Knowledge Series on ICT for Development

ISSUE I

April 2017

50 YEARS

ADB

KNOWLEDGE SUMMARY

3-5 April 2017, Singapore e-Government Leadership Centre
Institute of Systems Science, National University of Singapore

TA-8813 REG: INFORMATION AND COMMUNICATION TECHNOLOGY FOR DEVELOPMENT INITIATIVE FACILITY IN ASIA AND THE PACIFIC – TRAINING ON SMART CITIES: A CASE STUDY OF SINGAPORE (48240-001)

About the Smart Cities Training

In 2012, Singapore's Deputy Prime Minister and the President of the Asian Development Bank (ADB) signed a Memorandum of Understanding (MoU) to strengthen the partnership for development of activities for developing countries in Asia and the Pacific. The focus of this MOU was on governance and public policy, private sector development, and climate change.

During the MoU implementation, it was proposed that the scope be extended to also include information and communications technology (ICT) in key areas of ADB operations and ADB member countries. It was under this collaboration that the idea was hatched for a knowledge training session on the use of ICTs and technologies in Smart Cities planning and projects be conducted.

The ADB's objective was to have a training program that will allow its staff from various operational departments to better understand Singapore's approach and plans to becoming a Smart Nation. This is expected to contribute to enhancing ADB's operations in the design of potential ADB urban development projects.

The training covered key aspects of urban development, land transportation, water management, and e-government, based on the identified learning outcomes. It introduced ADB officials to Singapore's approach to integrating the use of ICT technology and data services to its various projects. At the end of the training, participants were equipped with tools and knowledge they can use to craft an integrated and coherent approach towards Smart City programmes/projects.

At a Glance

Training Dates:
3-5 April 2017

Training Agency:
Singapore e-Government Leadership

Venue:
Singapore e-Government Leadership Centre
Institute of Systems Science, National University of Singapore

Instructors and Facilitators:
9 senior officials of the Singapore government and sector experts

Participants:
18 senior officials and sector specialists from ADB

Site Visits:
Singapore's Land Transport Authority, Integrated Transport Systems Centre (ITSC), and Ecosoftt's water and waste treatment facilities

Organizers

The three-day Smart Cities training was organized by the ADB's Sustainable Development and Climate Change Department. Overall coordination was led by Seok Yong Yoon, Senior Public Management Specialist (e-Governance), of the Department.

The department partnered with the eGovernment Leadership (eGL) Centre of the Institute of Systems Science at the National University of Singapore.

eGL designs and conducts lectures, site visits, and workshops and provides the frameworks and best practices that equip leaders to challenge the status quo and undertake whole-of-government digital transformation. To date, it has engaged over 4,000 officers from more than 133 countries in transforming public services.

Instructors & Facilitators

Dr. Leong Mun Kew
Deputy Director,
Institute of Systems Science (ISS)
National University of Singapore (NUS)

Mr. Leonard Tan
Deputy Director
Road Pricing Systems
Land Transport Authority (LTA)

Ms. Serene Ho Fung Ying
Lecturer/Consultant
e-Government Leadership Centre
Institute of Systems Science (ISS), NUS

Mr. Silvester Prakasan
Director
Fare System
Land Transport Authority (LTA)

Ms. Chay Pui San
Smart Nation Program Office (SNPO)
Prime Minister's Office

Mr. Tan Nguan Sen
Director and Chief Sustainability Officer
PUB

Mr. Huang Shao Fei
Director
Innovation & Smart Mobility Office
Land Transport Authority (LTA)

Mr. Michael Koh
Fellow
Singapore Centre for Liveable Cities

Mr. Kok Tse Weng
Chief Engineer/Water Supply Networks
PUB

Participants

A total of 20 participants from ADB's various departments and sectors participated in the training.

1. Sanjay Divakar Joshi
   Principal Urban Development Specialist
   SAUW, SARD
2. Johan Thierry Georget
   Transport Specialist
   SATC, SARD
3. Satoshi Ishii
   Senior Urban Development Specialist
   SEUW, SERD
4. Rabin I. Hattari
   Public Management Economist
   SEPF, SERD
5. Ramola Naik Singru
   Urban Development Specialist
   CWUW, CWRD
6. Kamel Bouhmad
   Transport Specialist
   CWTC, CWRD
7. Hinako Maruyama
   Urban Development Specialist
   EASS, EARD
8. Kristina N. Katich
   Urban Development Specialist
   EASS, EARD
9. Siddharta Shah
   PPP SpecialistPrincipal Public-Private Partnership Specialist
   OPPP
10. Chaorin Shim
    PPP Specialist
    OPPP
11. Euna Shim
    OPPP
12. Joris Van Etten
    Senior Urban Development Specialist
    Urban SG, SDCC
13. Seok Yong Yoon
    Senior ICT / e- Governance Specialist
    ICT Team, SDCC
14. Ki Joon Kim
    Senior Transport Specialist
    Transport SG, SDCC
15. Sung Su Kim
    Financial Sector Specialist
    Finance SG, SDCC
16. Arun Ramamurthy
    Senior ICT / eGovernment Specialist
    ICT, SDCC
17. Young Uck Kang
    Knowledge Sharing and Services Specialist
    KSSC, SDCC
18. Shirin Hamid
    Principal Director
    OIST
19. Micheal Tittel
    IT Specialist
    IT Gov, OIST
20. Jeffrey Gerobin
    Associate Operations Analyst
    SDTC, SDCC

Programme

DAY 1		
Time		**Speaker/Organisation**
09:00 - 09:10	Welcome and Opening Remarks Venue: NUS-ISS	Mr. Khoong Chan Meng Director and CEO, Institute of Systems Science
09:10 - 09:45	**Introduction: What is a Smart City?** The 'smart city' is a complex concept which has different definitions globally and includes several basic parameters such as: smart energy, smart buildings, smart mobility, smart healthcare, smart infrastructure, smart technology, smart governance and smart education, and a smart citizen. The segment will thus cover the following : • Definitions of what is a "Smart City" • Key Parameters that define a Smart City • What are the Drivers and Opportunities • Key Challenges and Critical Success Factors This session will look at international best practices and will share Singapore's approach and plans for its Smart Nation Initiative.	Dr. Leong Mun Kew Singapore e-Government Leadership Centre, NUS-ISS
09:45 – 10.30	**Governance : Leadership, Collaboration and Coordination** This segment will look at the Governance model that will drive leadership, collaboration and coordination across agencies and industries.	Ms. Chay Pui San Deputy Head, Singapore Smart Nation Program Office (SNPO) Prime Minister's Office
10:30 - 11:00	*Coffee Break + Group Photo-Taking Session*	
11:00-11:30	Travel to LTA Academy Venue: LTA Academy	
11:30 - 12:15	**Smart Transport and Communications (I)** The challenge to every rapidly urbanized country is limited space for Roads and Transport. With a population of 5.5 million and approximately one million cars on the roads, the number of vehicles that Singapore can have is severely limited. At the same time, roads take up 12% of land space suggesting that we cannot increase its operating capacity. In response to this, the Singapore government has come up with ideas and plans that make use of ICT solutions for better traffic management, monitoring etc. In this segment, our Singapore Land Transport Authority, LTA will share some of these plans and its various Smart Mobility initiatives.	Mr. Huang Shao Fei Director, Innovation & Smart Mobility Office Land Transport Authority, Singapore
12.15 – 13.00	**Smart Transport and Communications (II)** There is a focus on a closer connection between the role of transportation and the economic health of cities and its impact on people. The three key trends that experts predict will shape the transportation industry over the coming years are: connectivity, automation, and environmental concerns. Policymakers need to be flexible in formulating policies to ensure that new technologies can be accommodated quickly for the benefit of the public. This session will look at the dynamics between innovators and policymakers and what each side needs to do to create a supportive environment for innovation. It will cover the governance structure, institutional arrangement, engaging various stakeholders including private sectors to address the issues and how our local authority LTA has facilitated this. This segment will also showcase some of the emerging technologies that may impact the future of the transport sector, including the ERP2/Fare System.	Mr. Leonard Tan Deputy Director, Road Pricing Systems Land Transport Authority, Singapore Mr. Silvester Prakasam Director, Fare System, LTA Singapore

