Asia-Pacific
Economic Cooperation

APEC Case Study

Best Practices of Smart Cities in the Digital Age

APEC SOM Steering Committee on Economic and Technical Cooperation

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Executive Summary / Key Messages

More than 55% of the world's population lives in urban areas today. By 2050, based on the gradual shift in residence of the human population from rural to urban areas, it is expected to increase to 68%, with close to 90% of this increase, taking place in Asia and Africa[1].

The Asia-Pacific is the world's fastest growing region for urbanization development. The cities will be an increasingly critical factor for creating and sustaining economic growth. Although this region includes some of the fastest-growing and most developed economies, many cities in the APEC region still face the challenges of inadequate infrastructure, growing inequalities and poverty, as well as rising environmental pollution, and require increased resilience towards natural disasters.

The upward trajectory of Asia-Pacific`s urbanization rate and its related impacts on the quality of life for its inhabitants as well as the environment, challenge local governments and authorities in providing or maintaining an adequate functioning, public infrastructure of the sub-sectors mobility, energy, healthcare, waste, water, education, safety, and building construction, among others. This requires a strategic,

[1] Please see Annex 1 with a resume about revised current reports and websites including short content descriptions.

THE ASIA–PACIFIC IS THE WORLD'S FASTEST GROWING REGION FOR URBANIZATION DEVELOPMENT. THE CITIES WILL BE AN INCREASINGLY CRITICAL FACTOR FOR CREATING AND SUSTAINING ECONOMIC GROWTH.

sustainable spatial planning. The use of data-based technology offers a wide range of possibilities to support decision-makers to overcome these challenges and improving their responses to these.

This publication presents twelve exemplary case studies shared by APEC economies in order to spread ideas and know ledge about smart solutions, which focus on better life conditions for their urban citizens.

In this context, two outstanding components have been identified as essential for the creation of smart, sustainable cities, and will be further explained in this report: (1) the role of digital technologies in decision-making processes while guaranteeing personal data protection, and (2) a people-centered development approach, focused on the citizens` needs and the empowerment of local capacities.

The case studies of the transport, infrastructure and energy sector presented in this report follow a structure of problem – solution – conclusion and are an active contribution to smart city knowledge exchange. Based on the lessons learned shared by the participating APEC member economies, current research papers as well as experts` opinions, the authors conclude this report with specific policy recommendations.

This APEC self-funded project aims to encourage more economies to adopt self-funded solutions to improve urban environment and meet the Sustainable Development Goals (SDGs).

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I. List of Acronyms

AMI	Advanced Metering Infrastructure
AI	Artificial Intelligence
APEC	Asia-Pacific Economic Cooperation
AR	Augmented Reality
BLE Tag	Bluetooth Low Energy Tag
BOT	Build–operate–transfer
BIM	Building Information Modeling (BIM) Technology
CAPEX	Capital Expenses
CCTV	Closed-Circuit Television
COVID/COVID-19	Coronavirus
CO_2	Carbon Dioxide
e.g.	exempli gratia = for example
EIA	Environmental Impact Assessment
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GW	Giga Watt
ICT	Information and Communication Technology
IDB	Inter-American Development Bank
IoT	Internet of Things
IRIS	Integrated and Replicable Solutions for Co-Creation in Sustainable Cities
KCEs	Key Contributing EconomiesSustainable Cities
KPI	Key Performance Indicator
kV	kilo Volt
LED screen	Light-Emitting Diode Display
LGU	Local Government Unit
LNG	Liquefied Natural Gas
MCI	Mild Cognitive Impairment
MoU	Memorandum of Understanding
MUSD	Million US Dollar
MW	Mega Watt
NCD	Non-Communicable Disease
NDC	Nationally Determined Contributions
OECD	Organisation for Economic Co-operation and Development
OPEX	Operational Expenses
PDCA	Pan-Do-Check-Act

PPP	Public-Private-Partnership
PwC	PriceWaterhouseCoopers
SaaS	Software as a Service
SCADA	Supervisory Control and Data Acquisition
SCC	Smart Cities Challenge
SDG	Sustainable Development Goal
SKPPAS	The System of Environment Pollution Control at Source
SSC	Smart Sustainable City
UFRO	Universidad de La Frontera
WHO	World Health Organization
WiFi	Wireless Network

II. Glossary

3D	Three-dimensional/three dimensions: in computers, 3D describes an image that provides the perception of depth.
4G, 5G	Fourth and fifth generation technology standard for broadband cellular networks.
Artificial Intelligence (AI)	AI refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions.
Augmented Reality (AR)	AR is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities.
Autonomous Mobility	Mobility based on autonomous vehicles, in its different autonomy levels (until full self-driving/ driverless cars). Self-driving cars combine a variety of sensors to perceive their surroundings.
Big Data	Big data is a field that treats ways to analyze, systematically extract information from, or otherwise deals with data sets that are too large or complex to be dealt with by traditional data-processing application software.
Bluetooth Low Energy (BLE) Tags	BLE (or active RFID) systems operate by a tag sending out transmission to a reader, and then transmitting that location to the cloud. Because of the low power consumption, good range and ability to transmit sensor, data Bluetooth Low Energy lends itself to usage a tag.
Build-Operate-Transfer (BOT)	BOT or build–own–operate–transfer (BOOT) is a form of project delivery method, usually for large-scale infrastructure projects, wherein a private entity receives a concession from the public sector (or the private sector on rare occasions) to finance, design, construct, own, and operate a facility stated in the concession contract. BOT is usually a model used in PPPs.

Building Information Modeling (BIM)	BIM is a process supported by various tools, technologies and contracts involving the generation and management of digital representations of physical and functional characteristics of places. Building information models are computer files (often but not always in proprietary formats and containing proprietary data), which can be extracted, exchanged or networked to support decision-making regarding a built asset. BIM software is used by individuals, businesses and government agencies who plan, design, construct, operate and maintain buildings and diverse physical infrastructures, such as water, refuse, electricity, gas, communication utilities, roads, railways, bridges, ports and tunnels.
Closed-Loop Management	A closed loop management system is a management system that promotes a controlled base of both preferred outcomes and feedback from the system. This common style is different from open loop management systems, which support zero feedback and have all inputs driven off of set calculations designed around anticipated outcomes only.
Internet of Things (IoT)	IoT describes the network of physical objects—"things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.
Mobile Application	A mobile application, also referred to as a mobile app or simply an app, is a computer program or software application designed to run on a mobile device such as a phone, tablet or watch.
Open Data	Open data is the idea that some data should be freely available to everyone to use and republish as they wish, without restrictions from copyright, patents or other mechanisms of control.
Power Purchase Agreement (PPA)	A long-term electricity supply agreement between two parties, usually between a power producer and a customer (an electricity consumer or trader).
SCAN	Surveillance, Contact Tracing, Analysis and Networking (Initiative realized in The Philippines).
Smart Grid	A two-way interchange where both electricity and information can be exchanged in both directions between power utilities and consumers. It uses digital technology to improve reliability, security and efficiency in the power system, and allows for especially volatile renewable energy, such as wind and solar power production, to be integrated on a large-scale into the domestic grid.
Supervisory Control and Data Acquisition (SCADA)	A generic name for a computerized system that is capable of gathering and processing data, and applying operational controls to geographically dispersed assets over long distances.
WiFi	WiFi is a way of connecting to a computer network using radio waves instead of wires.

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V. ACKNOWLEDGMENTS

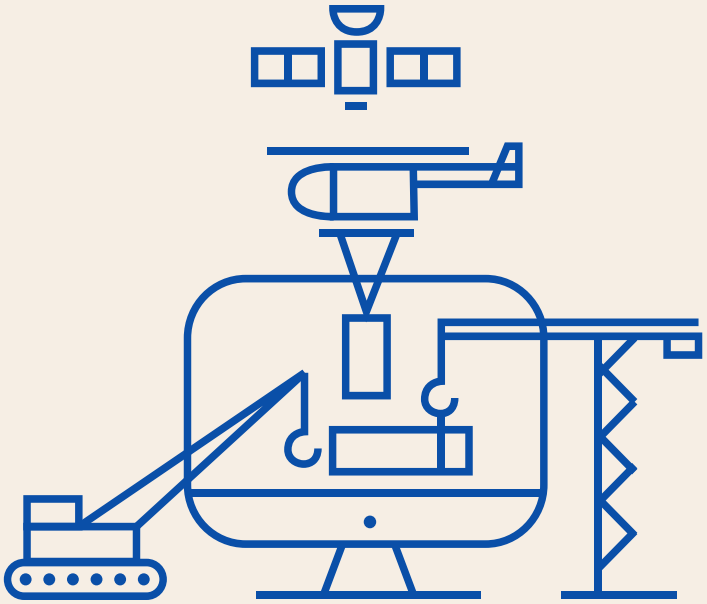
The producers of this report would like to express their sincere thanks and gratitude to APEC team Chile and China for their support in coordinating this project.

Also a special acknowledgement is assigned to the APEC member economies Canada, Chile, China, Japan, Malaysia, Thailand, The Philippines and Viet Nam, for sharing their very interesting smart city initiatives in order to foster the knowledge exchange among all APEC member economies.

Additionally, the producers of this report express their gratitude to the smart city experts for sharing their views, knowledge and lessons learned regarding the realization of smart city initiatives.

1

Introduction



This report is the outcome of a case-study research project, which is based on an open call for smart city initiatives in the transport, infrastructure and energy sector among Asia-Pacific Economic Cooperation (APEC) member economies. It shall offer these economies useful knowledge, policy recommendations as well as reference material on successful practices and innovative solutions implemented by other member economies that have overcome similar challenges.

The Universidad de La Frontera, the selected institution to conduct the present case-study research project, is a public comprehensive university located in Temuco, Region of La Araucanía in the South of Chile. The university counts with considerable experience in the realm of smart cities, leading the initiative Smartemuco, which is based on the innovative project Smart City in a Box, financed by the Innovation Laboratory of the Inter-American Bank of Development (BID LAB).

THIS REPORT IS THE OUTCOME OF A CASE-STUDY RESEARCH PROJECT, WHICH IS BASED ON AN OPEN CALL FOR SMART CITY INITIATIVES IN THE TRANSPORT, INFRASTRUCTURE AND ENERGY SECTOR AMONG ASIA-PACIFIC ECONOMIC COOPERATION (APEC) MEMBER ECONOMIES.

1.1. Background

The Asia-Pacific is the world's fastest growing region for urbanization development and already comprises the world´s largest geographic concentration of population. It is estimated that the region's urbanization rate will reach 50 per cent in 2026 and that the cities will be an increasingly critical factor for creating and sustaining economic growth. Although this region includes some of the fastest-growing and most developed economies and cities in the world, which contribute around 80 percent of output in most of the region's economies, many cities in the APEC region still face the challenges of inadequate infrastructure, growing inequalities and poverty, as well as rising environmental pollution, and require increased resilience towards natural disasters.

The upward trajectory of Asia-Pacific`s urbanization rate and its related impacts on the quality of life for its inhabitants as well as the environment, challenge local governments and authorities in providing or maintaining an adequate functioning, public infrastructure of the sub-sectors mobility, energy, healthcare, waste, water, education, safety, building construction among others, and requires a strategic, sustainable spatial planning. Sustainable urban development and -management considers the economic, social as well as environmental dimension.

The use of technology in these urban planning and management processes has a high potential in supporting decision-makers facing these challenges and improving their responses to these. At global level, a wide range of different intelligent technologies already exists to address specific aspects within urban planning and – management processes, making them "smart". Thus, "a smart city is one that uses technology and data to enhance its livability, workability and sustainability" [Smart Cities Council, 2020].

Mobile applications, digital platforms, the Internet of Things (IoT), Big Data, Open Data, 3D-Printing, drones or autonomous mobility are just a few examples of technologies, which are nowadays revolutionizing urban life. The functioning of all these technologies is based on data. "Cities, in all their complexity and scope, generate oceans of it. Finding the insights in all that data helps municipal governments respond to fluid situations, allocate resources wisely, and plan for the future" [Woetzel, J.; Remes, J.; Boland, B. et al., 2018].

To give an example that will be also presented in this report: public transport route and traffic management can be planned much better when having data about the passenger and vehicle numbers in certain routes, hours, and transportation modes. The analysis of this data facilitates making intelligent decisions, which reduces congestion and travel times for citizens and thus, negative environmental, social as well as economic impacts.

The essence of a smart city is to use intelligent means to enhance governance capacity and improve governance models, so as to improve the living environment of citizens, optimize the business environment, conserve natural resources and protect the environment.

MAKING CITIES SMARTER IS AN ESSENTIAL FACTOR IN THE GLOBAL EFFORT TO ACHIEVE SUSTAINABLE, INCLUSIVE GROWTH, CONSISTENT WITH THE SUSTAINABLE DEVELOPMENT GOALS.

Presenting exemplary solutions as well as lessons learned can support the replication of smart city solutions among economies, which face similar challenges and can be an impulse for the digital transformation of cities. At global level, as of October 2020 there exist various websites and recent publications, which present smart city case studies in different sub-sectors of urban development and –management.

A preliminary literature benchmark realized at the beginning of this project identified that most of the presented case studies originate from Asian, European and North American cities[2] . However, existing platforms and studies rarely report their existing innovative efforts in a detailed way, share information about implementation methodologies, required policies or investment, nor do they reflect a public institutions/governmental perspective; these are relevant aspects for other economies interested in replicating similar solutions.

The consulting company Deloitte (2018) presents implemented smart city initiatives in different cities around the globe from their perspective, focused on their own contribution as a service provider without deepening investment requirements or methodological advises for political authorities.

Machina Research (2016), one of the world's leading providers of strategic market intelligence on the Internet of Things, developed a 'Smart City Playbook' commissioned by Nokia, which ranks 22 selected cities of varying sizes and geographies in terms of their levels of progress of 'smartness' and investigates the key parameters and general lessons involved in becoming smart.

Other recently published reports on smart cities [[Woetzel, J.; Remes, J.; Boland, B. et al. (2018); OECD, 2019] emphasize on *what makes a city smart,* explaining the concepts behind this term and specifying existing technologies that may transform a city into a smart one, which is very helpful for orientation and general understanding.

The International Development Bank (IDB) in 2016 published a short series of international case studies of smart city initiatives, mainly of Asian economies, which presents single projects in more detail.

At European level, there already exist some interesting digital information sharing platforms of smart city solutions, like Bable, IRIS or Morgenstadt – City of the Future Initiative. These platforms aim to impulse the development of smart cities by presenting innovative urban solutions both for city planners as well as businesses and by fostering the networking between them. They offer the possibility to search smart solutions regarding sub-sectors and download case studies. However, these platforms just present initiatives of European cities.

Besides the publications and websites mentioned in Annex 1, there are also local government websites which demonstrate their smart initiatives in different topics, e.g. the Department of Infrastructure, Transport, Regional Development and Communications of the Australian Government.

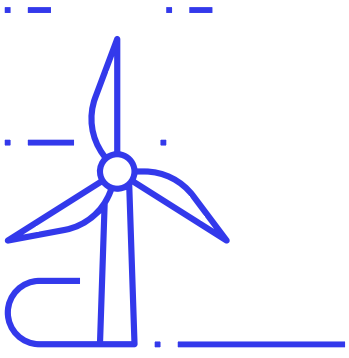
Furthermore, some economies have compiled their development strategies as well as current and future smart city initiatives in one document, like Hong Kong, China, in its Smart City Blueprint.

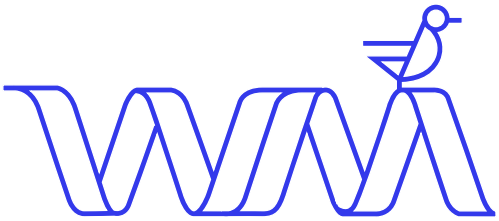
[2] Please see Annex 1 with a resume about revised current reports and websites including short content descriptions.

1.2 Relevance and Objective

As the leading economic forum of 21 economies in the region, APEC aims to support the sustainable development, economic growth and prosperity of the region, addressing diverse aspects related to the sustainable development of cities. Already in 2015, a report elaborated by PriceWaterhouseCoopers (PwC) for the APEC CEO Summit 2015 stated that "city mayors know they need models. They often want a more fluid process than natio nal government and infrastructure offers; they fear that rapidly evolving technology developments will make large tech bets outmoded overnight; and they contend with stretched municipal budgets. Therefore, they want to learn from each other, whether it is how to install a bike-sharing program or gradually grow an entire new business district; how to protect relics of their past or build a highway for flood relief. Formal exchanges could be put in place to speed up the process" [PwC, 2015].

Taking into account the importance of knowledge sharing including details on implementation methodologies and specific policy recommendations, this case-study research project focuses on presenting intelligent urban solutions in the transport, infrastructure and energy sectors developed by different economies within the APEC region, whereas.





a. Transportation

Considers solutions that contribute to minimize the impact of transportation on climate and the environment, improve traffic for public and private transit systems and other transportation methods by means of congestion management; new transport technologies; intelligent traffic planning through IoT/ICT solutions; (public) transportation management systems; improved interconnectedness of all road users promoting network efficiency; safety and vehicle control systems for accident prevention, and other similar solutions.

b. Infrastructure

Includes smart solutions for urban infrastructure management that focuses on the sustainability, resilience and efficiency of cities. This can include: waste, water, air, safety, healthcare and housing as well as education management.

Examples are initiatives, which reduce the environmental impact of construction and demolition waste, building automation, energy and water efficiency, as well as security management.

c. Energy

Refers to solutions that contribute to reducing CO_2 emissions and energy costs, and promote the transition to clean energy, including cross-sector smart energy systems, energy efficiency, renewable energy and the promotion of alternative combustion engines.

This final project report includes very specific orientations in order to motivate and support decision makers in the application and replication process of technological solutions. The international cooperation of smart cities contributes to a mutual support for improving resource efficiency, learning advanced practice cases, accelerating the development of technology and industry, forming a sustainable development of a smart city construction alliance, and providing more effective governance models for urban governance of various economies.

As previously described, most of the existing publications and websites do not elaborate on the details of smart city initiatives, e.g. their implementation methodology or specific policy recommendations. Therefore, the present project aims to cover these aspects in a complementary manner by identifying and presenting them in this final report, based on the detailed information shared by the participating Key Contributing Economies (KCEs). The detailed presentation of the delivered smart city case studies should (1) facilitate their replication in other economies and (2) foster networking and the information exchange within the APEC Region, as "case studies are an excellent learning tool to study the way cities in the region address and adapt to problems that impact the sustainability of urban development (...)", and further, "(...) show that partnerships among APEC economies and cities can facilitate better knowledge and practical action to improve outcomes" [Roberts B. et al., 2018].

Following the conclusion of Tran and Nguyen (2020) in their research study about recommendations for the implementation of Smart Sustainable City (SSC) Information and Communication Technology Infrastructures in the APEC Region, this report becomes especially important as, "the APEC member economies are mostly facing several challenges and difficulties in upgrading and expanding ICT infrastructures for smart sustainable cities", for example regarding "the need to identify policy/regulatory approaches that promote innovation and put cities and communities in the lead in their smart city projects; skills gaps (...); financial constraints; difficulty in replicating SSC models due to wide disparities among cities in terms of administrative, politic, cultural and infrastructure aspects; lack of SSC-related recommendations, consensus standards to enhance interoperability among SSC systems and equipment."

Finally, an additional part of this report elaborates on exemplary initiatives that contribute to combating the current COVID-19 pandemic. The aim is to share recently implemented, successful approaches that may be of relevance for other APEC and also non-APEC economies.

SHARING EXPERIENCES, INFORMING ABOUT LESSONS LEARNED AS WELL AS OFFERING POLICY RECOMMENDATIONS, WILL CONTRIBUTE TO SMARTER URBANIZATION PROCESSES ACROSS THE ASIA-PACIFIC REGION AND FOSTER OPPORTUNITIES FOR SMART CITY COOPERATIONS WITHIN APEC ECONOMIES IN THE DIGITAL AGE.

1.3 Methodology

The present case study report is based on a specific questionnaire that was addressed to all APEC member economies, which have been responsible for implementing urban initiatives within the energy, transport and infrastructure sector.

With the objective to obtain detailed information about implemented smart city solutions among APEC economies and to assess the replicability of each initiative, a detailed questionnaire was developed, focusing on the implementation methodology and challenges, stakeholder engagement, financial aspects and its long-term economic sustainability, impacts, monitoring and verification methods, lessons learned as well as policy recommendations.

Considering the current context of the COVID-19 pandemic, three additional questions were added, aiming to visualize the pandemic´s impact on current initiatives and their possible adjustments, and whether any new smart solutions have arisen in this context (please refer to Annex 3).

The authors decided to evaluate the complexity of each initiative in order to provide a first orientation on its replicability, especially addressed to economies interested in adopting it, or similar solutions.

Despite its length, most questionnaires were answered nearly completely, some of them including additional files with background and visual information. In each case, the Universidad de la Frontera (UFRO) reviewed the submitted information, gathered additional clarifying questions for the respective KCE and transmitted them eventually to each economy. In some cases the authors researched and included additional information from official sources in order to complement information in case of missing aspects.

All case studies were evaluated and analyzed according to an internal evaluation scheme developed by the authors based on their experience as well as the delivered information of primary sources, considering in particular, their methodological and financial complexity as well as the positive impact of the initiative.

According to this evaluation scheme, **the methodological and financial complexity of an initiative depends on its level of difficulty, which is ranked according to the delivered information with low, medium or high**. For example, if the level of methodological and/or financial difficulty of an initiative is low, then the complexity of that initiative is low. And thus, an initiative´s replication to another economy is likely easy.

In case of insufficient delivered information, no evaluation was defined.

Specifically, the **methodological complexity** is ranked low, medium or high depending on different aspects like the required stakeholder engagement, capacity building/trainings, technical requirements and – complexity, or necessary infrastructure modifications. If an initiative requires for example the development of an elaborated technology infrastructure as well as the involvement of multiple stakeholders, this results in a high level of complexity.

The financial complexity is defined by taking into account aspects like the required investment, complexity of the funding mechanism/scheme or financial model, as well as its economic sustainability and existing funding opportunities. Hereby, the required investment was defined as "low" from 0 – 5,000,000 USD, "medium" from 5,000,000 – 10,000,000 USD, and "high" in case of more than 10,000,000 USD.

For example, if an initiative requires a low investment amount, the financial model is very simple and there is no informed risk linked to its economic long-term sustainability, it will result in a low level of complexity. In case the required budget was low, yet there is no guarantee for financing the initiatives` maintenance, the level of financial complexity would be assessed as "medium".

The third evaluation aspect **positive impact** refers to the problem solving ability of an initiative and highlights the degree to which the initiative could solve the initial problem and challenges, which led to its development. This aspect includes

- the magnitude and type of benefitted citizens; considering only a single part of the population, or also the inclusiveness of less favored groups of the population, e.g. women, elderly, people living in poverty;
- if the initiative or the policy resulting from it have shown any impact on the economy´s sustainable growth
- any negative impacts observed
- the initiative´s overall impact on people´s quality of life[3].

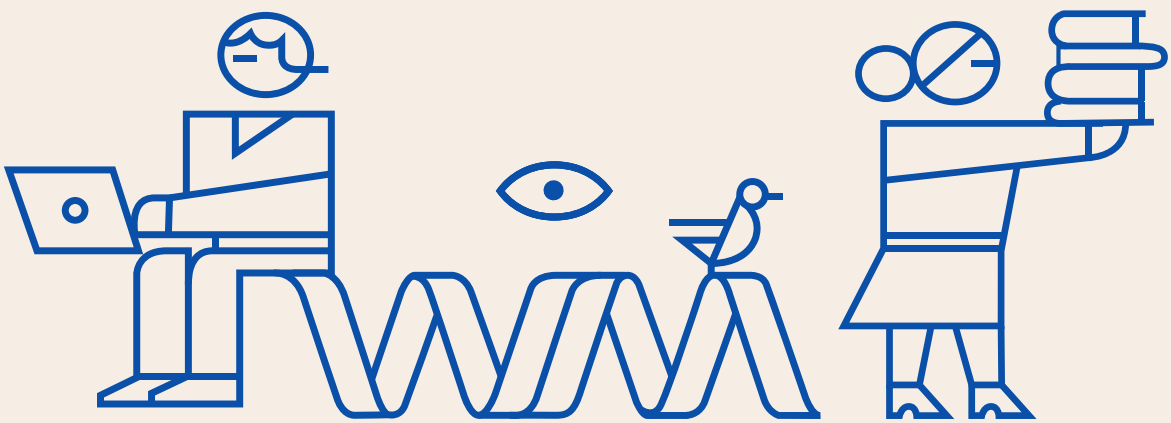
The result of this single evaluation is presented at the end of every case study. In case of insufficient information, no evaluation is submitted.

[3] For details, please refer to the detailed questionnaire in Annex 3.

WITH THE OBJECTIVE TO OBTAIN DETAILED INFORMATION ABOUT IMPLEMENTED SMART CITY SOLUTIONS AMONG APEC ECONOMIES AND TO ASSESS THE REPLICABILITY OF EACH INITIATIVE, A DETAILED QUESTIONNAIRE WAS DEVELOPED, FOCUSING ON THE IMPLEMENTATION METHODOLOGY AND CHALLENGES, STAKEHOLDER ENGAGEMENT, FINANCIAL ASPECTS AND ITS LONG-TERM ECONOMIC SUSTAINABILITY, IMPACTS, MONITORING AND VERIFICATION METHODS, LESSONS LEARNED AS WELL AS POLICY RECOMMENDATIONS.

2

Results: Smart City Case Studies



Eight out of 21 APEC member economies (38%) responded the questionnaire, submitting a total of 14 case studies, most of them provided by economies of Asia.

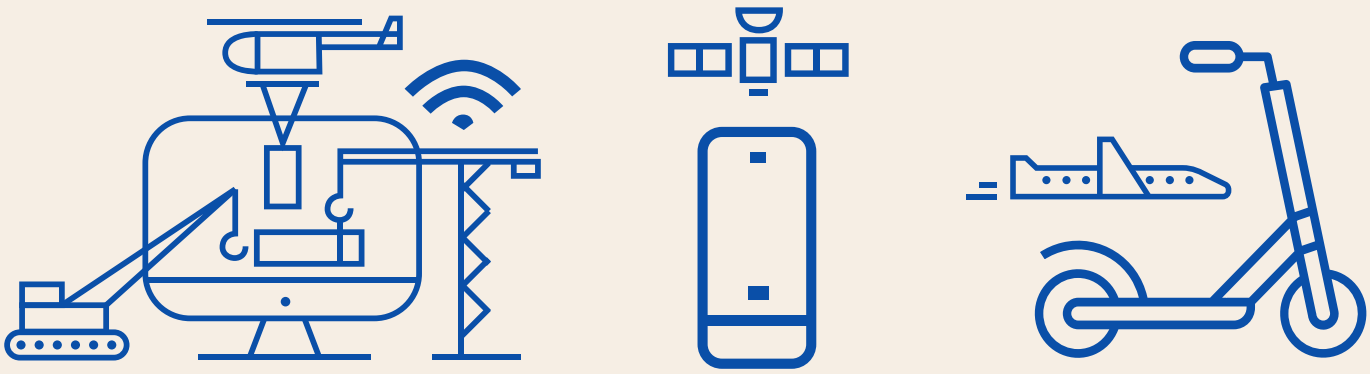
The majority of the submitted case studies are implemented in the transport or infrastructure sector. Just one case study related to the energy sector was delivered. The received case studies are further divided into sub-topics, which are visualized in Table 1:

Table 1. Overview of Submitted Initiatives by Topics and Technologies

Providing Economy	Name of Initiative	Topic	Sub-Topic	Applied Technology/ies
Canada	Smart Cities Challenge	Cross-sectional	Cross-sectional	Various technologies, as applicable to community challenge at issue
Chile	First autonomous vehicle pilot in Chile	Transport	Pilot Project Autonomous Driving	Autonomous Driving
China	Jinan: Building an Intelligent Ecosystem for Its Traffic Management ("Jinan Traffic Brain")	Transport	Traffic Management	Artificial Intelligence
China	Overall Plan of New-Type Smart City Construction of Shenzhen Municipality	Infrastructure	Cross-sectional	Sensor networks, Artificial Intelligence
Japan	Kakogawa Smart City Project	Infrastructure	Safety and Security	ICT platform, Monitoring cameras (CCTV)
Japan	Smart City Aizuwakamatsu	Cross-sectional	Cross-sectional	ICT platform
Malaysia	Putrajaya Lake: The System of Environment Pollution Control at Source (Sistem Kawalan Punca Pencemaran Alam Sekitar - SKPPAS) by Putrajaya Corporation	Infrastructure	Water quality Management	Sensors for physiochemical water quality data monitoring; mobile application
Thailand	Phuket Smart Tourism	Cross-sectional	Digital start-ups, IoT, Digital Infrastructure	IoT, CCTV, Digital infrastructure (i.e., Core Fibre, LoraWan, NB-IoT, WiFi, 5G)
Thailand	Khon Kaen Smart Health, by Khon Kaen Smart Living Lab	Infrastructure	Connected Digital Health	Smart watches for health monitoring
The Philippines	Tri-City Initiative on Public Transportation	Transport	Inter-city coordination	Internet for coordination, other technologies not specified
The Philippines	Community Risk Assessment	Cross-sectional	Risk prevention	Digital Platforms, other technologies not specified

The Philippines	Tacloban SCAN System (COVID Application)	Infrastructure	Health security management	Mobile Application
The Philippines	Davao City - Smart City Project 1: Converged Command and Control Center	Infrastructure	Security	CCTV, Underground Fiber Optic Cabling Project
Viet Nam	Project Developing Smart Grid in Viet Nam	Energy	Smart grid	Telemetry

In every case, technologies have been applied; however, the type of technology used as well as the level of technological complexity varies highly. Figure 2 visualizes the main technologies used per topic (transport, infrastructure, energy or in the case of cross-sectional initiatives):



Infrastructure

Sensor networks
CCTV
Fiber optic
Cabling 4G-5G

Energy

Telemetry

Transport

Autonomous driving
Integrated coordination platforms
Big data

Cross-Sectional

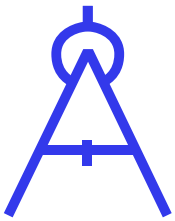
Mobile applications
Artificial Intelligence
ICT/Digital platforms

Digital Infrastructure (Core fibre, LoraWan, NB-IoT, WiFi, 5G)

Figure 1. *Overview of Applied Technologies by Topics*

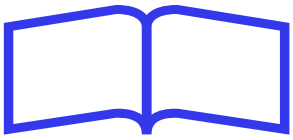
The following section presents the delivered smart city case studies[4] following the structure ***PROBLEM – SOLUTION – RESULTS - CONCLUSION*** for every initiative, where

the **PROBLEM** describes the situation before implementing the initiative,



the **SOLUTION** presents the initiative, in what it consists, its implementation methodology, stakeholders engaged, investment, challenges faced and other relevant aspects,

the description of the **RESULTS/BENEFITS** includes the initiative`s impacts, as far as they were assessed, and



the **CONCLUSION** about the initiative, based on the internal evaluation scheme, considers its methodological and financial complexity as well as the lessons learned and policy recommendations.

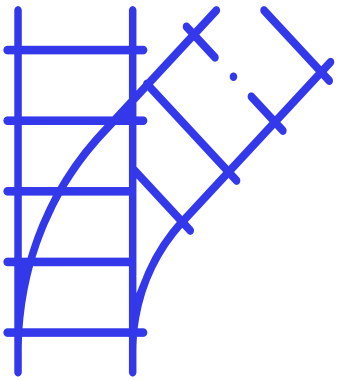
[4] Considering the extension of this report, as well as the provided information, a maximum of two initiatives per economy are presented. In this context, from the four initiatives shared by The Philippines, only two initiatives are presented in detail.

2.1 Smart City Initiatives

Transport

Mobility is one of the biggest challenges linked to urban growth. It has direct impacts on human wellbeing and the quality of life of the cities` inhabitants, the environment (e.g. air quality) as well as on the economic growth.

Smart city initiatives in the transport sector may contribute among others to



• minimize the impact of transportation on climate and the environment

• improve traffic for public and private transit systems and other transportation methods by means of congestion management

• new transport technologies

• intelligent traffic planning through IoT/ ICT solutions, (public) transportation management systems, as well as

• improved interconnectedness of all road users promoting network efficiency, safety and vehicle control systems for accident prevention, and other similar solutions.

2.1.1: First autonomous vehicle pilot project in Santiago de Chile

Santiago de Chile

Population Chile:
17,57 million (2017)

GDP per capita Chile:
15,091 USD (2019)

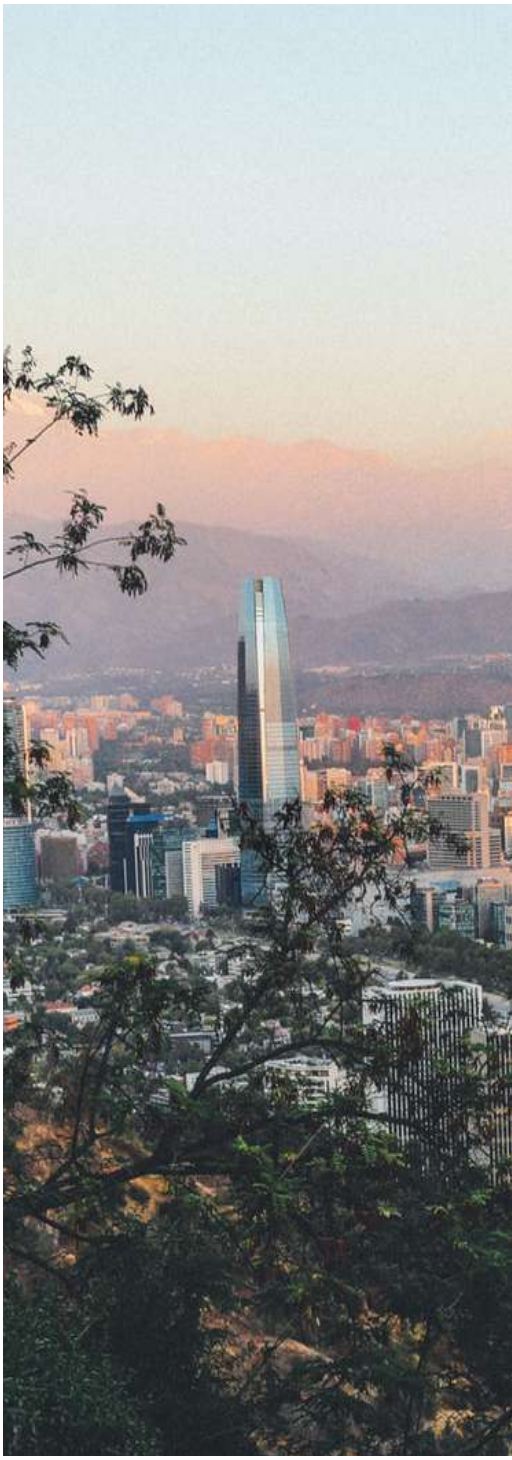
40% of inhabitants live in the Metropolitan Region of Santiago

In early 2020, Chile realized its first practical experience of operating a shuttle-type autonomous technology transport system in a controlled and safe environment, for the passenger transport in the city of Santiago de Chile.

Problem

New technologies like autonomous driving require regulation and safety standards, based on the practical experience of operating autonomous technology transport systems in a controlled and safe environment, for a safe passenger transport.

The institutional competencies of the Chilean Ministry for Transport and Telecommunications (MTT) regarding these technologies were low, and technical training for personnel from key institutional areas was necessary in order to improve relevant instruments of transport systems` regulation, management and planning. Also, Santiago de Chile suffers critical air quality and high noise emissions due to the cities` high traffic volume and loud engines of conventional buses.



Solution

In a technical cooperation together with the Inter-American Development Bank (IDB), the MTT realized the first autonomous vehicle pilot project in Latin America. The project aims to promote zero-carbon technologies (the pilot minibus runs on electricity), to reduce noise emissions as well as to foster the involvement of the local academy and innovating actors in finding new solutions to improve transport in the region. The specific objectives include gaining practical experience of operating a shuttle-type autonomous technology transport system in Santiago de Chile, as well as strengthening the institutional competences of the MTT regarding regulation, management and planning instruments for transportation systems by means of digital data as well as technology exploration and regulation associated with autonomous vehicles.

This autonomous driving pilot project shall prepare the economy for what is to come, through a short, medium and long-term agenda.

Methodology:

The autonomous vehicle project implemented in the Metropolitan Park "Parque O'Higgins" in Santiago de Chile was set-up in December 2019 by the MTT, the financing entity IDB and the company Transdev Chile, the supplier of the autonomous shuttle minibus from the manufacturer EASYMILE.

The vehicle model EZ10 Gen1 which dimensions are 4 meters (m) long, 2m wide and 3m high, has the capacity to transport a total of 12 passengers and is equipped by a high resolution GPS system as well as a camera and sensor system capable of identifying activities in a radius of 18 meters, together with a 3G/4G communication system.

