Hong Kong, China. https://bit.ly/2YT43on

A6	Cryptographic Information Technology Security and Resiliency Systems		
Summary	Development of blockchain-based information technology security systems that are cryptographically encoded to protect highly sensitive data		
Challenge addressed	High vulnerability to cyberattacks		
Target user	City authorities, companies, and residents who share sensitive data online		
Service feature	Blockchain cybersecurity software		
Results	Prevention of cyberattacks, protection of digital data, rise in trust of online services, rise of use rate of e-services		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	Medium, high	n/a
City example	Estonia		
Source	e-estonia. 2019. Security and Safety. https://e-estonia.com/solutions/security-and-safety/ksi-blockchain/ https://bit.ly/2MozbJg

C. Urban and Land Use Planning Table

A7	Digital 3D Cadaster		
Summary	Implementation of a fully digitized, 3D land-recording system		
Challenge addressed	Inefficient public administration processes, unclear property rights, weak planning capacities		
Target users	City building authorities, construction companies, land and real estate owners		
Service features	Cadastral database with online accessible 3D data		
Results	Full transparency about land/real estate ownership, location, and dimensions; improved urban planning; improved access to land records		
Regional (city/ country) context	Development status	Maturity level	Other
	Developing, emerging	Medium	High building density
City example	Kuala Lumpur, Malaysia		
Source	University of Melbourne, Centre for Spatial Data Infrastructures and Land Administration (CSDILA). 2018. Malaysian 3D Cadastre. https://csdila.unimelb.edu.au/projects/malaysia-3d . https://bit.ly/2YxyX6p

A8	Geographic Information System- and Geodesign-Based Urban Planning		
Summary	Visualization of geographic data coupled with impact simulations to plan and to design urban areas		
Challenge addressed	Diversity of stakeholder backgrounds and conceptions, growing complexity in urban planning and impact analysis		
Target users	City building authorities, construction companies, neighboring residents		
Service features	Video presentation of construction scenarios		
Results	Full visualization of construction scenarios, improved planning of real estate and infrastructure projects, full involvement of all stakeholders in the design process		
Regional (city/ country) context	Development status	Maturity level	Other
	Developing, emerging	Low, medium	n/a
City example	Honolulu		
Source	B. Patrick. 2019. Honolulu Planners Visualize Housing Patterns with an Eye on Affordability. ESRI: Seoul. https://www.esri.com/about/newsroom/blog/honolulu-planners-visualize-urban-development-patterns/ https://bit.ly/2ZjCZM8

D. Mobility and Transport

A9	Intelligent Traffic Management		
Summary	Integration of different transport coordination, monitoring, and control operations into one system		
Challenge addressed	High pollution levels, road accidents, traffic congestion		
Target user	City traffic management authorities, public transport providers, transport users		
Service feature	CCTV snapshots, live webcasts		
Results	Improved road security, reduction of carbon dioxide emissions, shorter travel times		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	Medium, high	n/a
City example	Hong Kong, China		
Source	Government of the Hong Kong Special Administrative Region of the People's Republic of China, Transport and Housing Bureau. 2019. Traffic Control Centre. Transport Department. https://www.td.gov.hk/en/transport_in_hong_kong/its/its_achievements/traffic_control_centre/index.html https://bit.ly/2MfkOnK

A10	Multimodality Platform		
Summary	Physical and digital integration of transport modes, travel information, and fare payment systems into one platform		
Challenge addressed	Improper route management, inconvenient payment systems, last-mile connectivity, traffic congestion		
Target user	City traffic management authorities, public transport providers, transport users		
Service feature	Mobile app, unified payment card		
Results	Improved travel convenience, increase of public transport users, shorter travel times		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	High	n/a
City example	Hong Kong, China		
Source	Government of the Hong Kong Special Administrative Region of the People's Republic of China, Transport and Housing Bureau. 2017. <i>Public Transport Strategy Study</i> . Hong Kong, China. https://bit.ly/2AJCP8R

A11	Smart Traffic Lights		
Summary	Installation of smart traffic lights, equipped with motion sensors and cameras, which recognize vehicles and persons and react to traffic congestion by adjusting city speed limits		
Challenge addressed	Traffic congestion		
Target user	City traffic management authorities, road users		
Service feature	Smart traffic sign		
Results	Efficient adjustment of traffic flows to actual street occupancy, improved travel convenience, fewer accidents, reduced congestion, shorter travel times		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	Medium	n/a
City example	Vienna, Austria		
Source	Smart City Wien. https://smartcitywien.gv.at/site/smart-ampeln/ https://bit.ly/zzU95Du