Time		Speaker/Organisation
11:30-12:30	**Presentation by NETS Pte Ltd - e-Payment** This session will be presented by NETS Pte Ltd. Founded in 1985 by a consortium of local banks, NETS is a key payment provider in Singapore and has a full suite of e-payment solutions.	Mr. Khoong Chan Meng Director and CEO, Institute of Systems Science
13:30-14.30	**Discussion – Sharing Sessions by ADB Project Teams**	Facilitated by eGL, NUS-ISS
15:00 – 17:45	**Site Visit – Ecosoftt** Ecosoftt is a global pioneer in the field of decentralised management of water, wastewater and environmental services. Participants of the training will get the chance to understand how their solution have been innovatively incorporated into projects to benefit homes and communities.	
18:30	**Networking Dinner Hosted by IE Singapore** Venue: Peach Garden Restaurant	IE Singapore
DAY 3		
09:00 - 10:30	**Urban System Studies: Green City and Energy Sustainability** All big cities around the world have to cope with increasing population density while managing serious urban challenges which would include issues such as air pollution, traffic congestion, floods etc. How then do we pack more people into cities and yet continue to achieve a high quality of life? How do we create and manage 'good cities' which are safe, spacious and green. This segment will look at how Singapore tackle these key urban challenges and espouse on some of the key principles and programs. The Center for Liveable Cities (CLC) will be sharing on Singapore's Liveability Framework, which will cover how long term integrated planning and dynamic governance are two critical systems to support the move towards achieving a balanced outcome between sustainable environment, competitive economy and quality of life.	Mr. Michael Koh Fellow Singapore Centre for Liveable Cities
11:00 - 12:15	**Smart ICT Infrastructure and Platform** In the context of Smart Cities, ICT Infrastructure is a very wide topic and includes most aspects of ICT. This segment will present on the rising use of IOT devices and the underlying network and platform to support this.	Dr. Leong Mun Kew Deputy Director and Chief - Software Engineering & Design, NUS-ISS
12:15 – 13:00	**Smart Data: Data Sharing, Open Data** This segment will examine the important role played by Digital Data that will connect horizontally across the different sectors to enable seamless collaborations. It will also introduce participants on the importance of putting in place the right data management policy framework that will allow for the use of open data, big data and data analytics. Key issues for consideration will be discussed: - Balancing the need for privacy/data protection and accessibility needs - Facilitating information sharing to allow better operational decisions to be made - Managing massive data	Ms. Serene Ho Lecturer/Consultant e-Government Leadership Centre, NUS-ISS
14:00 – 15:30	**Workshop– Participants' Action Planning** The workshop exercise is intended to allow participants to apply the concepts, ideas and opportunities introduced in the 3 days to their target cities/country of which the ADB's participants comes from. Participants will breakout into the 4 groups to discuss and draw up their action plans for smart city at the target cities. The Project team will choose the City as their project and prepare a 15-minute presentation per group.	Dr. Leong Mun Kew NUS-ISS Workshop Facilitator
16:00 - 17:00	**Participants' Action Plans Presentation** Participants will present their Action Plans, which will be critiqued by the faculty members and rest of the team, so as to yield a comprehensive, actionable plan.	Dr. Leong Mun Kew NUS-ISS Workshop Facilitator
17:00 – 17:30	**Closing Ceremony & Certificate Presentation**	

Programme *(con't...)*

Time		Speaker/Organisation
14:00 –15:00	**Presentation by ST Electronics (Info-Comm Systems) – Smart Mobility** ST Electronics (Info-Comm Systems) Pte Ltd., a wholly owned subsidiary of ST Electronics, is a leading Information Communications Technologies (ICT) solutions provider in the Asia-Pacific region	
15:30 – 17:00	**Intelligent Transport Systems Centre (ITSC)** The ITSC is the central nerve center of the Intelligent Transport System manage by the LTA. At the forefront of the daily operations, it operates 10 expressways with a total length of 166km, road tunnels, including the Marina Coastal Expressway (MCE), Kallang-Paya Lebar Expressway (KPE), Central Expressway (CTE), as well as Fort Canning Tunnel (FCT), Woodsville tunnel (WVT) and more than 2000 sets of traffic lights. ITSC operates 24 hours daily throughout the year and manages via the i-Transport platform. This platform integrates the various ITS seamlessly to enable control through a single common interface. The key ITS features that are integrated through a single common interface include: (1) Green Link Determining (GLIDE) System (2) Expressway Monitoring and Advisory System (EMAS) (3) Junction Electronic Eyes (J-Eyes), and (4) Traffic.smart	LTA Intelligent Transport Systems Centre
DAY 2		
09:00 - 10:00	**Urban Water (I) - Urban Water Management and the Development of Smart Systems** Over the last 50 years, Singapore has evolved from its past urban water management challenges and developed a diversified and robust water supply through the Four National Taps – local catchments, imported water, NEWater and desalinated water. A long term view has always been taken in our water resources, catchment, drainage and used water planning. This session will introduce PUB, Singapore's National Water Agency, and cover why and how we take the lead in innovating and developing smart solutions for urban water management. To realise this, PUB works with relevant government agencies to test and apply these solutions in key areas identified, such as in our city planning, urban habitats and utilities management. Within PUB, the Sustainability Office coordinates these smart solutioning efforts across departments and with the other government agencies to better achieve PUB's mission and other larger sustainability outcomes. The development of these smart solutions is supported by our internal policies for the funding, research and development. The implementation of these solutions is driven by an organisation-wide commitment towards innovation and a strong focus towards improving our operations and benefiting our citizens.	Mr. Tan Nguan Sen Director and Chief Sustainability Officer PUB, Singapore
10:30 - 11:30	**Urban Water (II) - Technologies and Implementation of Smart Water Systems** Smart solutions can be applied to manage the entire water loop. PUB engineers are developing and trialing smart solutions in the management of reservoirs, drainage, water supply and sewers. The session will cover smart applications in the implementation of sensor network and data analytics to manage and analyse network parameters to detect pipe leaks and bursts or longer-term trend changes. Details on how these plans were conceived, developed and implemented will be shared; highlighting the challenges and key lessons learnt.	Kok Tze Weng, Chief Engineer/Water Supply Networks, PUB Singapore

Explainer

What is a ‘Smart City’? Ask Singapore

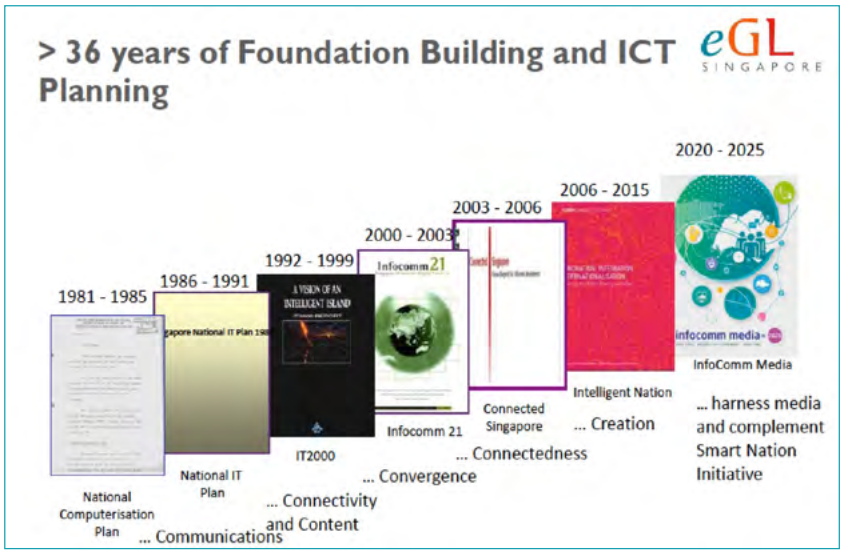
Many cities and municipalities have set the goal to become a "smart city," but just what exactly are they aiming for? Singapore started 36 years ago with a clear vision to solve complex challenges through technology and innovation. In 2014, this vision acquired a name: Smart Nation.

“When people come to Singapore, they don’t get impressed first with the tall buildings. They get impressed by the fact that there are no homeless people and no slums, and that we can even drink water from the tap,” said Dr. Leong Mun Kew, deputy director at the Institute of Systems Science at the National University of Singapore (NUS).

The success of Singapore as a livable city, however, did not take overnight to build.

Dr. Leong Mun Kew, deputy director of the Singapore e-Government Leadership Centre at the National University of Singapore's Institute of Systems Science (ISS), discusses the complex concept of ‘smart city' and Singapore’s approach and plans for its Smart Nation Initiative.

To get to where it is now, it took the government of Singapore 36 years of building a strong foundation and planning its information and telecommunications technology (ICT) sector. From investing in a massive National Computerization Plan from 1981 to 1985, to achieving convergence and connectivity since year 2000, Singapore is now aspiring to become the world's first “Smart Nation.”