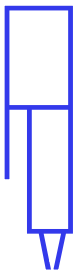
According to the manufacturer, the driverless minibus runs a 100% electric and is designed for operation in mixed traffic environments, bridging the gap between existing transport services and additional mobility in cities or town centers as well as on business or other campuses. It can be deployed alone or in a fleet. The EZ10 does not need a special infrastructure, it follows predefined routes, and it detects and avoids potential obstacles with a full set of sensors.

The driverless minibus operated during three months in a defined testing route of 0,8 km length with three stops, realizing this distance in three minutes. The route had coexistence with pedestrians, bicycles and vehicles of municipal services. The pilot project included test drives with users, the development of a survey about users` satisfaction as well as capacity and training instances for technical teams of the MTT.

Around 6500 people were transported, of which 40% were children, during business days with an established schedule between 9 AM and 2 PM and a frequency of 10 trips per hour, although an hourly average of 17 trips was reached due to the existing demand, completing an average of 54 km per operation day and transporting around 250 passengers daily.

Figure 2. *Autonomous Minibus Shuttle tested in a Park in Santiago de Chile*
Source: MTT online: http://mtt.gob.cl/archivos/23621

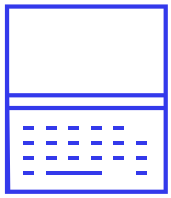
The project was realized in three steps:



1. Deployment

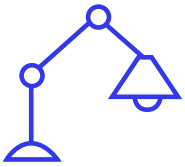
• Acquisition and preparation of the test vehicle (transport and branding)

• Distance calibration and white run
• Staff training by Transdev



2. Operation

•Three months of operation, starting in early 2020



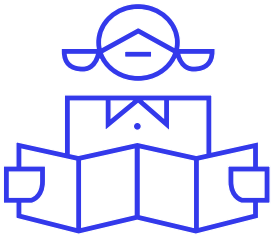
3. Analysis of operational data and user survey

Stakeholder engagement:

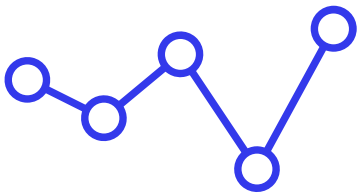
The stakeholders engaged in this pilot project were the Chilean Ministry of Transport and Telecommunications, the Inter-American Development Bank through its Innovation Laboratory BID LAB and its Transport Division, the company Transdev, acting as a technology partner in charge of the implementation and realization of this project, as well as the Faculty of Physical and Mathematical Sciences and its Innovation Center “OpenBeauchef” of the University of Chile. Also, the Municipality of Santiago was a supporting actor of this pilot project.

Policies:

The search processes for new technological solutions strengthened the institutional competencies of the MTT regarding these technologies, generating technical training for personnel from key institutional areas such as the National Transport Security Commission (CONASET), the Department for Regional Public Transport (DTPR), the Division of Standards and Operations, the Operational Unit for Transport Control (UOCT) as well as the transport inspection. The interest of the MTT to include this kind of innovative mobility concept in the economy's urban transport, which has led to this pilot project and international collaboration with the IDB, is an outstanding criteria in this context.



Financial Aspects:



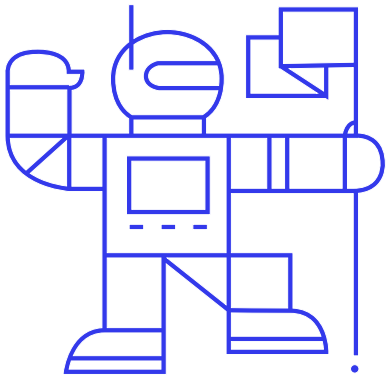
The Autonomous Mobile Pilot project was financed with the support of the Inter-American Development Bank (IDB) in the context of its technical cooperation with the Ministry of Transport and Telecommunications (MTT); the total cost of the project covers about 320,000 USD.

Implementation Challenges:

A general challenge, which addresses this initiative, is the planning of transport systems and the exploration and regulation of technologies associated with autonomous vehicles.

Specifically, the main challenge of this pilot project was the establishment of an enabling context for the correct operation of level 4 autonomous shuttles[5], including the definition of a route, storage and local authorizations. Location limitations, obstacle detection and decision-making determine both the environment and the type of traffic in which the vehicle can operate and interact, including its maximum speed.

Further challenges were the signal stability and interference 4G communications; both become essential in order to deliver the proper operation of the minibus, representing 90% of the failure causes identified and solved.



[5] Level 0 autonomy refers to a typical, everyday car. The driver performs all operations, including steering, accelerating, and braking and the vehicle has no autonomous or self-driving controls at all.

Level 4 automation refers to high automation vehicles that are capable of steering, accelerating, and braking on their own. They are able to monitor road conditions and respond to obstacles, determining when to turn and when to change lanes. Level 4 autonomous driving can only be activated when road conditions are ideal. At this level, vehicles cannot negotiate more dynamic conditions like traffic jams or other major obstacles. Source:

https://www.intelligent-mobility-xperience.com/the-5-levels-of-autonomous-driving-explained-a-912861/?cmp=go-ta-art-trf-IMX_DSA-20200217&gclid=CjwKCAjwqML6BRAHEiwAdquMnc0fdbKRokmG75AhwsM3qpezrX_p2UgvoN-ByE95Cf0vC2iYdBG-PtxoCJioQAvD_BwE

Results / Benefits

This pilot project brought multiple benefits, as Figure 4 resumes:

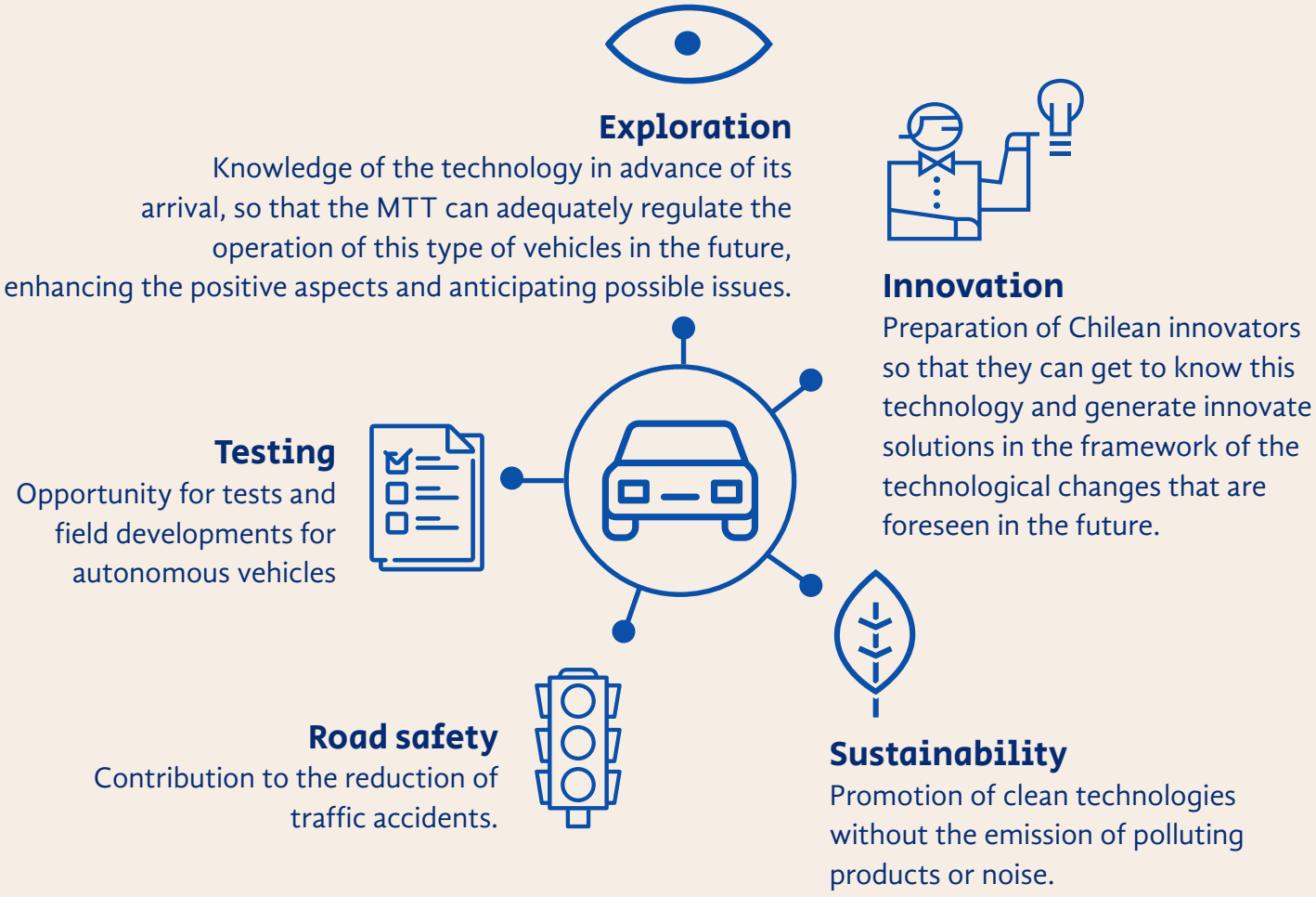


Figure 3. *Benefits of the Autonomous Shuttle Pilot Project in Santiago de Chile*
Source: IBD online: https://www.iadb.org/en/countries/autonomousvehiclepilot

During this trial operation phase, the driverless minibus has benefitted around 6500 people, 40% of them children. Above all, the pilot project has served to improve the existing regulation instruments, management and planning of transportation systems, through the use of digital data for planning transportation systems, and the exploration and regulation of technologies associated with autonomous vehicles.

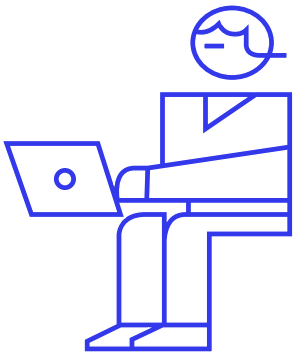
The institutional competencies of the MTT with respect to these technologies have been strengthened, generating various technical visits and training for personnel from Chilean institutions involved in topics of transport such as CONASET, DTPR, Division of Standards and operations, UOCT, transport inspection, among others. This will serve to improve the instruments of regulation, management and planning of the transport systems

of the future .Regarding the user perception survey, its evaluation showed that 91% of the passengers had a very high satisfaction of the trips, 95% felt safe throughout the trip, 12% of the passengers which were interviewed suffer reduced mobility and 63% of the interviewed passengers were women.

Along with this pilot project, BID LAB, MTT and Transdev launched the "Autonomous #MobilityChallenge" in order to foster local innovation and start-ups. It is the first open autonomous mobility challenge in Chile and Latin America, where innovators and entrepreneurs from the region are invited to propose solutions in this area. This activity represents an unprecedented opportunity for entrepreneurs in the Region to present innovative ideas regarding one of the technologies that could revolutionize the transport of the future, such as autonomous mobility.

IT IS THE FIRST OPEN AUTONOMOUS MOBILITY CHALLENGE IN CHILE AND LATIN AMERICA, WHERE INNOVATORS AND ENTREPRENEURS FROM THE REGION ARE INVITED TO PROPOSE SOLUTIONS IN THIS AREA.

Lessons learned and policy recommendations



- For installing autonomous vehicles, both become important: to explore as well as to regulate technologies associated with them.
- Signal stability and interferences of 4G communication signals are essential in order to deliver a proper operation of the autonomous minibus.
- It is also important to assess the impact of pavement conditions on the detection of obstacles, especially aspects like great accumulation of dust and leaves.
- Data generated from surveys concerning the user´s perception and travel experience are an important input for internal feasibility analyses.

Conclusions

This pilot project of autonomous driving in benefit of public transport was a successful initiative in order to gain experience in the operation of a 4-level, 100% electric autonomous vehicle. Also the results of this pilot project delivered valuable input for the definition of regulatory aspects of this technology, whereby the respective Ministries can define and optimize related regulation.

Evaluation Scoring

Santiago de Chile: First autonomous vehicle pilot project in Santiago de Chile

Methodological complexity

Medium

Financial complexity

Low

Positive impact
(Problem solving)

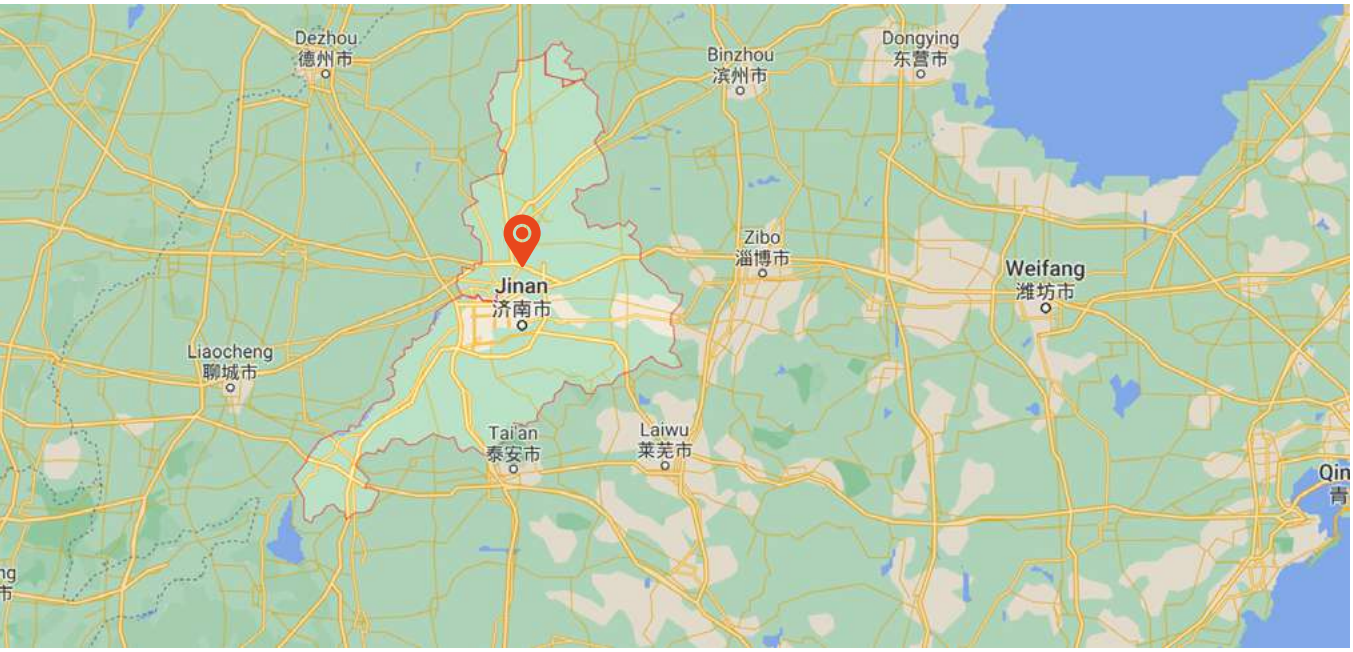
★★☆ **Medium**

2.1.2 China: Jinan – Building an Intelligent Ecosystem for Its Traffic Management ("Jinan Traffic Brain")

Jinan

Population:
8.7 million (2018)

GDP per capita:
14,555 USD (2017)



Problem

Transportation is an important part of urban construction, an important guarantee for economic and social development, and a social issue related to people's livelihood. With the increase of urban residents' travel demand and the continuous growth of the number of urban motor vehicles, the problem of urban traffic congestion has intensified in Jinan. Further, the supply of transportation resources is not coordinated with the demand for diversified activities, nor is the allocation of technical strategies and the demand for transportation development.

Solution

The Chinese city of Jinan has built a “one cloud plus four hubs” operating system architecture, which is a traffic management ecosystem with real-time perception of traffic signs, dynamic analysis of traffic emergency events, scientific evaluation of traffic status, and intelligent traffic control decisions.

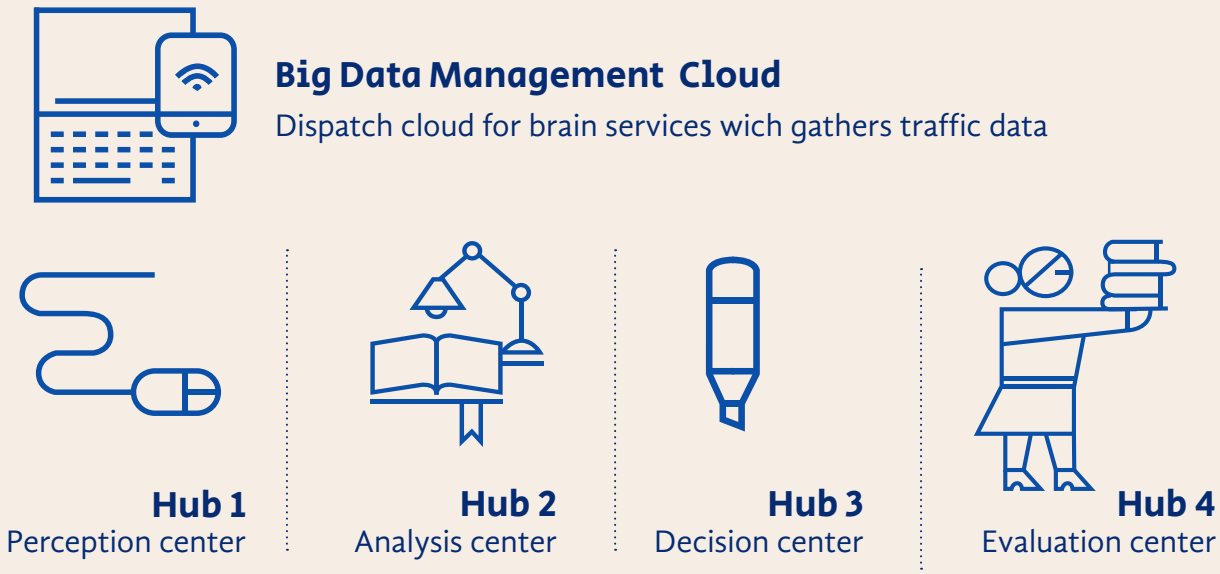


Figure 4. *Jinan Traffic Brain Structure “One cloud, four hubs”*

The overall big data management cloud gathers traffic data, while the “four hubs” are composed of a perception center, an analysis center, a decision center, and an evaluation center. These hubs are responsible for building a closed-loop control mode of “real-time perception-analysis and judgment-intelligent decision-release evaluation”, which finally evolves into a real traffic brain that is capable of self-evolution and self-learning.

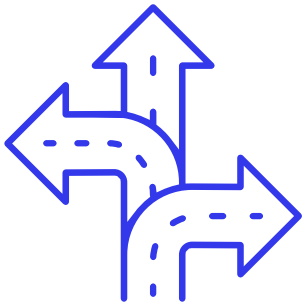
Through accurate and complete data collection, the system platform relies on the learning, cognition, interpretation, calculation, simulation, and decision-making, which makes traffic management and decision-making more effective, while the carrying capacity of the road network can be maximized.

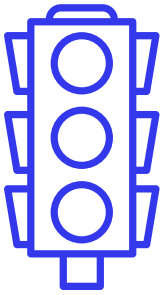
By using Augmented Reality (AR) panoramic and situation monitoring, static and slow traffic sensing and other technologies in order to build a full domain, time and dimensional information perception tentacles, Jinan Traffic Brain has created a citywide real-time situational awareness.

Figure 5. *Screenshot of the Jinan Traffic Brain Real Time AR Command Center Interface*

1. Jinan's **road traffic index** was established, which uses operating speed, congestion level and other factors as status indicators to accurately describe the traffic operation and management and thus, to provide more/better data support for traffic police decision-making.

2. **Analysis and judgment of traffic congestion:** through the analysis of traffic conditions, accidents and traffic violations based on data-supported research and assessment, the data mining of historical traffic conditions, the visualization analysis of accidents as well as police force deployment analysis, the traffic agencies can trace the cause and diffusion mechanism of various congestion events and can detect frequent congestion nodes. The congestion situation and impact of road sections and areas are quantitatively deduced and the evolution process of traffic congestion events is visualized based on electronic maps.

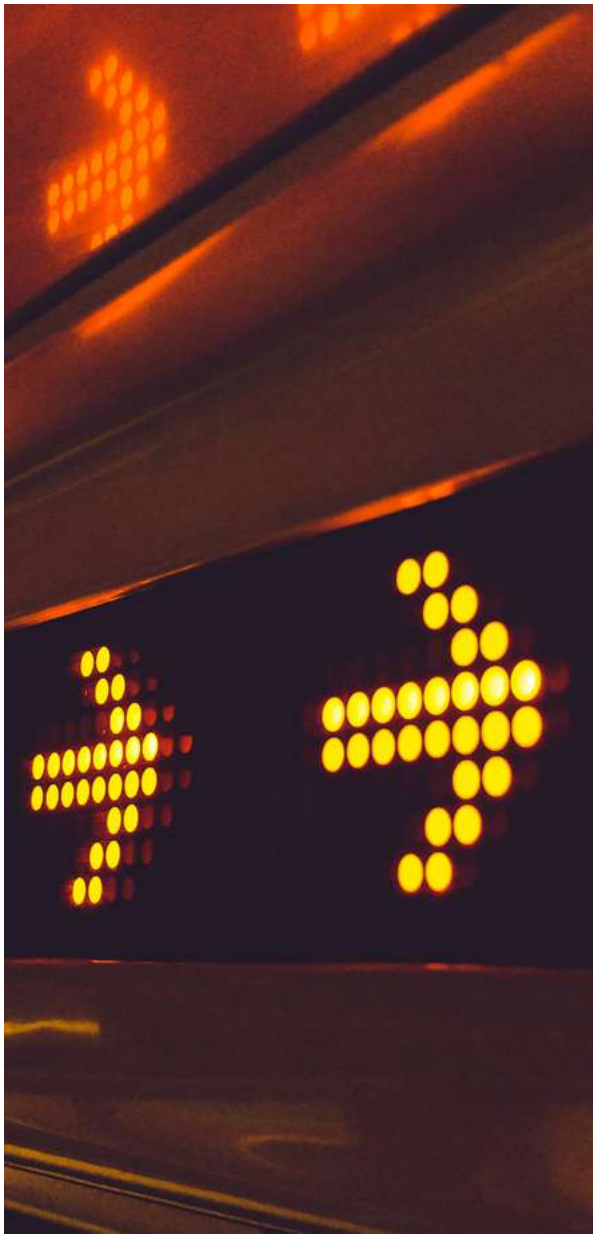




3. **Intelligent control of traffic signals** by creating two closed-loop signal management mechanisms: a closed-loop management for the signal timing scheme optimization; and a closed-loop management for the maintenance of traffic signal facilities. With the "Quancheng Xing+" App, Jinan Traffic Police WeChat, and its Mini Program as front-end service carriers, the two closed-loop signal management mechanisms achieve functions such as dynamic traffic guidance, traffic management information release, business query processing, information push, and interactive participation. There are currently more than 900,000 registered users on the platform.

4. **Coordinated police supervision management** through four "closed-loops": a closed-loop police dispatch and handling, a closed-loop remote mediation and closed-loop video inspections, which form a closed-loop management of the entire life cycle of smart services, enabling the respective commander to fully control the workload and efficiency of the civilian police. The system aims to increase police visibility, to improve management and on-site law enforcement, to innovate and reform the police service assessment mechanism, and to strengthen the application of evaluation results, effectively improving the morale and efficiency.

Methodology:



In 2018, the Jinan municipal traffic bureau, Shandong University and the transport company DiDi signed a trilateral cooperation agreement on the so-called JT Brain project led by the municipal traffic police department.

In 2018, transportation agencies integrated internet data and traffic management resources, building an integrated linkage platform, which can display real-time traffic situation of urban expressways and arterial roads. Electronic boards on urban expressway ramps were set up in order to display travel guidance; and a plan was worded out to build a city-wide traffic sensing system that specifically targets weak points.

The transportation department set up and improved the intelligent traffic management and control system, connecting various traffic management and application resources, and establishing traffic situation awareness, traffic guidance automatic release and comprehensive integrated linkage platform, and improving traffic situation control, command and dispatch, management and control, traffic information interaction and application service capabilities, resulting in a "safe and smooth, harmonious and inclusive" road traffic environment.

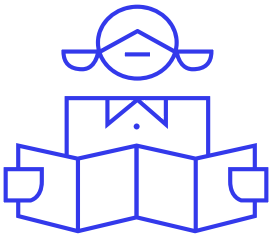
Since its launch in 2018, the intelligent traffic system has been expanded to cover the whole core city of Jinan.

Stakeholder Engagement:

In general terms, after ten years of development, China's cities have formed a construction mode of planning first and combining government and enterprise in the development of smart cities.

In Jinan, the government and enterprises realize smart city projects through government procurement, Public-Private-Partnerships (PPP), Build-Operate-Transfer (BOT) and other diversified investments and financing modes. Both actors stimulate the market vitality and continuously carry out in-depth evaluation of new smart city solutions, encouraging the participation of social capital and direct social institutions to conduct third-party evaluation.

The Chinese government upholds the principle of "people first", enhancing public participation and carrying out public satisfaction surveys to evaluate smart city projects. Public actors aim to find out the breakthrough point and focus point of urban governance to address the difficulties and blocking points reflected by the public, so as to realize the collaborative linkage of online and offline management services.

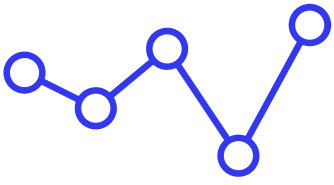


Policies:

In 2018, the local Government of Jinan formulated an *Action Plan for the Construction of New Smart City in Jinan* (2018-2020) in order to accelerate the construction of a new smart city in Jinan, to improve the urban governance capacity as well as the modernization level, and to promote the city´s digital and intelligent transformation and development.

Financial Aspects:

The local government finances the Jinan Traffic Brain through government procurement. In general terms, the investment and financing of smart city construction in China can be divided into three main modes: government funding, PPPs as well as enterprise investment. Based on the different local development situations, there are differences in the proportion of the three modes applied.



It is worth noting that in the economically underdeveloped areas, the construction of smart city requires a large amount of funds and has a long construction period. There may be insufficient government investment to achieve the desired effect.

Implementation challenges:

It is challenging to strengthen the leading role of planning, to innovate the investment and financing mode, to encourage more social capital to participate, and to find new profit points.

At present, there is no recognized international standard for smart city construction, and also a lack of international standard for data management. With the deepening of international cooperation, standards among cities, regions and even economies will be improved and established, which may have certain impact on the existing smart city construction, including increasing management difficulty and construction cost.

Undoubtedly, a large number of emerging technologies have been applied in the construction of smart cities, including 5G, IoT, AI and big data. Among them, the large-scale construction of a 5G base station, which is seen as the core technology to connect all kinds of terminals and realize high-speed and low delay transmission, and also one of the core technologies to promote the interconnection of all things.

In addition, decision-makers must pay attention to the legislative protection of data security and personal privacy, which in China will be an indispensable part of the construction of smart city, as the economy adopts the position that only under the guidance of laws and regulations, smart cities can serve the people better.

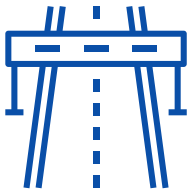
Results/ Benefits

Standardized data and interfaces, multi-engine optimization and open pattern analysis together ensured the system capable of self-evolving and growing gradually.

Based on its accurate display of the city's driver behavior and urban traffic operation, and by providing intelligent parking guidance and signal light management, theJinan Traffic Brain is able to control congestion points at the micro level, analyze the traffic planning at the medium level, and support the traffic development at the macro level.

Micro level

Medium Level



Macro Level

Since the application of the four closed-loop systems, the intelligent dispatching business has been significantly improved in the following four aspects:

1. Command and dispatch daily average handling of more than 500 accident alarm cases, more than 150 quick accident handling alarm cases, and more than 400 traffic congestion alarms.

2. The average time of receiving and dispatching police was reduced from 7 minutes before the establishment of smart office, to 4.5 minutes, and the overtime rate of receiving and dispatching police was less than 0.5%.

3. The average time of handling the police on the spot was improved from 9 minutes to 7 minutes, and the overtime rate was less than 0.9%.

4. The average time of police mediation in the traffic accident remote mediation center decreased from 7 minutes to 5 minutes, and the overtime rate was less than 0.8%.

The video inspection seat inspects 800 video points every day, with an average inspection time of 5 hours, while more than 30 police cases are found daily. Since the signal control management systems were activated, parking times during rush hours have decreased by 6.7% (morning) and 8.7% (evening). The average delay time in rush hours has decreased by 10.73% (morning), and 10.94% (evening). The traffic congestion index has decreased by 8.9% month-on-month. In theory, 8.9 million citizens in Jinan benefit from this kind of smart city initiative.

Additionally, the smart transformation of transportation has improved economic operation efficiency, reduced logistic costs and promoted the development of related industries such as automobile, shipping, metallurgy, logistics, e-commerce, tourism and real estate, creating multiple new jobs. It further has promoted progress in urban energy conservation, emission reduction and ecological environment protection due to reduced transport times based on route optimization and due to the inclusion of more than 5.000 buses running on electricity or Liquefied Natural Gas (LNG) or Compressed Natural Gas (CNG).

Lessons learned and policy recommendations:

Using the analysis center to analyze and excavate the internal mechanism and essence of the traffic system can achieve accurate prediction and simulate traffic jams, traffic accidents, traffic demand and traffic violations as a predictable demand, situation, alertness, and predictable behavior by truly understanding the principles of the urban traffic system and accurately describing the evolutionary law of complex traffic signs.

It is recommended to deeply integrate big data, cloud computing, AI and other technologies into traffic management decision-making in order to create an Internet+ information service that benefits people (1) through a technology-driven transportation system with cognition, calculation and decision-making functions, (2) through using AI to assist traffic organization and control, and (3) through accurately combating illegal behavior with data.

It is important to analyze the essence of actual traffic issues accurately and to use big data to create a closed-loop intelligent police supervision model to automatically conduct early warning, in order to achieve fast, accurate and just police supervision and management.

ADDITIONALLY, THE SMART TRANSFORMATION OF TRANSPORTATION HAS IMPROVED ECONOMIC OPERATION EFFICIENCY, REDUCED LOGISTIC COSTS AND PROMOTED THE DEVELOPMENT OF RELATED INDUSTRIES SUCH AS AUTOMOBILE, SHIPPING, METALLURGY, LOGISTICS, E-COMMERCE, TOURISM AND REAL ESTATE, CREATING MULTIPLE NEW JOBS.

Conclusions

Jinan Traffic Brain has built an intelligent, self-learning and -improving transportation management ecosystem, which is capable of comprehensive real-time perception of traffic signs, dynamic analysis of traffic behavior in detail, and quick scientific assessment of traffic status in order to realize precise intelligent traffic decision-making.

Evaluation Scoring

China:
Jinan – Building an Intelligent Ecosystem for its Traffic Management ("Jinan Traffic Brain")

Methodological complexity

High

Financial complexity

High

Positive impact
(Problem solving)

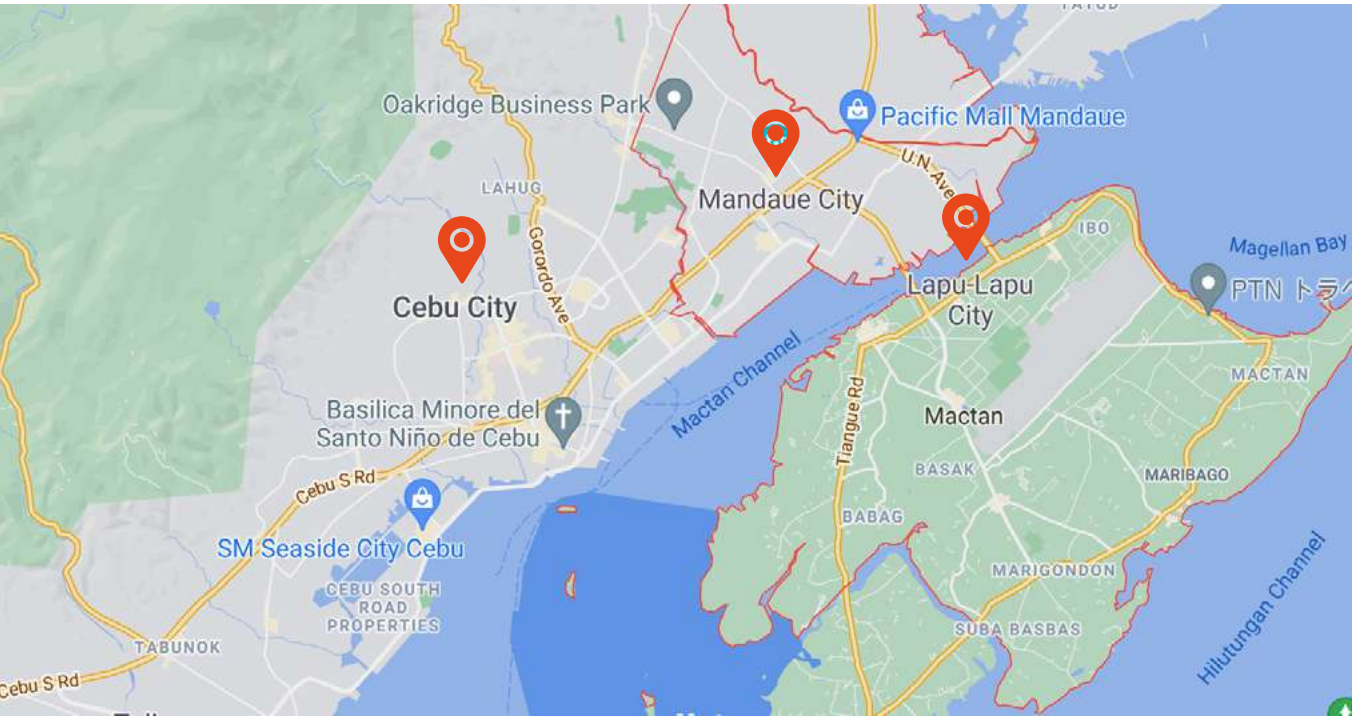
★★★ **High**

2.1.3 The Philippines: Tri-City Initiative on Public Transportation

Mandaue City, Lapulapu City and Cebu City (Region of Central Visayas)

Population of the three cities:
Nearly 1.7 million inhabitants (2015)

GDP per capita of Central Visayas Region:
2,810 USD (nominal, 2018)



Also called Cebu Metropolitan Area or Metro Cebu, the Cebu Province is the second largest metropolitan area in the Philippines, after Metro Manila. Mandaue City is one of the highly urbanized cities located at the heart of the Cebu Province. Considered as the industrial hub of Cebu, Mandaue experiences rapid economic growth and dynamic development. It is located between both Cebu City as a significant center of commerce, trade and education, and Lapu-Lapu City, which occupies the Mactan Island, a few kilometers away from the main island of Cebu, yet is directly linked to Mandaue by two bridges.

Problem

Mandaue City in the center of Metro Cebo, is considered a transportation corridor or "gateway" as it is a junction of major roads leading to north, south and mid-west of Cebu. It faces a large amount of through-traffic with different origins and destinations from and to other cities and muni- cipalities. As part of the APEC Low Carbon Model Town project [6], a feasibility study was conducted in Mandaue in order to assist the city develop its plan on low carbon development. This study showed that the transport sector is the largest contributor to carbon emissions, accounting for nearly half (49%) of total carbon emissions in Mandaue in 2015.

As the city is located between Cebu and Lapulapu, Mandaue needs the cooperation of its neighboring cities, and vice-versa, to resolve transportation issues and consequently reduce its carbon emissions contributed by the transport sector. Although their road networks are interconnected, the three cities have different rules and policies regarding public transport, so whenever problems related to this sector have surfaced, each city has reacted differently, sometimes detrimental to the general public.

Solution

In order to collectively address challenges related to urban transportation, the three Cities of Mandaue, Cebu and Lapulapu set up a Tri-City cooperation consisting of weekly coordination meetings among the planning offices of the three involved local government units (LGUs).

The Tri-City Initiative is piloting on a public transportation route system and other issues relating thereto such as the formulation of a Local Public Transport Route Plan (LPTRP) and the installation of bike lanes. Other urban issues such as flooding, solid waste management, air pollution and noise pollution will be addressed in other plans and programs that also require a collective action of the three cities.

[6] The APEC Energy Ministers implemented the APEC Low-Carbon Model Town Project in 2011; it aims to demonstrate best practices and successful models in the implementation of advanced low-carbon technologies. The project is one of the priority initiatives under the APEC energy cooperation framework.

Methodology:

1. Participation of the planning offices of the three cities in several workshops and trainings in traffic administration and public transport route plan formulation conducted by domestic agencies such as the Land Transportation and Franchising Regulatory Board (LTFRB) and the Department of Transportation (DOTR).