A12	Shared Mobility		
Summary	Sharing motorcycle rides by connecting owners with passengers over a website		
Challenge addressed	Limited mobility possibilities of the poor, limited/over-occupation of public transport possibilities, traffic congestion		
Target user	Vehicle owners, people looking for a ride		
Service feature	Website, mobile app		
Results	Full capacity utilization of private vehicles, full connection of rural to urban areas, improved mobility of low-income persons, reduced congestion, reduced carbon dioxide emissions		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging	Low	n/a
City example	Nationwide in Bangladesh		
Source	Z. Amin. 2018. Decoding Pathao's Success Code. LightCastle Partners. 15 July. https://www.lightcastlebd.com/insights/2018/07/15/decoding-pathaos-success-code https://bit.ly/31ubgJg

A13	IOT-Based Electric Charging Infrastructure		
Summary	Installation of IOT-connected, bookable charging stations with flexible charging speeds		
Challenge addressed	Congestion of electric grid, low trust and use of electric vehicles		
Target user	Electric vehicle users		
Service feature	Mobile app		
Results	Exact data provision about available charging points, full prevention of grid congestion, increased demand for electric vehicles, reduction of street congestion through appropriately adjusted charging speeds		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	High	n/a
City example	Amsterdam, Netherlands		
Source	International Renewable Energy Agency (IRENA). 2019. Innovation Outlook: Smart Charging for Electric Vehicles. Abu Dhabi; and i8 Ventures. 2018. https://bit.ly/2MMpzol

A14	Autonomous Vehicles		
Summary	Connection of urban areas through self-driving taxis that pick up customers along fixed routes		
Challenge addressed	High number of accidents due to human error		
Target user	Mobility providers, taxi users		
Service feature	Mobile app		
Results	High convenience for passengers, safe transport of passengers		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	High	n/a
City example	New Jersey, United States		
Source	J. Cassin. 2018. Should New Jersey Give Self-Driving Vehicles the Green Light? <i>Scarinci Hollenbeck</i> . 19 December. https://scarincihollenbeck.com/law-firm-insights/business-law/nj-self-driving-vehicles/ https://bit.ly/31qzaVU

A15	Smart Parking Finder		
Summary	Introduction of a parking system that informs users about the exact position of free parking spaces and uses a demand-based pricing system		
Challenge addressed	High volume of traffic in certain city districts, traffic congestion		
Target user	City traffic management authorities, drivers		
Service feature	Mobile app		
Results	Improved travel experience through real-time information about free parking spaces, fewer road accidents, reduced congestion, shorter travel times, traffic shift to less busy areas		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	Low, medium	n/a
City example	Los Angeles, United States		
Source	P. Ghent. 2017. Los Angeles Cuts Downtown Congestion with Smart Parking App. <i>Apolitical</i> . 5 September. https://apolitical.co/solution_article/los-angeles-cuts-downtown-congestion-smart-parking/ https://bit.ly/2h5bQM1

E. Energy

A16	Real-Time Grid Monitoring and Control		
Summary	Equipment of electricity systems with IOT-based measuring and control technology that enables the integration of additional network components		
Challenge addressed	Lack of information about defects, low-price transparency, poor integration of decentralized electricity producers into energy systems		
Target user	Electricity consumers, electricity producers		
Service feature	Control center, mobile app		
Results	Faster grid repairs, lower energy costs for users through real-time price information, successful integration of decentralized renewable energy providers through automatic management of power fluctuations into grid.		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging, developed	Medium	n/a
City example	Amritsar, India		
Source	Interact. 2018. Energy Savings and Operational Excellence with Interact City. https://www.interact-lighting.com/en-us/customer-stories/guadalajara https://bit.ly/2MQfOWb

A17	Automated Energy Management in Buildings		
Summary	Integration of fully automated energy management systems in buildings		
Challenge addressed	High energy consumption		
Target user	Energy consumers, energy providers		
Service feature	Computer-based dashboard, mobile app		
Results	Better home/living experience, fully IOT-connected electrical devices and heating systems, lower energy demand and costs, optimized control of energy consumption based on meteorological data		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	Medium	n/a
City example	Songdo City, Republic of Korea		
Source	Unwork. 2017. <i>Smart Working: Smart Buildings and the Future of Work</i> . London. https://bit.ly/2TfKpxE		

Building Automation and Control System (BACS)

A18	Connected Streetlight System		
Summary	Installation of a fully IOT-connected and remotely managed lighting system		
Challenge addressed	High electricity consumption		
Target user	Passers-by, private/state-owned maintenance company		
Service feature	Fully automatic dimming and brightening of lights		
Results	Demand-based light management, lower energy consumption, reduced energy costs		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	Medium, high	n/a
City example	Guadalajara, Spain		
Source	Interact. 2018. <i>Energy Savings and Operational Excellence with Interact City</i> . https://www.interact-lighting.com/en-us/customer-stories/Guadalajara https://bit.ly/31vTqFQ