While many cities and municipalities around the world have started to embrace the dream of becoming a ‘smart city’, they find that the road from dream to reality is arduous. For one, the concept of what makes a city ‘smart’ often means different things to different people.

Many of these definitions have a core element: addressing the complex challenges that cities face today — a growing population that leads to traffic congestion and housing problems, resource scarcity, carbon emissions, and aging infrastructure and population — through the use of ICT.

However, being a ‘smart city’ requires more than just connection; it calls for sustainable action. “Smart City is more about designing things today for tomorrow’s needs,” said Dr. Mun Kew.

For Singapore, a 'Smart Nation' is one that:

1. Anticipates the needs of people. Citizens are at the heart of the Smart Nation vision, not technology. Like many other countries, the city faces challenges such as an ageing population and urban density which require a smart response. The world's third most densely populated nation anticipates that the number of elderly people aged 65 years and above in Singapore is expected to triple to 900,000 by 2030. These individuals will be supported by a smaller working-age population and add pressure to its healthcare system and its citizens' ability to use resources such as energy, food and water sustainably.

Singapore is creating various solutions that utilize technology to address these problems in the future. Among these solutions is the tele-health rehabilitation system where data is transmitted wirelessly through sensors to enable preventative and out-of-hospital care. Another project involves trialling the use of smart devices and applications in Singapore's public housing flats to help elderly residents move safely and with more independence.

2. Delivers services more efficiently through technology. 'Smartness' is not a measure of how advanced or complex the technology being adopted is, but how well a society uses technology to solve its problems and address existential challenges.

Before the Smart Nation Initiative was launched in 2014, Singapore's various channels and agencies tend to operate in silos, where systems of information, activity and governance are isolated from each other. This posed a challenge for the delivery of public services.
By harnessing data, Singapore is able to identify problem areas and formulate solutions to work around them. This is most evident in the city's bus transport system. Using sensors on bus fleets, the government is able to capture 12 million records on public transport each day and performed data analyitics to decongest the streets of Singapore. By identifying where more buses are needed has reduced congestion by around 90% and commuters' wait times on popular routes three to five minutes.

3. Empowers citizens to solve problems.
The government strives to facilitate innovations by the public and the private sector. It puts in place appropriate policies and legislations to nurture a culture for experimentation, encourage innovation and the eventual adoption of new ideas.

At the heart of Singapore's entrepreneurship action is the Launchpad, a dedicated zone for start-ups, where they can build a proof of concept and then scale it up quickly, leveraging government support and a ready network of accelerators, incubators and venture capitalists in the eco-system.

In addition to offering test beds for knowledge sharing, business collaboration and deal-making, the government is also opening up some 9,000 government data sets for the world's tech community to use to explore and test new ideas.

Get Singapore's Smart City Recipe!

The good news is, any city can become 'smart' regardless of its size. Whether big or small, you can copy Singapore's recipe for 'smart city' success which essentially requires:

- Leadership and governance
- Stakeholders and citizen focus
- Effective use of data
- Integrated ICT infrastructure

"Ultimately, citizens, not technology, are the heart of every 'smart city'" said Dr. Mun Kew.

To find out more about the Smart Nation Initiative:
https://www.iss.nus.edu.sg/centres-of-excellence/e-government-leadership-centre/smart-nation

Case Study

How to Be 'Smart' Like Singapore

Singapore is showing the way to become the world's first 'smart city-state' by 2025.

More people now live in cities than in rural areas around the world, and this number is climbing. By 2050, 70% of the world population will be in urban areas, according to a United Nations study.[1]

Rapid urbanization, or the the gradual increase in the proportion of people living in urban areas, poses complex problems. It results in more competition for houses and space, jobs, infrastructure, and resources like water and energy, as well as traffic congestion and pollution, among others.

Ms. Chay Pui San is the Deputy Head at the Smart Nation Programme Office in Singapore. She helps coordinate the government of Singapore's efforts and engagements with the public and private sectors to build a Smart Nation.

With the fate of their population hanging in the balance, more cities now embrace the 'smart city' concept. This means harnessing information and communications technology (ICT) to develop solutions that will address these challenges. Among these is Singapore, which has a 36-year head start in modernizing its ICT system.

Urbanization Challenges

Singapore used to be the poster child for rapid and uncontrolled urbanization. As early as 1965, the island city-state was already exhibiting growth pains: polluted rivers, decaying slums, and a stagnant job market. After declaring independence from mainland China, it managed to transform into a vibrant city and a jobs magnet for immigrants.

However, Singapore inevitably became a victim of its own success. With more than five million residents crammed into an island of 750 square kilometers, the city has one of the world's most densely populated areas on Earth. Around one million cars fight for space on the city's 3,800-kilometer road network, which take up 12% of land space. This affected mobility and productivity.

In addition to land scarcity, Singapore is also faced with an ageing population.

By 2030, the number of elderly people aged 65 years and above in Singapore is expected to triple to 900,000 and will be supported by a smaller working-age population (1:5 ratio). This will add pressure to the healthcare system and to citizens' ability to use resources such as energy, food and water sustainably.

Singapore's Smart Way

Amid these challenges, Singapore continues to win praise for being one of the world's most liveable and economically successful cities in the word.

Barely three years since Singapore unveiled its lofty, tech-centric Smart Nation development plan, the small island-metropolis has already emerged as a hotbed for cutting-edge technologies that stand to overhaul how large cities operate.

[1] Urbanization: Facts & Figures *www.un.org/ga/Istanbul+5/bg10.htm*

Here are some of the innovations on its 5 key priority areas:

1. Transport: Enhancing Mobility

Creating innovative business models such as a real-time demand-driven intelligent transport system, the city is able to optimise the use of land, reduce reliance on limited manpower, and provide commuters more convenient and pleasant rides.

- Using more than 1,000 sensors deployed in busy areas such as traffic junctions, bus stops and taxi queues, Singapore collects and crunches data and uses real-world applications. Its aim is to share these data to empower commuters and make public transport more convenient and less congested.

- Pushing new technologies such as self-driving vehicles or autonomous vehicle (AV) technology and AV-enabled mobility concepts, the government has opened more than six kilometres of public roads for AV trials, including sites at Jurong Lake District and on the NTU and NUS campuses.

Singapore's Land Transport Authority partnered with nuTonomy to trial a shared autonomous mobility-on-demand concept. These robo-taxis have been plying the 6-kilometer stretch in Singapore's One-North technology business district so commuters can hail them through a ride-sharing app and give it a test ride. (Photo: www.smartnation.sg)

2. Home and Environment: Improving Livability

With 83% of Singapore households living in public housing, government agencies are working with industry players to develop and test smart home solutions in Home & Development Board (HDB) public estates that span 26 towns and 1 million flats. Singapore has 2 test-bed sites — in Punggol Eco-Town and in Yuhua — to serve as "HDB Living Labs" in making housing estates smart.

Carefully masterplanned Punggol town

- Since April 2016, residents from some 3,200 households in Yuhua estate have been participating in a trial to use smart devices in their homes, including the use of an Elderly Monitoring System that provides peace of mind to caregivers of elderly loved ones, and the Utility Management System that help manage household utilities usage.

- In Punggol town, town planners, architects and engineers use smart planning tools and data analytics to analyse the wind flow, solar irradiance and shaded areas within a town, and determine how best new flats can be designed and sited to provide maximum thermal comfort and a more conducive living environment for our residents.

3. Public Services: Transforming into a Digital Government

State agencies are re-designing online services to make it easier for citizens to access public services.

- The government is creating next-generation platforms such as a nationwide sensor network (Smart Nation Platform) that will enable the public sector to pull together data from multiple sensors and help agencies in the efficient running of the country, including maintenance, urban planning, and incident response.

- The government has also built a new developers portal — https://developers.data.gov.sg/ — to make open data much simpler for all agencies. This helps agencies publish real-time streams of data to app builders, enabling the co-creation of solutions with citizens and businesses.

- Digital technology is also utilized to empower citizens in sharing governance responsibility. An example is the OneService App is a convenient way for members of the public to give their feedback on municipal issues, without having to find out which agency is responsible for the issue. The city is also experimenting with crowdsourcing models such as the myResponder app that enables qualified private volunteers to assist people suffering from cardiac arrest near their location.

4. Health and Ageing: Making Citizens More Pro-active

With an elderly population that is expected to triple to 900,000 by 2030, and with a declining number of young people who will assist the elderly in the future, Singapore is using technology to help deliver holistic healthcare and eldercare to aid active ageing.