2. Constant coordination through online meetings for planning and monitoring the implementation results of the agreed items in the cities` LPTRPs since early 2020.

THE TRI-CITY INITIATIVE IS PILOTING ON A PUBLIC TRANSPORTATION ROUTE SYSTEM AND OTHER ISSUES RELATING THERETO SUCH AS THE FORMULATION OF A LOCAL PUBLIC TRANSPORT ROUTE PLAN (LPTRP) AND THE INSTALLATION OF BIKE LANES.

Stakeholder engagement:

The stakeholders involved in the initiative are the neighboring LGUs, domestic government agencies such as the LTFRB and the DOTR, transport groups, establishments along the domestic highways and the riding public in general. These stakeholders were also involved in the meetings so as to get their input and include them in the preparation of the LPTRP.

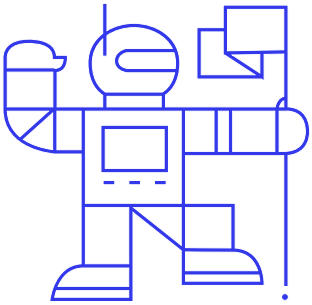
Policies:

The initiative has led to coordinated actions regarding public transportation, traffic rules and policies, identification of bus stops/terminals and connectivity of transport routes and bike lanes. In this respect, any new development that arises and concerns the three cities will be discussed within the Tri-City LGUs and agreed upon so the three cities act as one.

Financial aspects:

• The budget for the activities of this initiative is already included in the operational budget of every Local Government Unit. Therefore, there was no additional budget needed to implement this Tri-City cooperation.

• The long-term economic sustainability of the Tri-City Initiative is seen in the possibility of it being adapted to other programs and projects that will have to involve the cooperation of the three cities.



Implementation challenges:

• Each city has different rules and policies regarding their traffic management and public transport. Different timelines as well as different approaches in dealing with urban problems were the main challenges for the implementation of this inter-city cooperation.

• The initial challenge for setting up the coordination among the three cities was to establish collaborative connections between the neighboring LGUs and partnering Government Agencies, as well as contacting key responsible persons.

• Reliable internet connections for online meetings for everyone concerned, especially during COVID-pandemic related quarantines.

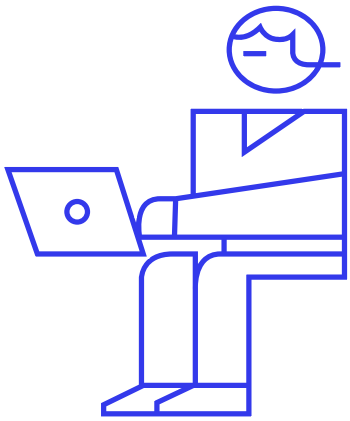
DIFFERENT TIMELINES AS WELL AS DIFFERENT APPROACHES IN DEALING WITH URBAN PROBLEMS WERE THE MAIN CHALLENGES FOR THE IMPLEMENTATION OF THIS INTER-CITY COOPERATION.

Results / Benefits

- Coordinated route systems.
- Synchronized traffic policies.
- Interconnected bike lanes collectively called the bike network.
- The present LPTRP of Mandaue has identified routes now serving the domestic highways, which were not considered by public transportations before.
- During the COVID-19 related community quarantine and general community quarantine period, the three cities acted uniformly, allowing only public buses as mode of transport, which served the front liners and essential workers.
- The coordination among the three LGUs benefits the general public and not just certain sectors.

No data has yet been gathered to measure its effectiveness but, on average, the initiative´s benefits are especially seen during this pandemic as essential workers and front liners were catered.

Lessons Learned and Policy Recommendations:



- The institutionalization of the Tri-City Initiative becomes an important aspect for ensuring the initiative´s overall long-term impact.
- Coordination and the adoption of an area-wide perspective are very important in the implementation of transportation plans, especially if there are many LGUs involved.
- The established inter-city cooperation is an opportunity for collective actions in addressing other type of issues and problems experienced by the cities, dealing with other area-wide urban issues such as river management, water management (sewerage, septage, and drainage), coastal management, air pollution and green building.

Conclusions

The Tri-City cooperation is a successful approach to integrate public transport plans and management tools in order to improve the public transport for all citizens of the three metropolitan areas, besides the existence of different related legislations.

A future challenge is to institutionalize this cooperation; in order to be sustainable over time and in case of eventual changes of LGU involved actors.

Evaluation Scoring

The Philippines: Tri-City Initiative on Public Transportation

Methodological complexity

Low

Financial complexity

Low

★★☆

Positive impact

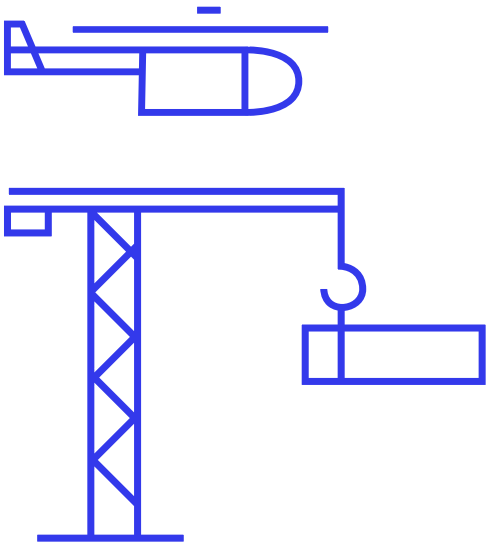
(Problem solving)

Medium

2.2 Smart City Initiatives

Infrastructure

Smart solutions for urban infrastructure management focus on the sustainability, resilience and efficiency of cities. This can include: waste, water, air, safety, healthcare and housing as well as education management. Examples are: initiatives which reduce the environmental impact of construction and demolition waste, building automation, energy and water efficiency, as well as security and health management and other examples from urban infrastructure management. The initiatives presented below address some of these topics.

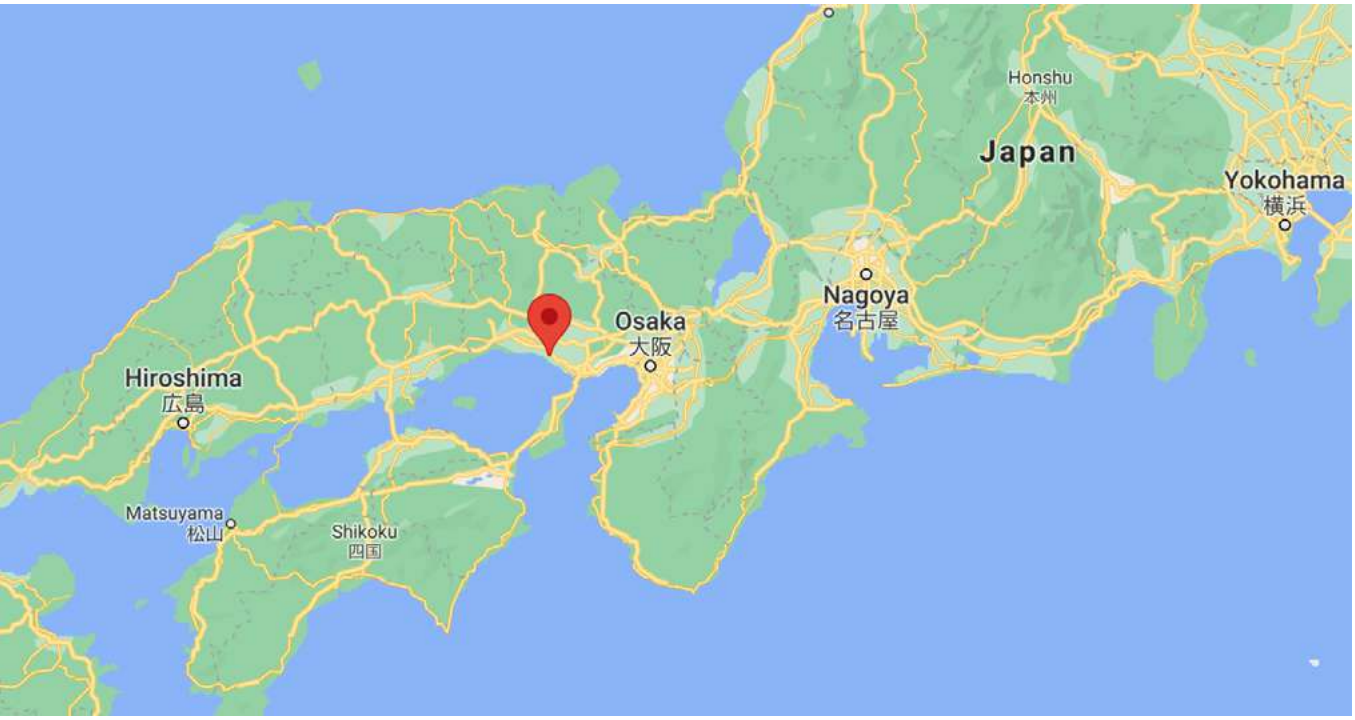


2.2.1 Japan:
Kakogawa Smart City Project

Kakogawa

Population:
262,300 inhabitants (2018)

GDP per capita of Japan:
40,247 USD (2019)



Japan is facing various problems in its cities, such as an aging society, a decline of the population, and an economic gap between urban and rural areas. In this context, the Ministry of Economy, Trade and Industry (METI) of Japan, emphasizes that the introduction of technologies utilizing data to improve the quality of life in compliance with personal information and privacy protection is important to revitalize cities.

Problem

In 2015, the crime rate[7] of Kakogawa city was the third worst in Hyogo, the prefecture where the city is located in. Also, Japan`s domestic violence rate, offenses by elderly as well as child abuse have grown since 2014; the number of people arrested over child abuse stood at 1,149 in 2018, rising from 242 in 1989[8]. Therefore, there was growing need for a safe and secure environment.

Solution

Kakogawa City set the target to become a "town selected by families with children". Therefore, the city promotes initiatives that utilize ICT platforms, which focus on the safety and security of the city in order to improve the living environment for families with children and strengthen the community's network.

One exemplary initiative in this context is the installation of several monitoring cameras in the whole city, especially in school zones. Each monitoring camera has a built-in "beacon tag (BLE tag) detector" which provides a monitoring service, sharing location information of people, such as children and elderly, with their families.

The city further enacted ordinances focusing on the collection and protection of personal information. These ordinances stipulate necessary items for proper and strict management and operation of monitoring cameras and how data will be used.

[7] Number of cases of street crime and invasion crime per 1,000 citizens
[8] Osumi, M. (2019)

Methodology:

The city administration held 12 civic "Open Meetings" in order to create understanding about the initiative and the monitoring cameras among the citizens. The mayor himself explained the initiative to the citizens, and the city started to implement the initiative once it confirmed that over 90% of the citizens expressed their agreement to it.

By March 2018, the city installed 900 monitoring cameras for purposes of crime prevention, mainly in school zones. 575 additional monitoring cameras were installed around parks, bicycle parkings and main road intersections by March 2019.

Moreover, Bluetooth Low Energy (BLE) tag detectors[9] were incorporated into the city's public vehicles, public facilities, postal vehicles and others in order to complement the monitoring cameras, while the tracking of images in private properties is strictly prohibited.

Appropriate masking of the video is applied to images of private property, in order to protect portrait and privacy rights of citizens.

12 civic "Open Meetings"

were held to gain explicit citizen support.

Stakeholder engagement:

The main actor in the realization of this initiative was the citizen. Kakogawa City carefully built the consensus with its citizens by conducting citizen surveys and holding public hearings when enacting the linked ordinances.

Policies:

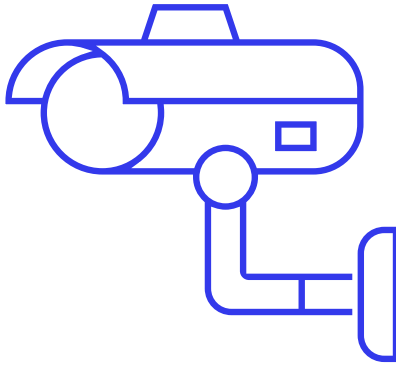
When the city installed the monitoring cameras, the city enacted ordinances for a proper and strict management and operation of the devices. These ordinances focus both on the collection, as well as the protection of personal information.

Furthermore, the initiative can be related to two follow-up policies within health prevention as well as road security: (1) the city started a healthcare demonstration project to detect early-stage Mild Cognitive Impairment (MCI) diseases with the private sector in August 2019. As the aging rate of the city stands at 29%, it became an urgent issue for the city to work on challenges in areas such as healthcare and welfare. (2) Another example is the road surface management; the city currently conducts a study on setting timing criteria for road repairments by analyzing GPS data, acceleration sensors data, image data among others, and using the communication network of vehicle video systems as an ad-hoc network in an emergency. It is expected that the data transmitted by moving vehicles can be applied to various kinds of services.

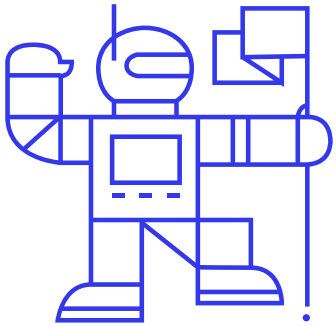
[9] A BLE TAG is a pocket-sized tag based on high performance RF technology, which is able to provide accurate identification of individuals` mobility patterns, as a complementary method or alternative to monitoring cameras. Please also refer to II. Glossary.

Financial Aspects:

The initiative was funded with public city budget and the distribution of local allocation tax for regional revitalization[10].



The initial investment for the installation of the monitoring cameras was approximately JPY 500 million (4,75 M USD) while the annual cost to operate the monitoring cameras is approximately JPY 60 million (570.000 USD). According to the city, this amount seems to be appropriate given the result of citizen satisfaction surveys although there is a room for improvement.



Implementation Challenges:

A lack of regulations about tracking and recordings was one of the biggest issues when the city started the initiative. Another challenge was how to install and operate such a large number of monitoring cameras. To solve these issues, the city enacted the ordinances in September 2017, which stipulate necessary items for proper and strict management as well as the operation of monitoring cameras.

Results/ Benefits

The crime rate of the city drastically decreased: in 2018, the crime rate of the city became lower than the overall average of Hyogo prefecture, while it was the third worst city in 2015. Also the citizens' awareness about security increased, as their satisfaction about the city´s safety and security rose: the ratio of those who are satisfied with the city's security measures increased from 51.3% in 2014 to 66.2% in 2020. Therefore, the city administration assumes that the quality of life has improved significantly.

[10] According to the Japanese Furusato Nozei Tax System, citizens can designate part of their tax burden as a financial contribution to a prefecture or municipality of their choice, thereby creating an alternative means of taxation. Source: Rausch, A. (2017).

The city uses two Key Performance Indicators (KPIs) to measure these benefits:

1) the number of criminal offenses and
2) the ratio of those who are satisfied with the city's security measures

The target of 1) was to achieve a 10% reduction in two years. As a result, there were 2,025 cases of criminal offense in 2019 versus 2,926 cases in 2017, showing a total decrease of 30%.

The second target was to increase the civic satisfaction on the city's security measures to 57% by 2020, versus its 51.3% satisfaction in 2014. The result showed 66.2% of satisfaction in 2020, exceeding the initial target.

One of the indirect impacts of the initiative is the abovementioned new service demonstration the city started in 2019; a healthcare demonstration project that aims to early detect MCI diseases by utilizing AI technologies, which analyze behavioral data of the elderly and data of appliance usage. It is expected that this will lead to an extension of the healthy life expectancy and a reduction of the social security cost. As of now, the city does not observe any negative impact of the initiative.

Implementation Challenges:

The KPIs confirm the effectiveness of the monitoring service; it is backed by the citizens' consensus and is provided by digital technologies. However, the monitoring costs represent an issue that has not been resolved. In order to optimize the cost for the initiative, services other than monitoring which use the same ICT platform may be developed.

In this respect, the accountability of the usage of the data collected by IoT devices cannot be stressed enough. Therefore, it is mandatory to gain understanding and agreement from the citizens about the installation of monitoring cameras and other IoT devices for infrastructure management, in order to develop smart city solutions.

THE KPIS CONFIRM THE EFFECTIVENESS OF THE MONITORING SERVICE; IT IS BACKED BY THE CITIZENS' CONSENSUS AND IS PROVIDED BY DIGITAL TECHNOLOGIES.

Conclusions

To realize a “citizen-centric” approach, the city focused on consensus building with citizens. Protection of personal images and privacy rights, especially through masking of personal images in video recordings, played an important role in gaining acceptance. As a result almost all citizens of the city accepted the installment of a large number of cameras in the city.

Evaluation Scoring

Japan:
Kakogawa Smart City Project

Methodological complexity

Medium

Financial complexity

Medium

Positive impact
(Problem solving)

★★★ **High**

2.2.2 Malaysia: Putrajaya Lake: The System of Environment Pollution Control at Source

Putrajaya Lake

Population:
Around 100.000 (2018)
Intended population: 350,000

GDP per capita of Malaysia:
11,373 USD (2018)

Putrajaya Lake is a man-made lake located at the centre of the city of Putrajaya, Malaysia's new federal administrative capital built in 1995. It is "designed to be the new home to all of Malaysia's federal government ministries and domestic level civil servants,"host all diplomatic activities of Malaysia, and function as a potent symbol of the Malaysia's ambitious modernization agenda".[11] The 400 hectare lake is designed to act as a cooling system for the whole city and also designated to recreation and water-based activities such as water sports, water transport and fishing. It has an average depth of 6.60m and a catchment area of 50.9 square kilometers.

[11] Moser, S. (2010)

Figure 6. *Firmly Embedded Extension of the Putrajaya Lake in the Eponymous City*

Source: Putrajaya Corporation

Problem

The water quality of the lake is an essential factor to ensure its environmental, social and also economical benefits as a natural asset that attracts thousands of visitors every year and provides the city with an important and characteristic blue infrastructure. Water quality measurements were regularly taken by the Putrajaya Corporation; however, laboratory analyses took up to 14 days to get the results. The officers in charge needed to proceed to the sampling site and send the sample to the laboratory. Whenever pollution incidents occurred at an upstream area, the enforcement act could not be carried out immediately. Thus, the pollution-causing offender could easily escape from any enforcement action.

Solution

In order to improve the water quality measurement and speed up the reaction time in case of pollution incidents, the city of Putrajaya implemented a continuous Lake Water Quality Monitoring programme, also known as Putrajaya Lake: The System of Environment Pollution Control at Source - Sistem

Kawalan Punca Pencemaran Alam Sekitar (SKPPAS). Since 2016, the spatial and temporal trends in water quality are determined by 21 physiochemical water quality data[12] monitored continuously for 24 hours by five selected stations, which have been selected as a hotspot area along the Putrajaya Lake, verifying that the water quality of Putrajaya Lake is suitable for the intended use of the lake. The monitored and observed real-time data from the stations are sent to a Command Center. Certain data, such as the hourly captured Water Quality Index, are also shared online with the public.

PUTRAJAYA LAKE: THE SYSTEM OF ENVIRONMENT POLLUTION CONTROL AT SOURCE – SISTEM KAWALAN PUNCA PENCEMARAN ALAM SEKITAR (SKPPAS)

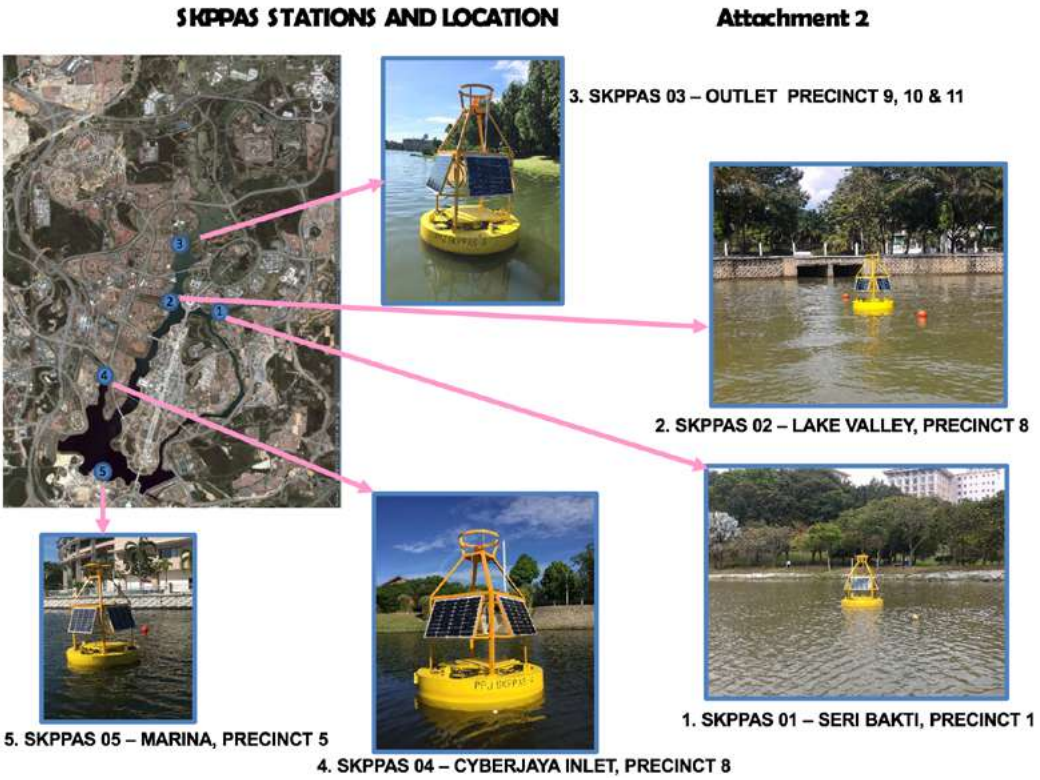


Figure 7. *Monitoring Stations in Putrajaya Lake*
Source: Putrajaya Corporation.

Methodology:

The Putrajaya Corporation, which is the local authority that administers the Federal Territory of Putrajaya, applied for an allocation budget from the Federal Government, which was approved in 2016. Subsequently, the contractor for the project was selected through an open tender, and the construction work on SKPPAS station commenced in June 2016; the installation process ended five months later.

[12] Water Quality Index, Ammoniac Nitrogen, pH, Dissolved Oxygen, Biological Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solid, Hydrocarbon Content, Blue Green Algae and some other important water quality parameters for the lake.

The two main required components that needed to be defined were the on-site physical equipment and the Data Server System at the Command Center. After the equipment installation stage, the observed data was tested and analyzed for six months to ensure that the received data reflected the desired lake water quality standard, which is class II of the Malaysian Water Quality Standard[13].

The observed data at the five measurement stations are used as a tracking indication device to assist in ensuring that the quality of the lake water remains within the permitted limits. The updated data can be found on the website http://enviro.ppj.gov.my on an hourly basis.

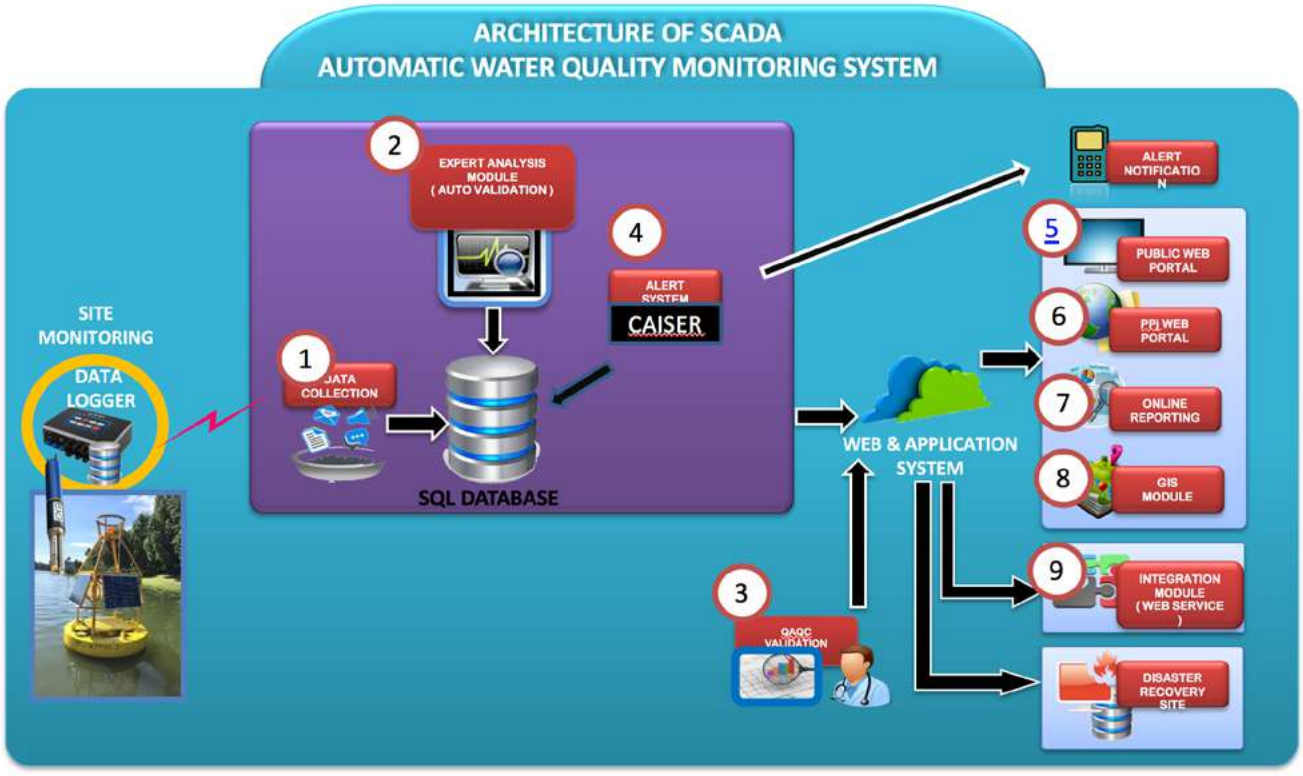


Figure 8. *SCADA Architecture of the Automatic Water Quality Monitoring System*

Source: Putrajaya Corporation.

[13] The water quality of the Putrajaya Lake has been designed to meet Class IIB of the Malaysian Water Quality Index for recreational purposes. Class IIB water quality requires dissolved oxygen (DO) levels between 5 and 7 mg L−1, pH ~6–9, ammonical nitrogen ≤0.3 mg L−1, biological oxygen demand (BOD) ≤3 mg L−1, chemical oxygen demand (COD) ≤25 mg L−1. The water should not contain visible debris and has low faecal coliforms, ≤400 count per 100 ml. Source: Sharip, Z.; Saman, J.; Noordin, N. et al. (2016) based on Perbadanan Putrajaya (2000): Catchment development and management plan for Putrajaya Lake. Perbadanan Putrajaya, Putrajaya.

Stakeholder Engagement:

This initiative was planned and implemented by the Department of Environment of Malaysia, the Water Regulatory Authority of the Region, Badan Kawal Selia Air Johor, as well as the private sector and the main contractor, Alam Sekitar Malaysia Sdn. Bhd.

Policies:

The initiative shall ensure that the lake water meets Class II of the Malaysian National Water Quality Standard, as set out in the Putrajaya Environmental Impact Assessment (EIA) Approval Conditions 1996. No new policy was required in order to develop and realize the initiative.

Financial Aspects:

The Ministry of Federal Territories of the Malaysian Government financed the SKPPAS System in 2016. It awarded 1,253 M USD, which covered the five-month installation and software development, as well as three years of scheduled maintenance.

The SPPKAS System is still functioning well. The System is expected to perform at its best capacity for the next seven years, if preventive maintenance is done regularly as per current practice. Long-term financial risks can be avoided due to the increasing number of professional knowledge on telemetry stations, preventing unnecessary spending on technical aspects and maintenance.

Implementation Challenges:

The main challenge during the development of SKPPAS System was to determine the selection of the most durable equipment in accordance with the weather conditions and environment of Putrajaya. Ensuring the system could function well with very low maintenance and within the estimated budget during the planning stage was also a challenge. To overcome the challenge, Putrajaya Corporation held a series of meetings, discussions and technical visits in collaboration with other agencies, including experts outside of Putrajaya.

Further, the selection of the station location, physiochemical parameters, sensors and probes, the data transmission method, power supply determination and software development were important elements that needed to be addressed before the SKPPAS System was successfully implemented.

Results/ Benefits

Since the establishment of the SKPPAS System in Putrajaya Lake, pollution incidents have been detected earlier and the effects of water quality damage can be controlled more efficiently within 24 hours. Putrajaya Corporation has improved its response time as pollution alarms are also triggered through smart phones.

The initiative maintains the water quality of the lake, which is measured by the Key Performance Indicator (KPI) of a minimum of Class II of the abovementioned Malaysia Water Quality Standard, and thus attracts a huge number of people to the lake - more than 1.5 million people every year enjoy the beautiful scenery of the Putrajaya Lake - in order to contribute to the Sustainable Development Goals (SDG) SDG 3-Good Health and Well–being; and SDG 11-Sustainable Cities and Communities.

The impact of deploying this innovative or advanced technology can be very essential in ensuring financial benefits for the authority: for a short-term impact, the government needs to invest to install and maintain the system. In the long run, the establishment of the SKPPAS System has brought economic impact compared with the rehabilitation of the lake in case a problem should occur. Until now, no negative impacts of the initiative have been observed.

Lessons learned and policy recommendations:

The existing SKPPAS System needs to be improved due to a new progress of infrastructure development in Putrajaya. New allocation budget is also needed to ensure that the lifespan of the existing SKPPAS System can be extended to more than 10 years.

Putrajaya Corporation welcomes APEC economies, which are interested in this solution, in order to share further for information with relevant parties.

Conclusions

The city of Putrajaya successfully implemented a real-time data-based measurement system of the lake water quality and was able to maintain the desired water quality standard. An outstanding criteria in this context is the fact that the hourly delivered Water Quality Index is being shared with the public through the government website http://enviro.ppj.gov.my.

Evaluation Scoring

Malaysia: Putrajaya Lake: The System of Environment Pollution Control at Source

Methodological complexity

Low

Financial complexity

Low

Positive impact

(Problem solving)

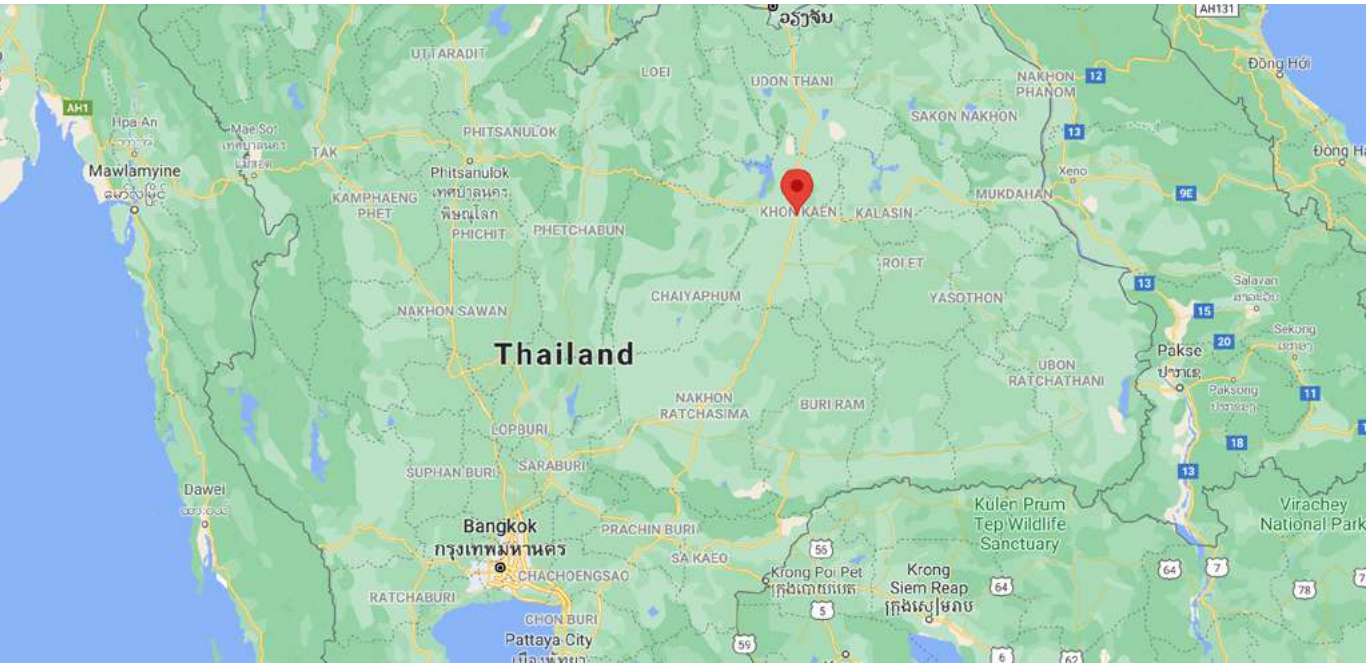
★★★ **High**

2.2.3 Thailand: Khon Kaen Smart Health

Khon Kaen

Population:
115,000 (2019)

GDP per capita of Thailand:
7,808.193 USD (2019)



Khon Kaen City, the ninth largest municipality in Thailand, and the central city of its northeastern region, home to the largest regional university and convention center. The city is the junction of main international and domestic railroads and the center of the economic region called NEEC - Northeast Economic Corridor. It holds about 200.000 residents with a growing urbanization in the past decades, resulting in higher land and housing prices. The purchase power of the city-dwelling residents is well performed; however, there is still a gap towards the sub-rural residents around the city with lower household incomes from farming and cheap labor.

Khon Kaen Province is one of the seven leading provinces selected for the Thailand Smart City National Agenda in 2017. The dynamic of the Smart City movement has reached multiple stakeholders in the areas of environment, energy, economy, mobility, living, people and governance. Khon Kaen City needs both the physical and digital infrastructure to expand systematically and sustainably in order to be inclusive for everyone and provide infrastructure equally and affordably. The city chose three development foci: Mobility, MICE[14] and Smart Health, as the main socioeconomic drivers of the city`s development.

Within the development area Smart Health, the "Connected Digital Health" program is one of the city`s flagship, which will be detailed below.

Problem

The increase of the aging population will soon surpass the economy`s public health capacity. Currently, Khon Kaen´s elderly population is 18% and will reach 21% in 2025. The majority of the elderly suffers one of the so-called non-communicable diseases (NCDs): diabetes, hypertension and cardiovascular disease, as well as chronic kidney diseases (CKDs). Both the central and local governments have already spent a large amount of their healthcare budget on the treatment of these diseases, while the required health budget increases every year. According to research and survey results, the reasons are; not empowering the patients to know their health status as well as the lack of well adjusted digital health technology in the public health service and personal health monitoring.

Solution

Khon Kaen implemented an integrated smart healthcare model denominated "Khon Kaen Smart Health", which incorporates three components: (1) preventive healthcare service, (2) smart ambulance/ambulance operation center and (3) health information exchange. It aims for a health perception transformation and thus, to provide a good design of the city´s healthcare infrastructure, which includes a seamless health connection from one´s home to the hospital and vice versa.

[14] The acronym 'MICE' stands for 'Meetings, Incentives, Conventions and Exhibitions'. It refers to a particular type of tourism in which large groups, usually planned well in advance, are brought together for some particular purpose. Source: https://www.thaiembassy.sg/friends-of-thailand/p/getting-to-know-mice-industry-in-thailand

The initiative follows a user-centric design, which puts the people at the center of all the services provided to them. It consists of (1) smart health monitoring from home using IoT medical and non-medical devices such as smart watches; (2) smart ambulance for emergencies and smart connected systems for health monitoring reports for the doctor; and a (3) Health Information Exchange (HIE) standard platform, where all medical and personal health records will be operated. Eventually, the overall aggregated data can be monitored and analyzed with AI to provide accurate predictions and personalized suggestions for better health outcome.

THE INITIATIVE AIMS FOR A HEALTH PERCEPTION TRANSFORMATION AND THUS, TO PROVIDE A GOOD DESIGN OF THE CITY'S HEALTHCARE INFRASTRUCTURE, WHICH INCLUDES A SEAMLESS HEALTH CONNECTION FROM ONE'S HOME TO THE HOSPITAL AND VICE VERSA.