F. Environment

A19	Air Pollution Monitoring		
Summary	Introduction of a mobile sensor network, carried by vehicles, to monitor air pollution		
Challenge addressed	Poor information about air quality		
Target user	City authorities, city visitors, local residents, research institutions		
Service feature	Web-based user dashboard		
Results	Availability of real-time data on air quality, better decision making of city authorities concerning environmental zones, higher public awareness of air pollution		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging, developed	Medium	n/a
City example	Glasgow, United Kingdom		
Source	D. Justin. 2017. How Glasgow Is Monitoring Air Quality with IoT. Samsung Networks; and i-SCOOP. 2019. Smart City Application: Glasgow Dynamically Controls Air Quality with IoT. https://www.i-scoop.eu/smart-cities-smart-city/smart-city-application-glasgow/

A20	Demand-Based Waste Collection		
Summary	Installation of a demand-based waste collection system using sensors and IOT		
Challenge addressed	Inefficient waste collection, pollution of public places		
Target user	City waste management authorities, private/public waste disposal companies		
Service feature	Mobile app		
Results	Real-time information-based emptying of trash bins, fewer overflowing bins, resource conservation through optimized waste collection routes		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging, developed	Low	n/a
City example	San Francisco, United States		
Source	L. Sumagaysay. 2019. San Francisco Gets Smarter about Trash Management. <i>Government Technology</i> . 28 February. https://www.govtech.com/fs/infrastructure/San-Francisco-Gets-Smarter-About-Trash-Management.html https://bit.ly/2Tgnd26

G. Water

A21	Intelligent Water Management		
Summary	Forecasting the development of groundwater levels and managing water consumption based on information from connected weather stations and IOT-connected sensors on the ground		
Challenge addressed	Natural hazards, water shortage		
Target user	City water management authorities, water consumers, water utilities		
Service feature	Sensors, IOT		
Results	Improved water supply management, optimized water consumption based on groundwater levels, strengthened community resilience		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging, developed	Medium	High risk of droughts
City example	Handan City, People's Republic of China		
Source	Y. Li, et al. 2018. Smart Water Management Case Study Report. Madison, WI: International Water Resources Association.

A22	Connected Sewage System		
Summary	Forecasting sewage levels and managing sewage flows by integrating data and IOT-connected sensors		
Challenge addressed	Natural hazards, flooding, pollution		
Target user	City water management authorities, municipal/private wastewater companies		
Service feature	Sensors, IOT		
Results	Improved wastewater management, fewer sewer outflows, water quality enhancement of city rivers		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	High	n/a
City example	Paris, France		
Source	Tabuchi, B. Blanchet, and V. Rocher. 2018. Integrated Smart Water Management of Sanitation System in the Greater Paris Region. https://www.iwra.org/wp-content/uploads/2018/11/4-SWM-Paris-final.pdf https://bit.ly/2KpX3Hu

H. Climate and Disaster Risk Management

A23	Climate Information Portal		
Summary	Development of a climate information database and online portal		
Challenge addressed	Missing access to climate data for a variety of stakeholders		
Target user	Construction companies, disaster control authorities, insurance companies, investors, research institutions, urban environmental authorities, urban-planning authorities		
Service feature	Database, online dashboard		
Results	Access to up-to-date climate data; exact forecasting of climate changes/extreme weather events; improved decision-making processes in areas such as disaster risk management, economic development, investment decisions, and infrastructure planning		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging, developed	Medium	n/a
City example	Provinces of Newfoundland and Labrador		
Source	Government of Newfoundland and Labrador, Office of Climate Change. 2019. Climate Data Information Portal. https://www.exec.gov.nl.ca/exec/occ/climate-data/index.html . https://bit.ly/2YQG7hf

A24	Mobile-Based Early Warning Systems		
Summary	Early warning of citizens via short text messages (SMS) about forecasted natural disasters		
Challenge addressed	Difficulty to reach all citizens with early warning information		
Target user	Disaster control authorities, people in area struck by a natural disaster		
Service feature	SMS		
Results	Effective, efficient spread of early warning information; fewer people harmed or killed through natural disasters		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging, developed	Low	High exposure to natural hazards
City example	Manila, Philippines		
Source	A.N. Yumang et al. 2017. <i>Real-Time Early Warning System Design for Pluvial Flash Floods – A Review</i> . Conference Document for the 2017 IEEE 9th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management. Manila: IEEE. https://bit.ly/2M8FAWe