- Several public hospitals are currently conducting trials on a tele-health rehabilitation system where data is transmitted wirelessly through sensors attached to chronic disease patients' limbs as they carry out therapy sessions at home.

- Singapore is also empowering individuals to be proactive about their health and wellbeing by pushing medical information to mobile devices. The Healthhub web portal and mobile application is a one-stop digital healthcare portal for Singaporeans to access medical records and useful health information.

- The State is also using gamification to nudge more Singaporeans to lead active lifestyles. In 2015, it launched a nationwide physical activity programme, the "National Steps Challenge," to engage Singaporeans in a fun way to take responsibility for their health and wellbeing by tracking their progress with the aid of a steps tracker and a mobile app.

5. Competitive Economy: Future-Proofing through Innovation

Singapore is world-renowned for its innovation. In the 2016 Global Innovation Index report , the city-state ranked No. 1 in Asia and 6th in the world for its innovation performance.
At the heart of this innovative spirit is the willingness of the government for Singapore to serve as a living laboratory for developing and prototyping innovative solutions to urban challenges such as healthcare, transport and an ageing population.

- One-north and Fusionopolis embody the government's vision for a vibrant research and development hub, with a focus on knowledge-intensive activities in key growth sectors, namely biomedical sciences, and infocomm and media. One-north also hosts trials on driverless vehicles on public roads in Singapore.

- At CleanTech Park, a 50-hectare eco-business and technology park, test-bedding on clean technology solutions are being done. These include a hybrid solar photovoltaic system based on top-cooling technology, and a wastewater recycling system that treats grey, brown and black water for nonpotable uses.

- The EcoCampus initiative focused on campus-level sustainability solutions such as Green Buildings.

- LaunchPad is a space for entrepreneurs, researchers and students to design, prototype and test-bed their new innovations.

- The government undertook a massive reclamation and redevelopment of Jurong Island into an innovation showcase for the energy and chemicals industries. The island is now an integrated complex to serve a "plug-and-play" environment where downstream and upstream companies can be easily connected.

5 Ways to Smart Cityhood

How did Singapore do it? Ms. Chay Pui San, deputy head of the Smart Nation Programme Office which coordinates the smart-city initiatives of the public and private sectors in Singapore, shares this playbook on smart cityhood:

1. **Know Your Strengths.** Its Smart Nation initiatives were created to leverage Singapore's four main strengths:

- Having a compact size and uniqueness as a city-state that enables faster policy making and implementation;
- Investing heavily in smart infrastructure and being one of the most well connected cities in the world, both in terms of fixed broadband and mobile cellular coverage;
- Being able to pull together its world-ranked universities, its multi-billion annual research and development investments, its fast-growing community of tech start-ups, and large pools of investment capital firms to achieve a shared vision for Singapore; and
- Having an engineering ethos that encourages technology builders and entrepreneurs from around the world to use the nation as a 'living lab' to test new ideas and solutions with global potential.

2. **Focus on People.** At the heart of the strategy is the idea that the population's needs and priorities come first. "The smart city's objectives should not be about putting policies or technology in place, but making a difference in citizens' lives," said Ms. Pui San.

3. **Set Your Priorities.** In Singapore's context, there are five key domains that will have significant impact on citizens and society, and in which digital technology can have a needle-moving impact:

- Transport;
- Home and environment;
- Public services;
- Health and enabled ageing; and
- Competitive economy.

4. **Build Enablers.** Singapore's smart city approach rests heavily on the government's role as the catalyst that facilitates innovations by the public and the private sector. It puts in place policies and legislations to nurture a culture for experimentation, encourage innovation, and the eventual adoption of new ideas.

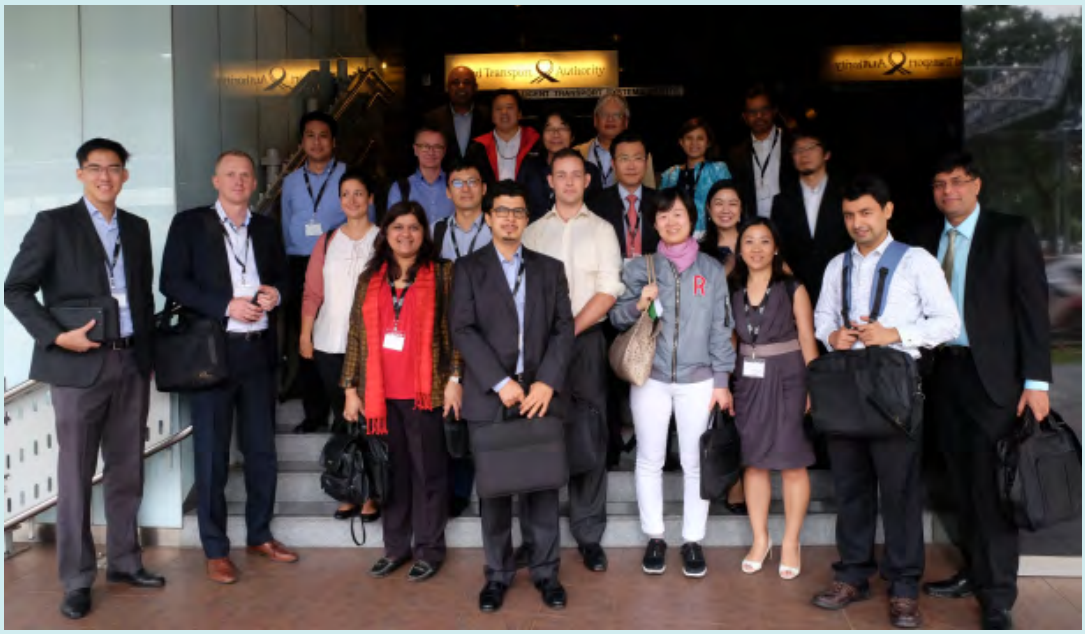
5. **Whole-of-Nation Effort.** While various cities around the world are experimenting with smart city technologies to tackle specific issues such as street lighting, waste collection, and traffic light management, Singapore has set a much more ambitious and whole-of-nation approach. This requires government agencies to collaborate and remove their silos, as well as for people, within and outside the government, to pool together their diverse knowledge, viewpoints, and ideas to find potential solutions.

At the end of the day, "It is not what technology is, but what you want to apply technology to, and what problems you want to solve," Ms. Pui San said.

For additional information, go to:

- Urbanization: Facts & Figures: *www.un.org/ga/Istanbul+5/bg10.htm*
- Singapore Smart Nation Initiative milestones: *www.smartnation.sg/about-smart-nation/milestones*
- Video showing the HDB Smart Home in Yuhua: *https://youtu.be/KnM3bL3O5TY?list=PLmGkYf0auQJyhg7DmHJZuXQrCWNw_qd9D*
- Singapore's Open Data portal: *https://developers.data.gov.sg/*

Site Visits



(Left) Participants at the lobby of Singapore's Land Transport Authority

(Below) Mr. Leonard Tan, deputy director of LTA's Road Pricing Systems, discusses the emerging technologies that Singapore has started to harness to make its transport system smart.

(Above) Participants visit the Ecosoftt Water and Waste Treatment Facility.

(Right) An inside look into Singapore's Intelligent Transport Systems Centre (ITSC), the nerve center of the Intelligent Transport System managed by the LTA.

Case Study

How Singapore Outsmarts Traffic

Singapore is investing heavily in smart technology and solutions to tackle challenges in transportation and urban mobility.

Like many other cities and countries around the world, Singapore is investing heavily in the future, particularly in smart technology, to solve its problems arising from rapid urbanization. Its "Smart Nation Initiative," unveiled in late 2014, is most evident in the transportation and urban mobility sector.

To find out how the city-state is tackling traffic congestion and other challenges to urban mobility, take a peek into Jurong Lake District, a regional hub that Singapore considers its test bed for its "smart nation" push.

With more than 1,000 sensors deployed to control and monitor everything — from traffic to street lights, and crowded buses — its residents are able to use phone applications that can help them find sheltered walkways, navigate traffic, and available parking, among others. There are also driverless electric buggies that ferry people around and advanced software analyses videos that monitor queues in stores or offices to deploy staff where they are most needed.

Singapore has pioneered the Electronic Road Pricing (ERP) system, an electronic toll collection scheme to avoid traffic congestion.