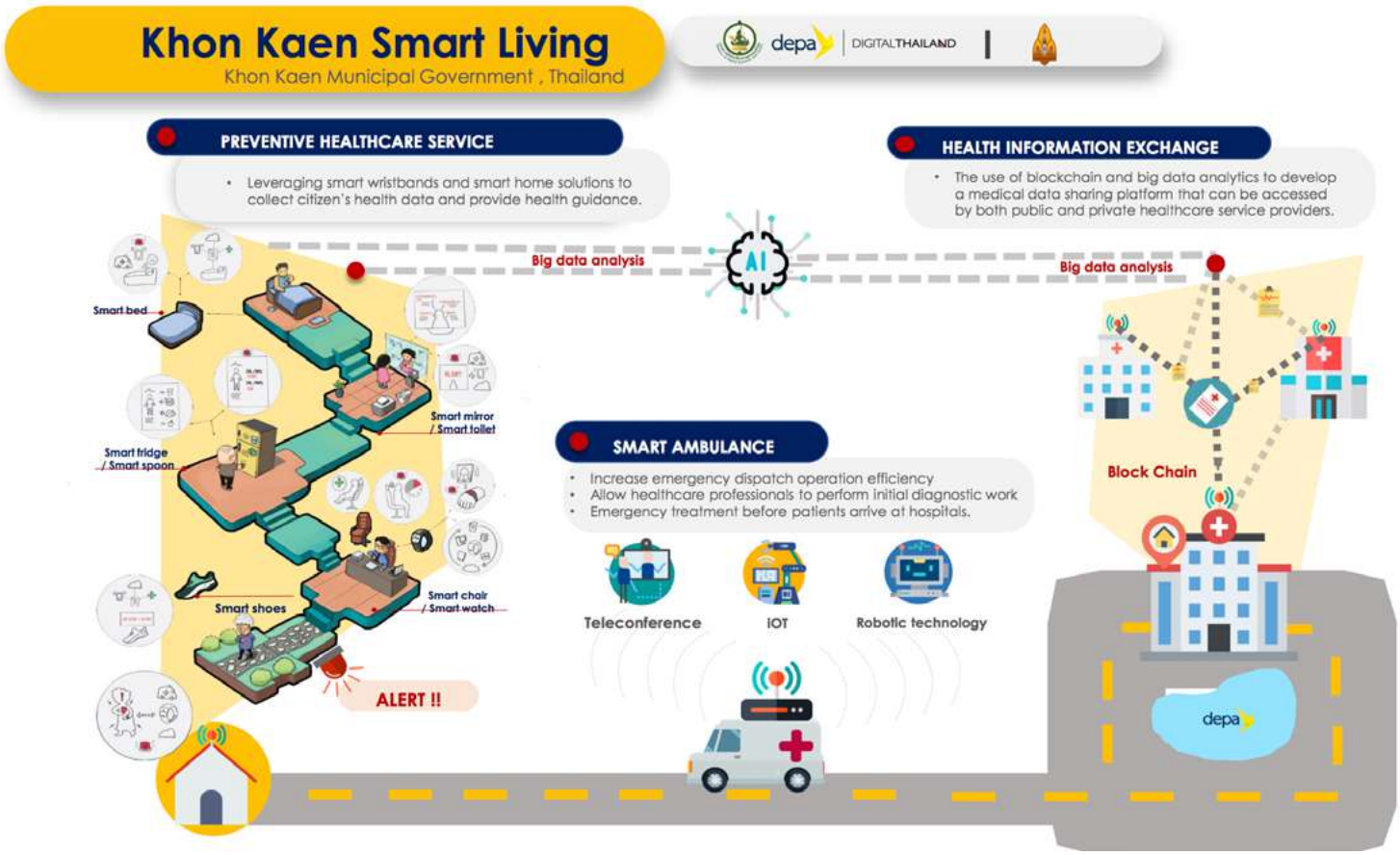


Figure 9. *Khon Kaen Smart Living Initiative*

Source: https://www.hfocus.org/sites/default/files/files_upload/khon_kaen_smart_living_in_khon_kaen_smart_city_27april2019_.chlthip.pdf

Methodology:

The initiative "Khon Kaen Smart Health" is the outcome of several digital health research projects from Khon Kaen University and a project called "Ambulance Operation Center" from Thailand's Digital Economy Promotion Agency (DEPA), which is the Secretariat of the National Steering Committee on Smart City Thailand. In order to demonstrate that the initiative and its people-centered approach were both practical and scalable, a Proof of Concept (PoC) was conducted.

As the main organization of this project, DEPA brought several key organizations together, setting up a multi-stakeholder alliance, based on a Memorandum of Understanding (MoU); the so-called "Khon Kaen Smart Living Lab (KKLL)[15]".

To elaborate on one of the three components of the Khon Kaen Smart Health initiative, the preventive healthcare focused on the following:

Smart digital health technology was introduced to elderly (60-75 years) of 30 households, monitoring their health with IoT devices during one year. Specifically, their glucose level, heart rate, blood pressure, steps, food saltiness, food types and sleep time were monitored. The elderly were considered active participants and taught to use blood pressure monitors, charging batteries and the corresponding IoT devices in order to know their own health status and use the information to manage their behavior. The KPIs applied to this group were: lower blood sugar, lower blood pressure, lower saltiness of food, higher steps, better sleep quality.

Furthermore, 125 village health volunteers and caregivers were introduced to and trained in the usage of the IoT medical devices and a corresponding Long Term Care application. The KPIs for this group considered: technology acceptance level, usability level (benefit of using the technology), ability to use the devices and application.

Also, 500 additional elderly people were introduced to and trained in the usage of smart watched. The KPIs applied to this group included: number of elderly people that are able to operate the device after training, number of devices active in the cloud after time passing.

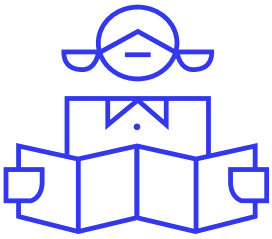
[15] A Living Lab is defined as a user-centered, open innovation ecosystem based on a systematic user co-creation approach, integrating research and innovation processes in real life communities and settings. Source: https://www.hfocus.org/sites/default/files/files_upload/khon_kaen_smart_living_in_khon_kaen_smart_city_27april2019_.chlthip.pdf

Stakeholder Engagement:

As a people-centered approach, all target groups were actively involved in the development of the initiative. Additionally, as "Khon Kaen Smart Health" was realized by means of the KKLL, its initial twelve organizations (2018) are considered the principal stakeholders. Up to 2020, the KKLL has doubled its number to 25 organizations.

Figure 10. *The initial 12 organization of the KKLL*

The target group of this initiative was a group of 30 elderly aged more than 60 years, with at least one chronically disease such as diabetes.



Policies:

"Khon Kaen Smart Health" follows the guideline of "Smart Living" set forth by DEPA (see Figure 15). The project continues to gain traction both locally and regionally; receiving various forms of support since Khon Kaen City has become one of Thailand´s Smart City Promotional Areas. In this respect, resources, public-private partnerships and public participation have contributed to an exponential growth of the city.

Financial Aspects:

The investment for this initiative was 2 M USD, designated to research activities, its design, development and implementation. The first allocated budget for this initiative was research funding from the Thailand Research Fund, assigned to find a suitable digital health technology for the elderly. Afterwards, additional budget was allocated by Khon Kaen University to define the fitting long-term care digital innovation that fits with the public health service of Khon Kaen municipality. Also, there was funding from DEPA to build an Ambulance Operation Center at Khon Kaen Hospital.

After the aforementioned projects were completed, Khon Kaen municipality allocated the budget to the provincial budgetary as well as the Khon Kaen municipality annual budget; it strived for promoting better health and smart living services for its citizens by means of the Khon Kaen City Health Data platform.

As health is both the key asset and the most important economic foundation, it is expected to further receive financial support from various stakeholders. The project also sustains itself through several possibilities; one is transforming the concept of health to "wellness". This way, the project may be able to benefit monetarily from Khon Kaen becoming a major regional as well as domestic wellness hub; not only focusing its programs on illness yet on the desire for overall health.

Implementation Challenges:

The main challenges faced during the implementation of "Khon Kaen Smart Health" were:

• A delayed implementation of the scheduled connected health agenda due to (1) a delayed implementation policy of the Ministry of Public Health (MoPH), (2) the lack of standardized health data across the economy, and (3) limited technological skills of the MoPH IT taskforce itself.

• Absence of domestic and local policies that offer adequate definitions and supporting guidelines for the correct implementation of Khon Kaen Smart Health. Even

though DEPA set up a National Smart City Policy including a guideline for seven sub-themes, there is none for smart health; the closest would be Smart Living and does not offer sufficient suggestions or support.

• The digital literacy of people, especially in terms of digital health literacy: not only the elderly presented lacks of technology skills and thus difficulties for learning and adopting new digital tools related to health, also health professionals suffered these knowledge gaps.

Hence, one of the lessons learned is the importance to train and equip the population/target groups in digital health literacy on both sides of the public health system: the caregivers as well as the caretakers.

Results/ Benefits

The initiative showed positive impacts on the group of elderly people as follows:

• The use of a salt detector enables the target group to know the salinity level of the food they consume, which leads to the decrease of their salt/sodium consumption

• The smart wristband enables the target group to know their own sleeping behaviors and body movements. Once acquired this knowledge, the target group showed higher tendency to realize more physical activities.

• The use of blood pressure monitors and smart glucose meters enables the target group to consistently monitor their blood pressure and blood sugar level, promoting behavioral changes. It was proven that patients with high blood pressure and sugar level achieved a decrease of both parameters within the first three months after.

This initiative is aligned with the Sustainable Development Agenda 2030, Target 3: Good Health and Well-being, with the aim to reduce the rate of premature deaths caused from non-communicable diseases with existing prevention and treatment options. This initiative strives for adding more channels in order to enable people to consistently monitor and learn about their own health state and

data by using health sensors and smart technologies; these build awareness of risk factors for non-communicable diseases, as well as provide advice and suggestions of proper behaviors. It was detected that participating volunteers of this initiative consumed less salt and sodium, had more physical activities and applied health labor to reduce high blood pressure and diabetes.

This initiative has won the first prize of the IDC Smart City Asia Pacific Awards 2018 and the prize in the category of Public Health and Social Services. Furthermore, in order to disseminate the results of this initiative, it has been presented in many exhibitions and conferences inside and outside the economy.

THIS INITIATIVE IS ALIGNED WITH THE SUSTAINABLE DEVELOPMENT AGENDA 2030, TARGET 3: GOOD HEALTH AND WELL-BEING, WITH THE AIM TO REDUCE THE RATE OF PREMATURE DEATHS CAUSED FROM NON-COMMUNICABLE DISEASES WITH EXISTING PREVENTION AND TREATMENT OPTIONS.

Lessons learned and policy recommendations:

• The initiative demonstrated a significant gap between the elderly and community health professionals, and the technology. It emphasized that an essential skill set is missing for embracing the technology in the healthcare services and personal health monitoring in order to empower its people. For implementing connected health in Thailand, based on a solid digital infrastructure and a people-centered approach, constant trainings are needed to familiarize the target groups with technologies and to understand its usefulness.

• One recommendation would be to push forward an agenda of Digital Health Empowerment for Elderly within APEC. Legal aspects like personal data and privacy acts may be adjusted to a simpler language and spread to a wider audience.

• Local governments dealing with public health services can set budget for training and capacity building, but not purchase the necessary technological devices. Thus, the challenge on how to access simple technology for the elderly remains, and arises the question on how social welfare or a policy of a local government may improve this issue.

Conclusions

This initiative is a good example for a successful use of technology to prevent or assess chronically health diseases. The initiative is in line with SDG 3: Good Health and Well-being, with the aim of reducing the rate of premature death caused from non-communicable diseases with prevention and treatment.

Evaluation Scoring

Thailand:
Khon Kaen Smart Health

Methodological complexity

High

Financial complexity

High

Positive impact
(Problem solving)

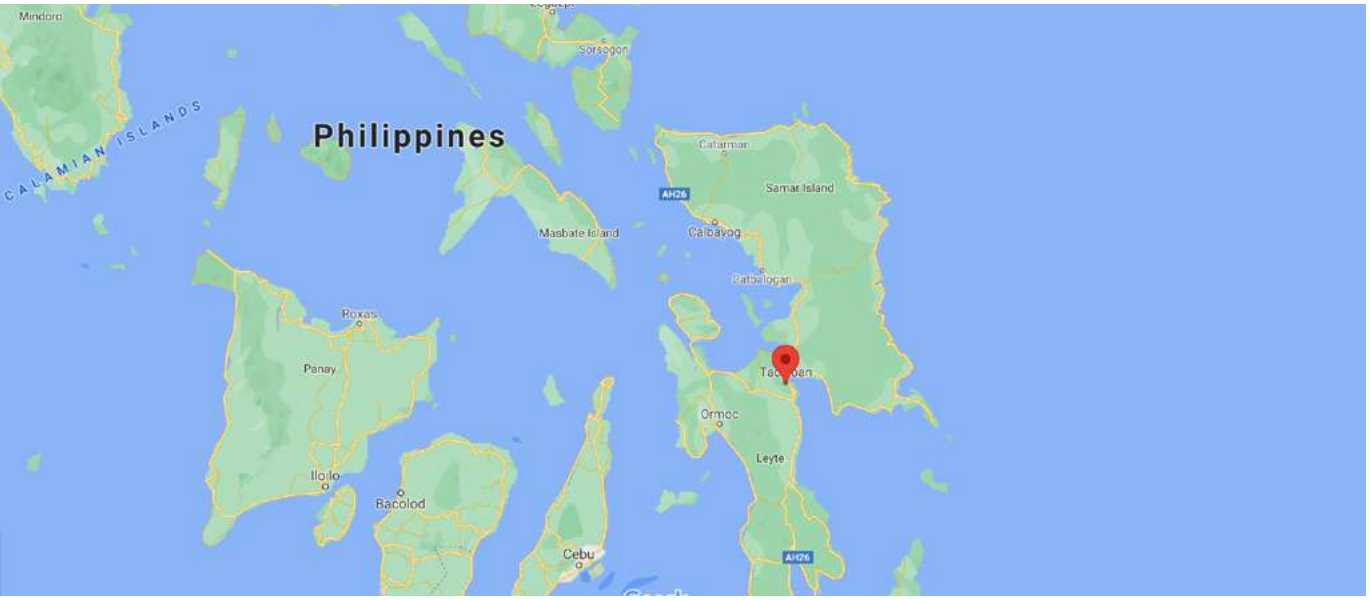
★★★ **High**

2.2.4 The Philippines: Tacloban SCAN System

Tacloban

Population:
242,089 (2015)

GDP per capita:
3,337 USD (2020)



The City of Tacloban is the premier city of the Eastern Visayas Region. It is the only Highly Urbanized City (HUC) of the region and is considered as the center of commerce and trade, banking, tourism, education and governance. The city ranked first in the Most Improved HUC in the 2017 Cities and Municipalities Competitiveness Index (CMCI) of the Department of Trade and Industry (DTI), and was finalist in the Search for the Most Business-Friendly Local Government Unit (LGU) in 2018 of the Philippine Chamber of Commerce and Industries (PCCI). In 2019, it received the Seal of Good Local Governance award of the Department of the Interior and Local Government (DILG). Tacloban serves as the gateway to the rest of the region through its various air, sea and land transport terminals. One of the priorities of the Tacloban

LGU is to strive for continuing its stature as the regional center. As emphasized in its Comprehensive Land Use Plan (CLUP), the LGU aims to institutionalize and mainstream climate change adaptation as well as disaster risk reduction and management in the local governance, and further promote the generation of economic opportunities for sustained socio-economic development.

Problem

Tacloban is considered as one of the most vulnerable places in terms of natural hazards. One such evidence is the devastation of the city by Super Typhoon Yolanda in 2013. The natural calamity caused millions of pesos of property damages and thousands of families displaced. Tacloban´s location besides the natural funnel of the San Juanico Strait and its adjacency to the Pacific Ocean continuously serve as a threat to its development.

During the Covid-19 pandemic, the city administration of this very commercial, regional gateway city faced the huge challenge of controlling the movement of people in order to prevent the spread of the virus.

Solution

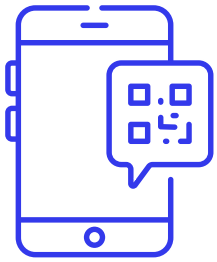
As an approach to rising up from the natural disaster, the LGU designed a system that encompasses the principles of resiliency and building back better in its operational mode. The “Tacloban Safe City application” was launched in 2016 as part of the Community Climate Guide and Response (CCGR) System in response to typhoon Yolanda and the need for centralized communication in times of emergency and disaster situations. The program used text blasting as an early warning to provide local residents with emergency advisory during calamities. Throughout the years, Tacloban Safe City evolved to include reporting concerns related to class status, water utility issues, garbage collection, and others.

With The Philippines in a state of public health emergency due to Covid-19, the city used the application for contact tracing, in order to control the spread of the coronavirus.

The Surveillance, Contact Tracing, Analysis, and Networking (SCAN) is a system devised to efficiently and effectively conduct contact tracing during the Covid-19 pandemic. SCAN is integrated into a bigger system - the "Tacloban Safe City app" - with the overall aim to deliver quick response in times of disasters and emergencies and offers a digital platform for surveillance activities.

Specifically, the system collects and analyses the name, address and contact details of individuals in Tacloban, including permanent or temporary residents, transients and tourists, so that public health officials can use the information for contact tracing. To do this, the application logs the individual entries, including each QR Code, ID Number and the corresponding entry date and time in a particular building and establishment.

The unique QR code given to the registrant can be read with an electronic scanner as identification prior to the entry in all government as well as non-government offices, business establishments and industries in Tacloban. Upon scanning, the application will either give a prompt that the respective individual is cleared to enter or deliver an alarm when a Covid-19 patient, probable or suspected coronavirus case, tries to enter a facility. In this case, the entry is denied and the Command Center immediately sends officers to pick up the respective person in the holding area of the establishment.



The application helps to ensure that returning Tacloban residents remain in isolation by identifying quarantine facilities for them. With the addition of SCAN, the city can monitor those who are still under mandatory quarantine and notify the Command Center in case of protocol violations. More importantly, the contacts of people who get infected with the coronavirus also receive an alert:

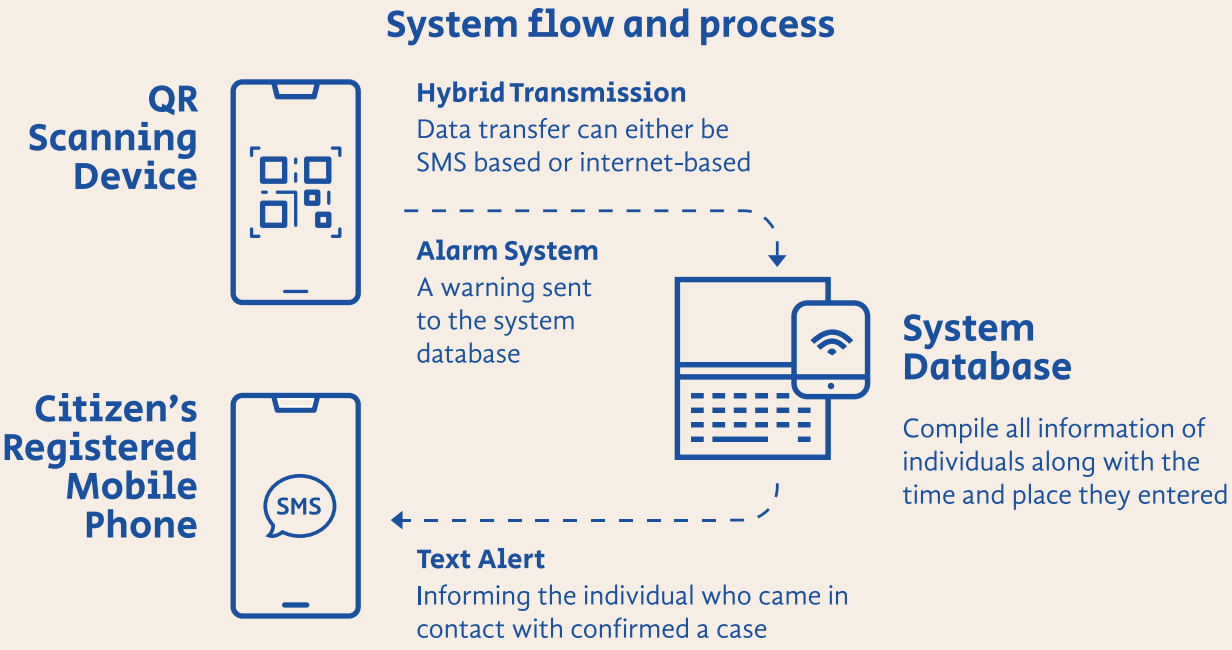


Figure 11. Operating of Tacloban SCAN System for Covid-19 Alert and Contact Tracing
Source: Tacloban City Planning and Development Office.

Methodology:

Tasked to contribute to the Covid-19 health emergency, the Management Information System (MIS) Division team designed a system that can easily involve stakeholders in its operation; constituents only use their mobile phones or tablets to generate a QR Code to establish mobility and trace possible linkages with positive cases. Through the use of modern technology, taking off from the existing Tacloban Safe City Application, the MIS expanded the function of the app to include functions for surveillance and contact tracing to support the Covid-19 response.

This requires that all individuals who need to undergo a 14-day isolation or home quarantine need to be tagged under the system as such. If these individuals attempt to enter an establishment using the QR code, the scanner used by the establishment will send an alert to the SCAN Command Center, informing them about the attempted entry and violation of quarantine protocols by the individuals.

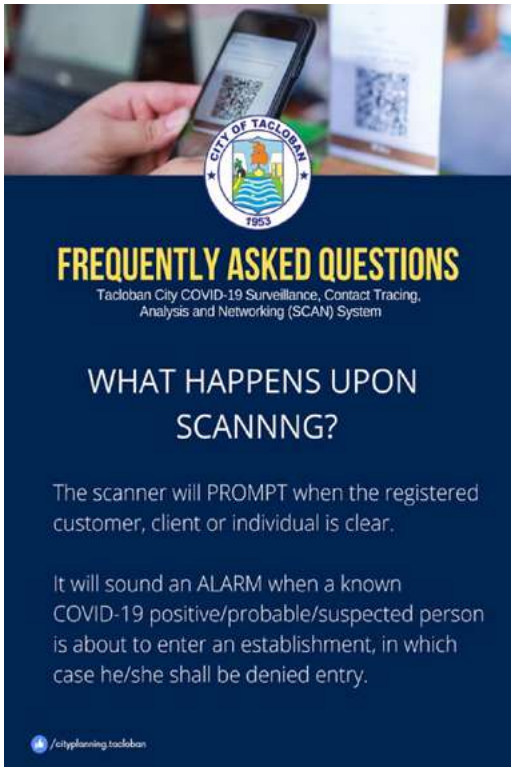


Figure 12. *Information Campaign about the operating principle of SCAN*
Source: Tacloban City Planning and Development Office.

Stakeholder Engagement:

As the fight to control the spread of Covid-19 is not only a concern of the government, the involvement of local stakeholders has been necessary to double-up and elevate efforts in the response. Continuing the tight connection of the government and the private sector through SCAN, the LGU has partnered with private and government institutions to strengthen connectivity. The MIS has conducted several trainings to business establishments and government agencies on how to operate the system.

The LGU has requested these facilities to require the use of the QR upon entry of clients. At present, a great number of facilities in the city have installed SCAN at their entrances. To introduce SCAN to a wider audience, the MIS Head presented the system during a City Development Council (CDC) meeting for members of the CDC, Barangay Officials and civil society organizations. The meeting was live streamed via Facebook for remote audiences. The LGU also conducted campaigns via diverse social media channels to inform the public about the application.

Figure 13. *Representatives of Business Establishments Attending Training about SCAN*
Source: Tacloban City Planning and Development Office.

As the SCAN system is implemented citywide, a holistic approach was applied, involving all relevant urban actors: *Barangays*, institutions, private establishments, government agencies, churches and hospitals, among others. Their active participation has been crucial to the effectiveness of the program.

Policies:

In adherence to Presidential Proclamation No. 922 declaring a State of Public Health Emergency throughout the Philippines and to support the implementation of SCAN, the Tacloban City Mayor issued an Executive Order (No. 2020-07-026) entitled "An Executive Order Institutionalizing the Tacloban City Covid-19 surveillance, Contact tracing, Analysis, and Networking (SCAN) System" on July 1, 2020, in order to improve and standardize the Covid-19 surveillance activity in the city. This Executive Order states that all data collected shall be under the custody of the Local Epidemiology and Surveillance Unit of the City Health Office (CHO), and that the analysis of such data can only be done by authorized personnel of the CHO and its counterparts at the Department of Health, using it only for public health purposes. The Order took effect on July 16, 2020, and will be in full force while the Public Health Emergency subsists.

Financial Aspects:

SCAN was conceptualized using LGU funds, which were charged under the Office of the Mayor. A total of 283,863.57 PHP (about 5.876 USD) has been allocated for the SCAN, covering hosting fees and office supplies used by the Command Center.

The LGU is currently in talks with the World Health Organization (WHO) for possible funding of the SCAN operations. The linkage with the WHO could be replicated by other economies as this involves health emergency response.

Implementation Challenges:

During the SCAN development, the MIS faced several challenges:

• Its compatibility with lower versions of the Android System: as it was developed using the newest Android processor, users of mobile phones with lower android versions had a hard time downloading the SCAN application.

• The deployment of the application to Google Play and App Store.

• The MIS had limited resources during the coding and testing phase.

• The developing team encountered issues in terms of cyber security and networking.

The MIS had to inform the public that only necessary information would be asked of them to register. This does not include information such as bank details, which are not necessary for contact tracing. To resolve these issues, the LGU issued QR codes to all inhabitants of the city for distribution to constituents who were not able to download the application on their phones and tablets.

Results/ Benefits

The SCAN application has helped the LGU in its efforts to contain the spread of the COVID-19 virus. The initiative prevents the spread of the virus by tracing the contactpoints of positive cases and providing appropriate health assistance.

As of October 5, 2020, six individuals - either people under monitoring, locally stranded individuals or confirmed Covid-19 cases - that violated health protocols were identified. The related information for each case was forwarded to the City Legal Office for possible prosecution. Additionally, the SCAN system received 157 emergency reports or alarms.

SCAN also assists in effective border control: non-resident individuals who are entering the city through the various borders, must fill out a registration form to be given a unique Tacloban Safe City SCAN Card with a QR Code to be used when they enter any establishment. Through this registration of non-residents in the SCAN system, contact tracing also goes beyond the boundaries of the city, in order to control the spread of the virus to areas outside the region.

Lastly, SCAN prevents the entry of individuals who are not permitted to enter public or private facilities, including minors and senior citizens who have other family members in their household to do their outside errands. As these individuals are vulnerable to the virus infection, they are not allowed to register in the system.

SCAN was launched on July 1, 2020. Until September 2020, the system already had 195,211 registered individuals, and 896 establishments and institutions implementing it. SCAN is an inclusive initiative in the fight against Covid-19. Individuals who are *allowed* to go outside of their residences are allowed to register and download or receive their QR codes from the LGU and the *barangays* (urban districts). The registration in the system does not discriminate against people of different gender and class.

The MIS regularly evaluates SCAN on its operational consistency by revising the information database e.g. whether the establishments using the app already uploaded their daily logs. The compliance of the establishments to the Executive Order is monitored by the Business Permits and Licensing Division (BPLD) of the LGU; it conducts random visitations of stores and offices. SCAN is seen as an important component of Tacloban City's holistic approach towards building a safe, secure, fair and resilient city. As the system requires sharing vital real-time information from different offices, it also provides the added benefit of strengthening linkages and cooperation among the offices involved.

THE SCAN APPLICATION HAS HELPED THE LGU IN ITS EFFORTS TO CONTAIN THE SPREAD OF THE COVID-19 VIRUS. THE INITIATIVE PREVENTS THE SPREAD OF THE VIRUS BY TRACING THE CONTACTPOINTS OF POSITIVE CASES AND PROVIDING APPROPRIATE HEALTH ASSISTANCE.

Based on its positive impacts, Tacloban is currently coordinating a region-wide expansion of the SCAN system with the Office of the Civil Defense and the Regional Inter-Agency Task Force on Emerging Infectious Diseases. The city is also in conversation with the WHO to recognize Tacloban as a model city in digital contact tracing in The Philippines and to adopt the system to the National Capital Region.

Lessons learned and policy recommendations:

An important lesson learned by the LGU during the development of the application was the preparation of a backup-plan for users: since not all stakeholders of the city own mobile gadgets, the LGU printed QR Codes and distributed these to their constituents. This way, all society groups have access to the app. To facilitate the surveillance and contact tracing and foster its

effectiveness, the support of the private sector becomes essential. By conducting trainings about the system and its benefits, more and more private institutions became involved in the tracking system, which led to a wider coverage of the app.

Since SCAN utilizes modern technology, it is essential for other APEC economies, which are also combating Covid-19, to strengthen their linkages between the government and the private sector. The private sector may possess the necessary or additional skills, technology and resources for the SCAN development and expansion, and therefore plays a vital role in the success of this initiative. In this context, it is highly recommended to follow a holistic development approach that involves a multi- sectorial and multi-generational mode.

Conclusions

The recently developed Covid-19 Surveillance, Contact Tracing, Analysis and Networking (SCAN) System application has served the city of Tacloban as an effective tool to improve and standardize COVID-19 contact tracing and has the potential to be expanded to other regions of The Philippines.

Evaluation Scoring

The Philippines: Tacloban SCAN System

Methodological complexity

Medium

Financial complexity

Low

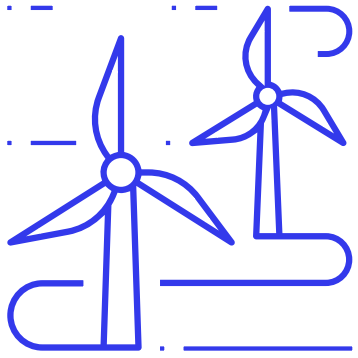
Positive impact
(Problem solving)

★★★ **High**

2.3. Smart City Initiatives

Energy

The globally growing energy demand, linked to the explosive growth of population and consumption habits which are, mainly, based on linear, not circular economic systems, requires intelligent solutions and strategies to reduce consumption and foster energy efficiency. One of the Sustainable Development Goals is to ensure access to affordable, reliable, sustainable and modern energy for all – a still significant challenge



in most of the APEC economies as well as other parts of the world.

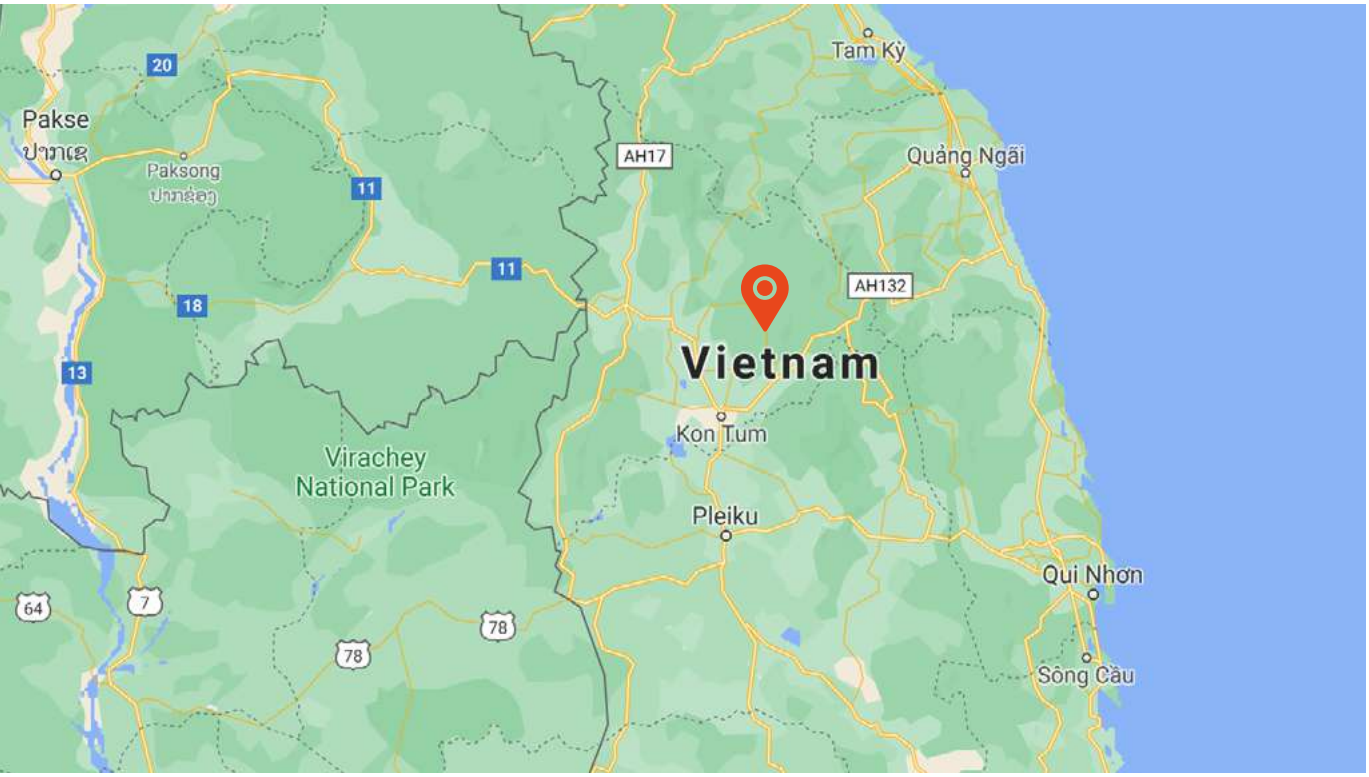
This section presents one successful smart city case study, a domestic-wide approach, which was delivered by the economy Viet Nam. It is important to emphasize that there exist multiple smart solutions related to energy supply among the Asia-Pacific economies; some of them can be reviewed on the APEC- Energy Smart Communities Initiative (ESCI) Knowledge Sharing Platform.

2.3.1 Viet Nam: Smart Grid Development

Viet Nam

Population:
97.3 million (2020)

GDP per capita:
2,566 USD (2018)



Viet Nam has been conducting various initiatives related to smart cities. Among these, the economy-wide project of smart grid[16] development is an outstanding initiative, which will be presented in this context.

[16] Smart Grid is a two-way interchange where both electricity and information can be exchanged in both directions between the power utilities and the consumers. It uses digital technology to improve reliability, security and efficiency of the power system and allows for especially volatile renewable energy, such as wind and solar power production to be integrated in a large scale into the domestic grid. In contrast, the current grid uses a limited one-way interaction, in which power flows from the power plant to the consumer. Source: http://gizenergy.org.vn/en/article/plans-viet-nams-smart-grid-development-2019

Problem

During the last decade, Viet Nam has experienced a steadily increasing energy demand; the annual growth rate of electricity demand between 2012 and 2018 was 11,21%[17] versus an annual average electricity supply (including imports) of 10,79% .

Strategies and action plans in order to close this demand-supply gap were needed. In 2020, Viet Nam's overall installed electricity generation capacity was 69.3 GW, mainly consisting of power production coal (31.1%), hydropower (30%), renewable energy (25.3%) and natural gas (10.3%). The economy has made efforts to increase its renewable energy share in power production substantially (800 MW for wind energy and 850 MW for solar up to 2020), according to the domestic Power Development Plan (PDP VII revised, March 2016). Successful incentive mechanisms for wind and solar energy development have driven this target. However, this transition of the power sector is a challenge to the domestic grid management, which has to ensure the electricity supply's reliability, long-term security and affordability[18].

Figure 14. *Viet Nam Transmission Grid (2018)*
Source: Huu, N. (2019)

Solution

With substantial foresight, the government of Viet Nam already issued Decision No. 1670/QD-TTg on the development of intelligent power grids in Viet Nam (in short: Smart Grid Road Map) on November 8, 2012. The Road Map aims to develop a smart grid with high technology support in order to improve the quality and reliability of Viet Nam's power supply; contribute demand side management, encourage energy saving measures and efficiency; create favorable conditions for the improvement of labor productivity, reduce the investment demand for generation and power networks; enhance the rational exploitation of energy resources; ensure Viet Nam's energy security as well as contribute to environmental protection and sustainable socioeconomic development.[19]The following figure resumes the overall targets of the Viet Nam Smart Grid Road Map:

[17] Huu, N. (2019) online.
[18] GIZ online: http://gizenergy.org.vn/en/article/plans-viet-nams-smart-grid-development-2019
[19] The International Bank for Reconstruction and Development/The World Bank (2016).