I. Food and Agriculture

A25	Vertical Farming		
Summary	Installation of space-storing, hydraulically operated, and multilayered farming towers		
Challenge addressed	High fluctuations in food supply, high pesticide loads in food		
Target user	Agriculture industry		
Service feature	Air management system, automatic illumination system, nutrient delivery system, plant health monitoring system		
Results	Improved public health through higher consumption of locally grown food, employment creation, lower dependence on food imports		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging, developed	Medium	High dependency on food imports from afar
City example	Singapore		
Source	S. Begum. 2019. Vertical Farm Receives the World's First Urban Farm Certification for Organic Vegetables. The Straits Times. 11 June. https://www.straitstimes.com/singapore/vertical-farm-receives-the-worlds-first-urban-farm-certification-for-organic-vegetables https://bit.ly/2KdJ6NW

A26	Zero-Food Waste Platform		
Summary	Introduction of a platform, integrating supermarkets and gastronomic businesses, to offer expiring food for reduced prices		
Challenge addressed	Missing or weak price adjustment system for food, high amount of wasted food		
Target user	Consumers, food processing industry, food retailers		
Service feature	Mobile app, online platform		
Results	Adequate adjustment of prices to expiration dates, less food waste, lower food costs for consumers of expiring food		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging, developed	Low	n/a
City example	Zurich, Switzerland		
Source	Migros. 2019. Migros Und «Too Good to Go» Gemeinsam Gegen Food Waste. 23 May. https://www.migros.ch/de/unternehmen/medien/mitteilungen/show/news/neuheiten/2019/migros-zuerich-too-good-to-go.html https://bit.ly/33pnyEg

J. Government

A27	Citizen E-Services		
Summary	Provide citizens with the opportunity to access public services online		
Challenge addressed	Excess demand of services in public administrations in urban centers, low efficiency of public administration processes		
Target user	Public administrations, public service users		
Service feature	E-services		
Results	Better online access to public services; enhanced user experience; fewer in-person visits to public administration offices; savings of financial, human, and time resources		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	High	n/a
City example	Singapore		
Source	Government of Singapore, Ministry of Manpower. eServices. https://www.mom.gov.sg/eservices https://bit.ly/2OQAaBa

A28	Cloud-Based Digital Public Filing Systems		
Summary	Introduction of a digital filing system that allows for and eases the submission of documents online		
Challenge addressed	Inefficient document processing		
Target user	Applicants, public administrations		
Service feature	Website		
Results	Fully electronic exchange of documents; higher user satisfaction; quicker processing times; savings in financial, human, and time resources		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	High	n/a
City example	Heidelberg, Germany		
Source	City of Heidelberg. 2019. Bau-Online Portal der Stadt Heidelberg: Elektronische Bauakte Heidelberg (elBauHD). https://www.heidelberg.de/hd/HD/Rathaus/Bau_Online.html https://bit.ly/2MRfF4l

K. Economy and Jobs

A29	Innovation Labs		
Summary	Provision of space, information technology, experienced mentees, and financial capital to start-ups in different development stages		
Challenge addressed	Low level of start-up activities, low number of start-ups that aim to transform established businesses		
Target user	Business experts/mentors, established companies, founders		
Service feature	Financial and expert support		
Results	Improved networking between companies and founders, more innovations, rising innovative pressure on already established companies to develop new solutions		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	Medium	n/a
City example	Berlin, Germany		
Source	M. von Harsdorf. 2017. Gemeinsam Innovativ: Die 20 Wichtigsten Digital Labs in Deutschland. Berlin Valley. 31 March. https://berlinvalley.com/uebersicht-digital-labs-deutschland/ https://bit.ly/2rYFZ3C

A30	Job-Matching Platform		
Summary	Introduction of an online platform that matches job seekers with job advertisements and companies based on personality analyses and algorithms		
Challenge addressed	Inefficient, time- and resource-demanding matching of labor demand and supply		
Target user	Employers, job seekers		
Service feature	Online platform		
Results	Better matches between job employers and seekers, lower turnover, lower unemployment, time and resource savings		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	Low	n/a
City example	Nationwide in the US		
Source	BirdieMatch. 2019. "Job-Matching – Wie Sie Jobs Oder Kandidaten Methodisch, Effizient und Zielführend Suchen." BirdieBlog. 31 December. https://www.birdiematch.de/logistik-news/job-matching/#was-ist-jobmatching https://bit.ly/2KAgQD5

L. Education

A31	Digital Skills Program		
Summary	Launching of information technology training courses by information technology companies or vocational institutions with support from state or local governments		
Challenge addressed	Poor information technology skills of large shares of the population, slow technology transformation progress in many societies		
Target user	People with low digital skills		
Service feature	Information technology knowledge		
Results	Improved information technology skills, integration of unemployed or elderly in the labor market		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging, developed	Low	n/a
City example	Nationwide in Australia		
Source	D. Bushell-Embling. 2018. Microsoft Launches National Digital Skills Program. Technology Decisions. 8 February. https://www.technologydecisions.com.au/content/it-management/article/microsoft-launches-national-digital-skills-program-385584329 https://bit.ly/33zoPpG