The Singapore Challenge

Getting stuck in traffic is rapidly becoming a shared experience for motorists living in many densely populated areas around the world. In Singapore, this has been posing challenges to urban mobility for more than four decades now since the city-state transformed into a vibrant city and a jobs magnet for immigrants.

Compared to highly dense cities and countries, however, Singapore is considered an outlier due to its unique characteristics:

- **Limited Land Space.** Singapore is an island of 716 square kilometers, with a population of around 5.5 million. This translates to more than 7,500 persons/sq. kms., making the city-state one of the world's most densely populated areas on Earth.
- **Growing Number of Vehicles.** Around one million cars fight for space on the city's 3,800-kilometer road network, which occupies 12% of Singapore's total land area compared to 14% for housing.
- **Meeting Diverse Needs.** The mobility of a growing population of elderly people in the city also poses a challenge to urban mobility. By 2030, the number of elderly people aged 65 years and above in Singapore is expected to triple to 900,000.

However, despite these challenges, the small city-state has managed to leverage on its strengths and seized opportunities to enhance mobility:

- **Strong government policies.** To decongest its roads and keep the city one of the greenest in the world, the Republic of Singapore has made owning a vehicle extremely restrictive. It levies high taxes (a car is taxed at least 100% of its open market value) as well as require vehicle owners to bid for a Certificate of Entitlement that allows the vehicle to run on the road. Therefore, despite the population of 5.5 million, only 0.65 million vehicles are registered and other transport modes

such as foot, bicycles, bus, taxis and train (Mass Rapid Transit or Light Rail Transit) are used more generally.

- **Connectivity.** Internet penetration is about 83% of households in Singapore and mobile phone penetration also remains high at over 137%, or more than 6.8 million mobile subscriptions. High connectivity has enabled the city-state to harness smart technology and data analytics to solve its transport problems.

4 Smart Ways to Outsmarting Traffic

To optimise the use of land, reduce reliance on limited manpower, and provide commuters more convenient and pleasant rides, Singapore has devised the following strategies:

1. Increasing public transport ridership:

- Real-time information for public transport commuters can be accessed on the MyTransport.SG smartphone application to improve their travelling experience. In 2017, the Land Transportation Authority (LTA) is rolling out an Intelligent Bus Management System that will determine real-time bus locations, and provide more accurate bus arrival information for more than 4,700 public buses over 360 routes. A similar initiative is being done to ensure the service and availability of taxi fleets in the city.

- Contactless cards to pay for bus and train rides enable commuters to simply tap their cards onto fare readers and carry out cashless transactions. In March 2017, Singapore became the first country in Asia to use contactless payment cards, making it convenient for transit riders, who no longer will have to carry or top-up transit-specific payment cards.

- Physical accessibility for people with special needs is being ensured by providing barrier-free access routes in MRT stations, lifts, pedestrian walkways, taxi and bus shelters, to improve accessibility for less mobile commuters like the elderly and people with disabilities.

- Integrated Transport Hubs (ITHs) are being built so commuters can easily run errands and shop conveniently and comfortably before transferring to their connecting buses or trains. ITHs are fully air-conditioned bus interchanges seamlessly linked to MRT stations and adjoining commercial developments such as shopping malls.

2. Enhancing road network capacity and reducing congestion:

To enhance traffic flow and keep roads safe, Singapore created the Intelligent Transport System (ITS) in 2006 as a holistic approach towards traffic management. ITS uses sophisticated traffic and control systems in Singapore's over 164 kilometers of expressways and road tunnel systems.

Vital components of the ITS:

- ITS Centre: A 24/7 Operations Control Centre (OCC) monitors traffic and deploys ground recovery crew to assist motorists in distress. Real-time traffic advisory information are also provided to motorists through electronic message signs.

- i-Transport: Provides an integrated and unified platform that centralises the management of all ITS, including traffic signal control, traffic monitoring, incident management, tunnel and highway monitoring, and provision of real-time traffic advisory information.

- Expressway Monitoring & Advisory System (EMAS): Monitors traffic along expressways, alerts motorists of traffic incidents, and ensures swift response to these incidents.

- Junction Electronic Eyes (J-Eyes): A system of surveillance cameras that monitor the traffic condition at major signalised junctions.

- Green Link Determining (GLIDE) System: Monitors, adjusts and optimises green time in an intelligent and adaptive manner to provide "green-wave" along main roads in response to changing traffic demand.

- Green Man: Extends green man time for both the elderly and pedestrians with disabilities to cross the road.

- Your Speed Sign: Displays the real time speed of vehicles and alerts motorists that they are speeding.

- Parking Guidance System: Provides real-time information on parking spaces availability of shopping malls at major shopping belts to reduce circulation of traffic in these areas.

- Electronic Road Pricing systems (ERP): The city has pioneered the introduction of one of the world's first tolls that vary according to traffic flows, and work as a congestion charge. The ERP uses a short-range radio communication system to deduct charges from smart cards inserted in the vehicles.

3. Mining information and promoting sharing and co-creation:

Using more than 1,000 sensors deployed in busy areas such as traffic junctions, bus stops and taxi queues, Singapore collects and crunches data and uses real-world applications. Its aim is to share these data to empower commuters and make public transport more convenient and less congested. Examples are:

- DataMall: a wide variety of transport-related datasets (static and dynamic/real-time) that the LTA publishes to encourage enterprises, third-party developers, and other members of the public to promote citizen co-creation of innovative and inclusive transport solutions.

- ONE.MOTORING: a comprehensive web portal where citizens can access traffic information collected from surveillance cameras installed on roads and taxi vehicles with global positioning system (GPS). Through Traffic Smart, drivers are able to see snapshots of roadways that is taken at every 5-minute interval.

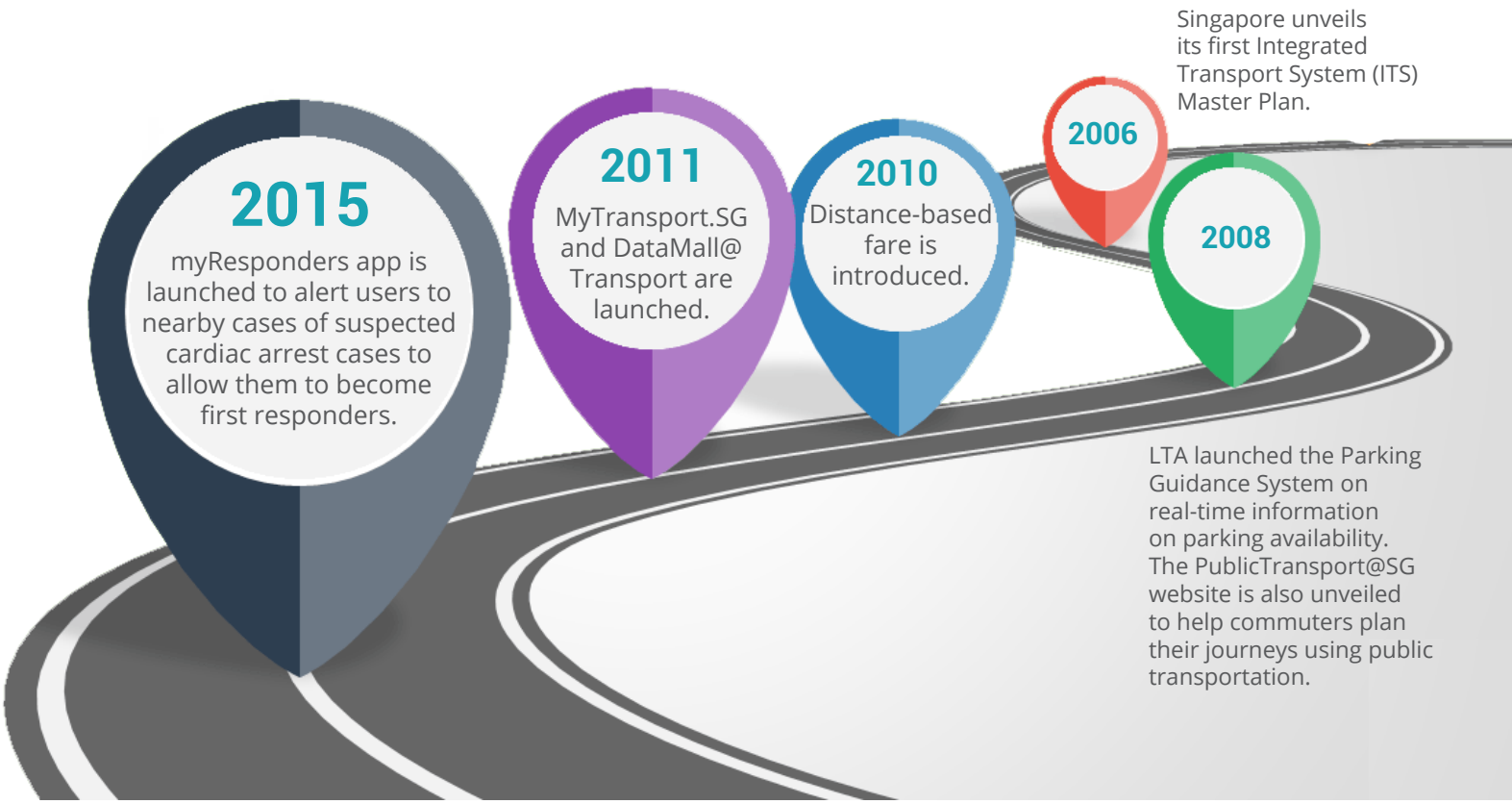
- e-TrafficScan: Uses taxis equipped with Global Positioning System as probes on the road network to provide motorists with information on the traffic conditions island-wide.