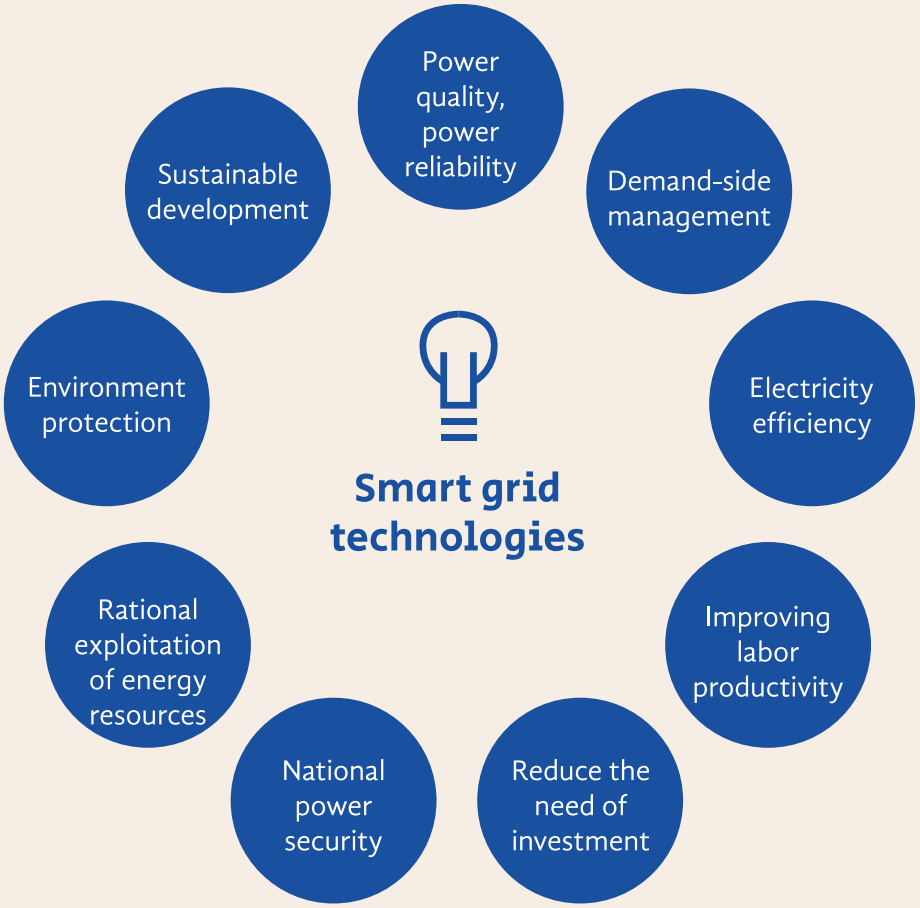


Figure 15. *Viet Nam Smart Grid Road Map – Overall Targets*
Source: Huu, N. (2019).

Currently, the smart grid project is being implemented according to the roadmap set out in Decision No. 1670/QD-TTg. In the third, post-2022 development period, a number of smart grid applications related to smart city development will be deployed, including the investment in a complete telemetry system for all customers using electricity, and expanding the installation of advanced metering infrastructure (AMI) for the customers, building a pilot smart home and smart city.

Methodology:

The underlying legal Decision No. 1670/QD-TTg defined three different phases for the development of the Vietnamese smart grid, consisting of various sub-programs. Phase 1/initial phase (2012-2016); Phase 2 (2017-2022); and Phase 3 (after 2022):

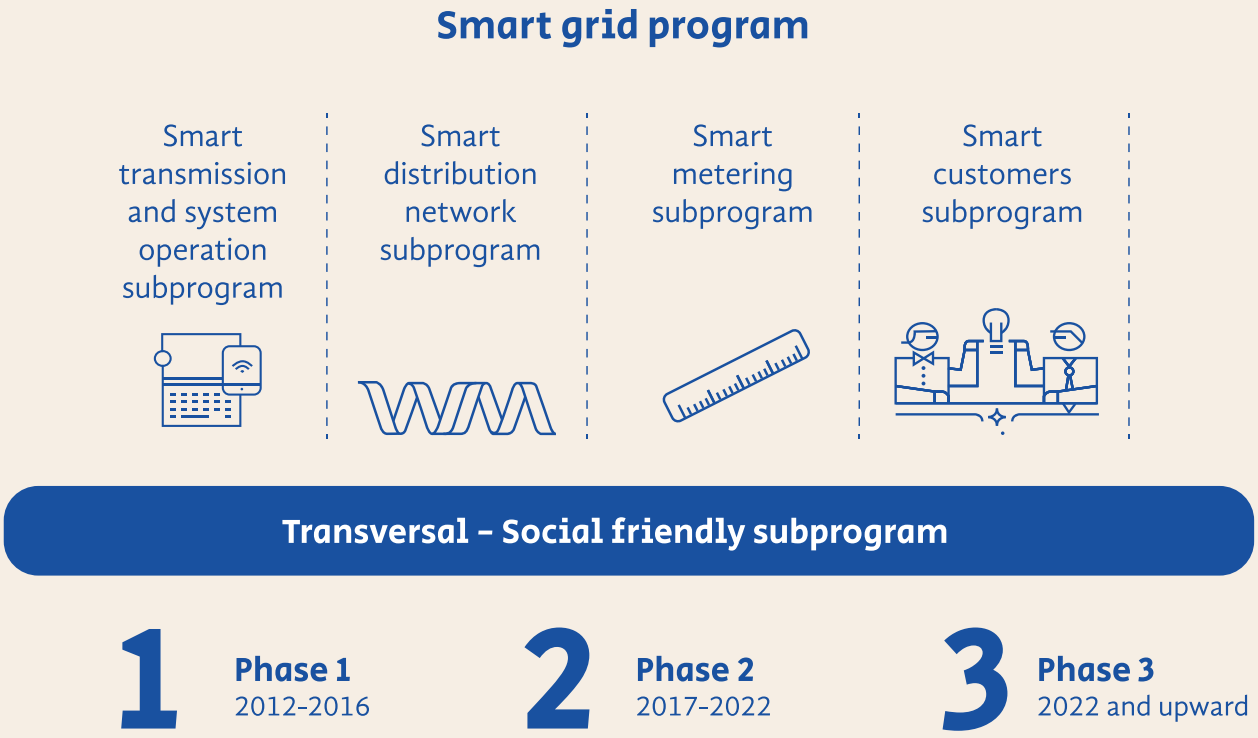
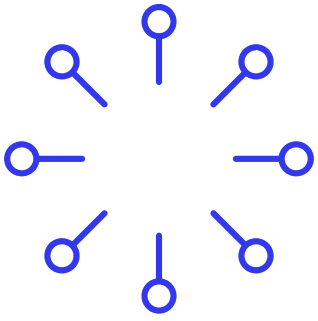


Figure 16. *Viet Nam Smart Grid Development – Implementation Phases and Steps*
Source: Huu, N. (2019).



The Road Map established detailed targets, including:

• The completion of legal documents for smart grid development and

• the implementation of the required IT infrastructure and Supervisory Control and Data Acquisition (SCADA).

The International Bank for Reconstruction and Development/ The World Bank (2016) delivers a very detailed technical and operational analysis about the specific aspects related to the smart grid development in Viet Nam.[20]

[20] Please refer to bibliography.

Stakeholder Engagement:

The government created a Smart Grid Development Steering Committee consisting of all relevant actors, to push forward the smart grid development:

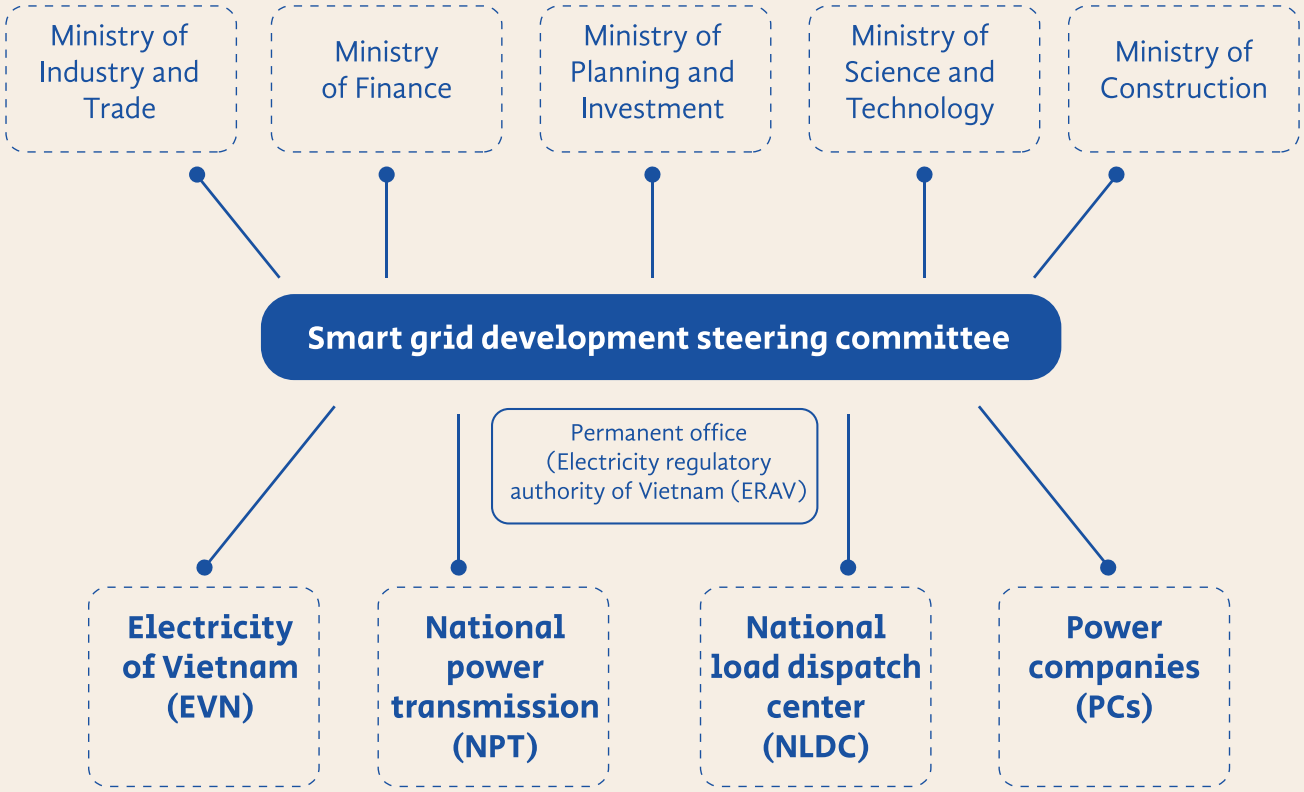


Figure 17. *Smart Grid Development Steering Committee*
Source: Huu, N. (2019).

The Ministry of Industry and Trade is the electricity regulatory authority of Viet Nam. To support the government of Viet Nam`s efforts, the World Bank has closely engaged with the National Power Transmission Corporation (NPT), the Electricity Regulatory Authority of Viet Nam (ERAV) and the National Load Dispatch Center (NLDC) to refine the existing Smart Grid Road Map on the basis of the lessons learned from the international experience with smart grid developments.[21] As the abovementioned figure shows, all relevant actors were included in the development process of the smart grid.

[21] The International Bank for Reconstruction and Development/The World Bank (2016).

THE INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT/THE WORLD BANK (2016) DELIVERS A VERY DETAILED TECHNICAL AND OPERATIONAL ANALYSIS ABOUT THE SPECIFIC ASPECTS RELATED TO THE SMART GRID DEVELOPMENT IN VIET NAM.

Policies:

On November 8, 2012, the Prime Minister of Viet Nam issued Decision No. 1670/QD-TTg approving the project "Developing Smart Grid" in Viet Nam, whose goal is to develop a smart grid with modern technology to improve electricity quality and the reliability of electricity supply. In the following years of the action plan implementation, the legal framework was extended by new regulations on:

• unmanned substations

• control center for power plants and substations

• technical requirements for renewable energy (wind, solar)

• a domestic program for demand-side management (Decision 279/QD-TTg dated 08/03/2018) and a demand response roadmap and implementation plan (Decision 175/QDBCT dated 28/01/2019)

• New feed-in tariffs for wind power (Decision 39/2018/QD-TTg dated 10/9/2018) of 8,5 US cents/kWh onshore and 9,8 US cents/kWh offshore

• Standard Power Purchase Agreements (PPAs) for wind projects (Circular 02/2019/TT-BCT dated 15/01/2019)

• New feed-in tariffs for solar power (Decision 11/2017/QD-TTg and 02/2019/QD-TTg dated 11/4/2017 and 08/01/2019) of 9,35 US cents/kWh

• Standard PPAs for solar projects (Circular 16/2017/TT-BCT dated 12/09/2017)

• Mechanisms to promote the development of solar power projects in Viet Nam (Decision 13/2020/QD-TTg dated 6/4/2020)

• Standard PPAs for solar projects (Circular 18/2020/TT-BCT dated 17/7/2020)

Stakeholder Engagement:

In general terms, the realization of the long-term smart grid development in Viet Nam, which is composed of different sub-programs, and its related policy measures, faces impacts of multiple parallel policies:

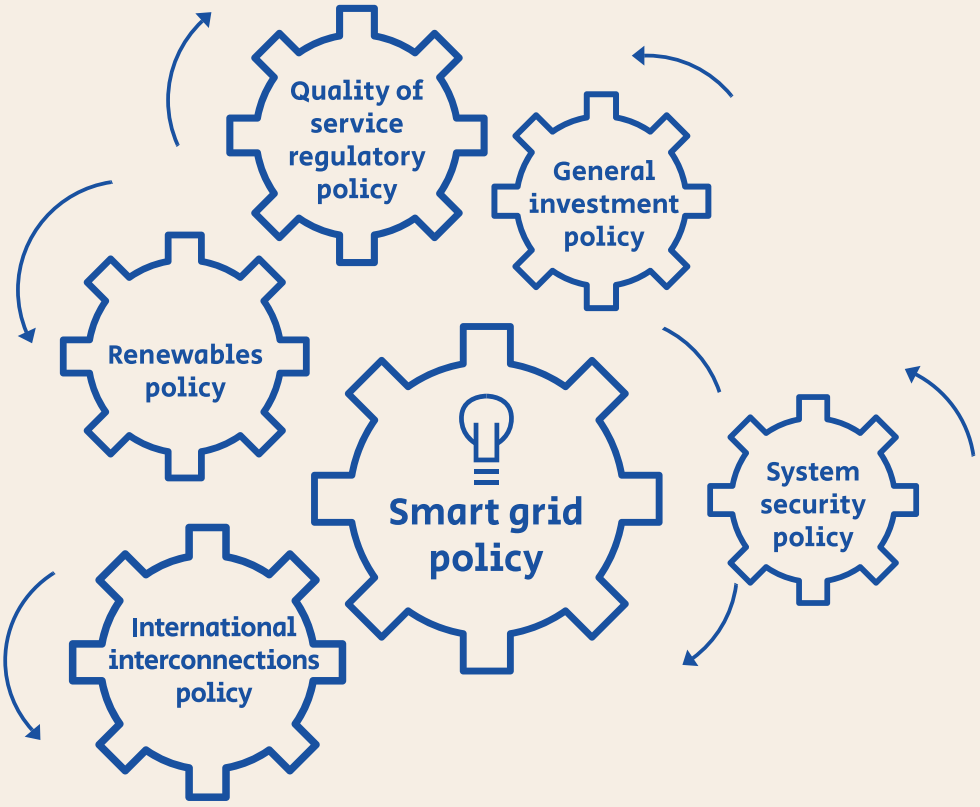


Figure 18. *Policies that Impact Smart Grids*
Source: The International Bank for Reconstruction and Development/The World Bank (2016).

These interdependencies of policies and regulatory mechanisms related to the energy market need to be assessed and taken into consideration in the context of this initiative.

A major, implementation challenge of this initiative is related to the regulation of electricity transmission, according to the analysis of the International Bank for Reconstruction and Development/The World Bank (2016):

First, transmission is subject to network externalities associated with real time operations such as loop flow, congestion and losses. (...) Second, investment in transmission networks exhibit significant economies of scale and scope, lumpiness and externality effects. Scale effects in transmission occur because the incremental cost of doubling the size of a new line may significantly lower the average cost per MW compared to a line only half the size. (...)Third, because of the strong network externalities associated with investments that both widen and deepen the transfer capability of the system (especially the high voltage system), expansion planning and investment processes suffer from a 'free-loader' problem. [22]

Results/ Benefits

In 2016, new SCADA systems were established and connected to all power plants with a capacity of above 30 MW. In 2020, 99% of big power plants with over 30MW capacity were SCADA connected, as well as 100% of the 500kV and 220kV substations each (97% in case of 110kV). Since the end of 2018, 99,7% of the power plants in Viet Nam has remote metering, as well as 100% substations (from 110kV and above).

In December 2019, the number of electronic meters, which were equipped to sell electricity to users, was 14,355,435 (accounting for about 52% of the total electricity meters sold to customers), of which 11,833,366 (accounting for 42.6% of total electricity meters sold to customers) were telemetry meters.

As of July 2020, the number of telemetry meters for electricity users in big cities such as Hanoi is 77%, in Ho Chi Minh City 50% and 100% in Da Nang City.

The rate of automatic substations has reached 77% of the total 110-220kV substations operating in the domestic power system. Technologies, solutions and equipment to improve automation of distribution grids are also gradually deployed.

Telemetry has contributed to increased labor productivity, transparency in power indexing and invoicing as well as improved customer service quality. The development of automatic substations and distribution grid automation programs have achieved many positive results, contributing to enhancing the power system operation efficiency, reducing power losses, and increasing the reliability of power supply and labor productivity.

[22] The International Bank for Reconstruction and Development/The World Bank (2016).

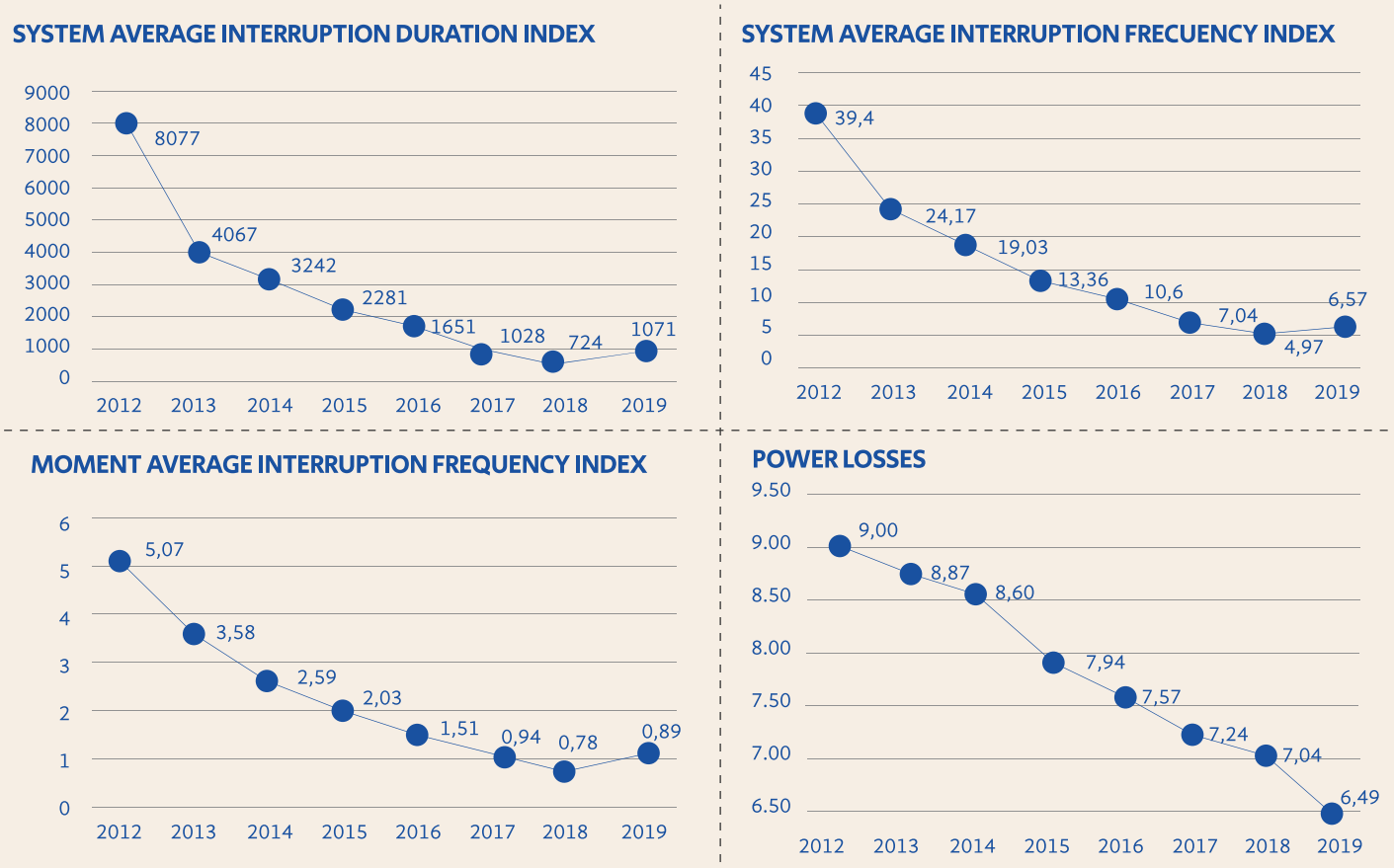


Figure 19. *Results of the Smart Grid Development in Viet Nam – Improved Reliability and Losses*
Source: Huu, N. (2019).

Lessons learned and policy recommendations:

According to the initiatives` analysis of the International Bank for Reconstruction and Development/The World Bank (2016),

• the willing and active participation of the main stakeholders is imperative to ensure a successful implementation of the Refined Roadmap (in case of Viet Nam, there are: ERAV, EVN, NPT, NLDC and PCs (Power Corporations) - main distributors in Viet Nam).

• the electricity law provides a basic legal framework in order to introduce new technologies like smart grid initiatives in the power system.

• it is recommended to create a Smart Grid Committee to both oversee and ensure the success of the smart grid initiatives. This approach will do much to reduce the risks associated with the introduction of new technologies and smooth the way

through the multi-layered approvals process.
• a Decision is required for approving the KPIs, which will control and monitor the smart grid initiative.

• the success of an initiative like this, depends on the commitment of the stakeholders, clearly defined roles and responsibilities and the possible pressure that can be exercised by the government and institutions.

Conclusions

The development of smart grids in Viet Nam has been very dynamic. A comprehensive package of measures was adopted, underpinned by several legal guidelines and incentive mechanisms, whereby significant achievements were made in a short-medium term.

According to The World Bank, *"given the approved Roadmap, the perceptions from the workshops and interviews and the consultant's experience in similar cases, the manner in which the Smart Grid initiatives have been introduced in Viet Nam, i.e. by Government Decision, is the most appropriate and indeed the recommended approach."* [23]

[23] The International Bank for Reconstruction and Development/The World Bank (2016) p. 266.

Evaluation Scoring

Viet Nam:
Smart Grid Development

Methodological complexity
insufficient information delivered

Financial complexity
insufficient information delivered

Positive impact
(Problem solving)

★★★ **High**

2.4. Smart City Initiatives

Cross Sectional

Some of the smart city initiatives delivered by the APEC economies are not only focused on one sector, yet adopt a rather cross-sectional focus, as the following case studies demonstrate.

2.4.1 Canada: Smart Cities Challenge

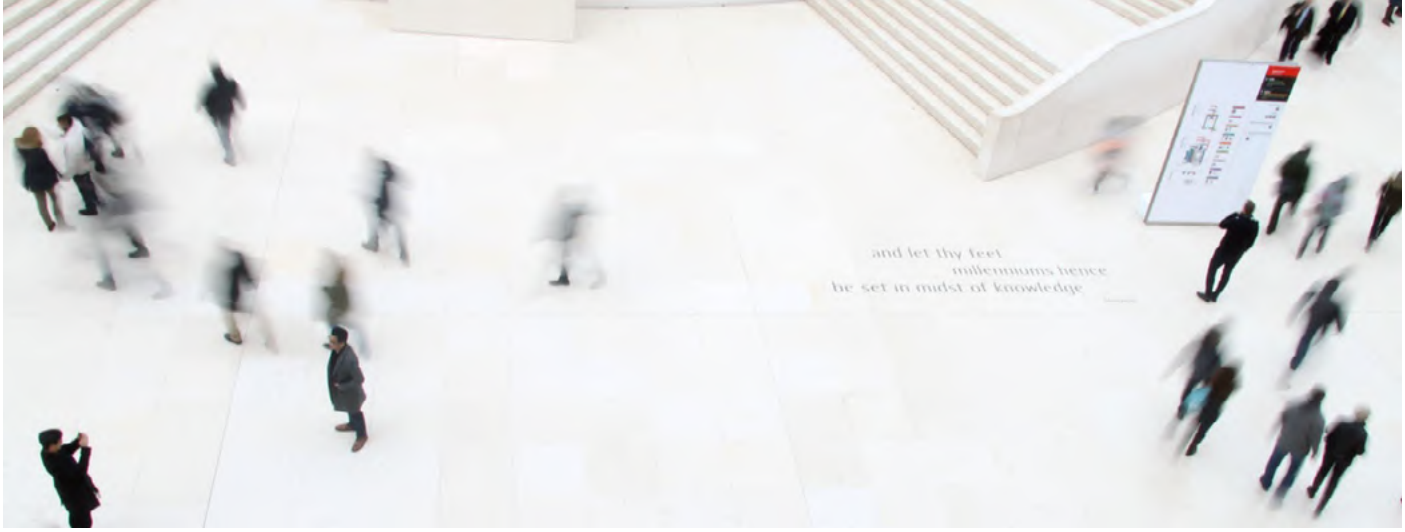
Canada

Inhabitants:
38 million (2019)

GDP per capita:
46,195. USD (2019)

As data and technology continue to evolve at a startling pace, communities worldwide have harnessed these tools to find innovative solutions to benefit society and improve local conditions for residents. Canada is working to encourage the adoption of smart city approaches, both through technology-driven solutions and data, to improve the lives of Canadians.

As a developed western economy with a huge landmass, small population and a significant number of rural, remote, Indigenous, coastal, and northern communities, this APEC economy brings a unique perspective to the implementation of smart city approaches that can contribute significantly to international dialogue and innovation.



Problem

THE SCC IS A $300 MILLION, 11-YEAR PROGRAM CONSISTING OF A CANADA-WIDE SMART CITY COMPETITION OPEN TO COMMUNITIES OF ALL SIZES

The challenges facing Canadian communities are diverse, including a changing climate, access to high-speed affordable internet, poverty, accessibility and mobility to name just a few. These challenges are also very context-specific. Each community faces their own unique blend of challenges.

Despite the high potential of smart city approaches for communities, their development was in the early stages in Canada, in part due to the lack of capacity for smart city planning and constrained budgets for innovation.

Solution

In 2017, the Government of Canada announced a suite of investments, including the "Smart Cities Challenge" (SCC). The SCC is a $300 million, 11-year program consisting of a Canada-wide smart city competition open to communities of all sizes, who can apply with their smart city projects and win one of four prizes ($5M, $10M, or $50M (CAD)). The SCC aims to incentivize innovation in Canadian communities by rewarding communities who use data and connected technology to solve local issues. The Challenge seeks to identify and mobilize around opportunities to address community needs as well as share and transfer these solutions to others.

Having noted international success with similar programs, SCC was envisaged as a way for municipalities to address pressing issues, and become more environmentally sound, economically prosperous, and socially just through exploring innovations in infrastructure, technology, and governance.

Methodology:

SCC encourages local governments, citizens, public and private sector organizations and the civil society to work together for the common good. Participating communities would create ambitious plans to improve the quality of life for their residents, through the implementation of connected technology and data-driven innovation.

As an experimental, outcomes-based program, the SCC is measured on the basis of an internal results framework. Outcomes include innovation capacity and socioeconomic improvements. Quantitative and qualitative data is collected and analyzed routinely. In addition, the program uses an innovative funding model, which links the projects´ payments to the achievement of concrete outcomes through outcomes-based Contribution Agreements. These agreements align funding to project outcomes and milestones, which are negotiated with each community to suit their unique project. The focus lies on evaluating each solution by closely monitoring its project outcomes, replicability, and impact. For example, Bridgewater, Nova Scotia's project, which aims to decrease energy poverty for residents, seeks to improve the health of residents and their quality of life, which will be measured by using survey data and a health index [24].

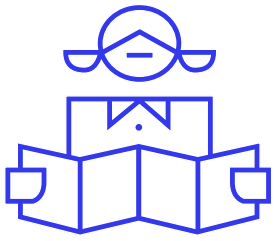
The SCC was also designed and implemented with inclusive innovation in mind, by integrating principles of openness, and engagement. An expert independent jury was used to ensure the technical capacities in adjudicating applications and further capacity building at the local level was supported through the Smart Cities Community Support Program [25].

[24] INFC SCC Website: https://www.infrastructure.gc.ca/cities-villes/winners-ann-gagnants-eng.html
[25] https://www.evergreen.ca/our-projects/community-solutions-network/

Stakeholder Engagement:

A wide array of stakeholders was consulted to inform the program design of the SCC – including other government departments working on innovation, provinces and territories, community and indigenous leaders, academics and researchers, international counterparts, municipal associations, National Indigenous Organizations, non-profits and community organizations, and Canadian innovation companies.

The Challenge was developed with the aim to prioritize community-led, resident-driven innovation, while encouraging applicants to develop multi-stakeholder partnerships: partnerships and community engagement were among the merit criteria used to assess applications. By creating a broad-based challenge, it was the communities themselves that had the task of engaging their residents to identify their most pressing local issues, in whatever manner they chose. Many also engaged with local community organizations, academia and researchers, as well as the private sector. The "bottom-up" approach of the Challenge means that communities work closely with residents to identify their challenge and propose smart city approaches to solve it.



Policies:

The SCC is a signature program of the Canadian Government's Impact Canada Initiative. Impact Canada introduced a new mission and outcomes-based approach in the federal government to help accelerate efforts toward solving Canada's big challenges. This initiative is led out of the Privy Council Office of Canada, and is part of a growing international trend to have dedicated innovation organizations focused on improving outcomes at the centre of government. This allows federal organizations to access special authorities to apply outcomes-based approaches using innovation methods such as challenges, behavioral insights, and pay-for-success funding, backed by rigorous evaluations.

The SCC did not result in new public policies; however, the creation of the SCC was facilitated by new government policies, such as the Impact Canada Initiative. Impact Canada introduced horizontal and flexible terms and conditions for grants and contributions, which departments can access for novel funding approaches, such as challenges and prizes. In particular, these new terms and conditions allow funding to be directly linked to the outcomes achieved – part of Impact Canada's 'pay for success' model. It also removed stacking limits and restrictions tying payments to eligible expenditures. This enabled challenge-based initiatives where prize values were linked to results, rather than expenditures.

THE SCC DID NOT RESULT IN NEW PUBLIC POLICIES; HOWEVER, THE CREATION OF THE SCC WAS FACILITATED BY NEW GOVERNMENT POLICIES, SUCH AS THE IMPACT CANADA INITIATIVE.

Financial Aspects:

SCC is funded entirely by the Government of Canada (led by the federal department, Infrastructure Canada), through three streams of the Investing in Canada Plan – public transit, green, and social. The winning communities of the Challenge have their projects funded by Infrastructure Canada, but are encouraged to leverage funding from other sources as well – including municipal and provincial budgets, private sector investment, and contributions from non-profits. Although it is too early to provide data, there are early indications that some non-winning projects are moving forward with their solutions by finding alternate public and/or private funding to support them.

The announced budget of the Challenge was $300,000,000 CAD, approximately $225,591,000 USD (2015). Due to COVID-19 pandemic, $31,000,000 CAD (August 2020) was repurposed for the Canada Healthy Communities Initiative [26].

The Challenge is meant to be a limited term mechanism that spurs innovation across the economy by directly funding winning communities, identifying replicable solutions, and boosting community capacity. Winning communities work with Infrastructure Canada to develop a funding agreement, which seeks to ensure the delivery of key outcomes in the timeframe agreed upon.

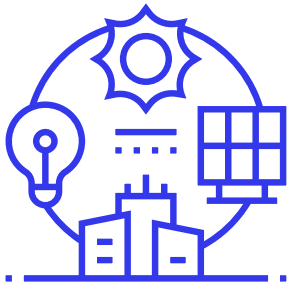
[26] INFC website: https://www.infrastructure.gc.ca/chci-iccs/index-eng.html

Implementation Challenges:

Some of the challenges encountered during the first SCC round included data and privacy considerations. Given that the Challenge encourages the use of technology-driven solutions that, in some cases, could involve the use and collection of data by communities, guidelines were developed with the assistance of a privacy working group. Finalist communities were required to work with provincial or federal privacy commissioners to ensure compliance with privacy legislation and include various privacy assessments with their submissions. Webinars and resources were provided to the communities in order to boost their understanding of privacy and data management.

Another implementation challenge was the varied capacity across Canadian communities. In some areas, basic connectivity challenges presented barriers to some forms of smart city projects – although interest in these approaches was noted across a range of communities with varying connectivity levels. Technology procurement was another sphere in which communities faced capacity challenges, as well as working with and mobilizing data. Through the Smart Cities Community Support Program, many communities are obtaining support and guidance in building their capacity in these and other areas related to smart city approaches.

In addition, it was found that the Challenge´s outcomes-based funding model and its more stringent requirements to demonstrate impact was fairly new to communities. As such, more resources were needed in order to boost capacity for outcome measurement and the data skills required in tracking and evaluating complex projects. Overall it took time for communities to turn their final proposals into implementation-ready projects, while extra time and resources to activate partnerships and set up offices and teams, were crucial when scaling to implement these projects.



Results/ Benefits

The first SCC round (2018-2019) received 130 applications from 225 communities addressing various socio-economic issues, including economic opportunity, empowerment and inclusion, environmental quality, healthy living and recreation, mobility, safety and security. Twenty submissions came directly from Indigenous communities.

Four winning communities were announced. The Town of Bridgewater, Nova Scotia was awarded the $5 million prize. The City of Guelph and Wellington County, Ontario and Nunavut Communities, Nunavut each received a $10 million prize. The City of Montreal, Quebec received the $50 million prize [27].

All information about the applying local communities, their topics and its contents are transparently presented online.

Figure 20. *Interactive Map of Applicants of the Smart Cities Challenge*
Source: Infrastructure Canada online: https://www.infrastructure.gc.ca/sc-vi/map-applications.php

In complement to the Challenge, the Smart Cities Community Support Program builds awareness and understanding of the benefits of applying a smart cities approach to communities across Canada. The program provides all communities in Canada with capacity-building resources and advisory services to ensure communities at various stages along the smart cities maturity continuum could benefit from the initiative.

[27] INFC SCC Website: https://www.infrastructure.gc.ca/cities-villes/winners-ann-gagnants-eng.html

Realize outcomes for residents

Because the Smart Cities Challenges is all about achieving outcomes, it will be vital for communities to measure where they are starting from, when they are making progress, and when they have achieved success. Establishing a baseline and measuring results will be central to doing this.

Empower communities to innovate

Communities should take risks and think big, identify significant, pressing, and perceived "un-solvable" problems, and achieve outcomes through data and connected technology.

Forge new partnerships and networks

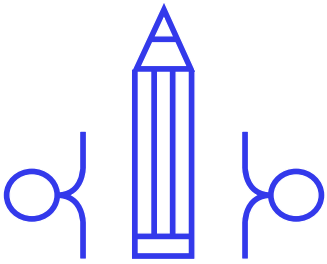
Communities will need to undertake meaningful engagement with residents, and forge relationships with new and non-traditional partners.

Spread the benefit to all Canadians

Smart city approaches should not only benefit a single community, they should be scalable and replicate across Canada.

Figure 21. *Objectives of the Smart Cities Challenge*
Source: Infrastructure Canada online: https://www.infrastructure.gc.ca/cities-villes/index-eng.html

With the winners of the first round of the challenge announced in the spring of 2019, the SCC Challenge is still in its early stages. However, the Government detected that it was effective in garnering widespread interest across Canadá in using smart city approaches at a local level. Early observations also found that the design of the Challenge itself yielded successes, chiefly the boost in resident engagement and encouragement to consider smart city approaches in city planning. Having an open-ended Challenge enabled resident-driven ideas that are responsive to local realities. Communities welcomed the opportunity to come forward with bold, new ideas and being provided a blank slate with few restrictions. A majority of participant communities reported that their participation led to increased technology use to solve community problems, introduced smart approaches and/or new ideas into community planning, and uncovered barriers to innovation. In addition, some communities reported that the SCC process allowed them to uncover previously unknown issues, which they are now committed to solving. Informal tracking shows that many program finalists, and even applicants, have continued with their smart city projects despite not winning, and are working in partnerships to implement their ideas.



Monitoring is in place to track the impact of the program on the winning communities. Some of the early benefits identified include; a positive discursive shift regarding smart cities, a 'tech for social outcomes' approach with a community emphasis, the promotion of multi-sectorial partnerships for communities, increased investment in smart city projects, and increased local innovation.

It is too early to tell what the socioeconomic impacts are, though these will be monitored. The four winning projects of the first round of the Challenge have ambitious expected outcomes which will improve the quality of life of their residents. For example, Guelph has set a goal to increase access to affordable nutritious food by 50%, create 50 new circular businesses and collaborations, and increase circular economic revenues by 50%.

THE SMART CITIES COMMUNITY SUPPORT PROGRAM RAISES AWARENESS AND UNDERSTANDING OF THE BENEFITS OF APPLYING A SMART CITY APPROACH TO COMMUNITIES ACROSS CANADA.