A32	Online Education Platform		
Summary	Introduction of online education courses that can be followed on websites or apps		
Challenge addressed	Unequal educational opportunities for individuals coming from high- and low-income households		
Target user	Students from low-income households		
Service feature	Mobile app, online platform		
Results	Better access to high-quality education for students from low-income households, better examination grades of students from low-income households, better-qualified workforce, higher level of innovation		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging, developed	Medium	Unequal educational opportunities; poor transport connections to schools
City example	Seoul, Republic of Korea		
Source	D. Shah. 2017. K-MOOC: A Look at Korea's Official MOOC Platform. MOOC Report. https://www.classcentral.com/report/k-mooc/ https://bit.ly/2ONwAaX

M. Health

A33	Health Information System		
Summary	Installation of a health information system that provides users with relevant, locally tailored health information via mobile communication technology		
Challenge addressed	Gaps in understanding disease prevention and amelioration, insufficient disease prophylaxis		
Target user	Residents		
Service feature	Short messaging system (SMS)		
Results	Increased health awareness; more people undertaking prophylaxis measures, such as vaccinations; fewer infections; reduced health expenditures, especially for low-income families		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging	Medium	n/a
City example	Nationwide in Pakistan		
Source	N. Sharif. 2016. mHealth Case Study: The Journey of Telenor My Health in Pakistan. https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2016/12/The-journey-of-Telenor-My-Health-in-Pakistan.pdf https://bit.ly/2ToaF9a

A34	Telemedicine		
Summary	Connecting hospitals that only provide basic health care services via telecommunication technologies with medical specialists staffed in other hospitals		
Challenge addressed	Inefficient transport of patients between different hospitals		
Target user	General medical practitioners, medical specialists		
Service feature	Video communication		
Results	Better patient care, lower health care costs due to fewer patient transports		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developing	Medium	Lack of medical specialists
City example	Furness, United Kingdom		
Source	NHS Providers. 2020. Case Study: Better Care Together Morecambe Bay. https://nhsproviders.org/new-care-models-harnessing-technology/case-study-better-care-together-morecambe-bay https://bit.ly/2KmnsWG

N. Society and Culture

A35	Digital Portal for Citizen Feedback and Participation		
Summary	Installation of a citizen feedback and participation tool that can be accessed online over the city's website or a specifically developed app		
Challenge addressed	Low direct citizen participation in decision-making processes concerning the city		
Target user	Citizens with change requests, public service providers, urban planners		
Service feature	Mobile app, online feedback file		
Results	Facilitated communication between city authorities and residents, improved understanding of residents' needs, integration of diverse social groups into city life		
Regional (city/country) context	Development status	Maturity status	Other
	Developing, emerging, developed	Medium	n/a
City example	Paris, France		
Source	T. De Feraudy. 2017. Yes, 'Govtech' Can Change the Way Cities Function: New Lessons in Open Government from Paris. Citiscope. 3 April. http://archive.citiscope.org/commentary/2017/04/yes-govtech-can-change-way-cities-function https://bit.ly/2OONSET

A36	Neighborhood Assistance App		
Summary	Introduction of an app-based solution that allows residents to connect with neighbors		
Challenge addressed	Weakly connected communities through high migration of people between cities and districts		
Target user	Residents that want to connect with neighbors		
Service feature	Mobile app		
Results	More communication, information sharing, and interaction among neighbors; evolution of more resilient cities		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	Low	n/a
City example	Nationwide in the US		
Source	Nextdoor. Discover Your Neighborhood. https://nextdoor.de/ https://bit.ly/1bmuuCX

O. Safety and Security

A37	Smart Surveillance and Alarm Systems		
Summary	Installation of a smart surveillance and alarm system based on CCTV and facial recognition		
Challenge addressed	Rising complexity in providing security to communities in megacities and densely populated places		
Target user	City security authorities, inhabitants, visitors, transients		
Service feature	Emergency alarm		
Results	Real-time information about crime or emergency incidents, faster reaction times in case of emergencies, decreased crime rate		
Regional (city/country) context	Development status	Maturity level	Other
	Developing, emerging, developed	Medium	n/a
City example	Namyangju, Republic of Korea		
Source	Milestone Systems. 2017. Goyang, South Korea's Smart City, Enhances Safety with a World Class Safety Surveillance Implementation. 27 July. https://www.milestonesys.com/press-releases/20170727-goyang-south-koreas-smart-city-enhances-safety-with-a-world-class-safety-surveillance-implementation/ https://bit.ly/2OLmZl2