4. Innovating smart mobility solutions:

- Singapore is pushing new technologies such as self-driving vehicles or autonomous vehicle (AV) technology and AV-enabled mobility concepts. It has opened more than six kilometres of public roads for AV trials, including sites at Jurong Lake District and on the NTU and NUS campuses.

- Singapore has also started to roll out its first large-scale electric vehicle car-sharing scheme, with with 125 "Bluecars" and 250 charging points set to be installed by the second half of 2017.

Snapshot



Lessons from Singapore's Smart Traffic System

1. Adopt new transport information collection technologies to meet diverse needs and enhance service delivery.
2. Engage multiple stakeholders to come up with relevant solutions to transport needs.
3. Embed environmental sustainability when designing and developing transport solutions.
4. Ensure the safety and security of roadways using smart technologies.

Case Study

Singapore Makes Every Drop of Water Count

Singapore is innovating and harnessing cutting-edge water and environment technologies to address the challenges of being a densely populated city-state on an island lacking freshwater lakes.

You can drink water straight from the tap in Singapore. This small island-state takes pride in having a water quality standard that is oftentimes even higher than the World Health Organisation's drinking water guidelines.

From having a below-average quality in 1965, Singapore's water is now touted as one of the best in the world. Thanks to the holistic water management strategy of its public utilities agency, the densely populated city-state is able to meet its water needs despite lacking freshwater lakes.

To become entirely self-sufficient in water in the future, Singapore is investing heavily in smart technologies and solutions as part of its "Smart Nation Initiative" launched in 2014.

Singapore's 15th reservoir – the Marina Reservoir – is the first of such kind in the heart of the city.

Water: Singapore's Existential Challenge

The World Resources Institute ranked Singapore as one of the most water-stressed countries in the world in 2015. Water sustainability is an existential challenge for Singapore because of these reasons:

- *Limited Land Space.* Singapore is an island of 716 square kilometers, with a population of around 5.5 million. The island receives an average of 2,330 millimeters of rainfall a year, but is unable to harness this due to the lack of land space to collect and store rainwater.
- *Reliance on Imported Water.* Half of its water needs is met by importing water from neighboring Johor, Malaysia.
- *Future Trends and Challenges.* Like many countries in the world, the island-state has to address the challenges of climate change; rising water demand, energy cost, and customer expectations; underground congestion as it continues to install new technologies; and shrinking manpower pool.

Making Water Smart

Singapore has become a world leader in urban water management because of its integrated, effective, and cost-efficient approach to meeting the nation's water needs with investments in research and technology to treat, recycle and supply water.

As a result, it currently derives more than half of its water supply from unorthodox sources: rainwater collection (20%), recycled water (30%), and desalination (10%). Its long-term plan is to become entirely self-sufficient in water. Singapore is also emerging as a Global Hydrohub, a leading centre for business opportunities and expertise in water technologies.

Here's how Singapore is future-proofing its water management:

1. Diversifying Water Sources: Over the last 50 years, Singapore has built a robust and diversified supply of water known as the "Four National Taps":

a. *Water from Local Catchment:* Since 2011, Singapore has increased its water catchment area from

half to two-thirds of its land surface with the completion of the Marina, Punggol and Serangoon Reservoir. Its target is to widen its water catchment area from two-thirds to 90% of Singapore's land area. It also put up reservoirs in the city, including the iconic Marina Barrage, Singapore's 15th reservoir.

b. *Imported Water.* Under two bilateral agreements, Singapore has been importing water from Johor, Malaysia. The first agreement expired in August 2011. The second agreement will expire in 2061.

c. *NEWater.* This is a high-grade reclaimed water produced from treated used water that is further purified using advanced membrane technologies and ultra-violet disinfection, hence making it ultra-clean and safe to drink. Currently, Singapore has five NEWater plants that can meet up to 40% of the nation's current water needs. By 2060, NEWater is expected to meet up to 55% of Singapore's future water demand. The nation also built a Used Water Superhighway comprised of a 48-kilometer-long used water superhighway called the Deep Tunnel Sewerage System (DTSS) that conveys used water to water reclamation plants to be treated and purified into reclaimed water, or discharged into the sea.

d. *Desalinated Water.* There are currently two desalination plants in Singapore with a combined capacity of 100 mgd. This can meet up to 25% of Singapore's current water demand. The third desalination plant is expected to be completed in Tuas by 2017, and the fourth in Marina East by 2020. Desalinated water is expected to meet up to 30% of Singapore's future water needs by 2060.

2. Conserving Water: Since the 1970s, PUB has been implementing a wide range of water conservation plans to encourage prudent water usage. Programs include a mandatory Water Efficiency Labelling Scheme that helps consumers choose products that use less water, and a Water Efficient Building Certification where businesses and industries are encouraged to certify their buildings, operations and premises. Singapore expects to reduce its per capita domestic water consumption from the current 148 litres per day to 140 litres by 2030.

3. Investing in Smart Technologies: In Singapore, a Smart Water Grid system enables the PUB to supply good water 24/7 to its 1.5 million customers. Under the Grid is a WaterWise Sensor Network comprised of more than 320 sensors installed island-wide in Singapore to constantly monitor the pressure, flow and quality of the water within the network. Sensors also enable PUB to detect water-related incidents such as pipe bursts to avoid water loss and supply disruption. There are also ongoing pilots on a Smart Meters & Home Water Management System that will empower PUB customers with data to monitor their real-time water usage, analyze their consumption patterns, as well as report water-related incidents to the PUB.

Unmanned Aerial Vehicle (UAV) such as this is fitted with multiple advanced sensors and special cameras to check Singapore's tunnels.

4. Engaging the Community: In April 2006, the PUB launched its Active, Beautiful, Clean Waters (ABC Waters) Programme as part of its strategic objective to bring people closer to water so that they can better appreciate and cherish this precious resource. Reservoirs, rivers and canals serve purposes other than their traditional functions of channelling water and water storage. Pockets of community spaces in Singapore now offer a host of recreational options for people to enjoy. More than 100 potential locations have been identified for the program by 2030.

5. Sharing Knowledge: To transform Singapore into a Global Hydrohub, it shares its water management experience and water sustainability solutions to create a vibrant local and global water industry. It welcomes international collaborations to commercialise new products and solutions and offers the city as a test bed for cutting-edge water solutions. To promote research and development in the water sector, the government has set aside an annual R&D budget of S$20 million to aid research initiatives of over 180 water companies and more than 20 research centres in Singapore. It also hosted the Singapore International Water Week as a major global platform for the sharing and co-creation of water solutions between various policy-makers, industry leaders, researchers and academia.

Case Study

How to Be Blue and Green: Take a Page Out of Singapore's Book

How can a densely populated city with limited natural resources become one of the most livable cities on Earth? Singapore says it's all in the master planning.

In just four decades, Singapore has leapfrogged from being a basket case of urbanization to a thriving metropolis.

During the 1950s-1960s, Singapore was a fledgling nation saddled with the challenges of urbanisation: high unemployment, urban slums, poor infrastructure, lack of sanitation, and an unskilled labour force.

Today, the city-state has managed to edge out all its regional rivals in the global rankings on the most liveable cities. It is also among just a handful of high-density cities in the world that have ranked high in the liveability matrix. Given its very limited natural resources and a land area that is just two-thirds the size of neighboring Hong Kong, Singapore is considered an "outlier" among the countries in the list.