Lessons learned and policy recommendations:

• Some of the most salient lessons learned by the Challenge involved civic engagement: having an open-ended challenge invited place-based solutions and fostered collaboration that made sense for local realities, and therefore garnered buy-in by residents who saw the projects as addressing tangible issues. Resident engagement was therefore key to creating truly inclusive, accessible and relevant smart cities projects. We also learned that safeguarding the privacy of data – indeed, building privacy considerations into the program – was crucial for fostering trust in adopting smart city approaches.

• Another lesson learned is that the concept of smart cities continues to be relatively new in Canada, and that capacity-building and knowledge-sharing should be boosted in order to even the playing field. Providing funding for finalists to develop their proposals was one important instrument in this effort, as well as ensuring local governments have sufficient time to prepare their proposal.

• The Challenge demonstrated strong interest in innovative solutions in all parts of Canada, and in all kinds of communities. Its prize methodology is an innovative funding approach that seeks to accelerate progress towards ambitious goals by awarding innovation in a relatively new sphere.

The key recommendation, based on the experience of the SCC, is that building resident engagement and a commitment to privacy protection into program criteria will yield better solutions and increased community buy-in for smart city projects.

Conclusions

Launched in 2018, the Smart Cities Challenge is an example of a federally led domestic program that calls on communities, independent of their size, to identify the challenges they face to design tailored solutions to fit their local needs.

Evaluation Scoring

Canada:
Smart Cities Challenge

Methodological complexity
Medium

Financial complexity
High

Positive impact
(Problem solving)
Insufficient information (Due to recent start of the project)

2.4.2 China: Overall Plan of New-Type Smart City Construction of Shenzhen

Shenzhen

Population:
12,129 million (2019)

GDP per capita:
30,917 USD (2019)

China is at the midpoint of its urbanization—the largest scale in human history. The recent smart city movement is influencing the discourse and practice of China's urbanization, with numerous cities building smart cities and/or adopting some forms of smart city strategies and initiatives. Shenzhen, China's fastest-growing, experimental city, which grew from a fishing village into an international metropolis in just 40 years, has won the nickname of 'China's Silicon Valley' or 'China's smartest city'[28], as it is at the top level of smart city development in China.

[28] Hu, R. (2019).

Problem

As a highly modern city, Shenzhen is facing common problems in urban development such as resource sustainability, environment and social governance, traffic jams, insufficiency of community management and -services.

Solution

In July 2018, the overall Plan of New-Type Smart City Construction of Shenzhen Municipality was introduced. It aimed to fit the profile of Shenzhen as a modern and innovative metropolis, prioritizing the improvement of public services and the city`s managerial ability. The six objectives, which the city established were, to build:

1. a system of sensor networks covering the entire city's security, transport, environment and web space.

2. a system of E-public services based on individual and enterprise identities.

3. a system of policy-making support utilizing big data, information-sharing and artificial intelligence.

4. a system of integrated city operation and management.

5. a platform of innovation and entrepreneurship.

6. a platform of integrated services benefiting city residents.

AS A HIGHLY MODERN CITY, SHENZHEN IS FACING COMMON PROBLEMS IN URBAN DEVELOPMENT SUCH AS RESOURCE SUSTAINABILITY, ENVIRONMENT AND SOCIAL GOVERNANCE, TRAFFIC JAMS, INSUFFICIENCY OF COMMUNITY MANAGEMENT AND –SERVICES.

Also, the city gave priorities to ten specific projects:

1. High-speed broadband network

2. Comprehensive sensor network and the Internet of Things (IoT)

3. A city center of big data and a unified platform of cloud services

4. Smart operation and management to integrate government information sources

5. Enhancement of smart services for citizens and enterprises by capitalizing the advantages of the internet

6. A smart public security system in order to set up all-dimension prevention and control for public order, step up safe production supervision and build smart ports

7. Smart city maintenance optimization including low-carbon transport systems, consisting of the construction and upgrading of traffic information infrastructure, including an adaptive traffic signal control system, roadside parking sensors, LED screens, and the full transition to more than 16.000 electric buses. This project also consists of environment monitoring systems, including air, water and waste management systems.

8. Smart industry parks; by promoting big data exchange and providing high-speed optical fiber connection and new generation ICT infrastructure, the industry parks attract and encourage the establishment of SaaS (Software as a service) startups that focus on internet-based services such as industrial design, crowd sourcing design and online 3D printing.

9. Cyber security support

10. Standardization; by introducing laws and regulations regarding the openness, safety, protection and proper use of data.

The urban big data center that was built provides open services related to data resources and data-sharing. A smart city operation center (SCOC) is in charge of operation exhibitions, trans-domain business coordination and support services for decision-making. These two centers are designed as the “brains” of the city. Relying on them, Shenzhen is becoming capable of providing smart services in many different aspects:

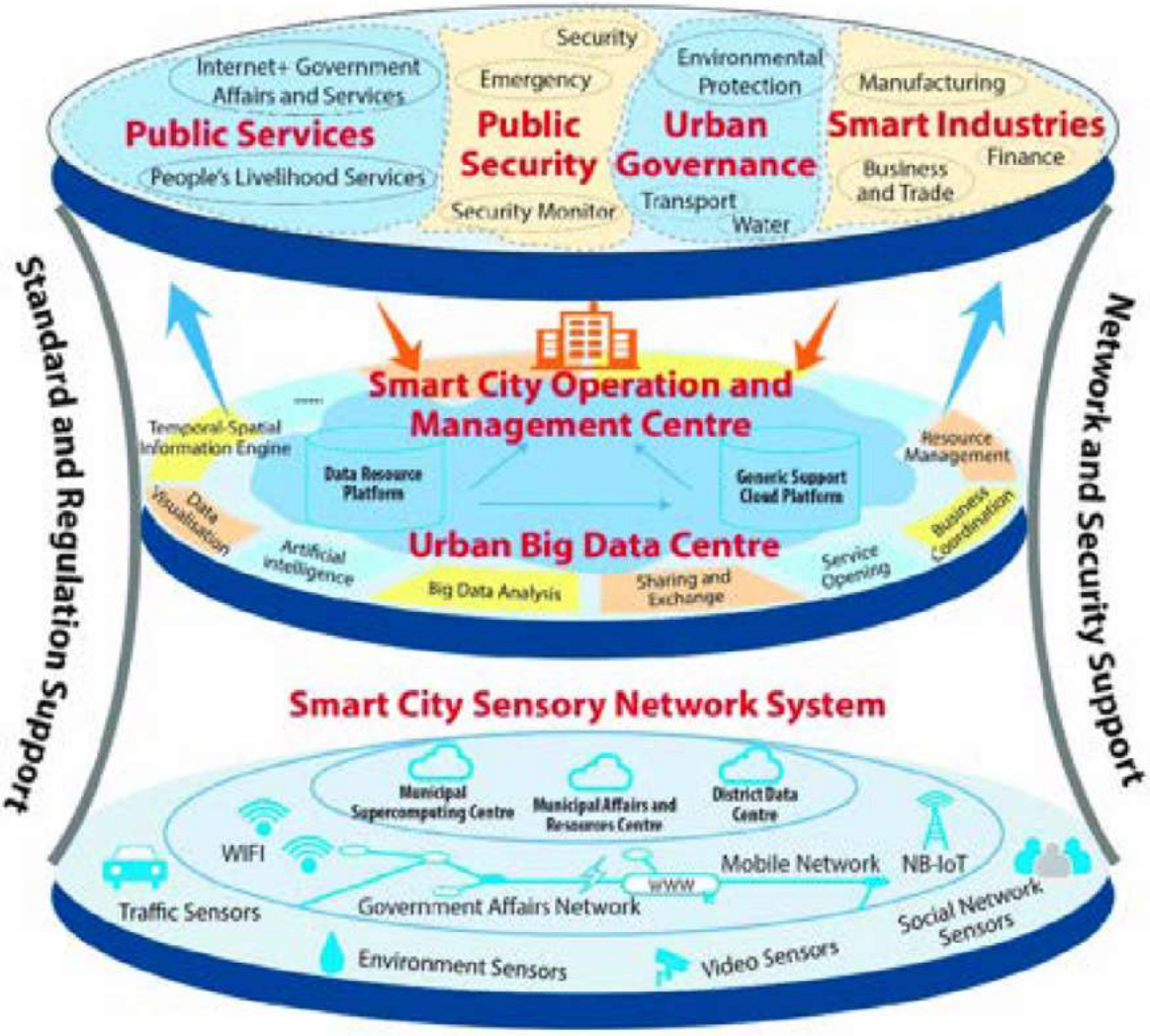


Figure 22. *Shenzhen's smart city functioning structure*
Source: Hu, R. (2019) based on Shenzhen Government (2019).

As Figure 24 shows, the framework of the whole functioning of the smart city solutions is composed by the network and security support, as well as standards and regulations. The whole system is based on the abovementioned technologies including sensors, WiFi, IoT, mobile networks and others.

Methodology:

In 2010, the goal to build "Smart Shenzhen" was suggested, and in 2015, this target was defined in its municipal work report. In 2016, China's 13th five-year Plan for Economic and Social Development explicitly proposed to build a batch of new-type demonstration smart cities, deeply integrating modern information technology and urban development.

Stakeholder Engagement:

China's smart city development is focused on a people-centered approach: all technologies and applications focus on "how the city can serve the people better", for example by making the citizens' lives more convenient, considering opportunities like paying the bills without leaving home, and quickly handling various businesses on the Internet.

Policies:

Since 2010, Shenzhen has introduced a series of policy documents and consistently upheld the high standards of smart city construction. In this ongoing process, upgrading the smart city is accompanied by a continuous improving of policy guidance.

Financial Aspects:

In general terms, smart city investment and financing in China have three main models: government appropriation, Public-Private-Partnership (PPP) and enterprise funding. The percentages vary along with the cities' development levels. Specific figures are not yet available. Normally, the projects last from one to five years, while the funding is distributed along different phases in order to ensure the progress and expectations of the project.

The smart city construction is essential for the development of a smart industry and digital economy, as well as for the optimization of business environments, the promotion of investment and business activities, the improvement of governance efficiency, the enhancement of linkages between the old, new industries and the internet, as well as for strengthening comprehensive competitiveness and providing strong impetus to economic growth.

Figure 23. *Smart Initiatives in Shenzhen*
Source: Hu, R. (2019).

Implementation Challenges:

While building smart cities, it is challenging to strengthen the guiding role of plans, innovate investment and financing models, and encourage the participation of more social capital. Currently, there are no commonly recognized international standards for the construction of smart cities. With international cooperation going deeper, standards among various cities, regions and even economies are expected to be continuously perfected and established. This might impact the existing smart city constructions, for example raising the management difficulties and construction costs.

Results/ Benefits

• Shenzhen is the first city in China covered by a complete 5G network. Furthermore, old and dilapidated residential areas in the city have been refurbished, and all-domain and high-speed Wi-Fi networks have reached 95% of them by 2018. The mass construction of 5G base stations is considered essential; 5G is the core technology to connect all types of terminals, realize high-speed and low-latency transmission and to promote the Internet of Everything.

• Through the objective and scientific top-down design and planning, the ability of Shenzhen's municipal government to provide public services has been greatly improved; public services have become more accessible, leading

to a significant improvement of public satisfaction and the efficiency of urban traffic management.

• Government efficiency, traffic congestion as well as community safety have all been significantly improved, whereby daily life has become more convenient.

• The people-centered approach is at the core idea of China's smart city development; therefore, it aims to benefit the citizens´ lives and generate more convenient and efficient services.

These results were measured through the ease of doing business index, public security index, citizen satisfaction surveys and other tools of statistical analysis. The city´s general premise is that the smart city benefits all citizens; in theory, all 13.4 million permanent residents in Shenzhen should benefit from its advanced developments. Also, smart city development has enhanced the momentum for economic growth: by optimizing urban governance, improving the living environment, streamlining administrative procedures and improving the quality of public services, efficiency has been increased, people's commute time shortened, the development of digital economy promoted and infrastructure construction boosted.

Lessons learned and policy recommendations:

• A long-term smart city strategy helps the government to formulate a more reasonable budget for the construction of smart cities. Through planning, enterprises and other commercial entities can clearly understand the future development and investment of various projects, which leads to better resource allocations.

• It is necessary to value the importance of internet governance and strengthen legislative protection of data security and privacy: this is an indispensable part of smart city constructions, as only by the guidance of laws and regulations smart cities will serve the people better.

• Smart cities give the push to industries to turn smart, transforming into new driving forces for economic growth.

•The construction of a smart city promotes the development of a digital economy, and improves the development environment and working conditions for SMEs and entrepreneurs.

• Local governments need to ensure coordination throughout the overall city planning in order to avoid the overlapping of duties, achieve synergy and harness the full potential of the smart city. Therefore, full play should be given to the government departments in charge of the overall planning process; facilitate data sharing and co-governance, and step up data security to unleash the full potential of data governance.

• Inter-linkage between individual smart cities should be strengthened in order to create smart city clusters, to improve the co-governance, to share best practices among them and thus, achieve higher levels of intelligent regional development and governance, enhancing overall regional competitiveness.

• ECONOMIES SHOULD STICK TO THE PEOPLE-CENTERED APPROACH, ENHANCE STRATEGIC PLANNING AND GUIDANCE, BREAK THROUGH THE "ISOLATED DATA ISLAND", AND BUILD AN INTEGRATED SMART CITY NETWORK.

• THE DEVELOPMENT OF SMART CITIES IS AN INTERDISCIPLINARY AND CROSS-SECTORAL WORK. COORDINATION AND GUIDANCE ARE ESSENTIAL. AGENCIES IN VARIOUS FIELDS MUST NOT ACT ON THEIR OWN.

Conclusions

Shenzhen belongs to the most developed cities in terms of the implementation of (smart) technologies and thus, it is a very interesting example for the overall functioning of a fully digitalized system with influence on nearly all areas of urban life. Certainly, the fact that the city is the base for two giant telecom firms—Huawei and Tencent – which contribute the most innovative hardware and software solutions, is a contributing factor in advancing the smart city movement in China, elevating Shenzhen in a domestically as well as internationally edgy position of smart city constructing.

Evaluation Scoring

China: Overall Plan of New-Type Smart City Construction of Shenzhen

Methodological complexity

High

Financial complexity

Insufficient information

Positive impact

(Problem solving)

★★★ **High**

2.4.3 Japan: Smart City Aizuwakamatsu

Aizuwakamatsu

Population:
Approximately 120.000 (2018)

GDP per capita:
34,300 USD (2018)

This midsized city in Fukushima prefecture about 200 km north of Tokyo, uses information and communication technology (ICT) and environmental technologies in various fields such as health, welfare, education, disaster prevention, energy, transportation and environment. The city aims to promote a resilient and strong community, which enables residents to live in peace and comfort.

Problem

The city of Aizuwakamatsu was facing issues, common throughout Japan and generally in great parts of the developed world: shrinking local industry, young people who preferred to live and work in bigger cities, and an aging population matched by low birthrates[29].

To remake itself and become a more attractive place to live for young people and to settle new businesses, the city recognized the need to innovate, implementing the use of new technologies.

Solution

Business and civic leaders are thinking through the strategic and cultural issues that matter most, by putting citizens at the center, drawing on big data to make better decisions, and collaborating across boundaries[30].

To promote data utilization, the city has established a digital information platform that provides diverse types of (regional) information on government services, analyzing and linking it to diverse types of data and introducing a personal authentication infrastructure. This makes it possible to develop and expand different information-providing applications, which meet the needs of each citizen through ICT devices.

Citizens of Aizuwakamatsu are free to choose, whether they want to share their data; the collected and visualized data comes only from those who have accepted. However, the digital information platform is open to all users who are interested in using it. Figure 16 shows the functional structure as well as all included services and applications of the digital information platform.

[29] Nakamura, S.; Okabe, H. (2019).
[30] Nakamura, S.; Okabe, H. (2019).

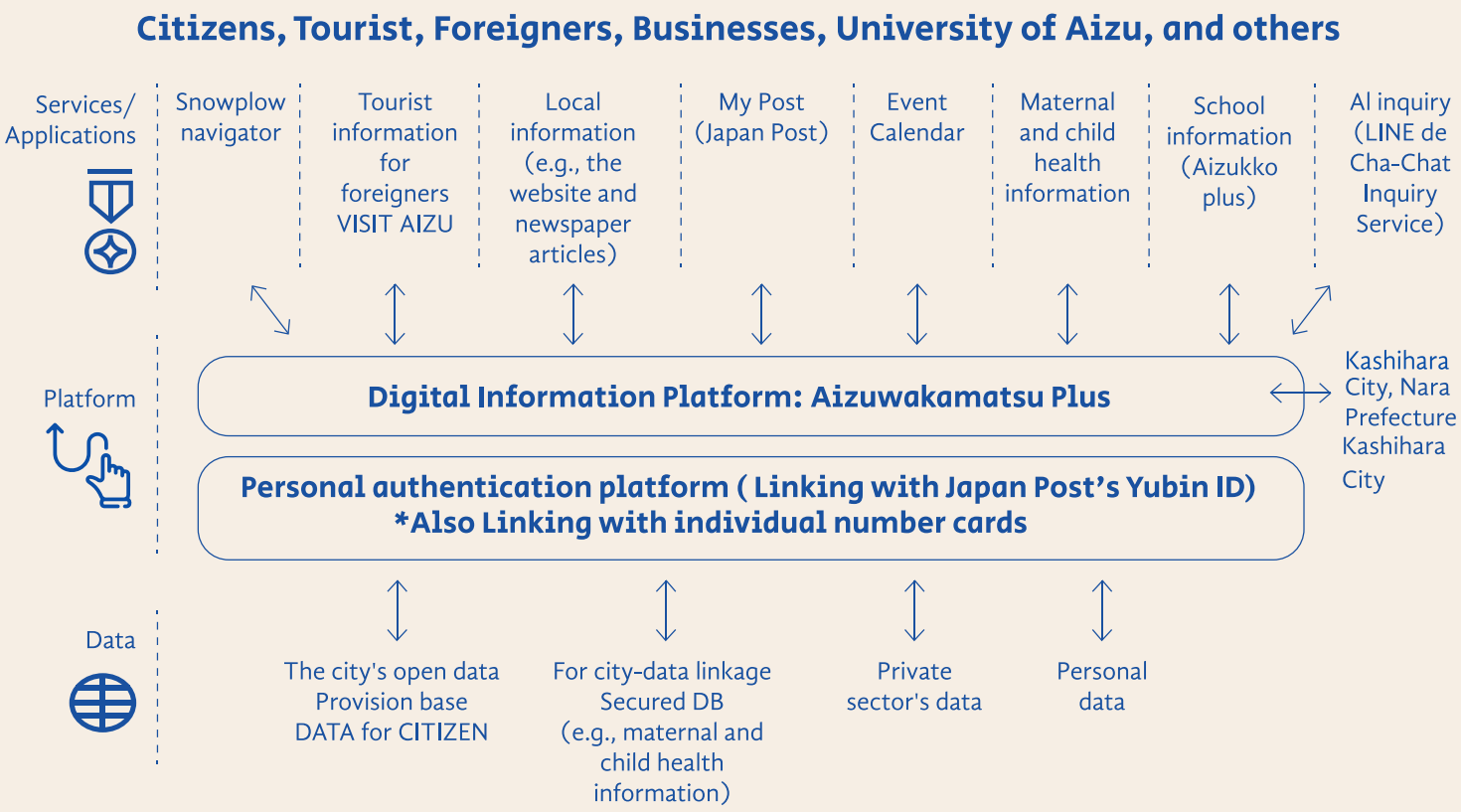


Figure 24.*The Digital Information Platform of Aizuwakamatsu City*

Source: Aizuwakamatsu City.

Additionally, the agriculture sector of the city, has installed sensors in order to automatically supply the hydroponic soil cultivation system with water and fertilizer. The hydroponic soil cultivation system is one of the Smart City Aizuwakamatsu initiatives, which automatically supplies the optimal amount of water and fertilizer based on sensor-measured data to improve productivity and efficiency.

Methodology:

The city implemented the initiative considering, in a first step, the issues to be solved based on the citizens` voices. In a second step, the city requested member companies of the Aizu Regional Smart City Promotion Council - in which several regional businesses participate - to propose solutions. This way, companies who wish to participate in a project, are asked to submit their proposals. The Aizu Regional Smart City Promotion Council implements the business plan.

THE 'OPT-IN' MODEL, WHERE EACH SERVICE IS EXPRESSLY GIVEN PERMISSION TO COLLECT PERSONAL DATA, IS THE CITY' S STRATEGY TO GAIN THE RESIDENT'S TRUST, AS WITHOUT THIS, SMART URBAN DEVELOPMENT WILL NOT SUCCEED.

Residents choose if they want to provide personal information in exchange for smart services. This so-called 'opt-in'-model, where each service is expressly given permission to collect personal data, is the cities` strategy to gain the residents' trust, as without this, smart urban developments will not succeed.

The Digital Information Platform of Aizuwakamatsu City links the data provided by the citizens with companies, which can develop and provide effective and efficient business solutions based on the citizens´ needs[31]:

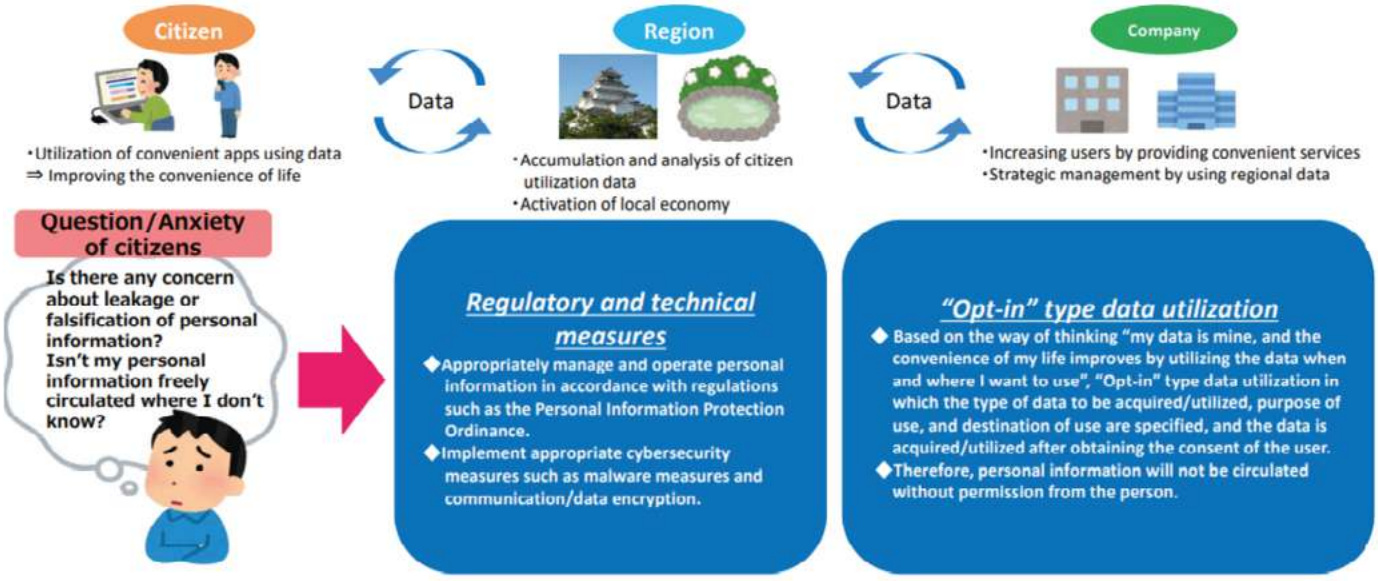


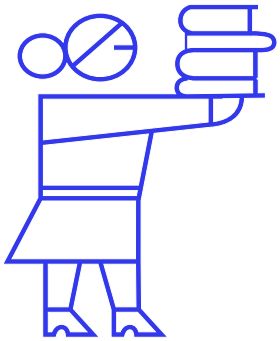
Figure 25. *Smart City Aizuwakamatsu: The way of thinking the data utilization*
Source: Aizuwakamatsu City.

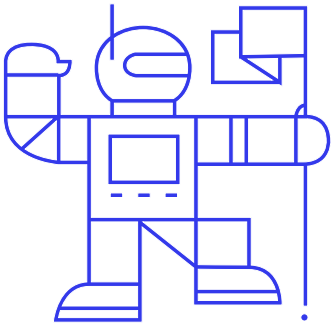
[31] https://asia.nikkei.com/Business/Business-trends/Small-Japanese-towns-look-to-lead-world-in-smart-city-tech

Stakeholder Engagement:

The Smart City Aizuwakamatsu is based on a people-centered approach. It is the citizens who detect the issues to be solved and the government and private sector to develop the plans for implementation and its respective technological solutions.

In this respect, the "Aizuwakamatsu City Comprehensive Cooperation Council for overcoming population decline and vitalizing local economy", which is a council composed by government officials, industry, academy, financial sector and media, has been set up to develop the business plans and to implement the Plan-Do-Check-Act (PDCA) cycle. The responsible party for implementing the business plan is the Aizu Regional Smart City Promotion Council.





Implementation Challenges:

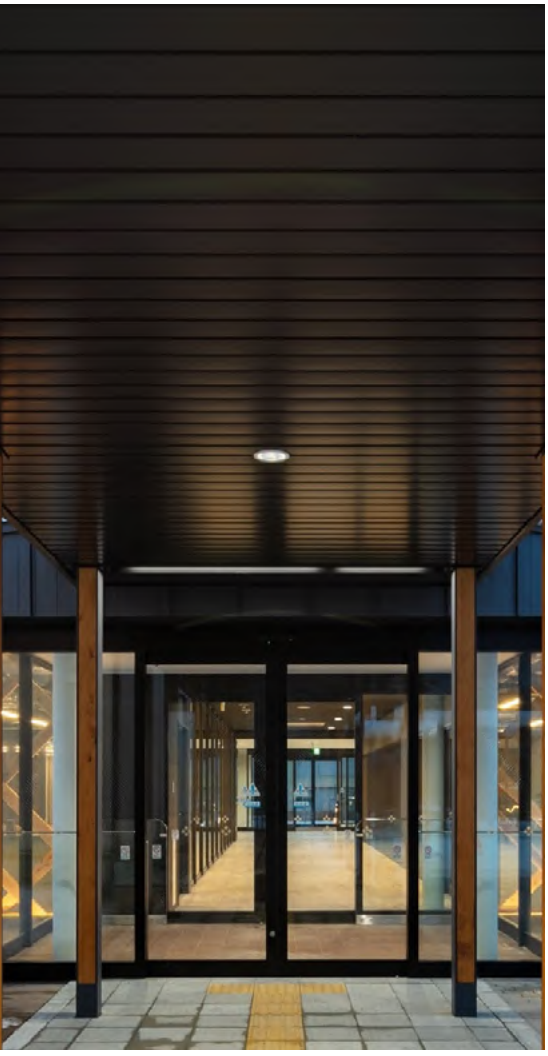
The initiative has been funded with city budget as well as central government subsidies (including the distribution of local allocation tax).

Some plans run by the Aizu Regional Smart City Promotion Council, not the city. The councils ensure its economic efficiency and sustainability by collecting usage fees directly from the users.

Results/ Benefits

In order to implement the initiative, a new ICT office "Smart City AiCT" was opened in April 2019. This has led to the creation of new jobs; currently, over 400 workers from 27 companies work in the office, among them not only local residents yet also workers from outside the city.

The city of Aizuwakamatsu sees the promotion of a smart city that uses data as a successful way to improve the convenience of citizens' lives, and to enable companies to carry out effective and efficient businesses by using local data. The city has introduced



several useful services for citizens, and a virtuous economic cycle is already created in the region, from which everybody in the city can benefit. Some examples for successful implemented programs are:

• The sensors installed within the hydroponic soil cultivation system have decreased work time by about 10%, and sales have increased by about 40% compared to those before the sensor installation.

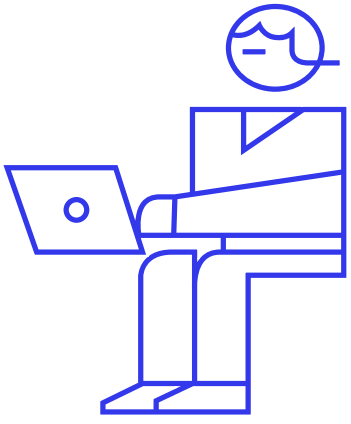
• The digitalization program of maternal and child handbooks "Aizukko Plus" enables citizens to view school events and information easily by smartphone.

• The TV "Minato Channel" which is used by about half of all the households (about 500 inhabitants) in the city's target area enables citizens to get regional information through TV, which is especially user-friendly with the elderly.

The number of the subscribers of "Aizuwakamatsu Plus", which shows recommended information based on citizens' needs, is approximately 10,000.

"The Aizuwakamatsu City Comprehensive Cooperation Council for overcoming population decline and vitalizing local economy" holds a business verification meeting every year, setting and monitoring KPIs for each program included in this overall smart city initiative.

Lessons learned and policy recommendations:



The implementation of the initiative is not possible without the understanding and consent of the citizens. Activities and programs will not work unless they are citizen-centric activities. It is the citizens who shall lead the initiative, not the government nor the private sector.

In addition, it is important to introduce several highly convenient services so that citizens note the initiatives` benefits and keep their interest in using the offered services. Besides, it is necessary to constantly check how to ensure economic efficiency and self-sustainability of the proposed programs and plans.

Conclusions

This initiative can be distinguished by the possibility of the horizontal integration of the ICT Platform with other cities, as well as a strong personal data approach known as “opt-in” model.

Evaluation Scoring

Japan:
Smart City Aizuwakamatsu

Methodological complexity

High

Financial complexity

Medium

Positive impact
(Problem solving)

★★★ **High**

2.4.4 Thailand: Phuket Smart Tourism

Phuket

Inhabitants:
525,000 (2010)

GDP per capita:
11,448 USD (2017)

Tourism is Phuket's main industry; therefore, most of its businesses are associated to this industry. Owing to that, Phuket receives a large number of tourists every year. Between 2000 and 2010, its population has more than doubled and is much higher when taking into account seasonal workers and the multitude of tourists that visit one of the most popular places in Asia.

Phuket is one of the first cities in Thailand to be selected as a pilot smart city project. With strong private enterprises and the tourist industry, Phuket offers various domains for smart city development. In this respect, its main goal is to foster the sustainability in the tourism industry.

Problem

Thanks to the rapid growth of Phuket's tourism industry, almost 15 million tourists visit Phuket, making its income the second highest in Thailand. While this growth creates massive economic gain, it also brings many "classic problems" to the tourism areas, such as traffic congestion, overcapacity of the total infrastructure (from electricity to wastewater treatment) and the people's wellbeing as a result of the city's socio-cultural, economic and environmental change.

These problems pose challenges to the city's management to find solutions in order to balance the positive impact while keeping negative externalities such as traffic congestion, safety and environment under control. In this context, the city strives for enhancing the sustainability in the tourism industry by incorporating smart city technologies and tools such as the collection and analysis of real-time data in order to improve the decision-making power. In essence, this is both a classic capacity problem as well as a smart city challenge.

Solution

Phuket Smart Tourism focuses on four smart city areas:

1. Smart Living	a. Traffic Law Enforcement (red light, speed limit, helmet) for road safety; b. CCTV integrated system (1,200 cameras) for safety monitoring by the police; c. Phuket Smart Gateway for access control (in/out) between the mainland and the island
2. Smart Economy	d. Fostering, incubating and driving digital startups and digital transformation in the tourism sector in order to leverage the quality services of Phuket tourism
3. Smart Environment	e. Smart Environment to introduce the use of IoT devices for disaster management, including flooding and landslide.

THIS INFRASTRUCTURE CREATES A VALUE-BASED ECONOMY TO ENTREPRENEURS AND ENTERPRISES USING DATA TO ENHANCE THEIR OPERATION AND BUILD NEW SERVICES.

Methodology:

Digital infrastructure (Core Fibre, LoraWan[32], NB-IoT[33], wifi, 5G) has been planned to provide safety and convenience to both the residents and tourists. Moreover, this infrastructure creates a value-based economy to entrepreneurs and enterprises using data to enhance their operation and build new services.

In 2019, Thailand presented the roadmap "Smart City Framework and Guidance for Thailand"[34], which also elaborated on the "Smart City Services for Phuket".

Currently, Phuket is focusing on an urban smart city data platform and aims to deploy further key smart city services in each area, following this larger smart city roadmap.

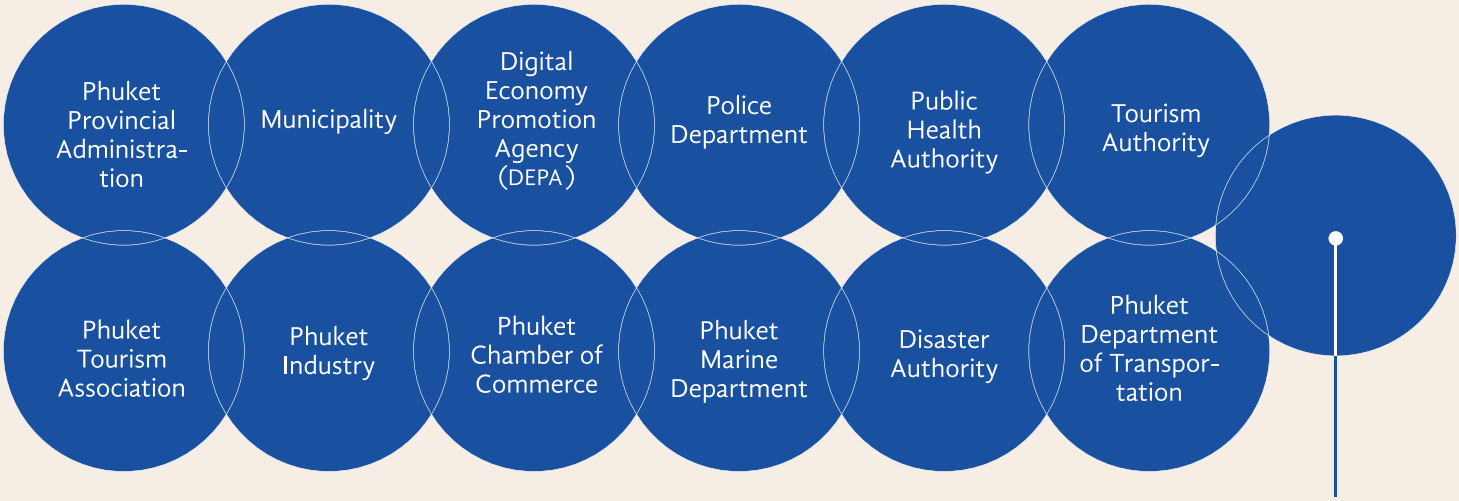
[32] LoRaWAN is a point-to-multipoint networking protocol that uses Semtech's LoRa modulation scheme. It's not just about the radio waves; it's about how the radio waves communicate with LoRaWAN gateways to do things like encryption and identification. It also includes a cloud component, which multiple gateways connect to.

[33] Narrowband Internet of Things (NB-IoT) is a Low Power Wide Area Network (LPWAN) radio technology standard to enable a wide range of cellular devices and services.

[34] https://www.mglobale.it/kdocs/1962677/5B9F4D7B-3F7E-4ED4-A9EE-3ECD47D38554SMART_CITY_FRAMEWORK_AND_GUIDANCE_FOR_THAILAND_SMART_CITY_SERVIC

Stakeholder Engagement:

The city of Phuket formed a Smart City Committee consisting of all key stakeholders from both the public and private sector, including



CAT Telecom (the state-owned company that runs Thailand's international telecommunications infrastructure) and TOT (the public mobile cellular data network provider)

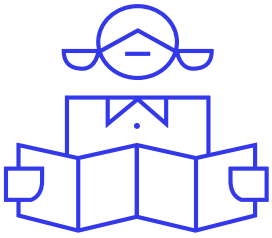
Figure 26. *Participants of Phuket Smart City Committee*

The Digital Economy Promotion Agency (DEPA) serves as the Secretariat of this Steering Committee, who works closely with the city of Phuket.

Policies:

Phuket is one of six Thai cities, which have been designated as the pilot areas for Smart City Thailand. The smart city development project is part of the government's 20-year domestic development strategy in order to create livable cities with an eco-friendly landscape. According to DEPA, "the government wants to see 100 smart cities by 2024"[35]. In this respect, the selected cities need to meet the following criteria in order to receive the approval for their smart city developments:

[35] The Bangkok Post 8.10.2020 online: https://www.bangkokpost.com/business/1998475/depa-readies-first-batch-of-smart-cities



- Clear geographical boundaries and smart city goals
- Infrastructure investment and development plan
- Design for an open and secure city data platform
- Smart city solutions
- Sustainable management model

Once a city would be approved, they will be entitled to utilize the Smart City Thailand-logo and will be permitted to apply for investment privileges from the Board of Investment.[36]

Phuket has attracted the interest from both public and private stakeholders for implementing smart city technologies.