A38	Intelligent Crime Prediction and Prevention		
Summary	Use of econometric forecasting models, algorithms, and big data to predict and to prevent crimes		
Challenge addressed	Poor achievement in integrating socially vulnerable groups		
Target user	City security authorities, social security authorities		
Service feature	Crime prediction models		
Results	Accurate forecasting of crimes, early recognition of risk groups, implementation of effective preventive measures, integration of socially vulnerable groups in society, lower judicial costs for societies, safer cities and communities		
Regional (city/country) context	Development status	Maturity level	Other
	Emerging, developed	Medium	n/a
City example	Wellington, New Zealand		
Source	Acuity. 2017. Fighting Crime with Statistics. 23 June. https://www.acuitymag.com/business/fighting-crime-with-statistics https://bit.ly/2YWlhBb

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APPENDIX 3: ILLUSTRATIVE EXAMPLES FOR DIGITAL ELEMENTS IN ASIAN DEVELOPMENT BANK URBAN PROJECTS

This section outlines urban projects and relevant digital elements of Asian Development Bank (ADB) projects. The urban projects, including digital components, were derived from the project data sheet provided on the ADB website.

Table A3: Illustrative Examples for Digital Elements in Asian Development Bank Urban Projects

Project Name	Year Approved	Assistance Type	Digital Element	Short Description	Defined Impact	Sector							
						Agriculture	Education	Energy	Finance	ICT	Industry	Transport	Water
India: Mumbai Metro Rail Systems Project	2019 (active)	Loan	Mobile apps for women's security Priority e-ticketing closed circuit television (CCTV) facilities	Installation of safe, energy- efficient trains Installation of signaling, train control, and telecommunication systems Provision of last-mile solutions	Increased efficiency, safety, gender, and social inclusiveness of rail-based urban transit system							X	
India: Tamil Nadu Urban Flagship Investment Program— Tranche 1	2019 (active)	Grant, loan, and technical assistance (TA)	Geographic Information System (GIS) technology Data collection and analysis	Development of priority water supply, sewerage, and drainage infrastructure Strengthening of institutional capacities	Enhanced environmental sustainability, climate resilience, and urban livability								X
Nepal: Urban Water Supply and Sanitation (Sector) Project	2019 (active)	Loan	Supervisory control and data acquisition system Smart meters Smart billing, tariff collection, and management systems	Improvement of water supply and sanitation infrastructure Strengthening of institutional and community capacities	Improved quality of life for urban population through inclusive and sustainable access to water supply and sanitation								X

continued on next page

Table A3 continued

Project Name	Year Approved	Assistance Type	Digital Element	Short Description	Defined Impact	Sector							
						Agriculture	Education	Energy	Finance	ICT	Industry	Transport	Water
Bangladesh: Secondary Education Sector Investment Program—Tranche 3	2018 (active)	Grant and loan	School information hub Use of digital technologies in pedagogy	Support of the construction of school buildings, and repair and maintenance of existing schools that support enhanced use of information and communication technology(ICT) Creation of ICT learning centers	More efficient, equitable, and higher- quality secondary education system Better skilled labor force		X						
Bhutan: Phuentsholing Township Development Project	2018 (active)	Grant and loan	GIS database Supervisory control and data acquisition system ICT infrastructure	Installation of flood and erosion measures such as river walls and a flood early warning system Construction of municipal infrastructure Implementation of township management projects	Balanced and sustainable development of human settlements	X							X
Mongolia: Human Settlements Development Project	2018 (active)	TA	Online platform E-book/ database	Development of national strategy and policies for human settlement and territorial development Development of national laws and regulations Web-based mapping platform and provincial e-atlas	Improved policy environment for urban and land development for economic diversification and social stability Support of sustainable human spatial distribution							X	
Mongolia: Ulaanbaatar Green Affordable Housing and Resilient Urban Renewable Sector Project	2018 (approved)	Grant and loan	Smart monitoring system for building performance and renewable energy control	Development of ger city areas into affordable, low-carbon, climate-resilient, and livable eco-districts Construction of resilient urban infrastructure Long-term financing Strengthening of institutional capacities	Improved living conditions Transformation into safe, healthy, resilient, and green city			X	X				X