How did Singapore achieve this transformation, and what lessons can other cities learn from its experience?

Michael Koh, who is currently a Fellow with the Centre For Liveable Cities, a division of Singapore's Ministry of National Development and previously the Head of Projects and Design at SC Global who oversaw overseas and Singapore development projects, said an integrated and collaborative approach has enabled the city to manage its rapid urban development over the years.

How the City's Innovation Began

When pioneering leaders started to build the city, they did not have a particular framework in mind, or a written set of principles and guidelines. In 2008, the Ministry of National Development and the Ministry of the Environment and Water Resources established the Centre for Liveable Cities (CLC) to distil the tacit knowledge from those that led Singapore's urban planning and governance over the decades.


Park Royal @ Pickering

As a knowledge hub, the CLC also facilitates global knowledge exchange on approaches to making cities liveable and sustainable.
These research outcomes are embodied in a blueprint called the "CLC Liveability Framework."

What Makes Cities Liveable

Based on Singapore's experience, there are three key outcomes that every city must desire to achieve to become liveable:

- Competitive Economy

To spur economic growth, Singapore's urban planners carefully allocated land and facilities for industrial use, transportation networks, water supply, and the provision of sewerage facilities. Policies have also been geared towards making the economy resilient, inclusive, and competitive for sustained development.

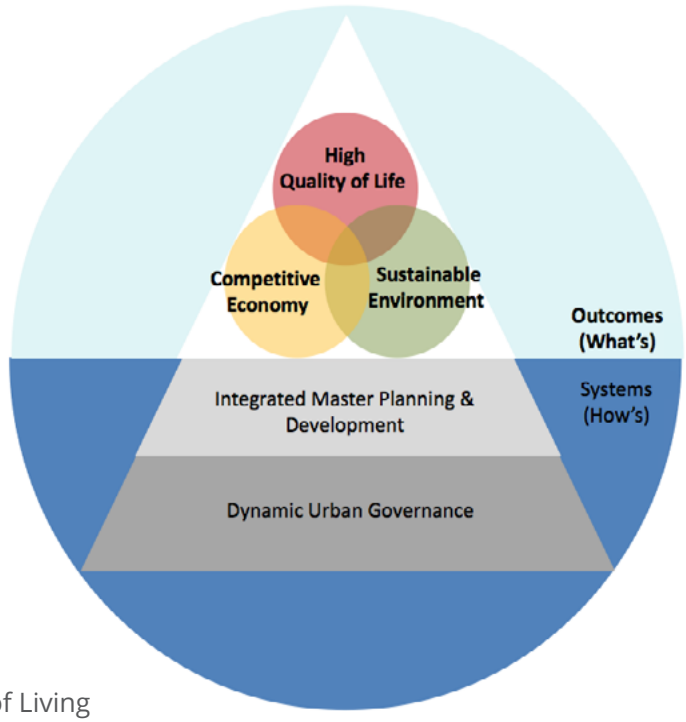
- Sustainable Environment

As early as the 1960s, Singapore already set a vision to become a "Garden City" as a means to distinguish itself from regional peers. It brought environmental protection in line with both economic development and city planning. These early greening efforts has produced a "City in a Garden" that has a green cover of almost 50% despite the nearly doubling of its population between 1986 and 2011.

Singapore's water blueprint (called ABC for Active, Beautiful & Clean Waters Programme) also includes a strategy that calls for the creation of new recreational spaces, the integration of water bodies the urban landscape to bring people closer to nature, and improvement in water quality. Clean technologies are on trial to collect every drop of rainwater, collect every drop of used water, and recycle every drop of water more than once.

- High Quality of Life

In addition to making a conscious decision to keep Singapore blue and green, the government also uses urban systems to make the city more pleasant for its residents. Initiatives include making Singapore a "car-lite" by developing sheltered walkways, putting up car-free zones, and encouraging cycling and pedestrianisation.



Rules in Integrated Master Planning and Development

1. Think long term.
2. Fight productively — consider the overall strategic goals and national interests when ironing out concerns and differences.
3. Build in some flexibility.
4. Execute effectively.
5. Innovate systematically.

For additional information, go to:

- Liveability ranking based on the "Mercer 2016 Quality of Living Survey". *www.mercer.com/newsroom/2016-quality-of-living-survey.html*
- "The CLC Framework." *http://www.clc.gov.sg/documents/publications/urban-solutions/issue1/12_Research&Reports_The_CLC_Framework_for_Liveable_and_Sustainable_Cities.pdf*

Summary

How to Become a 'Smart City' like Singapore

Singapore's roadmap to becoming a 'Smart City' enables it to address the challenges of having a denser, more diverse, and growing urban population in a more strategic way.

By 2025, Singapore envisions to become the world's first "Smart Nation" — bringing data, technology, and people together to address the challenges of having a denser, more diverse, and growing urban population.

Dr. Leong Mun Kew, Deputy Director at the Institute of Systems Science at the National University of Singapore, said the small island-state uses a roadmap — the "Smart Cities Maturity Model" — to guide its journey towards 'smart nationhood.' This is designed to walk cities through the process of becoming 'smart', together with investment and resources required to realize their ambitions.

The model was first developed for the Government of Scotland to help Scottish cities assess their current position on the journey to becoming a 'smart city', create a clear vision and align their strategic priorities, identify the needed investments and adjustments to get them there, and find out potential areas of collaboration with other cities and partners.

Roadblocks to Smart Nationhood

The Republic of Singapore unveiled its 'Smart Nation Initiative' in late 2014 after a digital transformation journey that took more than three decades. The island-state has identified the challenges that it needs to address to transform into a 'smart city':

- Highly dense population: Singapore is one of the world's most densely populated nation, with 80,000 people per square kilometer compared with just 265 people/sq. kms. in the United Kingdom and 35 people/sq. Kms. in the United States;
- Rising elderly population: Expected to triple by 2030 from 300,000 as of 2015;
- Growing demand for hospitals and medical care: Public hospital occupancy rates are at 90% and 11,000 more hospital beds needed by 2020;
- Limited road network: 1 million cars on the road take up 12% of the island's total land area; and

Smart Cities Maturity Model Stages

- Increasing demand for power: Expected to rise to 30% by 2050.

Where Singapore Wants to Be

- Carbon Emissions:
  Reduce to 16% below BAU (business as usual) levels by 2020 with global agreement, and to 7-11% without global agreement;
- Renewable Energy:
  Source 5% of its peak electricity demand from renewable energy by 2020;
- Green Buildings:
  Convert 80% of all buildings to eco-friendly or "green" buildings by 2030;
- Energy Intensity:
  By 2030, improve by 35% from 2005 levels
- Public Transport:
  Increase use to 70% of all journeys by 2030;
- Smart Nation:
  Roll out 1,000 sensors under phase 1 of the Smart Nation Platform

5 Steps to 'Smart Nationhood'

While a mature ICT infrastructure is important to become a 'smart city', it is not a cure-all solution to urban challenges, as Singapore's 'smart city' journey would show. For a city seeking to be 'smart', there are essentially five major components that must be in place before moving forward:

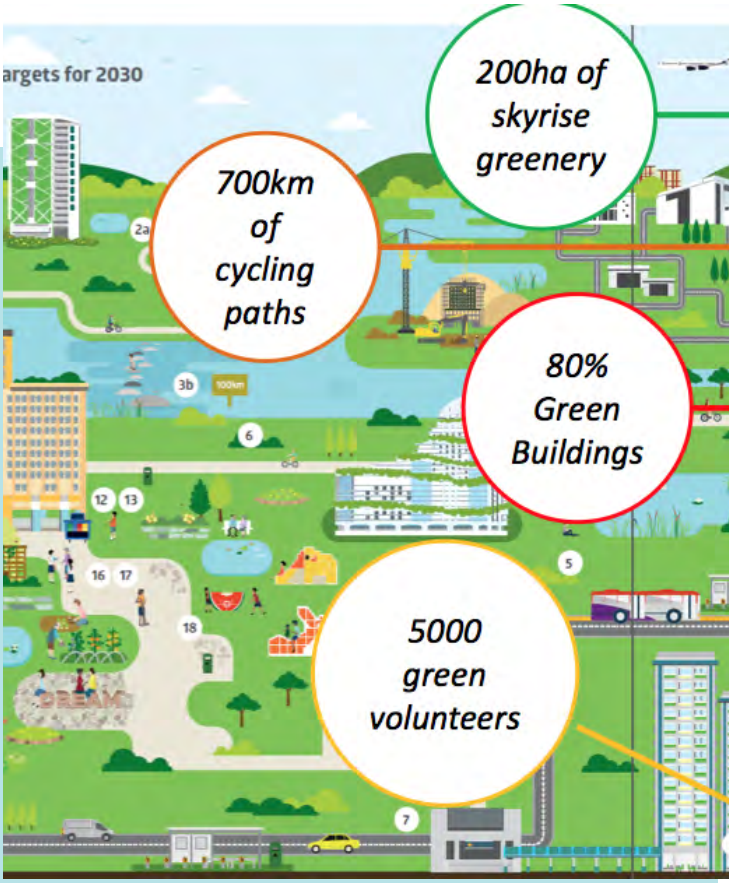
Step 1: Find out your strategic intent for being a 'smart city'.
No one city or country is like, just as not every city will pursue the same goals to become 'smart'. Smart Cities have a clear strategy that focus on delivering outcomes aligned to the city's priorities. A roadmap sets out the kind of investment needed in data and digital technologies that would lead to improved service delivery and partner collaboration.