Financial Aspects:

Phuket has a unique public-private-partnership (PPP) strategy that continues to attract more investors thanks to tourism as its main successful economic engine. The main investment source for this smart city initiative comes from the central government; however, both the economic prospect and the success of previous projects, have led to attracting additional financial resources from the local government as well as private investments for Phuket´s smart city project. Among the private financial sources, especially the Phuket City Development Company (PKCD) stands out, a joint venture of 25 leading businessmen in Phuket, established in 2016 in order to cooperate with all government levels to transform Phuket into a smart city. This has widely been regarded as a largely successful operation.

During the first year, Phuket received 14 million USD. Afterwards, the city has been investing around 5 million USD each year in its smart city projects, arising from both public and the abovementioned private funds.

The success of the adopted business model enables the city to demonstrate the transformative

[36] The Bangkok Post 8.10.2020 online: https://www.bangkokpost.com/business/1998475/depa-readies-first-batch-of-smart-cities

ability of technologies in various sectors; it also attracts more investment from the interested private and public parties. In this context, DEPA, the Ministry of Digital Economy and Society, the international consultancy Roland Berger and the Chinese IT company Huawei published the detailed whitepaper "Smart City Framework and Guidance for Thailand – Smart City Services for Phuket" in August 2019. It aimed at analyzing Phuket's critical areas in need for development, in order to address them through technology.[37]

THE MAIN INVESTMENT SOURCE FOR THIS SMART CITY INITIATIVE COMES FROM THE CENTRAL GOVERNMENT; HOWEVER, BOTH THE ECONOMIC PROSPECT AND THE SUCCESS OF PREVIOUS PROJECTS, HAVE LED TO ATTRACTING ADDITIONAL FINANCIAL RESOURCES FROM THE LOCAL GOVERNMENT AS WELL AS PRIVATE INVESTMENTS FOR PHUKET' S SMART CITY PROJECT.

Implementation Challenges:

One of the encountered challenges can be related to the authority that manages the smart city development. Phuket´s smart city project has been associated with the local municipality, yet existing regulations do not support or facilitate the investment in smart city projects, which may affect the project´s longevity, sustainability, and existing partnerships and collaborations.

Results/ Benefits

Phuket has been recognized worldwide as a city with an effective smart city development approach. For example, the Eden Strategy Institute's 2019 Smart Government Ranking listed the city among the top 50 of the world in terms of its effectiveness as well as strong efficacy in the provision of public services. In addition, MasterCard's Global Destination Index also lists Phuket as one of the foremost destinations globally, entailing Phuket as a safe, affordable and livable city that attracts trust from visitors from across the globe.

The realized smart city projects yield substantial impact on the measurable improvements in terms of quality of life and safety; the results emphasize an increasing confidence from both the residents and tourists. Besides, the implementation of smart city projects has increased the government's capacity to utilize smart city services and tools, which has improved their operation in both domains, tourism and road safety. According to the road safety statistics, the smart city projects have also contributed to decrease substantially the number of deaths in Phuket.

[37] DEPA, the Ministry of Digital Economy and Society, Huawei, Roland Berger (2019).

Finally, a developed city data platform allows consistent data collection within all applied smart city areas. It is the key tool for the city´s monitoring and verification processes, and covers topics like; sense of livability, economic viability and environmental sustainability.

Lessons learned and policy recommendations:

1. Technology does not need to be in the front, visible to everyone. It should rather be playing an important role in the background, making people's lives more convenient and economically viable, promoting the facilitation of people`s life.

2. People-oriented PPPs are key to the success of smart city projects. Multi-actor alliances generate synergies that will contribute to the long-term goals of the smart city developments; the public sector is the principle engine for providing services and resources, while the private sector offers technologies and innovative solutions.

3. Cities should contain both digital and physical solutions that exist hand-in-hand.

It cannot be emphasized enough that technology is not everything and that the people need to be at the center of smart city developments. As much as it was important to build economic and technological capital, there is also the need to maintain and foster social capital in cities.

AS MUCH AS IT WAS IMPORTANT TO BUILD ECONOMIC AND TECHNOLOGICAL CAPITAL, THERE IS ALSO THE NEED TO MAINTAIN AND FOSTER SOCIAL CAPITAL IN CITIES.

Evaluation Scoring

Thailand: Phuket Smart Tourism

Conclusions

Phuket is among the first waves of smart city development in Thailand. However, unlike the other smart cities, Phuket has multiple key drivers in various areas, like the exponentially growing number of visitors every year and the limited infrastructure readiness to cope with a growing demand and competition from neighboring tourist destinations. These key drivers have pushed stakeholders, both public and private, to initiate change, whether in smart waste management, smart transportation and city data analytics. However, despite a handful of implemented initiatives, Phuket still has areas, which urgently need to utilize smart city technologies, for instance traffic management, security systems and tourism as seen in the present case.[38]

[38] DEPA, the Ministry of Digital Economy and Society, Huawei, Roland Berger (2019).

Methodological complexity

Insufficient information delivered

Financial complexity

Medium

Positive impact
(Problem solving)

★★★ **High**

3

The effect of the COVID-19 pandemic on smart city initiatives

How has the current global health emergency affected smart city initiatives in APEC economies? Did the smart city initiatives strengthen the cities` ability to better cope with the COVID-19 pandemic, or did even new projects arise within the economies due to the health emergency?

Canada

In Canada, the pandemic has accelerated the calls for communities to implement smart city approaches due to the digital shift, the need to rethink public spaces and increasing financial pressure on municipalities. The short-term priorities of Infrastructure Canada were radically shifted in response, redistributing some of the funding from the Smart Cities Challenge to the Canada Healthy Communities Initiative (CHCI). The CHCI aims to provide funding to a broad range of organizations, including local governments, charities, Indigenous communities and non-profits to help them adapt and respond to the needs arising from the pandemic over the next two years considering three main themes: (1) creating safe and vibrant public spaces, (2) improving mobility options and (3) digital solutions. Like the SCC, the CHCI is intended to encourage community-level innovation and improvements in residents´ quality of life. Infrastructure Canada considers this as a creating fertile ground for the adoption of new technologies as well as more nimble and innovative approaches for local governments.

COVID-19 has already led to a number of new initiatives within Canada, including the roll-out of a federal exposure notification application, digital approaches to public consultation, and re-thinking of transit services.[39]

Chile

In Santiago de Chile, pedestrian flow priorities at traffic lights were established as well as decongesting measures for public transport stops.

China

China has implemented different intelligent technologies to better control the spread of the virus, including verification and trajectory tracking and contributions to the safe and orderly flow of personnel. The project "One-Code Access" focuses on the domestic recognition of health codes for travelers, and AI technology enables intelligent recognition of people wearing masks. By using mobile phone health codes, medical institutions can know precisely whether the resident has been to the pandemic area recently or met with confirmed cases, which has greatly improved the pandemic prevention and control. Real-time information via a smart medical platform enhanced the public's ability to know and strengthen its own preparation for pandemic prevention and control.

In China, local communities have played an important role in the pandemic prevention and control. Based on their experience in responding to the COVID-19 pandemic, China suggests that smart cities should track the spread of the pandemic by domestic pandemic prevention systems and "travel and services" solutions based on blockchain technology. These support travelers to avoid pandemic areas through path planning and tracking, as well as backtracking information like starting points, destinations and transportation modes. Also China recommends ensuring safe and timely distribution of medical and emergency supplies through smart logistics and further conduct temperature testing of passengers in public transport modes, among other measures.

[39] For more information, please see https://citysharecanada.ca/

Japan

In Japan, the established ICT platform in Kakogawa City has helped to understand citizen's health status under COVID-19, and the related ordinances about personal data have been very helpful for the city`s ability to collect health data with the citizens´ agreement. Within its smart city initiative, in response to COVID-19, Kakogawa City has identified the opportunity to utilize digital technologies in the educational sector: the city distributes SIM cards to each student and provides him/her with an environment for remote learning by utilizing a Broadband Wireless Access system operated by a local cable TV company.

The city of Aizuwakamatsu is also promoting school information apps as well as telemedicine services, such as providing free video calls in cooperation with regional medical associations.

The Japanese Ministry of Health, Labour and Welfare started to distribute the smartphone app "COVID-19 Contact-Confirming Application" for iPhone and Android users, enabling them to receive notifications about their possible contact with a person infected by the virus. In this context, the Ministry also defined rules for privacy protection: information about close contacts is encrypted and recorded only in the user's smartphone, and automatically disabled after 14 days.

In order to encourage users to provide data and maximize the outcome of the data utilization, governments must pay special attention not to collect any unnecessary personal information, present such policies, and obtain the public's understanding.

IN ORDER TO ENCOURAGE USERS TO PROVIDE DATA AND MAXIMIZE THE OUTCOME OF THE DATA UTILIZATION, GOVERNMENTS MUST PAY SPECIAL ATTENTION NOT TO COLLECT ANY UNNECESSARY PERSONAL INFORMATION, PRESENT SUCH POLICIES, AND OBTAIN THE PUBLIC'S UNDERSTANDING.

The Philippines

With the implemented contact tracing app "SCAN" in the city of Tacloban, The Philippines have shown an exemplary method of surveillance and contact tracing for the Covid-19 response. SCAN is able to give responses to natural and human-induced risks, thus its holistic approach contributes to build safe, secure, just, and resilient cities.

Thailand

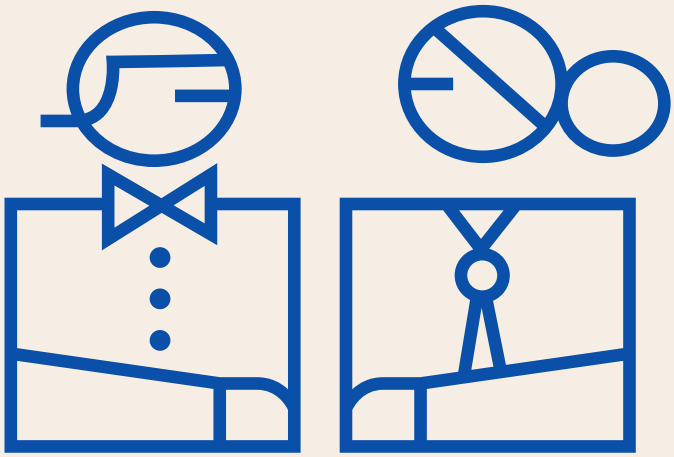
In Khon Kaen, Thailand, the smart health initiative has demonstrated being an excellent way to deliver health data from home to hospital so that the doctor can closely monitor infected patients. Phuket, however, due to the city´s heavy reliance on the tourism industry, has been affected in a significant way; a large number of tourism businesses had to shut down for security reasons, and due to low tourism rates, operations could not be sustained. Among others, the city of Phuket has been active in providing ample and robust public services to the citizens during the time of crisis and economic downturn.

Malaysia

As already known, the pandemic has also brought some positive, environmental impacts: in Malaysia, the Putrajaya lake achieved Class I of the Malaysia National Water Quality Standard, due to a slowing down of activities by the anthropogenic polluters such as food premises, restaurants and constructions sites.

4

Comparative Analysis



The following sections address relevant aspects for the implementation of an initiative and thus, for its replication. These aspects include the required investment, topics related to the stakeholder engagement, implementation challenges, impacts and the role of digital technologies, among others.

4.1 Investment:

The delivered case studies present bright investment ranges. The investment for the implementation of the delivered smart city initiatives ranks from 5,867 USD (Tacloban, The Philippines) to 225.6 M USD (Smart Cities Challenge Canada)[40]:

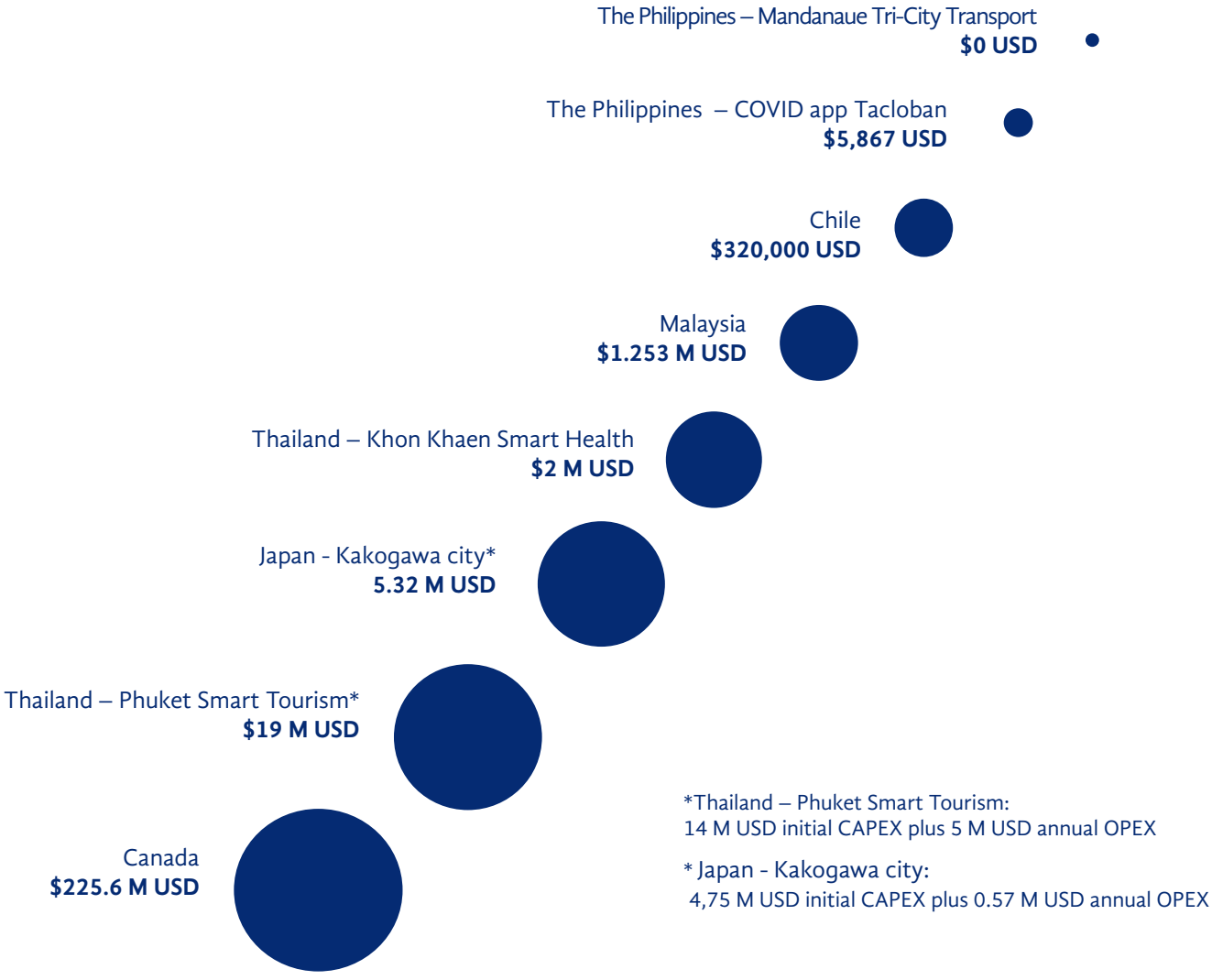
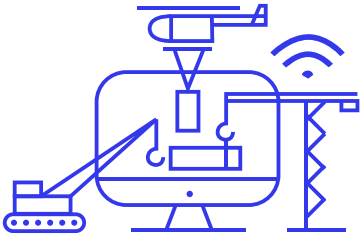


Figure 27. *Investment in Realized Initiatives Informed by KCEs*

[40] The investment amounts of the initiatives in Viet Nam and in Shenzhen and Jinan, China, as well as Japan - Aizuwakamatsu City, were not informed.

A significantly high investment is not always needed to implement a smart solution, as the Tri-City Initiative of Mandaue City in The Philippines has shown: no additional investment than the regular local governments´ budgets was needed to establish the cooperation activities.



It is important to note the importance of considering the operational expenses (OPEX) related to an initiative in its design: the long-term operation and thus, its sustainability, depend on secured budgets. Initiatives like the Phuket Smart Tourism Strategy lean on private funding, which requires a permanent engagement with the relevant stakeholders and result-based financial incentives.

The city of Kakogawa in Japan informed much higher operational expenses than the required initial capital expenses (CAPEX) for the implementation of its urban security initiative – these need to be ensured by the respective public institution, which provides the required budget.

In the case of Putrajaya City in Malaysia, new, additional, allocation budget is needed to ensure that the lifespan of the existing water quality monitoring system can be extended to more than ten years.

Based on these examples, a recommendation to overcome the challenge of secured investment budgets for the OPEX of an initiative is to count on a long-term sustainability model, and to consider well the costs of operation and maintenance of the applied technologies.

A common denominator of the reported initiatives is the public investment, in many cases co-financed by private companies (for example, the smart tourism initiative in Phuket, Thailand). The financial model adopted by Canada, where funding is released according to performance implies outcome based investment.

Just one pilot project initiative – Chile – reported significant international funding, in this case provided by IDB. The reasons behind the fact of using only local investments are unclear; they may refer to sufficient local funding or possible missing of international project funds, or the capacities to apply to these.

4.2 Stakeholder engagement:

As Key Contributing Economies stated in the questionnaire, there were both initiatives following a top-down as well as a bottom-up approach during the planning and implementation phase.

In most cases, a governmental institution gave the impetus for a project and cooperated with research centers/universities as well as service providing businesses and the society. In case of the existence of foreign (international) investment, the corresponding financing entity was also involved in the planning and realization of the respective initiative, for example IDB-Lab in Chile`s autonomous driving pilot project.

Various initiatives also showed the focus on PPPs, partnerships between the government and the private sector, highlighting their mutual investment and collaboration in the development of technological solutions and its corresponding data exchange. In this respect, the Aizuwakamatsu city in Japan is an interesting example for how citizens are incentivized in order to share their personal data; they receive better urban services and –solutions, which the private sector developed as they were given access to these data.

The case studies which explicitly showed a bottom-up approach during the development and implementation phase are the Smart Cities Challenge in Canada, but also the Kakogawa Smart City Project, which ensured an active public participation through the realization of 12 public audiences ("Open Meetings") prior to the installation of the monitoring cameras, in order to gain understandings and support from the public; the city started to implement the initiative once it confirmed that over 90% of the citizens expressed their agreement to it.

The city of Tacloban in The Philippines would not have been able to build such a successful Surveillance, Contact Tracing, Analysis, and Networking (SCAN) System to conduct contact

tracing during the COVID-19 pandemic without having involved all local stakeholders and ensured their active participation in this system. This was considered necessary to double-up and elevate efforts in the response to the virus.

However, the importance of human well-being and the urban life conditions for its citizens has been considered a main objective in all received case studies. China recommends to uphold the principle of "people first", to enhance public participation and to carry out public satisfaction surveys in combination with the evaluation of new smart city initiatives.

RESIDENT ENGAGEMENT IS KEY TO CREATING TRULY INCLUSIVE, ACCESSIBLE, AND RELEVANT SMART CITY PROJECTS.

Resident engagement is key to creating truly inclusive, accessible, and relevant smart city projects.

4.3 Complexity:

The methodological and financial complexity of an initiative depends on different aspects like the required investment, implementation challenges, the difficulty of stakeholder engagement, required trainings and capacity building, as well as necessary modifications of existing infrastructures, and others.

The complexity evaluation of the delivered case studies was realized based on an internal analysis scheme detailed in chapter 1.3 "methodology", and shall provide guidance for other economies interested in implementing a similar initiative. The following table resumes the single evaluations of the presented case studies without establishing any kind of ranking among them. As not all aspects were completed equally, this evaluation should just be seen as an approximation.

Initiative	Methodological Complexity	Financial Complexity	Positive Impact (Problem solving)
Canada Smart Cities Challenge	 **Medium**	 **High**	 **Insufficient Info**
Chile First autonomous vehicle pilot project in Santiago de Chile	 **Medium**	 **Low**	★★☆ **Medium**
China Jinan - Building an intelligent ecosystem for its traffic management	 **High**	 **High**	★★★ **High**
China Overall Plan of New-Type Smart City Construction of Shenzhen	 **High**	 **Insufficient Info**	★★★ **High**
Japan Kakogawa Smart City Project	 **Medium**	 **Medium**	★★★ **High**
Japan Smart City Aizuwakamatsu	 **High**	 **Medium**	★★★ **High**
Malaysia Putrajaya Lake: The System of Environment Pollution Control at Source	 **Low**	 **Low**	★★★ **High**
Thailand Khon Kaen Smart Health	 **High**	 **High**	★★★ **High**

Initiative	Methodological Complexity	Financial Complexity	Positive Impact (Problem solving)
Thailand Khon Kaen Smart Health	**Insufficient Info**	**Medium**	★★★ **High**
The Philippines Tacloban SCAN System	**Medium**	**Low**	★★★ **High**
The Philippines Tri-City initiative on public transportation	**Low**	**Low**	★★☆ **Medium**
Viet Nam Smart Grid Development	**Insufficient Info**	**Insufficient Info**	★★★ **High**

Table 2. *Overview of complexities of the presented smart city case studies*

4.4 Implementation challenges:

The implementation challenges the economies experienced during the planning and realization of their smart city initiative/s can be divided into four main categories, as visualized in the following figure:

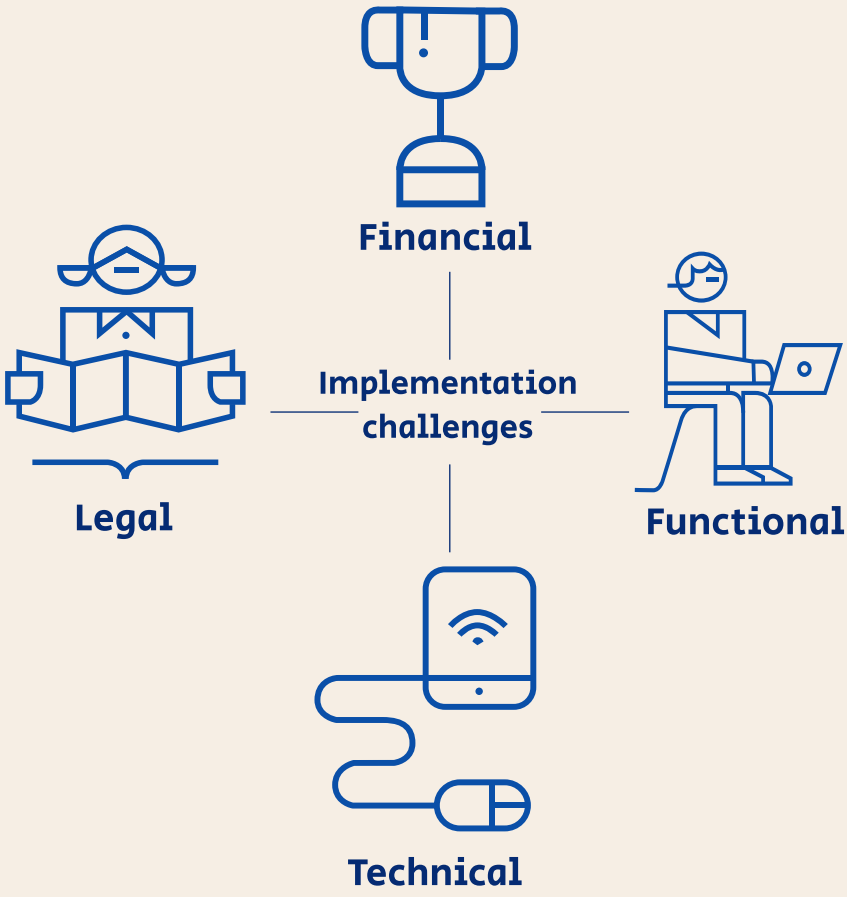


Figure 28.*Thematic Categories of Experienced Implementation Challenges*

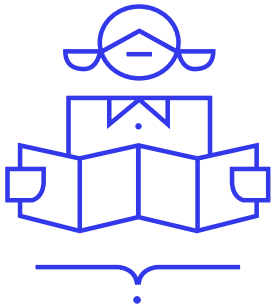
The category "legal" refers to regulatory aspects, like data protection, required policies and/or ordinances for the realization of an initiative, as well as standards.

"Financial" describes challenges related to the investment and financing of an initiative, including its financial scheme, funding model, aspects of CAPEX and OPEX and its long-term sustainability.

The category "functional" resumes all challenges, which concern the workability of an initiative, thus the critical factors for its successful realization. It refers to the required capacities both of technology as well as human resources.

"Technical" implementation challenges emphasize the required technological equipment and infrastructure as well as the required technology access for succeeding in an initiative.

APEC member economies faced the following challenges while implementing the abovementioned smart city initiatives:



ONLY BY THE GUIDANCE OF LAWS AND REGULATIONS WILL SMART CITIES SERVE THE PEOPLE BETTER.

Legal implementation challenges:

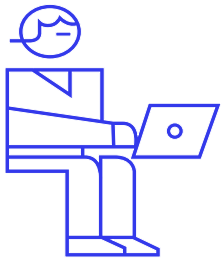
• Need of local authorizations for realizing the respective initiative.

•Lack of a recognized international standard for smart city construction and lack of international standard for data management.

• Lack of regulations, for example about legislative protection of data security and privacy considerations, or about the tracking and recording of public monitoring cameras.

• Absence of local and/or domestic policies for supporting certain initiatives

•Non-existence of a recognized international standard for the construction of smart cities.



SOME APEC ECONOMIES FOUND OUT THAT NOT ONLY ELDERLY PRESENT A LACK OF TECHNOLOGY SKILLSETS TO LEARN AND ADOPT NEW DIGITAL TOOLS; ALSO OTHER GROUPS OF THE POPULATION DO. THUS, IT IS URGENT TO EQUIP THE WHOLE POPULATION WITH DIGITAL LITERACY.

Functional implementation challenges:

• Combining government and enterprise in the development of smart cities.

• Projects with poor risk management may not be able to achieve the expected goals.

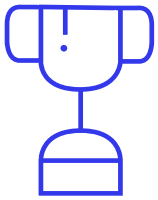
• Buy-in of stakeholders.

• Cooperation between different local government units requires dealing with different rules and policies (for example, in the case of public transport).

• Varied capacities across economies` communities (regarding their possibilities to implement certain solutions, technology procurement, to define new projects, or apply for funding etc.)

• Insufficient technological skills of the agencies´/institutions´ staff that is implementing the project

• Lack of digital literacy.



Financial implementation challenges:

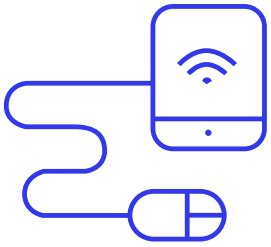
• Need for innovation of the investment and financing mode.

• Encouragement for more social capital participation and finding new profit points.

• Selection of well functioning equipment with very low maintenance costs.

• Outcomes-based funding models and their more stringent requirements to demonstrate impact, may be new to communities, as Canada experienced while implementing its Smart Cities Challenge.

• High dependence on public funds.



Technical implementation challenges:

• Reliable internet connection.

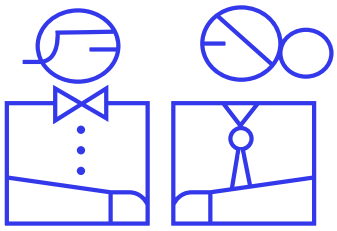
• Selection of the most durable equipment.

• Existence of different data standard formats across an economy.

• Unequal access to technologies: there are still groups of the population without internet access or smart phones, which requires a "plan B" when implementing a technology-based solution.

4.5 Impacts:

The participating APEC economies reported diverse positive impacts that have been achieved by the implementation of their smart initiative(s); these are primarily experienced on a social, environmental and economical level, following the three dimensions of sustainability, where the category "social" includes institutional benefits:



AN OPEN-ENDED SMART CITY FUNDING CAN ENABLE AND PROMOTE RESIDENT-DRIVEN IDEAS THAT ARE RESPONSIVE TO LOCAL REALITIES.

Social:

All presented initiatives report an improvement of quality of life for citizens, by

• Strengthened institutional as well as citizen technological competencies (increased ability to use certain IoT devices and applications, higher technology acceptance and usability)

• Improvement of regulation, management and planning instruments, especially within transport systems

• Creation of new jobs, related to the smart city initiatives

• More efficient and accessible public services (e.g. transport and governmental administrational services)

• Optimized urban overall governance

• Increased citizens‘ as well as tourists` awareness and confidence about important aspects related to urban life, like safety and security

• Improved resilience of the communities against climate change and other threats (including virus infections, as especially the Tacloban initiative demonstrates)

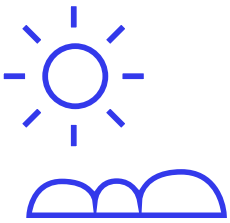
• Participative bottom-up approaches have improved the government response to experienced problems by the communities, and communities can address local problems

• Capacity building for communities and increased resident engagement to encourage the adoption of smart cities approaches in city planning (Smart Cities Challenge Canada)

• Lower crime rates and though, increased awareness about safety and security

• Lower death rate due to better road safety based on the use of technologies

• Better behaviors and daily habits in the people´s life due to consistent monitoring and learning about their own health data by using health sensors and smart technologies; newly gained awareness of risk factors.



Environmental:

• Reduction of Greenhouse Gases (GHG) through
- Innovative transportation systems and low/zero-carbon mobility
- Energy efficiency

• Improvement and maintenance of water quality

• Improved productivity and water efficiency within agriculture, due to hydroponic soil cultivation systems based on sensor-measured data to automatically supply optimal amounts of water and fertilizer (initiative of Smart City Aizuwakamatsu)

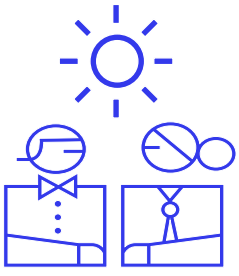
Economical:

• Improved economic operational efficiency, reduced logistic costs and promotion of the development of related industries

• Increased labor productivity and transparency, for example by the use of telemetry in power indexing and invoicing, or decreased work time by automation of agricultural processes

• Ensuring long-term financial benefits for an authority by deploying an innovative or advanced technology, as the example of the water quality measurement equipment in Putrajaya Lake, Malaysia shows: first, the government needs to invest in the installation and maintenance of a new system, yet by focusing on the problem prevention, on the long term they avoid possible costs associated to environmental rehabilitation.

• Cost savings within the health system due to preventive health initiatives (case of Khon Khaen, Thailand).



Transversal:

• Smart transportation has promoted the coordinated development of urban and rural areas in the region by serving and improving people's livelihood, protecting the environment, and helping with poverty alleviation.

• Increased reliability of power supply by the use of telemetry, automatic substations and distribution grid automation programs

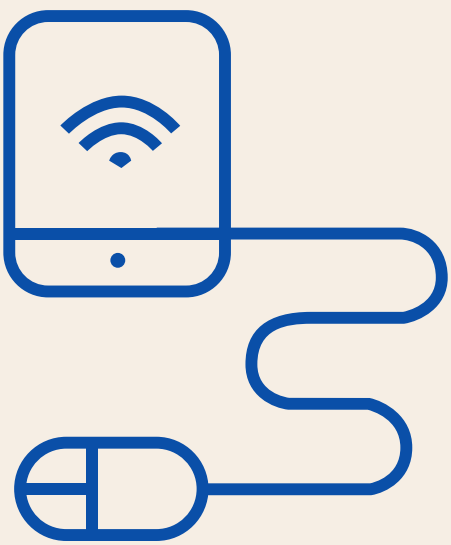
• Contribution to meet different Sustainable Development Goals (SDGs), especially SDG No. 3: good health and well–being; and SDG No. 11: sustainable cities and communities.

• Time savings, for example in urban mobility due to reduced traffic and parking times, or in industrial or agricultural working processes due to process automation. Also in health attendance, when using smart devices for transmission of health records from patients to doctors.

• Information transparency for users as well as transparent data access options.

5

The role of Digital Technologies



As participating economies stated, the use of digital technologies in the environmental assessment plays a significant role in ensuring sustainability and socio-economic development based on human and environmental well-being, as the following examples show:

• The use of innovative technology of sensors and digital monitoring to maintain the water quality of Putrajaya city`s lake in Malaysia, increases environmental well-being; by attracting more people to use the facilities of the lake, it also increases human well-being and supports the city to achieve the SDG's No. 3 of Good Health and Well–being as well as SDG 11 of Sustainable Cities and Communities.

• In Tacloban, The Philippines, the local government fostered a very quick development of a digital tool for public control of COVID-19, embedded in their "Tacloban Safe City application", which will not only be used for health emergency response, but also for delivering quick response in times of disasters and emergencies like typhoons.

• Facing common problems in urban development such as resource sustainability, environment and social governance, traffic jams, insufficiency of community management and – service, the city of Shenzhen in China invested in a big-data and smart city operation center, which provide cross-sectorial open services related to data resources and data-sharing as well as decision-making support services. This enables the development of a smart industry and digital economy, optimizes business environment and promotes investment and business activities, which ensures economic sustainability. Furthermore, the highly developed technology application has improved governance efficiency.

• The city of Jinan, China, created a big data management cloud, their "traffic brain", which is capable of real-time perception-analysis and judgment-intelligent decision-release evaluation, self-evolution and self-learning. Through accurate and complete data collection and analysis, the system platform can make traffic management and decision-making more effective, and the carrying capacity of the city`s

road network is maximized. The use of this technology decreased vehicle's parking times and the average delay times in traffic, making urban mobility more efficient and by this, increasing urban human well-being.

• The Japanese City Kakogawa improved the living environment for families with children and strengthened the community's network by promoting initiatives that utilize ICT platforms, which focus on the safety and security of the city. By installing nearly 1,500 monitoring cameras in critical areas like school zones, parks, bicycle parking places and main road intersections, the urban crime rate was reduced drastically, improving the citizens` awareness of safety.

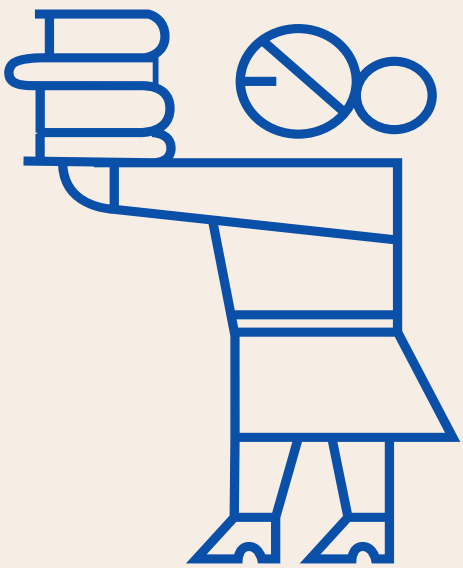
• In Khon Kaen, Thailand, the use of smart watches as part of the integrated smart healthcare model, trained and equipped the target population in digital health literacy on both sides of the public health system: the caregivers as well as the caretakers, Also patients improved their health conditions due to the real-time health monitoring.

Using digital technologies in a smart way not only enables socio-economic development, yet also optimizes emergency responses. The new generation of information technology has played an important role in pandemic monitoring and analysis, tracing, prevention and treatment as well as resource allocation, so as to achieve accurate information release and identification of risk groups, effectively foster the digital management of public health emergencies, and further improve the ability to cope with public crisis such as epidemic situations.

Smart cities give the push to industries to turn smart, transforming into new driving forces for economic growth.

SMART CITIES GIVE THE PUSH TO INDUSTRIES TO TURN SMART, TRANSFORMING INTO NEW DRIVING FORCES FOR ECONOMIC GROWTH.

6 Conclusions



6.1 Lessons learned:

The following conclusions are based on the delivered smart city case studies and their analyses, as well as secondary information and citations of smart city experts who were asked to share their opinion and experiences in the context of smart city solutions.

1. The implementation of (new) technologies requires capacity building and training of all beneficiaries. For example, when the Thai city of Khon Kaen introduced smart watches for real-time health monitoring to elderly patients, these were trained ex ante in using these devices, as well as the volunteer medical staff, as *"(...) not only the elderly (...) [present a] lack of the technology skillset to learn new digital tools related to health, (also) the health professionals (...). It is urgent (...) that, if we want smart healthcare as infrastructure for Khon Kaen (...) we urgently need to equip the population from both sides of the public health service (caregiver, caretaker) with digital health literacy."* (Digital Economy Promotion Agency, Thailand).

Thus, as implementing an initiative, it is always important to consider the technical skills and – equipment of its target groups.

"Initiatives regarding smart cities need to be accompanied by processes of capacity building at the political and technical level in city administrations. The focus of those efforts should look towards integrated analysis, planning and solutions. Smart solutions should look for platforms and apps that support efficiency and integration at the city level. At the same time they should promote innovation in management at the institutional level and integration of different stakeholders that need to be part of the transformation towards smart cities."