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Table A3 *continued*

Project Name	Year Approved	Assistance Type	Digital Element	Short Description	Defined Impact	Sector							
						Agriculture	Education	Energy	Finance	ICT	Industry	Transport	Water
China, People's Republic of: Shaanxi Transport and Logistics Port	2018 (active)	TA	Logistic information technology systems	Enhancement of cold-chain logistics management implemented Improvement of rural-urban logistics and passenger bus operation Streamlining of agricultural commodity distribution	Strengthened economic development by improving efficiency of logistics sector							X	
Tajikistan: Dushanbe Water Supply and Sanitation Project	2018 (active)	Grant	Smart meters Supervisory control and data acquisition system Customer database	Expansion of climate-resilient water supply and sanitation infrastructure Development of sustainable business model and institutional capacity	Economic growth Reduced poverty Gender equality, social inclusion, and environment								X
China, People's Republic of Sichuan Ziyang Inclusive Green Development Project	2018 (approved)	Loan	Computerized urban development planning and management component (smart information system)	Rehabilitation of urban environmental infrastructure Extension of exploring and testing places for green service industry Enhancement of urban development planning and management capacity	Sustainable economic growth Environmental improvement		X						X
China, People's Republic of Shanxi Urban-Rural Water Source Protection and Environmental Demonstration Project	2017 (active)	Loan	Hydro-logical and water quality monitoring stations with a telecommunication system	Improvement of watershed vegetation, water supply, and wastewater collection Strengthening of institutional capacities	Improved living and environmental conditions	X						X	X
China, People's Republic of: Mainstreaming Urban Climate Change Adaptation in the People's Republic of China	2017 (active)	TA	Smart city and GIS applications	Development of technical guidelines and policy concerning urban climate change adaption Support for cities in planning and capacity building	Improved resilience to extreme weather events	X		X	X				X

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Table A3 continued

Project Name	Year Approved	Assistance Type	Digital Element	Short Description	Defined Impact	Sector								
						Agriculture	Education	Energy	Finance	ICT	Industry	Transport	Water	Not provided
China, People's Republic of: Air Quality Improvement in the Greater Beijing–Tianjin–Hebei Region—Regional Emission-Reduction and Pollution-Control Facility	2017 (active)	Loan	Smart microgrids in industrial parks Intelligent digital control systems	Deployment of high technologies that reduce air pollution Establishment of pollution- control facilities Improvement of capacities of key stakeholders to deploy technologies for pollution reduction	Reduced air pollution Improved public health	X		X				X	X	
Mongolia: Ulaanbaatar Pro-Poor Urban Redevelopment Support System for Ger Areas (residential districts)	2017 (active)	TA	ICT applications Data collection Computerized project performance management system	Expansion of roads and urban services Improvement of economic and public services by piloting ICT applications Efficiency increase of service providers Strengthening of institutions and capacity	Environmentally sustainable growth Inclusive economic growth					X	X	X		
China, People's Republic of: Mainstreaming Urban Climate Change Adaptation in the People's Republic of China	2017 (active)	TA	Smart city and GIS applications	Development of technical guidelines and policy concerning urban climate change adaption Support for cities in planning and capacity building	Improved resilience to extreme weather events	X		X	X				X	
China, People's Republic of: Air Quality Improvement in the Greater Beijing–Tianjin–Hebei Region—Regional Emission-Reduction and Pollution-Control Facility	2017 (active)	Loan	Smart microgrids in industrial parks Intelligent digital control systems	Deployment of high technologies that reduce air pollution Establishment of pollution- control facilities Improvement of capacities of key stakeholders to deploy technologies for pollution reduction	Reduced air pollution Improved public health	X		X				X	X	

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Table A3 *continued*

Project Name	Year Approved	Assistance Type	Digital Element	Short Description	Defined Impact	Sector									
						Agriculture	Education	Energy	Finance	ICT	Industry	Transport	Water	Not provided	
Mongolia: Ulaanbaatar Pro-Poor Urban Redevelopment Support System for Ger Areas (residential districts)	2017 (active)	TA	ICT applications Data collection Computerized project performance management system	Expansion of roads and urban services Improvement of economic and public services by piloting ICT applications Efficiency increase of service providers Strengthening of institutions and capacity	Environmental-ly sustainable growth Inclusive economic growth						X	X	X		
China, People's Republic of: Air Quality Improvement in the Greater Beijing-Tianjin-Hebei Region-China National Investment and Guaranty Corporation's Green Financing Platform Project	2016 (active)	Loan	Investment in development of smart electric bicycles and smart control systems for energy-efficient heating ICT-based online platform	Establishment of a green financing platform for pollution- reduction projects Improvement of financing for small/ medium energy service providers Capacity building of financial industry for new financial products and risk management	Reduced air pollution Improved public health				X	X			X		
Georgia: Livable Urban Areas: Integrated Urban Plans for Balanced Regional Development	2016 (active)	TA	Comprehensive livability database comprising environment quality data and urban profiles	Enhancement of urban-planning capacities by developing integrated urban plans, urban management partnerships, and institutional and financial sustainability mechanisms	Inclusive economic growth and improved livability in selected urban areas Inclusive, safe, resilient, and sustainable cities								X	X	
India; Visakhapatnam-Chennai Industrial Corridor Development Program— Project 1	2016 (active)	Grant and loan	Establishment of an e-portal and a single desk system	Enhancement of the manufacturing sector by strengthening institutions for corridor management Improvement of the ease of doing business by assessing the rating of the state Capacity building in manufacturing sector	Improved manufacturing sector growth High-quality job growth				X		X	X	X	X	