Step 2: Optimize data assets for better outcomes.
By definition, a 'smart city' is data-driven, and uses a vast array of sensors and information inputs that help planners make informed and better policy decisions, and develop innovative applications and services. Singapore's notion of a smart nation is based on its ability to gather data, interpret it, glean insights, and then translate these into meaningful action. It tasked the Infocomm Development Authority (IDA), its ICT development agency and regulator, to bring about the island-state's vision referred to as "E3A," which means "Connecting Everyone to Everything, Everywhere, all the time."

Using sensors on bus fleets, for example, the Singapore government is able to capture 12 million records on public transport each day and performed data analytics to decongest the streets of Singapore. By identifying where more buses are needed has reduced congestion by around 90% and commuters' wait times on popular routes three to five minutes.

Step 3: Create an ICT infrastructure to improve collaboration.
Before it unveiled its Smart Nation Initiative in 2014, Singapore's various agencies tend to operate in silos, where systems of information, activity and governance are isolated from each other. Breaking down these silos is important so that each agency or department within the city operates with a centralized thought process.

Since 2014, Singapore has embarked on initiatives that extend computerisation and connectivity to the private sector, while also connecting people to the broader world. These programmes brought significant economic benefits and gains in the efficiency of service delivery.



Step 4: Stimulate innovation through governance and leadership.
The Singapore government recognizes that its role is that of a "spark plug" that puts in place appropriate policies and legislations to nurture a culture of experimentation, innovation, and co-creation. It invests in system-wide partnership models that focus on shared outcomes with local universities and colleges to develop technology, and provide venues for developers around the globe to test their innovative solutions to Singapore's urban challenges.

Step 5: Engage stakeholders.
As early as 2011, the island-state has already launched a free and open data portal — Data.gov.sg — where anyone can access datasets on Singapore, ranging from education, environment and health to transport. A new version of the portal in July 2015 goes beyond being a data repository; it now offers data visualisations and data-driven blog posts to make government data relevant and understandable to the public. This is just one example on how Singapore is engaging its citizens and forging multi-stakeholder partnerships that make effective use of digital technologies and address digital inclusion.

Summary

How Data Makes Singapore's 'Smart'

Singapore aims to become the world's first "Smart Nation" by 2025, powered by big data and analytics technologies, and the next-generation sensor networks.

In 2014, the Republic of Singapore announced an ambitious plan to become the world's first "smart nation" by 2025. The success of its "Smart Nation Initiative" heavily rests on Singapore's ability to collect data and generate data insights that will help the island-state address challenges related to having a denser, more diverse, and growing urban population.

Here's a guide to understanding the role of ICT in Singapore's Smart Nation Initiative, as explained by Ms. Serene Ho, a consultant at the Institute of Systems Science at the National University of Singapore who has over 20 years of public sector and ICT experience and driving public sector programs in Singapore.

What is the role of data analytics in Singapore's 'Smart Nation Initiative'?

By definition, a 'smart city' is data-driven, and uses a vast array of sensors and information inputs that help planners make informed and better policy decisions, and develop innovative applications and services.

Singapore's notion of a smart nation is based on its ability to gather data, interpret it, glean insights, and then translate these into meaningful action. The Infocomm Development Authority (IDA), its ICT development agency and regulator, is tasked to transform Singapore into the world's first "smart nation" and bring about a vision referred to as "E3A," which means "Connecting Everyone to Everything, Everywhere, all the time."

In fulfilling its vision, Singapore must ensure complete connectivity which is the basis for revolutionising the way every aspect of its society operates — from healthcare to the environment. This is to achieve its ultimate goal for being a "Smart Nation": to improve the overall quality of life for Singapore's citizens.

How long did it take for Singapore to develop a 'smart' data-driven platform?

It took the Republic of Singapore 36 years to build a strong foundation and plan its information and communications technology (ICT) system. The first national IT plan was formulated in 1980 and focused largely on a national computerisation programme for government agencies. Subsequent programmes concentrated on extending computerisation and connectivity to the private sector, while also connecting people to the broader world. These programmes brought significant economic benefits and gains in the efficiency of service delivery. Since then, several master plans have been implemented to bring Singapore closer to achieving its vision of becoming the world's first "Smart Nation" by 2025.

How does Singapore's 'smart' ecosystem work?

Singapore has a Smart Nation Platform (SNP) built around three focus areas:

- Connect: Provide connectivity to sensors;
- Collect: Through the more than 1,000 sensors being deployed throughout the island, collect data from busy areas such as traffic junctions, bus stops, and taxi queues; and
- Comprehend: The sensors connect to Aggregation Gateway boxes which will then send the data from surveillance cameras or air quality sensors back to government agencies for analysis.

At the heart of the SNP is a Smart Nation Operating System (SN-OS), similar to a computer operating system. The SN-OS connects to Singapore's sub-systems to create a "common picture" for better situational awareness.

What does Singapore do with collected and analyzed data?

The government believes that its primarily role in the Smart Nation Initiative is to put in place the necessary infrastructure, policies, and enablers to encourage innovation. This is why it is actively promoting open data sharing. By releasing data, the government aims to unlock economic value, enable quality research, and deepen public participation and engagement.

As early as 2011, the state has already launched a free and open data portal — Data.gov.sg — where anyone can access datasets on Singapore, ranging

from education, environment and health to transport. A new version of the portal in July 2015 goes beyond being a data repository; it now offers data visualisations and data-driven blog posts to make government data relevant and understandable to the public.

In April 2016, a developer's portal was introduced to provide developers easier access to real-time data from different government agencies via APIs (Application Programming Interfaces). As of January 2017, the one-stop portal provides access to more than 900 high-quality datasets from 70 public agencies. Agencies are now in charge of maintaining their own datasets, which will be fed to Data.gov.sg.

What are some of the data-driven 'Smart Nation' initiatives that Singapore has pioneered?

- 'Virtual Singapore': Unveiled in June 2016, this is an integrated three-dimensional map of Singapore, enriched with layers of data about buildings, land, and the environment that is publicly available and compatible with the SN-OS. It uses advanced Geographic Information System (GIS) technology to generate compelling 'real-world' visualisations of the entire island. This is part of a 'whole-of-government' Smart Nation initiative aimed at improving risk management, facilitating collaboration, and enhancing decision-making among Singapore's public agencies.

- Smart Elderly Monitoring and Alert System (SEMAS): With the use of motion sensors, the system tracks the living habits of the elderly in their homes, and alerts their caregivers via alarms and text messages when irregular patterns appear, such as when there is an unusually long period of inactivity. It also comes with a portable panic button which the elderly can press in times of distress. SEMAS is in trial stage.

- DataMall: This is an open data sharing site that contains a wide variety of transport-related datasets that Singapore's Land Transportation Authority publishes to encourage enterprises, third-party developers, and other members of the public to promote citizen co-creation of innovative and inclusive transport solutions.

- ONE.MOTORING: This comprehensive web portal gives Singapore citizens access to traffic information collected from surveillance cameras installed on roads and taxi vehicles with global positioning system (GPS). Through Traffic Smart, drivers are able to see snapshots of roadways that is taken at every 5-minute interval.
    - e-TrafficScan: This uses taxis equipped with Global Positioning System as probes on the road network to provide motorists with information on the traffic conditions island-wide.

What are the challenges to Singapore's data analytics program?

- Safeguarding data privacy and security
- Finding the best way to share data
- Developing technical standards to ensure seamless connectivity and interoperability
- Combatting cyber security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YEARS
ADB