(Andrea Palma, Arquitect, Consultant for cities and climate change)

2. Digital literacy is a fundamental requirement for a successful application of new/modern technologies: only if target groups know how to use it, technology-based solutions will offer benefits to citizens. The existence as well as barrier-free access to technological applications and infrastructure like internet/wifi is the foundation for the success of technology-based smart city solutions.

3. It is necessary to always consider a back-up plan for users during the development and implementation of a new technological application, since not all citizens own mobile gadgets or have an internet connection.

According to UN Habitat (2019), today, more than 50 percent of the world's population is online, **but there are still 3.6 billion people without affordable access to the internet, and only 2 per cent of the women in Latin America and the Caribbean, in East Asia and the Pacific own a mobile phone with internet access.**

The city of Tacloban, The Phillippines, faced this challenge when deploying its Surveillance, Contact Tracing, Analysis and Networking (SCAN) system; the local government needed to print QR Codes and distribute these among citizens so that all sectors of the society could have access to the app, also without using mobile phones. However, the goal of the central and local governments should be closing this infrastructural gap, in order to benefit all citizens from technological solutions.

4) The design of smart city solutions should follow an integrative approach of co-creation, involving all relevant stakeholders and considering inter-dependencies across all impacted sectors.

"It is crucial to consider that cities are complex systems, and as such, it requires a careful study and consideration of interdependencies across impacted sectors (mobility, energy, industry, etc.) and stakeholders (different citizen groups, the private sector, the public sector). While a top-down approach is thus most likely to fall short, a bottom-up approach in which smart and sustainable solutions are co-created by impacted stakeholders in a participative manner is the way to go, and in times of falling trust in established institutions, possibly a way to increase citizen participation and restore confidence."

(José Antonio Ordóñez, Fraunhofer ISI - Morgenstadt Global Smart Cities Initiative, Leader of the City Lab Saltillo, Mexico)

"After my experiences in various smart city pilot projects as consultant and lead partner, I am convinced that smartness can only be reached through a process design that ensures the integration of sectorial smart solutions during planning and implementation phases. A better quality of urban life can only be guaranteed if technological, social and economic measures and disciplines are planned as data-based and integrated approaches. "

(Dr. Nadine Kuhla von Bergmann, CEO of Creative Climate Cities)

5. All smart decisions are based on data. With regard to these, **it is necessary to protect personal rights, while creating value from the recollected data.** The need for protection of personal data was highlighted in all delivered case studies as a crucial factor for the success of the initiatives and their public support.

"Sooner or later, and hopefully sooner, cities will recognize that a key success factor is going to be the development of policy frameworks that govern the generation, aggregation and distribution of data; frameworks that make it possible to both protect data and participate in the creation of value from that data."

(Richard Budel, President, Softlab Industrial)

6. Experience sharing can help to develop smart city solutions. This exchange can be realized via conferences and publications, as is usually done, or through dynamic information management tools like websites presenting projects and lessons learned (like, for example, the European platform Bable). This last option could be an interesting approach/future project for the APEC in order to foster the information exchange about smart city solutions among its member economies. The results of implemented initiatives could be published relatively quickly as well as in a structured way, by categorizing all presented initiatives by thematically topics, with the possibility to filter search criteria (for example, required investment, or technological providers for certain solutions). Also the fact that cities of member economies could have access to a platform for presenting their initiatives to other economies could be a motivating factor both for economies/cities to share their experiences as well as for other economies/cities to replicate certain solutions, or start to turn smart(er) in their own way.

"Experience sharing through fora like the OECD Smart Cities and Inclusive Growth Program helps develop smart city solutions through development of best practice, implementation and analysis of pilot programs for new smart city approaches, or mutual peer review of smart city policies implemented by forum members."

(Georg Caspary, CEO Scaletech)

"The sharing of experiences is not only a transfer of knowledge, successes or failures, it is a possibility to think and plan together. Smart solutions call for integrated approaches and exchanges facilitate the construction of holistic understandings and problem solving responses. Additionally to that, exchanges allow the transfer of success stories and proof, sometimes, that smart city solutions are not always a problem of resources, but of creativity and coordination."

(Andrea Palma, Arquitect, Consultant for cities and climate change)

"Every city is different, and so are their smart city needs, but the smart cities will be the ones who work together and share both experiences and scarce resources to maximize success and minimize risk."

(Richard Budel, President, Softlab Industrial)

7. A smart city in the digital age needs a culture focused on innovation, integration, co-creation and sustainability, adopted both by domestic and local government institutions as well as businesses. As mentioned above, a smart city also needs legal frameworks for data protection, which is an indispensable factor for the success of data-based solutions.

"The cities that are successful in digital transformation are the ones who understand that being "smart" is a behavior and an attitude towards how they govern their communities, economies and environments; it is related to, but not dependent upon technology."

(Richard Budel, President, Softlab Industrial)

"Cities need different layers of innovation, technologies and capacity development to work digitally, innovation in management to implement holistic approaches to territory management, association with different sectors (private, public, academy and civil society) to lead the transformation and establish means for sharing information and join efforts."

(Andrea Palma, Arquitect, Consultant for cities and climate change)

8. The transformation into a smart city not only brings more convenience for urban governance, but also stimulates and promotes the development of various smart industries, including the transport sector, and digital economy, which brings great opportunities for its transformation and upgrading.

Through the implementation of smart city solutions, a city can improve the business environment, promote investment growth, construction and commercial activities, as well as strengthen stability and efficiency of supply chains, accelerate the efficiency of government governance, and improve the connection between the old and new industries and the internet.

9. A smart transformation of a city follows different steps:

According to Woetzel, J.; Remes, J.; and Boland, B. et al. (2018) there are three required layers of smartness:

1. a tech base, composed by networks of connected devices and sensors

2. smart applications and capabilities for the analysis of data, and

3. the adoption and usage of the analyzed data, which should lead to better decision-making and behavior change, both of public as well as private decision makers.

According to Guo Ping, Huawei's rotating chairman in 2019[41], every smart city goes through different steps of transformation based on four layers: The first is having a modern, digital ICT infrastructure for ubiquitous connectivity, as this is what everything else is built upon.

The second step is building up both physical and digital safety through the use of technology, including high-speed networks and advancements in Artificial Intelligence. The example of the smart city of Shenzhen presented in this report, underlines this aspect. The authors would like to add, in regard of "digital safety", that its usage leaves the term open to interpretation; when it is based on the use of AI, which is the back-end of many facial recognition tools, it is important to consider that face recognition (FR) is a highly controversial technology, especially when used in public settings. Additionally, AI tools used for public safety likely depend on high volumes of data collected by various IoT devices, some of which may be personal in nature, which if not managed properly could harm public safety for some individuals. But "digital safety" provided through the use of high-speed, integrated networks can also be an improvement of the reaction time to criminal prosecution, for example. Thus, it depends on which technologies "digital safety" is built upon, and how personal rights are protected, at the same time.

The third layer according to Ping, is public-private cooperation in the digitalization process, where government support is needed for sectors to develop, and for private companies to contribute to public service delivery. In this context, the smart city of Jinan is one example of how to collaborate with private companies for public needs: Huawei supported

[41] Ping, G. online: https://govinsider.asia/connected-gov/shenzhens-maslow-model-for-smart-cities/

the local authorities in realizing the Jinan smart traffic brain project presented in this report. The last step of a smart transformation of a city would be to equip it with a digital brain, "a city-wide system that integrates data across all government agencies and businesses to create social value."[42]

Digital Brain is quoted and understood in the context of smart city development, where a centralized, urban cross-sectorial database provides services, which may facilitate decision-making and urban processes. Good examples are the traffic management or parking assistance in the Chinese Smart Cities of this case study. This concept has also been described as "City Brain" or "Internet Brain" in other Chinese sources.

Ping illustrates these four layers of a smart city on the Maslow's hierarchy of needs, a motivational theory within the discipline of psychology used to explain human needs. First the needs on the lower hierarchy levels must be satisfied before individuals can attend their needs presented in the higher hierarchy levels. A smart city follows the same principle; it requires certain infrastructure and mechanisms until it is able to reach a fully digital, intelligent management:

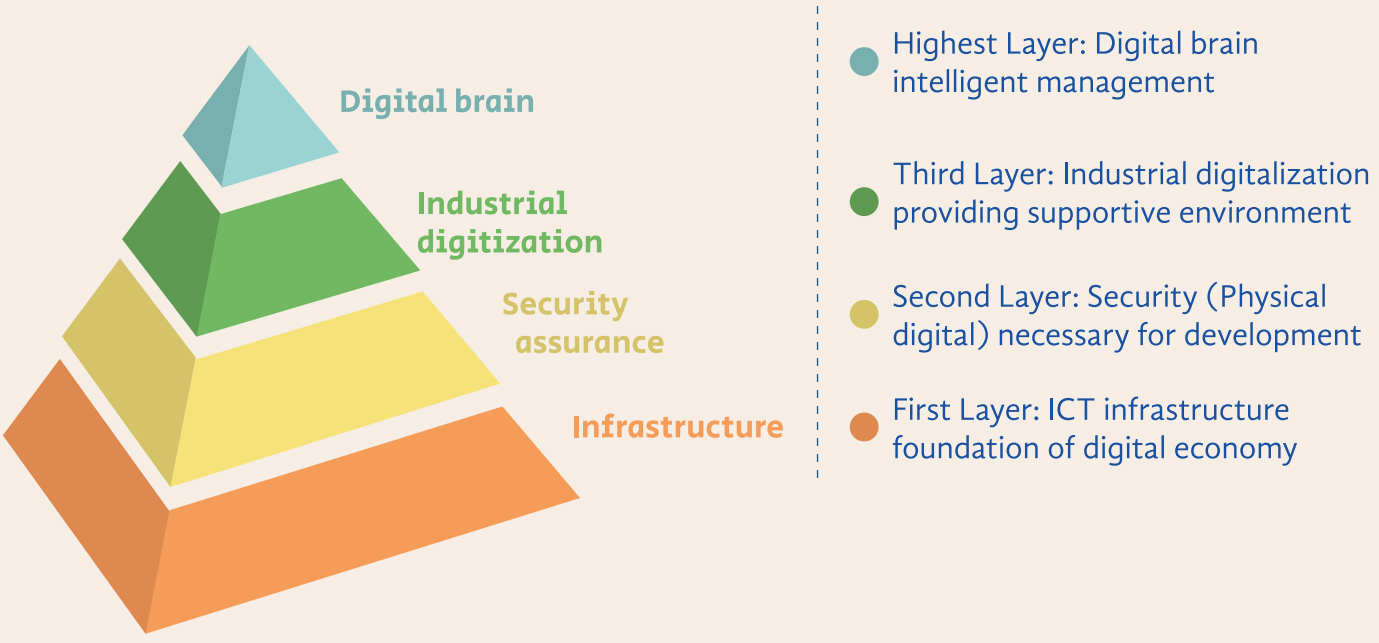
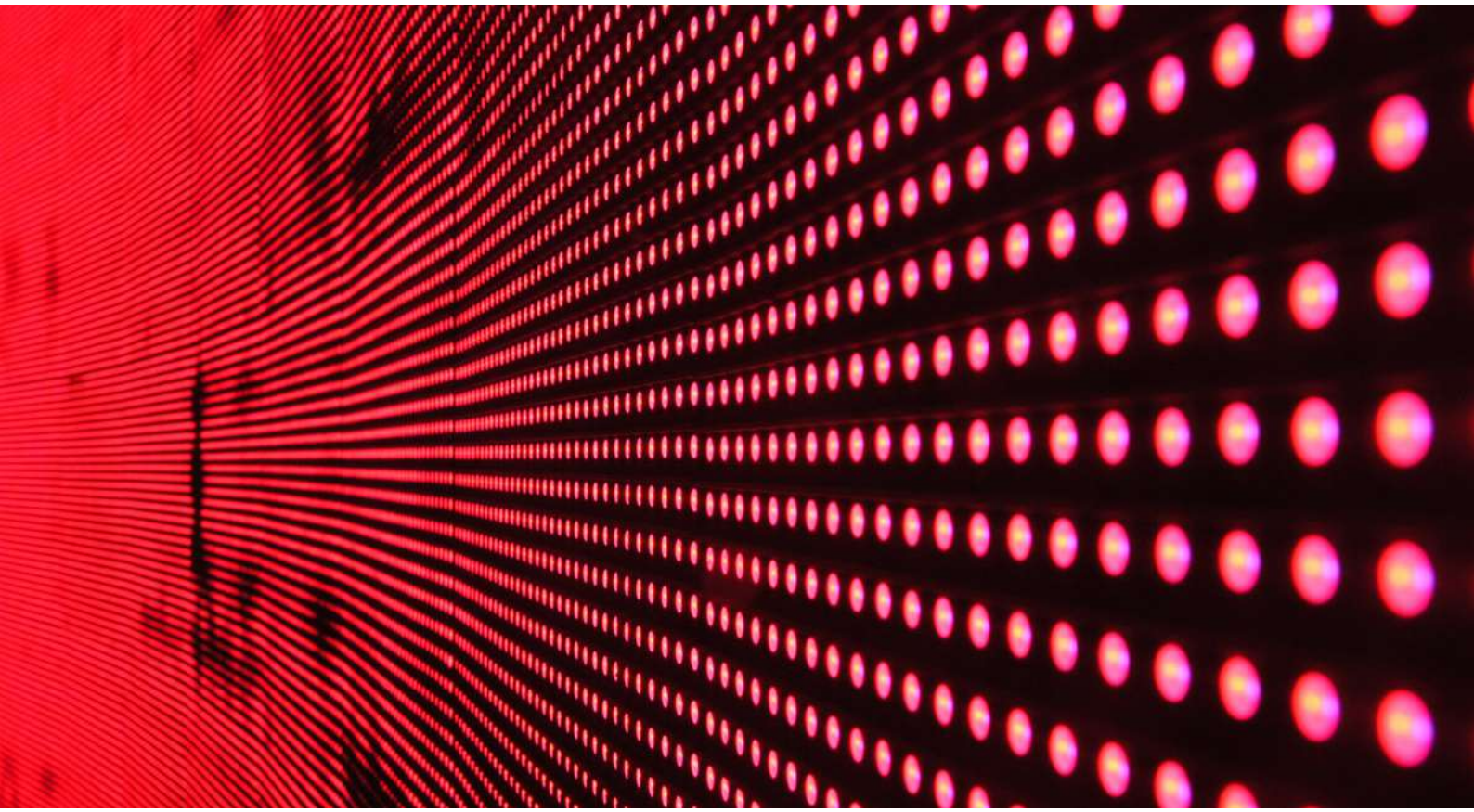


Figure 29. *Maslow Model for Smart Cities*
Source: GovInsider (2019).

[42] Ping, G. in GovInsider (2019).
Research Center on Fictitious Economy & Data Science, CAS, Beijing, China (2018): https://arxiv.org/ftp/arxiv/papers/1710/1710.04123. pdf AND DayDayNews online: https://daydaynews.cc/en/technology/946576.html



The present case studies show that there exist different development levels of this urban transformation among APEC economies: as presented in this report, some economies already use Artificial Intelligence to coordinate complex systems like urban traffic, thus they are already working at the highest layer of urban transformation, and others are in progress of deploying the required infrastructure of high-speed networks.

It is essential to mention that these differences in the technological development not only exist between the economies, yet also internally, at the economies´ local level. Various initiatives illustrate the unequal development of – general - infrastructure between urban and rural areas, or between different cities or regions.

This leads to the recommendation that both central and local governments of economies should consider a horizontal, comprehensive and economy - wide approach for technical development, for example by promoting the replication of successfully realized smart city initiatives of one city to others.

In this context it is necessary to emphasize that **technologies are not always the requirement to improve urban processes, but rather the vehicle** to turn decision making processes and urban development smart.

10. APEC is a very dynamic region in terms of urban development, where smart city solutions have been developed in different economies no matter their available budget or existence of funding opportunities.

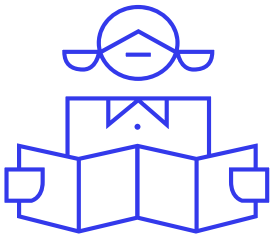
THE APEC MEMBER ECONOMIES ARE [STILL] MOSTLY FACING SEVERAL CHALLENGES AND DIFFICULTIES IN UPGRADING AND EXPANDING ICT INFRASTRUCTURES FOR SMART SUSTAINABLE CITIES

According to the International Data Corporation (IDC) *Asia/Pacific Datacenter Markets: Infrastructure and IT Services*[43], the Asia-Pacific economies (excluding Japan) will account for one third of global spending on smart city initiatives between 2019 and 2023 – reaching 65.5 billion USD in 2023.[44]

Nevertheless, "the APEC member economies are [still] mostly facing several challenges and difficulties in upgrading and expanding ICT infrastructures for Smart Sustainable Cities"[45]. Analyzing the main problems and challenges in building ICT infrastructures to deploy smart sustainable cities in the APEC region, Tran and Nguyen (2020) identified various existing gaps for a successful smart transformation of cities, like the need to identify policy/regulatory approaches that promote innovation and put cities and communities in the lead in their smart city projects; different skills gaps; financial constraints; and a "difficulty in replicating smart city models due to wide disparities among cities in terms of administrative, political, cultural and infrastructure aspects" as well as a lack of smart sustainable city-related recommendations.

This opinion can be confirmed with this report and some of the abovementioned gaps have been addressed within this project; this include sharing detailed case studies delivered directly by some of the APEC member economies, covering specific policy recommendations and information concerning possible implementation challenges and lessons learned. This publication only represents a very little fragment of initiatives that have been realized in the region. There exist much more initiatives worth sharing and presenting.

[43] It provides insights into the dynamics of the datacenter market, covering hardware, software, and facilities in the Asia/Pacific (excluding Japan) Region to help vendors gain a better understanding of the fast-moving landscape. Online: https://www.idc.com/getdoc.jsp?containerId=IDC_P23404
[44] IDC online (2020): https://www.idc.com/getdoc.jsp?containerId=prAP46158320
[45] Tran, N.; Nguyen, T. (2020).



6.2 Policy recommendations

1. Creating dynamic information exchange platforms/tools like the already existing APEC- Energy Smart Communities Initiative (ESCI) Knowledge Sharing Platform can promote the replication of these smart city solutions and improve the efficiency of resource utilization.

Thus, one of the authors` final recommendation on how APEC could keep supporting the smart development among its member economies, is to feed this website with more case studies from the APEC member economies, categorizing these by topics (for example: energy, health, building infrastructure, transport, education, water, waste, air, and other categories as cases are submitted) and presenting the respective cases as detailed as possible, offering information about required budgets, funding opportunities, implementation challenges faced and lessons learned based on these. Any such constant input of outstanding smart city solutions will benefit all economies and support them in their already existing efforts to use digital intelligence to solve urban problems and achieve a higher quality of life for its citizens.

2. The "social" smart city on the global level. Nowadays the majority of urban development strategies are led by public administrations, government actors and private companies, consigning the society as a "passive beneficiary". As another final conclusion, the authors of this report recommend to adopt a new perspective about smart city strategies as a mode of active and innovative participation of local communities.

This approach places citizens in the center of urban planning, which achieves a major social impact and empowerment of the bases on the development of public policies. **Social innovation needs a more relevant role within the smart transformation of cities, allowing the presentation of solutions with social usefulness as a response to concise (local) problems experienced by citizens, and not only taking into account economical return of investment.**

The three main responsible actors: **political decision makers, companies as well as civil society, need to collaborate** in order to offer solutions for the most vulnerable communities, ensuring citizen participation

in decision making processes, which can be facilitated by digital technologies. The Canadian Smart Cities Challenge is a good example for this recommendation. The program encourages citizen participation to find answers to local problems and propose concrete solutions (based on results).

The inclusion of citizens in smart city initiatives and urban planning decision processes can be achieved by:

• the implementation of a Smart City Committee composed by all relevant stakeholders both from the public and private sector, and certainly social organizations.

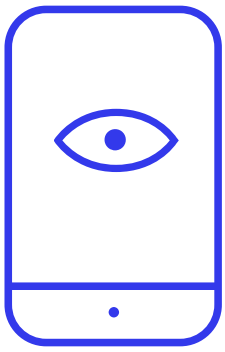
• the creation of a "Smart City Support Program" for all beneficiaries of smart city solutions, which shall create awareness and appreciation among communities.

• open challenges calling for ideas of solutions of local problems

• the establishment of a financial mechanism, which impulses innovation among communities by directly financing solutions created by those communities that are replicable and that generally address local capacity building.

• setting up a financing model based on performance agreements that increase the efficiency of public spending, gradually delivering budget following outcomes-based criteria.

The challenge is to adopt bottom-up-approaches that involve local communities and include their own solution proposals responding to their local needs.



3. Sustainable operation strategies and cost optimization. As investment in technological infrastructure may be high, using an infrastructure, digital platform or application for multiple purposes in a cross-sectional way can optimize investment costs. An outstanding example of this shared use is the Japanese city of Kakogawa, where security cameras are not only used for its main purpose of crime rate reduction, but also are further equipped and connected with Bluetooth Low Energy (BLE) tags, wich can detect road conditions[46] .The inclusion of the greatest possible user number of an infrastructure/platform/app can reduce the relative cost of it.

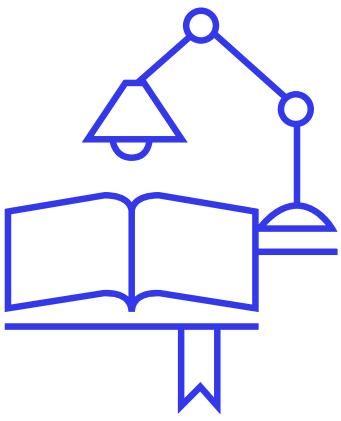
[46] Please also refer to: https://www.mlit.go.jp/common/001280802.pdf

4. Create robust privacy and data protection practices. Personal data are required for nearly every smart city solution, yet its use is a very sensitive topic and demands data protection protocols. In order to incentivize citizens to share personal data, on the one hand it is necessary to alleviate any concerns related to the collection and protection of personal data and on the other hand, clearly explain the benefits citizens can expect from data sharing. By setting up a clear legal framework for data collection and handling and ensuring that the collected data is only used for the agreed purposes, sharing personal data becomes more attractive for the citizens. The Japanese city of Aizuwakamatsu for example highlights the citizens' benefits of data sharing with new solutions and services offered by their city administration and local companies whilst securing data privacy.

5. Explore the development of a global smart city standard. As many cities around the globe may face similar challenges while implementing smart city solutions, the development of an international standard is an interesting aspect mentioned by APEC economies in this report. It should be further investigated.

6. KPIs are essential to measure the benefit of smart city solutions. The definition of concrete Key Performance Indicators (KPIs) is necessary to measure and verify the progress as well as the impacts of the initiatives. This includes both economic as well as non-economic impacts. KPIs may be defined before a solutions` implementation or during its pilot project.

7. Multi-actor alliances generate synergies that will contribute to the long-term goals of the smart city developments. While the public sector is the principal engine for providing services, resources, and the legal framework (e.g. by ordinances, which shall protect personal information and data), the private sector offers technologies and innovative solutions, and the citizens contribute with local problems and their possible solutions in order to guarantee long-term benefits of the initiatives.



8. Diversified funding. In order to reduce the dependence on domestic public funding, private as well as international funding resources, if available, should be explored and considered while designing and planning smart city solutions.

Cities globally turn every day smarter, transforming and optimizing their transport, infrastructure and energy sectors. Current discussions and recommendations around this positive wave of smart change shall not leave out the necessity to extend the access to technology and internet to all citizens and among all economies, in order to make this transformation process inclusive, without restrictions related to income or gender. As UN Habitat (2019) proposes, connecting all the world's population by 2030 should be a shared priority in this context, an essential goal for sustainable development which can be supported by international cooperation organizations like APEC.

VI. Annex

Annex 1. Selection of websites presenting information about smart city solutions

Website	Content
Smart Cities World.net	Platform to share smart city initiatives of different cities on a global scale. The information is presented in the form of articles, which give a general yet not very detailed overview of each initiative. The website includes whitepapers of the categories energy/buildings/transport and connectivity.
Smart Cities Council Australia – New Zealand: **Smart City Infocards**	Smart cities Info cards: short knowledge resources to support awareness raising and capacity building of government stakeholders and community members seeking to further engage in smart cities.
Centre for Cities	Smart city case studies of different topics primarily UK-wide, including a few European as well as North American cities. The topics "Housing" and "Smart Cities" only include European case studies. "Transport", "Low Carbon Economy" and "Clean Air" include examples from North American cities.
Impact Hub Vienna	A global network which aims to connect, enable, and inspire businesses for urban social innovation; connects a community of entrepreneurs, freelancers, investors, corporates, and NGOs.
EU Smart Cities Information System and IRIS Smart cities EU	The Smart Cities Information System outlines more than 60 European smart city projects and has options to exchange data, experience and know-how and to collaborate on the creation of smart cities and an energy-efficient urban environment. Includes information on project budgets, funding, relevant tools and results from the different projects. EU-funded project IRIS realizes pilot projects in different European cities.
BABLE - Platform of smart city initiative information exchange	Detailed information about different projects on European level. The website includes options for connecting cities, companies and smart city projects, in order to share best practices.
Fraunhofer- Morgenstadt Initiative	Network between research academies, industry and cities working on opening up new markets and identifying development potentials within urban systems. Considers information on different working city labs on a global scale and their working methodologies.
Smart City Expo World Congress	News, background information, multimedia and other materials from the Smart City Expo World Congress. Promotion of the magazine Tomorrow.mag that focuses on the latest issues and challenges in the spheres of urbanism, economy and society.

APEC- ESCI Knowledge Sharing Platform	Knowledge-sharing platform which presents already realized projects and development strategies among APEC economies of the different sub-tasks: Smart Transportation, Smart Buildings, Smart Grids, Smart Jobs, Industry, Low Carbon Model Towns. Includes information about and the APEC Cooperative Network of Sustainable Cities and recommendations about some smart technologies.
SMART LATAM	Platform which presents smart city initiatives and offers knowledge exchange about solutions applied in LATAM region. Platform requires members fee, no free access.
ASEAN Smart Cities Network	The ASCN aims to facilitate cooperation on smart cities development, catalyse bankable projects with the private sector, and secure funding and support from ASEAN's external partners. To this end, 33 partnerships have been established thus far.

Table 3. *Selection of websites presenting information about smart city solutions*

Annex 2. Selection of relevant publications of the last five years

Name of publication	Content	Publishing date
McKinsey Global Institute: Smart Cities: Digital Solutions For A More Livable Future	Assessment of deployment of 50 cities around the globe; the study does not elaborate on details about single initiatives.	2018
Deloitte – Smart Cities Report	The report explains multiple smart city solutions, but does not present specific case studies.	2015
Deloitte: Smart City | Smart Nation - Client stories in action	Project cards of smart city solutions implemented by Deloitte; includes detailed descriptions for each initiative yet does not mention financial or methodological aspects.	2018
Nokia / Machina Research - The Smart City Playbook	A report sponsored by Nokia with the aim of illustrating the experience and learnings from a number of cities at different stages on the smart city journey. The research focuses on aspects mostly related to IoT.	2016
IDB: International Case Studies of Smart Cities	The Inter-American Development Bank (IDB) published ten international studies developed by the Korea Research Institute for Human Settlements (KRIHS) for the cities of Anyang, Medellin, Namyangju, Orlando, Pangyo, Rio de Janeiro, Santander, Singapore, Songdo and Tel Aviv.	2016

OECD: Working Party on Urban Policy ENHANCING THE CONTRIBUTION OF DIGITALISATION TO THE SMART CITIES OF THE FUTURE	A background paper which seeks to take stock of a decade of experimentation, uptake and proliferation of smart city initiatives across the globe, in order to help understand what has worked, what has not worked, and what can be improved to leverage fully their potential to drive inclusive and sustainable growth. Very short description of selected examples of smart city initiatives on a global level.	2019
APEC: Recommendations for Implementation of Smart Sustainable City Information and Communication Technology Infrastructures in the APEC Region	The report presents the outcomes of the *workshop, Recommendations for Implementation of Smart Sustainable City (SSC) ICT infrastructures in the APEC Region*. The workshop discussion focused on problems and challenges in building ICT infrastructures to deploy SSC, and outlining recommendations to APEC economies in recognizing and capitalizing the benefits of ICT infrastructures for SSC.	2020
PwC: Building Better Cities: Competitive, sustainable and livable metropolises in APEC (and how to become one)	Comparative ranking of cities within the APEC region considering their smart development and their livabilit. The ranking considers the topics: culture and social health; connectivity; health and welfare; environmental sustainability; economics.	2015
Partnerships for the Sustainable Development of Cities in the APEC Region	The report explores the different ways cities in the APEC region are supporting partnerships for sustainable development. It documents the state of urban systems as well as lessons learned from the development of cities and urban corridors through 14 case studies.	2017
IDB: The Road toward Smart Cities: Migrating from Traditional City Management to the Smart City	A guide which presents the basic smart city concepts and principles, as well as the elements necessary for their formation.	2016

Table 4. *Selection of relevant publications of the last five years*

Annex 3. Questionnaire delivered to APEC Member Economies

Background information	
Just for internal use: Contact information (Name, Institution, E-Mail, Telephone)	
Introduction	Please briefly explain the economy's socioeconomic context in terms of urban development, considering its challenges of infrastructure, inequality and poverty, environmental pollution and how this may be related to smart cities development and digital inclusion. What are the economic priorities with respect to urban development?

Smart Cities Initiative	
Name of the initiative	
3. Description	a. Methodology: What approach was used to develop and implement the initiative? Implementation steps/phases (in mm/yy)? Communication strategy between involved stakeholders and the government? Capacity building and training requirements? b. Stakeholder engagement: Which stakeholders were considered in the development and implementation of the initiative? To what extent was the private sector involved in the development and implementation? c. Policies: Please introduce the policies and measures adopted to implement the Smart Cities Initiative. Did the initiative lead to the development of new public policies? Please provide references as appropriate.
4. Financial aspects	a. Financial model: How was the Smart Cities Initiative financed? Which entities financed it? What kind of funding was used? (e.g., public, private, or public-private-partnership)? Which business model did you use? b. Budget/Investment: How much was invested to achieve the Initiative (total estimated amount or USD as per date)? c. Long-term economic sustainability: How did you guarantee long-term economic sustainability? Did you face any financial (long-term) risks? d. Funding: Are there any public or private funds (from international or domestic entities) suitable to perform this kind of initiative that you would recommend to other economies?
5. Implementation challenges	What challenges did you face during the development and implementation of the Smart Cities initiatives (SWOT Analysis) and how did you overcome these challenges? Were there any requirements for modification of existing infrastructure (e.g., implementation of better technologies) or legal aspects?
6. Results	a. Effectiveness: How effective was the initiative in addressing the key challenges mentioned? What is the main benefit you identified? b. Impacts (financial and non-financial): What were/are the direct and indirect impacts of the Smart Cities initiative (please indicate both monetary and non-monetary impacts). Has the initiative or the policy resulting from the initiative shown any impact on the inclusiveness of less favored groups

	of the population (Women, elderly, people living in poverty, SMEs)? Has the initiative or the policy resulting from the initiative shown any impact on the economy´s sustainable growth? Did you observe any negative impact of the initiative? c. Improvement in quality of life: What was the initiative´s impact on people´s quality of life, which social benefits were identified? Was the initiative able to improve the quality of life of less favored groups of population (Women, elderly, people living in poverty SMEs)? If yes, how? How did you recognize/measure these impacts? How many people benefit from the implementation of the initiative? d. Monitoring and Verification (M&V): How was progress and impact measured (M&V Methodology)? Which KPIs did/do you use for determining these impacts? How have KPIs improved since the initiative was implemented? Please provide data and statistics as appropriate.
Experience sharing and policy recommendation	
7. Lessons learned	What lessons were learned by developing and implementing the Smart Cities initiative? What could have been done better? What else needs to be done, are there plans for further follow-up policies or actions?
8. Recommendations	What recommendations do you have for APEC economies that face similar challenges? Did you identify possible opportunities of cooperation for policy makers and urban planners among APEC economies?
Pictures / Reference links	Please feel free to add 1-3 pictures and/or reference links for the initiative.
COVID-19 health emergency	
9. Impact on initiative	How does the current global health emergency affect your initiative (in positive or negative terms)? Has the Smart Cities initiative strengthened your ability to better cope with the COVID-19 pandemic? If yes, please give some examples that highlights the advantages of smart cities.

10. Transformation Opportunities	Have you identified new opportunities to strengthen your smart city initiative as a result of the COVID-19 pandemic? If yes, please describe the opportunities you identified, and whether and how you modified the initiative taking into account this aspect (e.g., did you include/modify (more) sustainable criteria within the implementation?).
11. Emergence of new smart city solutions	Is there any new initiative within your economy that arose due to the COVID-19 pandemic? If yes, please feel free to elaborate on this initiative in order to include relevant recommendations for other APEC economies. Please consider any new initiative that aligns with the three topics of interest: transportation, infrastructure, and energy.

Table 5. *Questionnaire delivered to APEC Member Economies*

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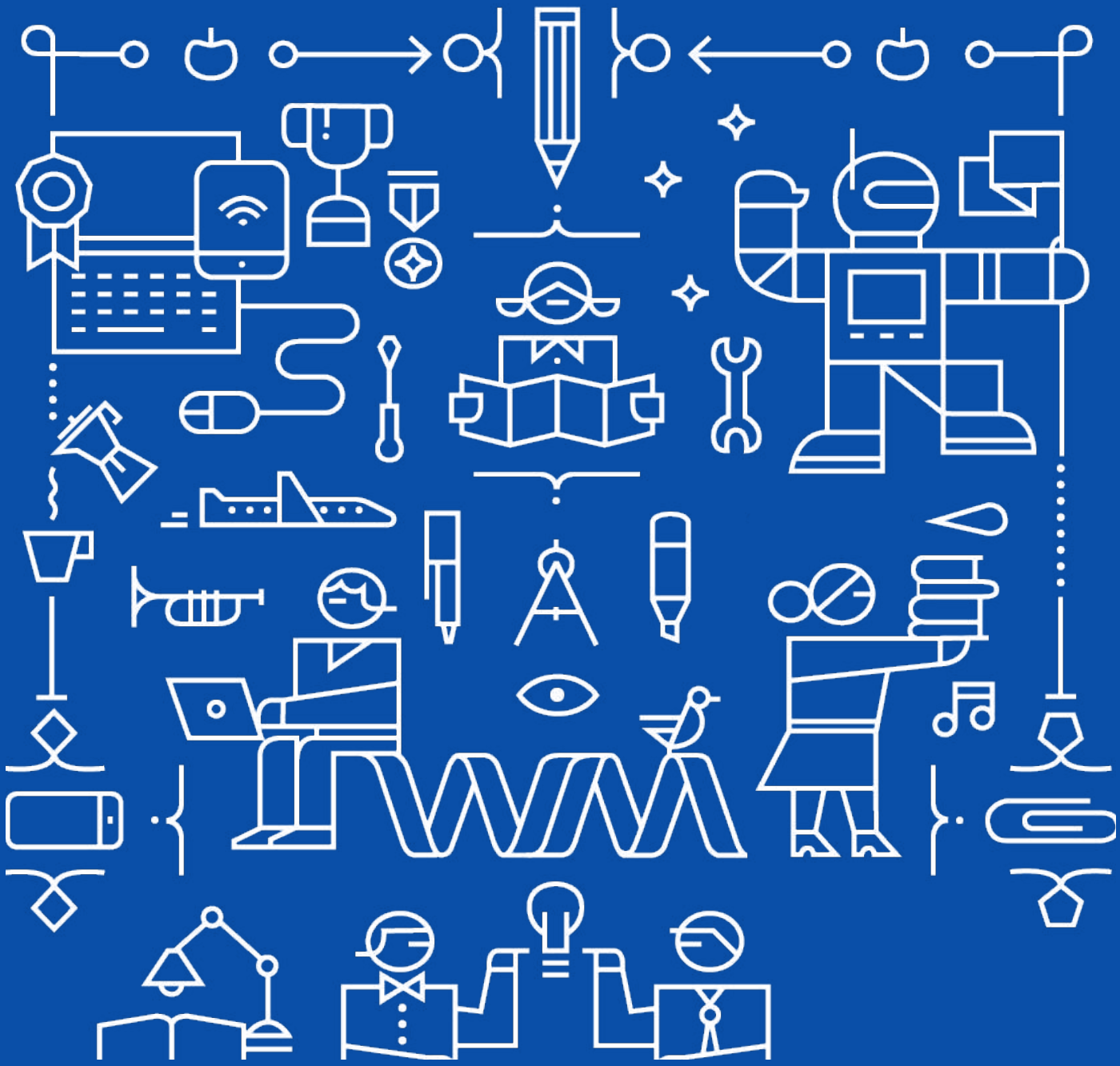

APEC Case Study

Best Practices of Smart Cities in the Digital Age.