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Table A3 continued

Project Name	Year Approved	Assistance Type	Digital Element	Short Description	Defined Impact	Sector							
						Agriculture	Education	Energy	Finance	ICT	Industry	Transport	Water
Mongolia: Southeast Gobi Urban and Border Town Development Project—Additional Financing	2016 (active)	Loan and TA	Supervisory control and data acquisition control systems and communication links	Construction and operationalizing of wastewater collection infrastructure and treatment infrastructure Strengthening of strategic planning, management, and capacities	Enhanced economic development and livability Improved urban development, government, and access to sustainable infrastructure								X
Promoting Smart Systems in ADB's Future Cities Program	2016 (active)	TA	Contribution to promoting smart infra- structure and systems in selected cities Infra-structure data systems and geo-located systems	Enhancement of ADB operational knowledge of promoting smart solutions to the development of cities Identification and sharing of best practice examples Preparation of further projects	Improved living standards of city residents, focusing on the urban poor and women								X
Uzbekistan: Tashkent Province Water Supply Development Project	2016 (active)	Loan	Computerized financial management system	Upgrading of existing water supply networks Improvement of financial, operational, and system management	Improved living standards, health, and economy Access to reliable, sustainable, and affordable water supply services								X
Regional: Building Climate Change Resilience in Asia's Critical Infrastructure	2016 (active)	TA	Interactive GIS platform Databases, simulation modeling, visualization tools Digital elevation terrain models at horizontal and vertical resolution	Identification of critical infrastructure in the energy, transport, and water sectors Assessment of climate change risks to existing and planned critical infrastructure Identification of policy, financial priorities, adaption options, and climate resilience standards for target sectors	Increased knowledge, promotion of innovation and good practices			X				X	X

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APPENDIX 4: ASSESSMENT TEMPLATES

This section presents blank assessment templates for practitioners, policy makers, and decision makers to make use of the smart city analytical framework put forward in this paper.

Figure A4.1: Urban Challenges

Challenge	Extent of challenge		Potential of digital solutions	
	Low	High	Low	High
1	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
2	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
4	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
6	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
7	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
8	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
9	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
10	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

Source: Authors.

Figure A4.2: Digital Maturity of the Five Enabling Factors

Enabling factors	Remarks	Digital maturity	
		Low	High
1 Policy and Institutions		1 2 3 4 5	
2 Planning and Coordination		1 2 3 4 5	
3 Technology and Innovation		1 2 3 4 5	
4 Business and Finance		1 2 3 4 5	
5 Skills and Capacity		1 2 3 4 5	

Source: Authors.

Figure A4.3: Potential Elements of a Target Picture of a Smart City

Identified challenges with digital solution potential					
Potential elements of a target picture	Topic 1	Topic 2	Topic 3	Topic 4	Topic 5

Source: Authors.

Figure A4.4: Ease of Implementation and Economic Value

Project	Ease of implementation					Total value				
	Low					High				
1 ...	1	2	3	4	5	1	2	3	4	5
2 ...	1	2	3	4	5	1	2	3	4	5
3 ...	1	2	3	4	5	1	2	3	4	5
4 ...	1	2	3	4	5	1	2	3	4	5
5 ...	1	2	3	4	5	1	2	3	4	5
6 ...	1	2	3	4	5	1	2	3	4	5
7 ...	1	2	3	4	5	1	2	3	4	5
8 ...	1	2	3	4	5	1	2	3	4	5
9 ...	1	2	3	4	5	1	2	3	4	5
10 ...	1	2	3	4	5	1	2	3	4	5

Source: Authors.

Figure A4.5: First Implementation Measures

Source: Authors.

Figure A4.6: Smart Indicators for an Effective Monitoring and Evaluation System

Source: Authors.

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Smart City Pathways for Developing Asia

An Analytical Framework and Guidance

Smart cities can improve access to and quality of urban services for citizens, businesses, and governments through the strategic use of digital technologies. Given the variety and complexity of smart city initiatives, this working paper offers an analytical framework to assess, design, and implement smart city concepts tailored to specific contexts. This is intended to support the targeted and implementation of smart city initiatives across Asia and the Pacific. This publication is designed for smart city practitioners and decision makers to guide their work, facilitate effective advisory, inform planning and implementation of smart city initiatives, and support discussions with stakeholders in developing member countries on how to initiate actions that help realize the opportunities of smart city solutions presented in this paper.

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